SIEMENS

SINUMERIK 840C
SIMODRIVE 611-D

Installation Guide **09.2001 Edition**

Installation Instructions

Service Documentation

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SINUMERIK 840C
SIMODRIVE 611-D
Installation Instructions

Installation Guide

SINUMERIK 840C/CE Control Standard/Export Version Software Version	SIMODRIVE 611-D Drive Software Version
1.x	
2.x	
3.x	1.x
4.x	2.x
5.x	3.x
6.x	4.x

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SINUMERIK® documentation

Printing history

Brief details of this edition and previous editions are listed below.

The status of each edition is shown by the code in the ”Remarks” column.

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This manual is included in the documentation available on CD-ROM (**DOCONCD**)

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Other functions not described in this documentation might be executable in the control. This does not, however, represent an obligation to supply such functions with a new control or when servicing.

We have checked that the contents of this publication agree with the hardware and software described herein. The information given in this publication is reviewed at regular intervals and any corrections that might be necessary are made in the subsequent printings. Suggestions for improvement are welcome at all times.

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Preliminary Remarks

Notes for the reader

This manual is intended for manufacturers of machine tools who use SINUMERIK 840C.

The "Installation Instructions" discuss the installation and start-up procedures, from installation of the system through the testing of the most important functions.

The SINUMERIK 840C Installation Guide is divided into two separate manuals:

- 840C Installation Instructions
- 840C Installation Lists

The supplementary manual, which is entitled "SINUMERIK 840, Installation Lists", provides additional aids in the form of lists and detailed information on NC and PLC machine data and setting data, as well as lists of control and programmer alarms.

The **manufacturer documentation** for the **SINUMERIK 840C** control is divided into the following parts:

- Interface
  Part 1: Signals
  Part 2: Connection Conditions
- Planning Guide PLC 135 WB**/**WB2**/**WD
- Function Macros
- Function Blocks
  Package 0: Basic Functions
  Package 1: Tool Management
  Package 4**/**5: Computer Link
  Package 7: Code Carrier
  Package 8: PLC-controlled Data Input/Output

Additional SINUMERIK publications which are valid for all SINUMERIK controls may also be consulted (e.g. Universal Interface, Measuring Cycles, CL800 Cycle Language).

Please contact your local SIEMENS office for further details.

Technical notes

A new Installation Guide is required for each new software version. Old Installation Guides can be used only in part for new software versions.

As from software version 4, please refer to the Installation Lists manual for a description of the alarms (Monitoring section).
This manual is valid for software versions 1, 2, 3, 4, 5 and 6.
As from software version 3, the data relevant to SIMODRIVE 611-D is also provided.

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Safety notes

	DANGER This warning notice means that loss of life, severe personal injury or substantial material damage **will** result if the appropriate precautions are not taken.

	WARNING This warning notice means that loss of life, severe personal injury or substantial material damage **can** result if the appropriate precautions are not taken.

	CAUTION This warning notice (with warning triangle) means that a minor personal injury **can** result if the appropriate precautions are not taken.

	CAUTION This warning notice (without warning triangle) means that a material damage **can** result if the appropriate precautions are not taken.

	NOTICE This warning notice means that an undesired event or an undesired state **can** result if the appropriate notices are not observed.

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1 Prerequisites and Visual Inspection

1.1 Prerequisites

The following prerequisites must be fulfilled prior to initial start-up:

- Electrical and mechanical installation of the machine must have been completed and the axes prepared for operation.

  The following points must be confirmed by the customer!
- Customer PLC program operational and pretested.
- Measuring system installed and wired as far as SINUMERIK.
- Cables connected to the machine. Cable shields run to the control neutral point as per Interface Description. Flexible earth wires installed. Earthing concept observed (inspect carefully!).
- Customer personnel support for work on the interface unit, work on the machine, machine operation and customer produced PLC program.

  Recommendation:

  Prelimit travel ranges (greater clearance distances) by displacing the end stop (EMERGENCY STOP cam).
- The specified machine data is available.
- Data carriers are available for checking machine specific functions.

1.2 Visual inspection

General remarks:

Refer to the "EMC Guidelines", Order No. 6FC 3987-7DB

These guidelines provide the following information:

- Why are EMC guidelines necessary?
- What external interference sources affect the control?
- How can interference be prevented?
- Practical examples for an interference free installation.
- How should electronically endangered components (EEC) be handled?
- How can an EMC problem be rectified?
- What standards are relevant to EMC?

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1.2.1 Information on module handling

- Synthetic or rubber soling, and in particular flooring and carpeting, may produce static charges of several kilovolts in human beings. Integrated circuits are sensitive to this kind of high voltage discharge.
- Electrostatic charging can cause damage even when the control is switched off. Short-circuiting across the VCC RAM printed conductors, for instance, can corrupt the data stored in the battery backed CMOS RAM chips or even cause the printed conductors to burn out.
- The safety measures listed below must therefore be carefully observed in order to avoid damage caused by improper handling.
- Never touch the printed conductors or components without first discharging on a grounded system part.
- Remove or insert modules and power supply cables only when the control is switched off.

  Note:

  If modules have to be replaced or should a malfunction occur, always make sure that all ICs are inserted properly and in the right place.

Special instructions regarding the handling of modules equipped with MOS chips:

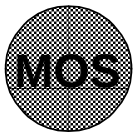
MOS is a technology used to produce LSI digital circuits. "MOS" stands for Metal Oxide Semiconductor.

The principle advantages of MOS technology are:

- Simple transistor design
- High component density
- Extremely low power consumption

There are special safety regulations for modules equipped with MOS chips. These modules are thus specially marked:

Identification on packaging:



Caution! Observe safety regulations!

MOS

Identification on the PCB:

M
O
S

The printed circuit board is fitted with MOS chips. To prevent these chips from being irreparably damaged, equipotential bonding must be ensured prior to installing the PCB. Remove the PCB together with the conductive foam plastic from the packaging and touch a part of the system that has been grounded.
Do not touch the printed conductors or components!

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Additional instructions:

- Do not open the special packaging unnecessarily.
- Do not bring into contact with synthetic materials (possibility of static charging).
- Disconnect the power supply prior to insertion and removal.

1.2.2 Grounding system

Proper grounding to divert external interference is vital to trouble-free operation. It must be ensured that the ground wires are not looped and have the required cross section.

Grounding concept

- The grounding system fulfils the requirements of the DIN VDE 0160 standard.
- The grounding concept for NC, PC, drives and machines is uniform.
- The ground connections are run in star configuration to a central mass point.
- The equipotential bonding strip is used for equipotential bonding of the external components.
- PE terminal.

Refer to the instruction manual for an example of the grounding concept for SINUMERIK 840.

1.2.3 Position encoders

Particular attention is to be paid to the prescribed installation of the graduated scales (air gap, etc.) and the pulse generators (coupling) (also see Heidenhain installation and adjustment instructions).

Check to make sure that the connectors are correctly wired and properly inserted.

If the customer has inserted plug/socket connectors in the measuring-circuit cables, a careful check must be made to ensure connection, strain relief and above all observance of the prescribed shielding.

The use of position encoders from other manufacturers may result in inaccuracy and surface quality problems beyond our control.

1.2.4 Cable laying

Power cables and control cables should be laid separately whenever possible. Do not produce ground loops, as such loops or non-regulation grounding may generate ripple voltage which would affect the speed controller setpoint. Smooth running of the motor at minimum speeds is then no longer guaranteed.

Care must be taken that the cables are run properly and that they are rolled carefully on the cable drum. Avoid kinking. Observe the permissible bend radii.

(Please refer to the Interface Description, Part 2, for information on connecting the cables.)

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1.2.5 Cables

Check all cables in accordance with the cable and equipment overview (refer to Interface Description, Part 2). This applies particularly to cables made up by the customer.

A random check should be made on at least one connector. Particular attention should be paid to elastomeric connections.

In the event of failure to comply with our guidelines, the relevant dealer must be notified and any necessary corrective measures instigated.

1.2.6 Shielding

The overall shields of all cables running to or from the control must be grounded at the control via the connectors (refer to Interface Description, Part 2). Only SINUMERIK connectors may be used, as other connectors cause interference problems.

1.2.7 Interference suppression

All d.c. and a.c. relays must be interference-suppressed using suitable means, as must a.c. or three-phase motors (e.g. lubricating pumps and the like). Observance of the prescribed measures for interference suppression should be checked on a random basis (also refer to the Instruction Manual).

1.2.8 Operator panel

Check to make sure that pushbuttons, keys, lamps, symbols and display are operational.

1.2.9 Overall state

Check the module mounts and blanking plates.

Make sure that the front panel screws have been tightened (ground connection).

Check to see that the accessory pack is complete.

The accessory pack must contain the following:

- Log book
- Complete parts list (the parts list is included with the original delivery note and must be inserted in the log book)
- Transparent cover plates and symbol overlays for keys
- Instruction manual

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1.2.10 Jumpering

The jumper configurations on the modules required at the time of installation and start-up is discussed in Part 2 of the Interface Description.

1.2.11 Position control, input and measuring system resolution

In SINUMERIK, position control resolution and input resolution can be entered separately. In order to maintain a closed position control loop, however, it is necessary to coordinate the pulses from the digital measuring system with the control's precision capability.

The "unit (MS)" is used as unit of measurement for the position control resolution, the "unit (IS)" as unit of measurement for the input resolution.

The following applies:

1 unit (MS) = 2 units of position control resolution
1 unit (IS) = 1 unit of input resolution

Example:

If the position control resolution is 0.0005 mm and the input resolution is 0.001 mm, then
1 unit (IS) = 1 unit (MS) = 1 µm

Refer to NC MD 5002, NC MD 1800*, NC MD 524* for details on input, position control and display resolution.

1.2.12 Input units

Unit (MS) = 2 units of position control resolution (reference system MS)

e.g. 1 unit of position control resolution = 1/2 µm (MD 1800* = xxxx0100)
x..is irrelevant here

1 unit (MS) = 1 µm

Unit (IS) = 1 unit of input resolution (reference system IS)

e.g. 1 unit of input resolution = 1 µm (MD 5002 = 0100xxxx)

1 unit (IS) = 1 µm

VELO ...smallest unit used by the digital-analog converter (DAC) for setpoint conversion

In the case of a 14 bit DAC: $1\ \text{VELO} = \frac{10}{8192} = 1.22\ \text{mV}$

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1.3 Standard/Export version

Export regulations

Due to the fact that the German export list requires approval for certain control functions, two versions of the SINUMERIK 840C can be configured.

The Standard Version (840C) is allowed to include the whole scope of functions of the control and is therefore subject to export approval concerning its **type**.

The following options are not available with the Export Version (840CE):

– 5D interpolation
– interpolation and compensation with tables and extended IKA, with SW 4 or higher

The corresponding option bits can be set but have no effect (alarm triggered if functions are programmed). As far as its **type** is concerned, the export version does not require export approval.

It is however possible that the intended **application** nevertheless requires export approval.

The character of the control depends on the installed system software, which can be delivered in the two versions Standard and Export. This also applies to the licences! Consequently, a control system requires export approval if a system software subject to export approval is installed on it (see specifications on delivery note or invoice of system software). This is of particular importance if the system software is changed or upgraded because the control can then become subject to export approval.

Identification of control

In addition to the specifications on the delivery note and the invoice, unambiguous labels identify the delivered software components as Standard or Export versions.
The package contains additional labels for identifying the control after installation.
If the software is loaded the first time when the control is installed, the included small label for the system software version has to be attached to the front plate of the MMC module in such a way that is is clearly visible (applies also to licence software).
The package label for the system software version, which is also included, is to be put into the logbook of the control. If new licences are supplied the corresponding number of labels is included, and they are to be dealt with in the same way.

After the control has been powered up, the Export version is identified by the additional character ”E” in the Service screen (NC information).

These measures for identification of the control version are important for servicing, and they are also useful if the version of the control must be proved for export purposes, in particular if existing negative certificates concerning the export version are to be used.

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1.4 Installation Checklist 840C

F-No. . . . . .

Installation sequence

Section 1 of the Installation Guide, Interface Description Part 2, and the information presented in the Instruction Manual must be carefully observed!

Copy the installation checklist, fill it out, and enclose it in the log book after installation.

Make a cross next to Yes or No after each section has been completed.

Enter all required values where stated.

Information relating to the individual sections is provided in the Installation Guide.

First installation

Name . . . . . Office . . . . . Date . . . . . .

Manufacturer . . . . . Address . . . . . .

Second installation

Name . . . . . Office . . . . . Date . . . . . .

Customer . . . . . Address . . . . . .

1. Are the prerequisites for installation per Section 1 fulfilled? Yes ☐ No ☐

2. Visual inspection: Mains connection, EMERGENCY STOP, grounding concept, grounding of the position encoders, cabling, shielding, external machine control panel, input/output modules, overall state OK? Yes ☐ No ☐

3. Version of the control software:
   NCK . . . . . .
   MMC . . . . . .
   PLC . . . . . .
   INT-DMP . . . . . .
   WOP-M/T . . . . . .
   SIMULATION-M . . . . . .
   S5/MT on MMC . . . . . .

4. Voltage test:

Power supply unit in the central controller	230 V AC (90...260 V), 50/60 Hz (45...65 Hz). 24 DC (20...30 V)
Monitor	230 V AC (90...260 V), 50/60 Hz (45...65 Hz).
Operator panel	230 V AC/24 V DC

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5. Standard installation completed and customer specific machine data entered? Yes ☐ No ☐

6. PLC program entered and tested (safety functions)? Yes ☐ No ☐

7. Position control loops of axes installed and the following checked: Axis speeds **/** tachogenerator compensation **/** multigain **/** servo gain (K_V factor) **/** acceleration **/** exact positioning **/** position control loop monitors **/** analog spindle speed **/** spindle positioning **/** traversing ranges? Yes ☐ No ☐

8. All conventional functions tested? Yes ☐ No ☐
   (10 mm programmed = 10 mm on machine) Yes ☐ No ☐
   Function test performed with test program (by customer)? Yes ☐ No ☐

9. Were backup copies made of the following data: Yes ☐ No ☐

- Drive machine data (611D) Yes ☐ No ☐
- NC machine data Yes ☐ No ☐
- QEC data Yes ☐ No ☐
- PLC machine data Yes ☐ No ☐
- WOP data Yes ☐ No ☐
- Cycle machine data Yes ☐ No ☐
- Cycle setting data Yes ☐ No ☐
- NC setting data Yes ☐ No ☐
- IKA data **/** ELG data Yes ☐ No ☐
- R parameters Yes ☐ No ☐
- Interface setting on MMC-CPU for customer devices Yes ☐ No ☐
- UMS (as source floppy!) Yes ☐ No ☐
- PLC user program + data blocks Yes ☐ No ☐
- Were these data deposited at the machine? Yes ☐ No ☐
- Have the stickers for the installed system software been stuck on the hardware and in the log book as specified in Section 1.3, Standard**/**Export version? Yes ☐ No ☐
- Installation checklist completely filled out (including options), inserted in the log book and deposited at the control? Yes ☐ No ☐
- Were the following functions explained to the customer:
- Drift compensation, reference point adjustment Yes ☐ No ☐
- Did the customer sign the installation report? Yes ☐ No ☐
- All data saved on HD of MMC-CPU and backup of HD Yes ☐ No ☐

Signatures

First installation **Second installation**

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1.5 Voltage and functional tests

1.5.1 Self-test and system start-up

NC area

The checksum of the system program memory is generated whenever the control is switched on (Power On routines) and during cyclic operation. The control flags discrepancies between reference and actual checksum in different ways.

The NC CPU flashes continuously (red LED) and goes into the stop state.

MMC area:

If the tests are carried out without any interruptions, the following messages appear in the MMC area on the screen:

386 Modular BIOS v3.05acf, MR0 1.45 *
Copyright (c)1984-90 Award Software Inc.
(c)1991-92 SIEMENS AG ERLANGEN

TESTING INTERRUPT CONTROLLER #1		PASS
TESTING INTERRUPT CONTROLLER #2		PASS
TESTING CMOS BATTERY		PASS
TESTING CMOS CHECKSUM		PASS
TESTING EXTENDED CHECKSUM		PASS
SIZING SYSTEM MEMORY	640K	FOUND
TESTING SYSTEM MEMORY		PASS
CHECKING UNEXPECTED INTERRUPTS AND STUCK NMI		PASS
TESTING PROTECTED MODE		PASS
SIZING EXTENDED MEMORY	3072K	FOUND
TESTING MEMORY IN PROTECTED MODE	3072K	PASS
TESTING PROCESSOR EXCEPTION INTERRUPTS		PASS
BIOS SHADOW RAM		ENABLED
VIDEO SHADOW RAM		ENABLED

Powering up

Hard-disk check (as from SW 4)

During booting from the MMC area, the consistency of the hard disk is checked. This check is time-dependent and is performed once every week. In this context, it is important to note that free disk space can be reduced due to **lost clusters** resulting from frequent switching on and off the control. It is only by means of a hard-disk check that this disk space can once again be made available. For this reason, a hard-disk check is also initiated if the remaining available disk space drops to less than 1 MB.

The setting for the hard-disk check is possible only in the **Service Mode** and can be carried out by the system service only.

---

* *BIOS version*

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File system check (SOFTWARE 4.4 and higher)

Messages during the file system check:

The previous message

Checking file system COMPLETE

is replaced by the following:

- During the file system check:

  Verifying file system: Pass 1 COMPLETE
  Verifying file system: Pass 2 COMPLETE
  Verifying file system: Pass 3 COMPLETE

- If the WOP work file has to be recreated, the following message also appears:

  Creating WOP working file ...

The following messages are output if an error occurs:

- If the file system cannot be restored

  ERROR in file system: can't fix

- If the WOP work file cannot be created:

  ERROR on WOP working file: can't create

After these error messages, the previous message

Can't start MMC - REBOOTING

appears.

Then the system branches to DOS.

Selection menu "SETUP/CONFIGURE OPTIONS"

The following entry has been added to the menu (so that the WOP working file can also be created via menu):

Create WOP working file

The menu is now structured as follows:

Please select:

1 Setup WOP option
2 Create WOP working file
3 Set streamer type
4 Setup disk check
5 Return to main menu

Enter a number [1-5]:

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1.6 Loading data into the NCK on starting up the control (as from SW 2)

After the control has been switched on, data are transmitted from the hard disk of the MMC into the memory of the NCK-CPU in 3 phases:

Phase 1: The system program of the NC-CPU is booted if

- the NC-CPU (using the Boot-EPROM) detects that the system program has been lost in the DRAM (the program memory ist not buffered by a battery)
- a preceding boot process has been aborted by PO or mains off
- user operations have initiated forced booting
- the NCK operating system has detected a system error **before** mains off (or PO reset) and is consequently no longer able to maintain data consistency (alarm: start-up due to system error)

In this phase the "NCK system being loaded" message is displayed. The user cannot influence this loading process.

Phase 2: Booting of user data which become effective after PO and are in the volatile memory (DRAM).

After phase 1 the NC branches into the booted system program and requests the following data from the MMC:

- the UMS (unless a customer UMS has been installed and activated, the SIEMENS standard UMS is loaded) if the UMS size has been set to 0 (memory configuration as from SW 4)
- all user data records which were found in the data management tree under user/NC data in the user branch.
  Data records of the IKA*, etc. type are recognized and loaded.

  If IKA is used, it is recommended to use this branch for storing the IKA 2 and IKA 3 data records which are used for machine fault compensation (use the Services area for copying).

In this phase the message "NCK user data being loaded" is again displayed.

After booting these user data records, the NC initiates a communication bus reset and runs its initialisation programs (e.g. preparation and calculation of IKA data records) and subsequently reports NC-RDY provided SIMODRIVE 611 D is switched on.

TEA 1, 2, 3, 4 are not loaded during start-up!

Phase 3: Now any data stored in the standard workpiece are loaded into the NCK.

Note:

The following data are booted:
as from SW 2, NCK data
as from SW 3, NCK and PLC data
as from SW 4, NCK, PLC and drive data (611D)

END OF SECTION

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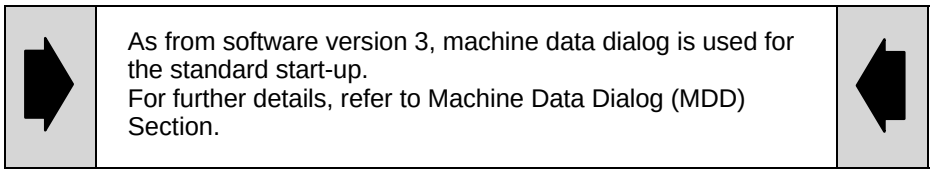
2 General Reset and Standard Start-Up



As from software version 3, machine data dialog is used for the standard start-up.
For further details, refer to Machine Data Dialog (MDD) Section.

2.1 First installation and start-up of control (as from SW 3)

Hardware

The central units of the SINUMERIK 840C are designed in a modular way. For system configuration, structure, slots, frame assignment, wiring diagrams, interface assignment and I/O interfaces, please refer to the Interface Description, Part 2 (NS 2).

Do not use other than the specified types of cable for connecting the components according to the wiring overview (NS 2).

Software

The standard version of the MMC CPU is programmed with the following standard software:

DR DOS V6.0
VALITEK SW + INSTALLATIONSTOOLS

The system software can be read in from magnetic tape.

Further optional software can be ordered either preinstalled or on cartridges.

For further information, please refer to the Catalog.

2.1.1 Erasing the S-RAM area of the NCK (as from SW 6)

General notes

In order to obtain a defined initial state when installing/upgrading the control you must erase the S–RAM of the NCK–CPU. In this way you will avoid errors caused by incorrectly initialized data.

Explanation

The S–RAM of the NCK–CPU contains data that must be stored permanently in the control, even after it has been switched off. These are user data (machine data, R parameters, tool data ...) and internal data.

Pressing the softkey ”Format user data” on starting up the control only initializes the user data, the other r areas remain partially undefined which can result in sporadic errors.

In SW 6 and higher, the S–RAM of the NCK–CPU is **automatically** deleted when you update the software or when the CSB battery fails, thus providing a defined initial state.

On initial start–up of the control after the software has been updated, alarm 10 ”Start–up after software update” is displayed and the control powers up in start–up mode. You **must** then perform a start–up of the control.

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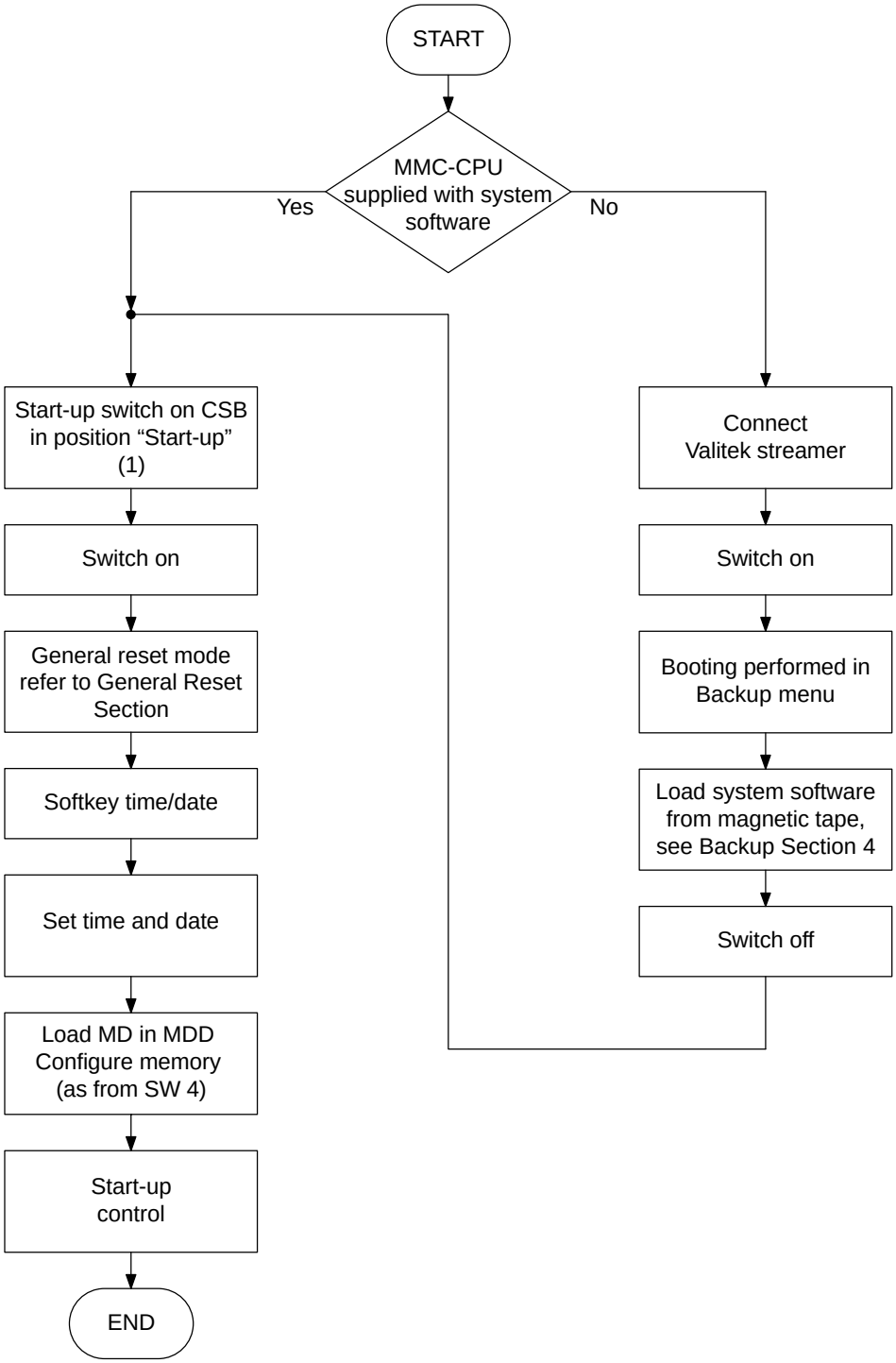
2.2 Standard installation and start-up as flowchart (as from SW 3)

Default values can be used for data in general reset mode during initial installation or after a loss of data caused by, for example, removal of a module, hardware defect of a module or empty back-up battery in the case of power failure.



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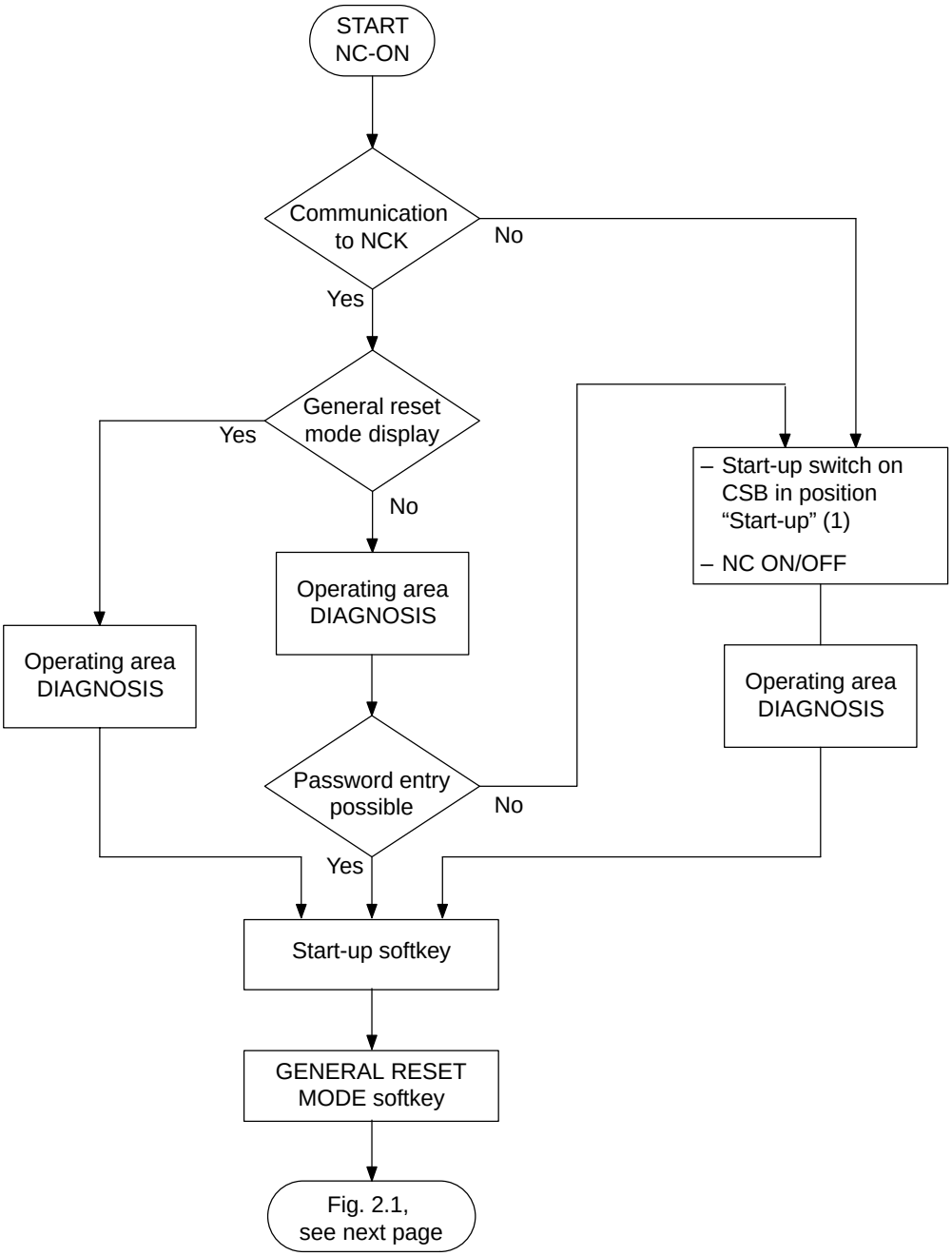
2.3 Select general reset mode (as from SW 3)



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2.4 General reset (as from SW 3)

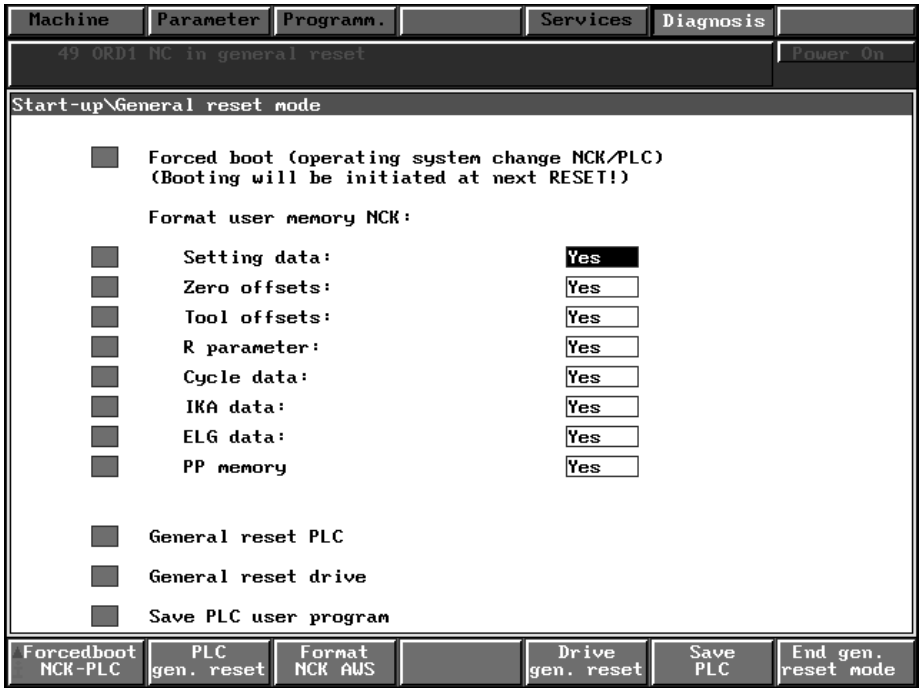

Fig. 2.1

The DIAGNOSIS, START-UP and GENERAL RESET MODE softkeys are used for selecting the GENERAL RESET MODE basic display.

Functions in GENERAL RESET MODE

FORCEDBOOT NCK-PLC

Required only for changing operating system of NC and PLC. This softkey initiates an identifier for NCK and PLC which results in subsequent booting.

CAUTION! Booting is started automatically after the next POWER ON-RESET (e.g. END GENERAL RESET MODE). Then a general reset of the NCK and the PLC is to be carried out.

PLC GEN. RESET

The PLC user memory is deleted and any existing user program is copied from the hard disk to the PLC. If the PLC is to be cleared, the ANW_PROG program must previously be deleted on the hard disk. More than one PLC program can be managed under SERVICES, however, ANW_PROG is the only program to be loaded in the PLC during general reset.

The cursor keys are used for selecting the toggle fields.

The selection key is used for selecting the objects to be deleted.

FORMAT NCK AWS

Formats the user memory of the NCK. The data areas to be formatted can be selected individually by means of the YES/NO toggle fields. The default setting is “YES”.

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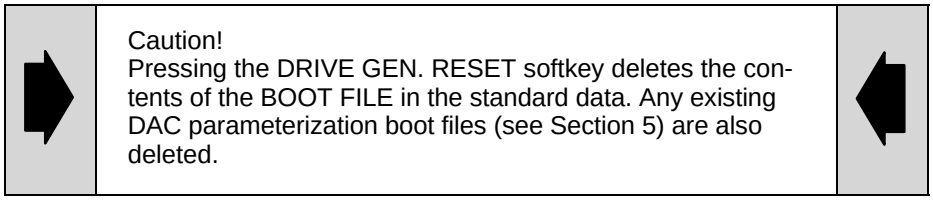
DRIVE GEN. RESET

The configuration file for digital drives is deleted on the hard disk. This function has no effect on analog drives.



Caution!
Pressing the DRIVE GEN. RESET softkey deletes the contents of the BOOT FILE in the standard data. Any existing DAC parameterization boot files (see Section 5) are also deleted.

SAVE PLC

The user program currently in the PLC is copied onto the hard disk as ANW_PROG file.

If the software is to be upgraded, this function must be executed before a forced boot.

END GENERL RESET MODE

Terminates general reset mode. This function triggers a POWER-ON-RESET.

CAUTION! It is also possible to use the RECALL key for leaving the general reset screen, but then no mode switchover is involved. The control consequently remains in general reset mode (operating the machine, for example, is not possible).

Note

- The PLC-MDs are not valid until general reset mode has been terminated.
- As from SW 4, the drives are booted.
- Take into account flexible memory configuration function.

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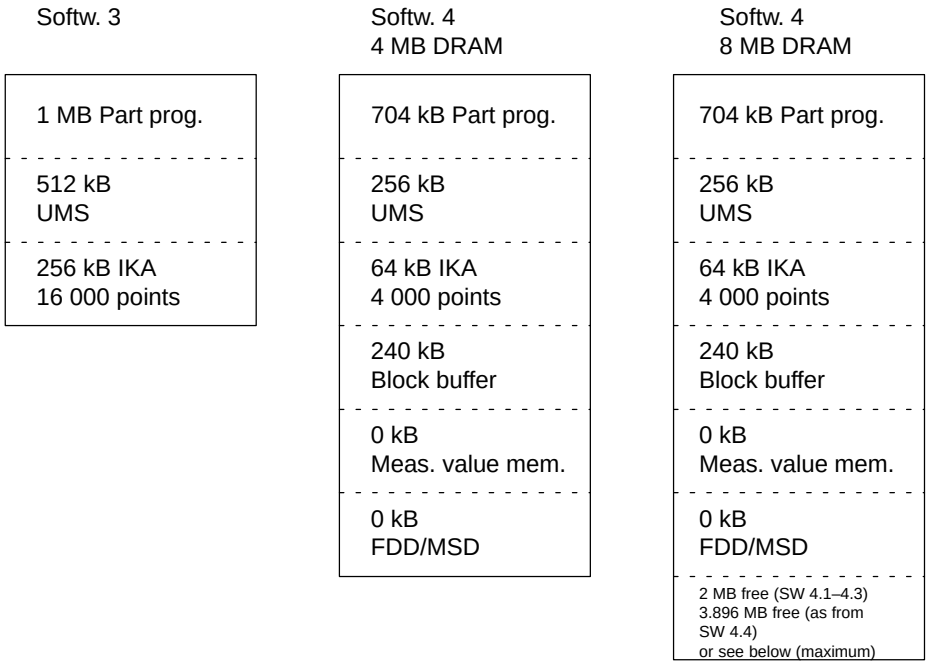
2.5 Memory configuration (as from SW 3)

Standard values for DRAM



Setting ranges for DRAM

Note: The ranges cannot be set in software version 3.

	SW 4.1 – 4.3	As from SW 4.4	As from SW 5.4
Part programs	32 kB to 2 760 kB	32 kB to 4 920 kB	
UMS	0 to 1 024 kB	0 to 2 760 kB [1]	
IKA	0 to 1 024 kB 0 to 65 535 points	0 to 1 024 kB 0 to 65 535 points	
FDD/MSD	0 or 194/388 kB	0 or 194/388 kB	
Block buffer	0 to 2 760 kB 0 to approx. 1 800 buffers	0 to 5 026 kB 0 to approx. 3 450 buffers	
Measured value memory	0 to 2 760 kB 0 to 700 000 meas. values	0 to 2 760 kB 0 to 700 000 meas. values	
Number of real axes			Axes 15 to 30 — 16 kB each
Data for extended overstore			Axes 1 to 6 — 49 kB each
Number of measured value buffers			Axes 1 to 30 — 4 byte each

Maximum
1 264 kB with 4 MB DRAM
3 264 kB with 8 MB DRAM SW 4.1–4.3
5 160 kB with 8 MB DRAM as from SW 4.4

Note as from SW 4: For UMS at least the memory capacity specified by the WS 800 configuration station must be entered (not the length of the UMS file transferred).

1) WS 800 can up to 1024

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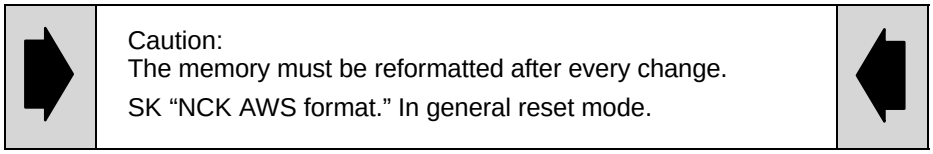
Setting ranges for SRAM

Default values	Setting ranges
Tool offsets 32 kB	0 to 1 638 tools 0 to 64 kB
R parameters 19 kB	Channel: 0 to 700 parameters Central: 700 to 9 999 parameters 0 to 64 kB
Free 13 kB	

64 kB are available for tool offsets and R parameters.



Caution:
The memory must be reformatted after every change.

SK “NCK AWS format.” In general reset mode.

Changing the memory configuration

The operating sequence “Changing the memory configuration” (see below) must be performed if the size of any of the following memories changes:

- FDD/MSD for digital drives
- UMS memory
- PP memory
- IKA (see Sect. 12: Interpolation and compensation with tables and temperature compensation)
- Block buffer (see Sect. 12: FIFO/predecoding)
- Measured value memory (see Sect. 12: Extended measuring)

Inputs

Procedure for changing the memory configuration

Step	Operation
1	Select general reset mode in the operating area diagnostics.
2	Selection of the file function: SK machine data/SK NC-MD/key ETC/ SK memory config./SK file function
3	Copy the file “NCMEMCFG” from the Siemens branch to the user branch with SK “Preset” **Caution!** If the file “NCMEMCFG” is already in the user branch it is overwritten with the default values.
4	Make the necessary settings in the file “NCMEMCFG” by editing the user file.
5	Press SK “Reconfig. memory”. The settings are transferred to the NC-MD and the memory is reconfigured.
6	Reconfigure NCK user memory if the setting has been changed for the SRAM. SK “Format NCK AWS”. Press initial clear in the display.
7	Deselect general reset mode
8	The values set can be checked in NC-MD 60000 to 62029.
9	Save the file “NCMEMCFG” from directory NC/data with PC format.

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2.6 Loading machine data (as from SW 3)

Note Loading the machine data function takes several seconds and is accompanied by the flashing message “Wait”.

Selection The following softkeys must be pressed: Diagnosis, Startup, Machine data, File functions:

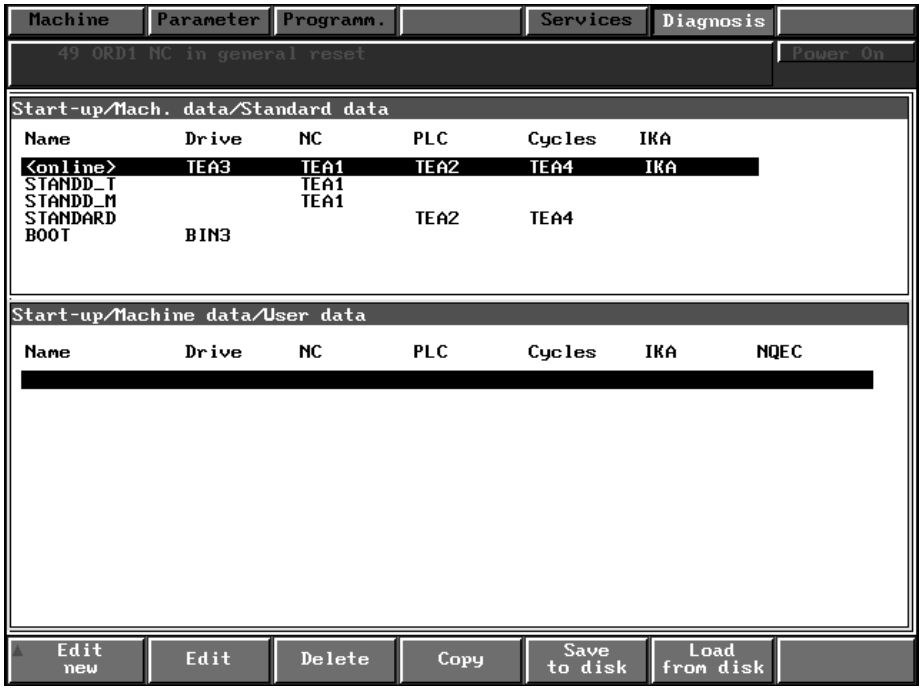
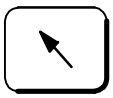


Fig. 2.2

Procedure

Step	Operation	Comment	
1	Activate the standard data window with the  key	The window has a yellow border	
2	Select STANDD_T or STANDD_M	NC-MD	The MD in the NCK area are cleared and assigned standard values
3	SK Load from disk		
4	Select STANDARD	PLC MD, cycl. MD	
5	SK Load from disk		

Initial start-up On initial start-up (state as supplied from Siemens), no files are available in the “User data” window(see Fig.).

Subsequent start-up On subsequent start-up, user files from the “User data” window can be loaded instead of the files STANDD_T, STANDD_M, STANDARD in the “Standard data” window.

Make sure that no communication is taking place with the digital drive systems. If the user file contains drive data (TEA3), you must acknowledge the drive-specific

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error messages that occur during the **Load from disk** function. On ending general reset mode, load the drive data (under file functions drive configuration) or the complete file (under file functions machine configuration) again.

Info key

You can obtain a summary of the procedure described above in the **General reset mode** display if you press the **Info key**.

End of standard start-up

With the following steps you can terminate standard start-up.

Step	Description
1	Enter the area **General reset mode** using the **Recall key** and the **General reset mode** softkey. There you can execute the functions **PLC initial clear**, **Format NCK AWS** and, possibly, **Drive gen. reset** (for digital drive systems only).
2	Deselection of General reset mode (see also the flow diagram below). Set the switch on the CSB module to 0. Now press the softkey **End gen. reset mode** and you have performed the standard start-up and prepared the further start-up steps.

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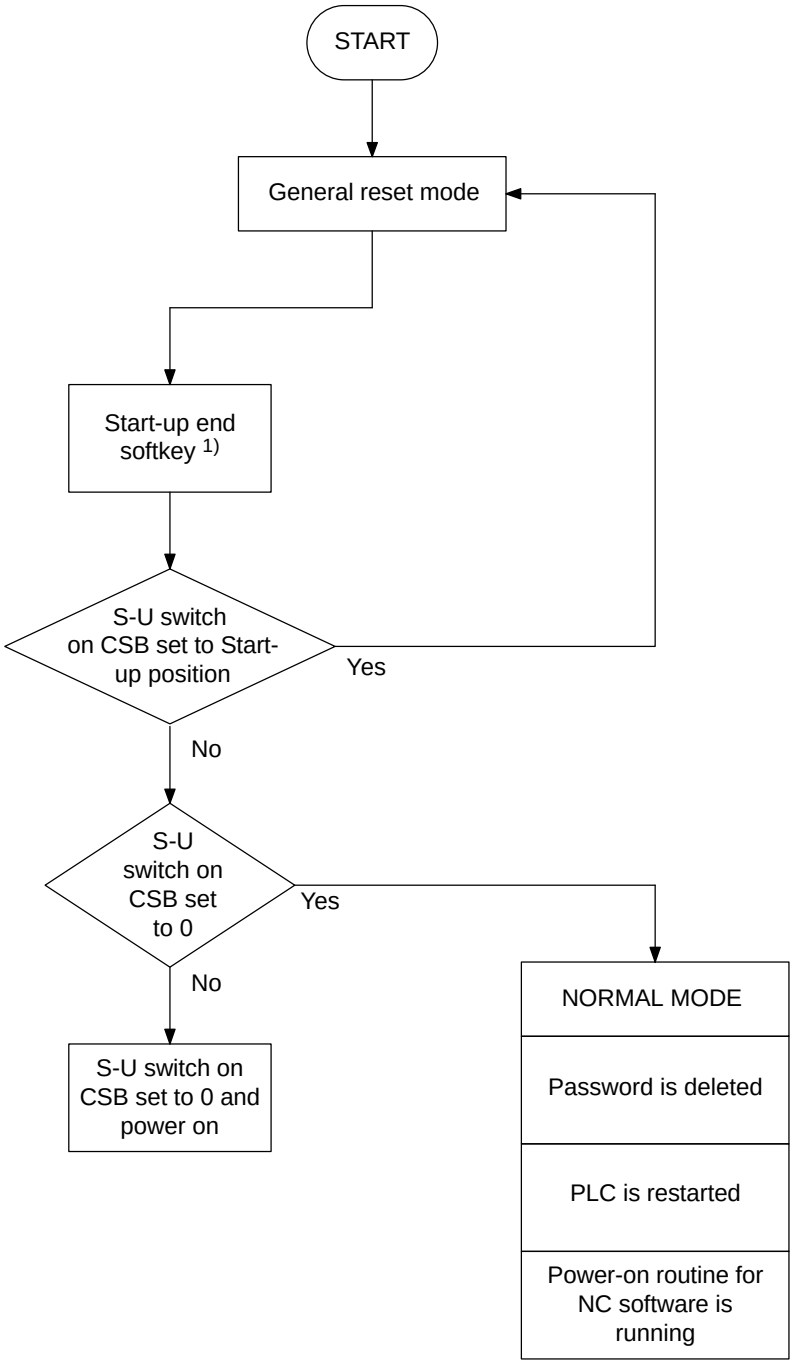
2.7 Deselect general reset mode



1) in SW 3 softkey end of GENERAL RESET

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2.8 Standard installation short version (up to SW 2)

As from software version 3, machine data dialog is used for standard installation and start-up.
See Machine Data Dialog Section (MDD).

Operation

The following sequence must be followed for standard SINUMERIK 840C installation and start-up:

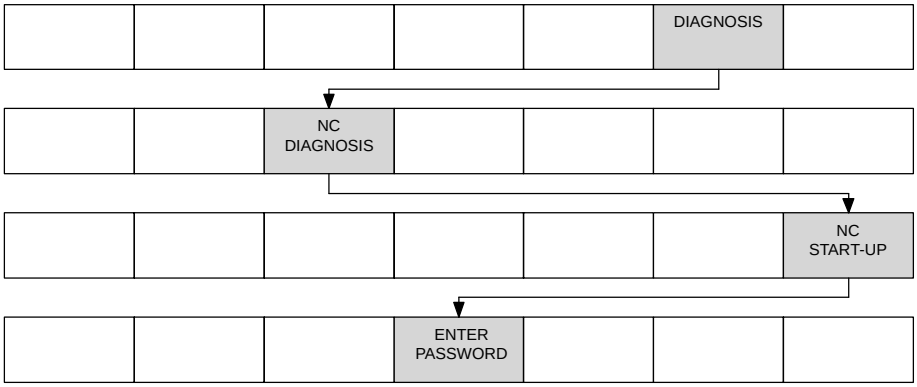
1. The control and the external components must be connected as described in the SINUMERIK 840C Interface Description.
2. Cabling and electrical operating conditions must be checked as defined in the Interface Description, Part 2.
3. Observe Section 1 of the Installation Guide carefully.
4. Installation of the axes and spindles, including the speed controller.
5. Servo disable set at the hardware level for all axes and spindles.
6. All input/output modules and handwheels connected.
7. NC MD and PLC MD entered.
8. All data, in particular NC MD and PLC MD, must be checked for validity.
9. Enclose the installation checklist in the completed log book.

Password

Data and files are protected against unauthorized access with the password.

The MMC and NCK areas are each protected with their own password.

Selecting a password in the NCK area



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When the softkeys, DIAGNOSIS, NC DIAGNOSIS, NC START-UP and ENTER PASSWORD have been pressed, the following display appears:

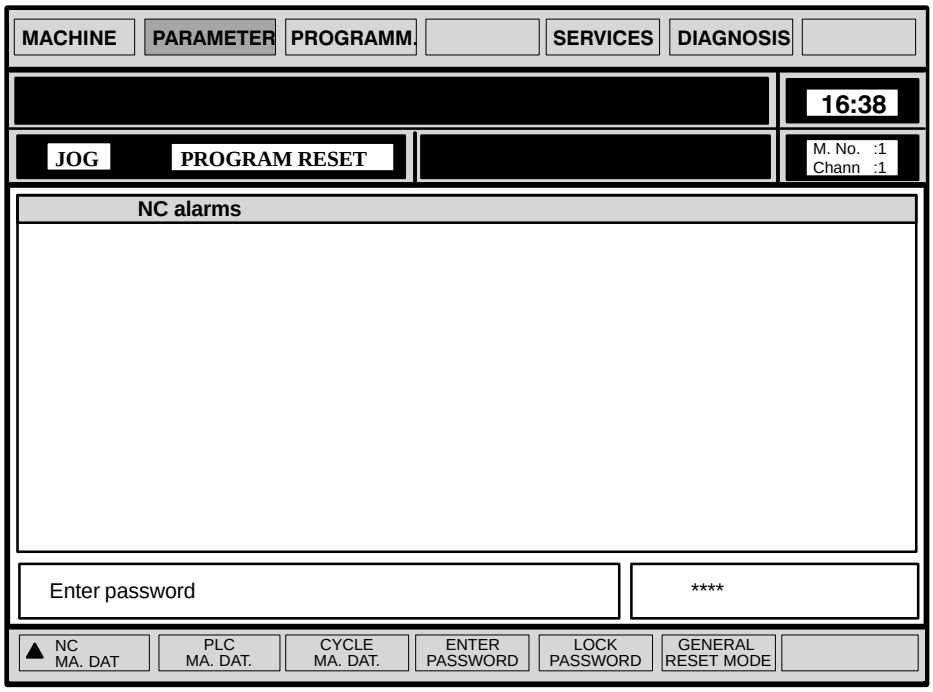

Fig. 2.3

The password for the NCK area is set in machine data 11. The default value 0 corresponds to password 1 < + 1 < + 1 < + 1 < .

Any other value defined in machine data 11 must have four digits.

The value is accepted with the INPUT key and the text “ENTER PASSWORD” disappears.

LOCK PASSWORD

The password is reset with the “Lock password” softkey.

If the password has not been set correctly, the message “Password incorrect” appears.

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2.9 General reset (up to SW 2)

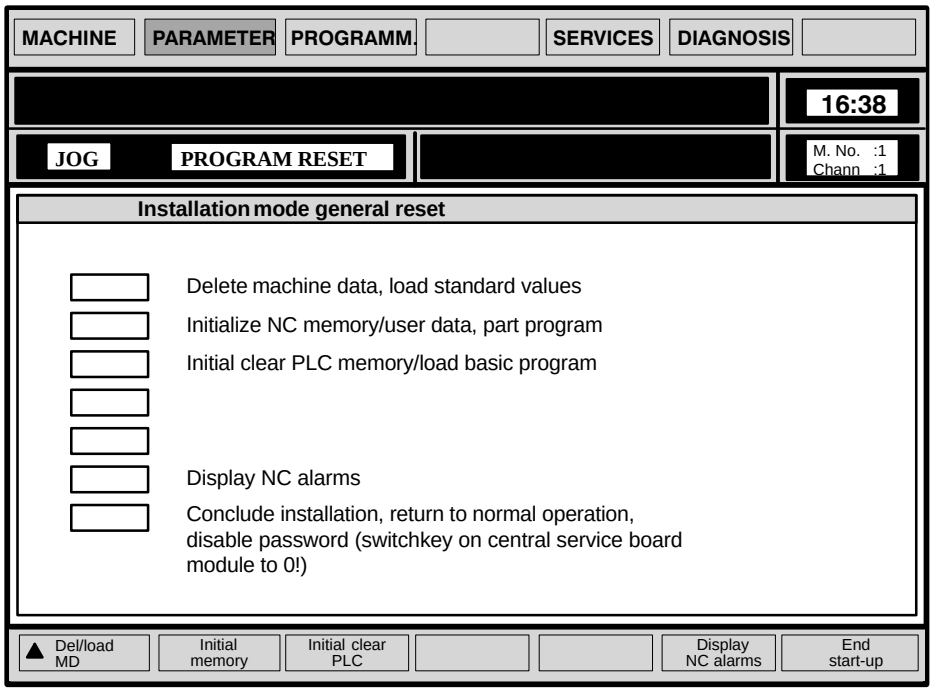

Fig. 2.4

The start-up sequence is obligatory since the NC and PLC machine data must have been entered before the user memory is formatted and the part program memory is deleted.

DEL./LOAD MACH. DATA

"DEL./LOAD MACH. DATA": The delete/load screenform is displayed.

DELETE NC-MD

"DELETE NC-MD": NC-MD are deleted and formatted.

LOAD NC-MD T VERSION or LOAD NC-MD M VERSION

"NC-MD LOAD T VERSION" **or** "NC-MD LOAD M VERSION": Standard MD for T or M version are loaded.

LOAD

If files exist on hard disk in the DIAGNOSIS, NC DATA MANAGEMENT, PC DATA MANAGEMENT areas, softkey "LOAD" can be used to load these files from the hard disk to the NCK-CPU.

DELETE PLC-MD

"DELETE PLC-MD": PLC-MD are deleted and formatted.

LOAD PLC-MD

"LOAD PLC-MD": The default PLC-MDs are loaded.

PLC-MDs are not transferred to the PLC until the general reset mode is exited.

Note

For selecting data management, press the area switchover key, "DIAGNOSIS" and "SHIFT" + "RECALL" in the General reset selection form.

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DELETE CYCLES MD

“DELETE CYCLES-MD”: The cycle setting data and MIB parameters are deleted and formatted.

The MIB parameters are the machine input buffers for the standard cycles during program support.

Activating the RECALL key calls the general reset screenform.

INITIAL. MEMORY

“INITIALIZE MEMORY”: The Initialize NC memory screenform is called.

FORMAT USER DATA

“FORMAT USER DATA”: Setting data, zero offsets, tool offsets, R parameters, cycle setting data are deleted and formatted.

FORMAT PART PROG.

“FORMAT PART PROGRAM”:
The dialog text DELETE DATA ? is displayed.
If the Format part program softkey is pressed again, the part programs are deleted and formatted.

PLC GEN. RESET

Activating the PLC GENERAL RESET softkey calls the PLC functions screenform. The PLC general reset softkey is pressed again for starting PLC general reset.

Activating the RECALL key calls the **General reset** screenform.

END START-UP

The “END START-UP” softkey is pressed to leave general reset mode. This results in the message “NCK RESET – please wait ...” and PLC restart, the password is deleted and the JOG mode basic display is called.

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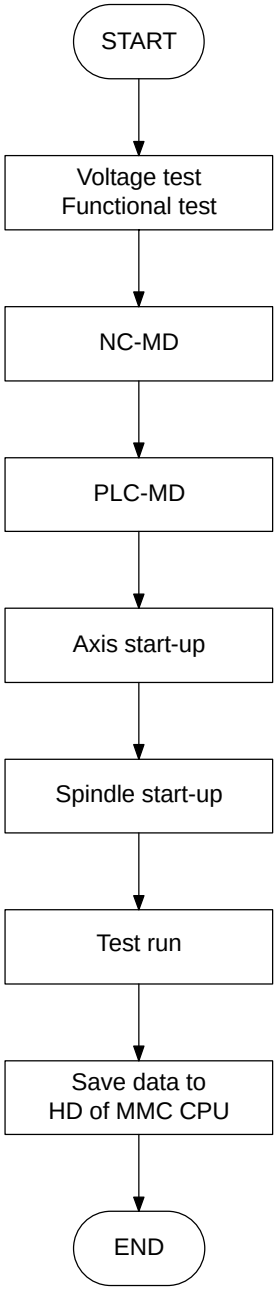
2.10 Standard installation and start-up as flowchart (up to SW 2 only)



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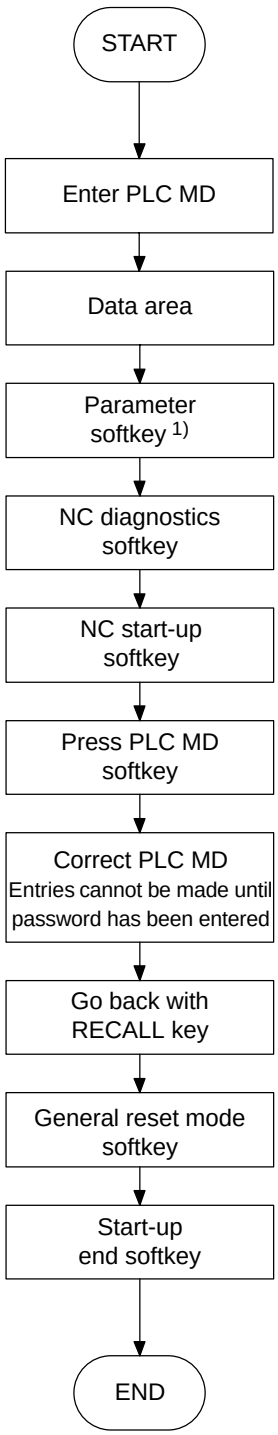
2.11 Enter PLC machine data (up to SW 2 only)



1) SW 1 only

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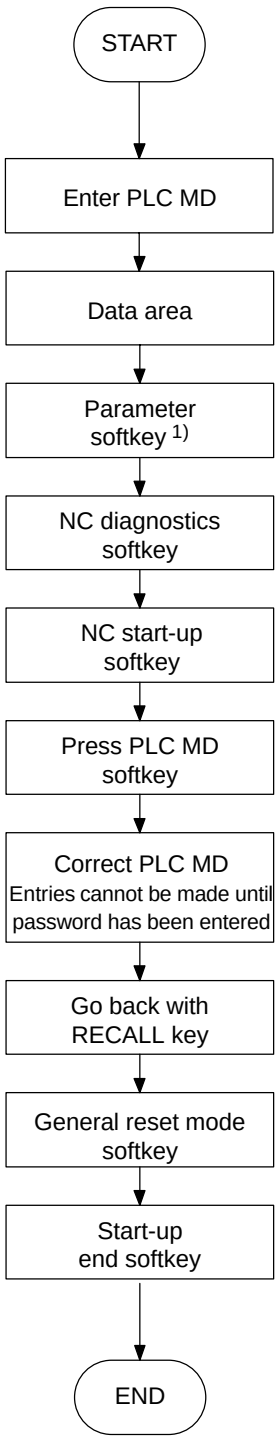
2.12 Enter NC machine data (up to SW 2 only)



1) SW 1 only

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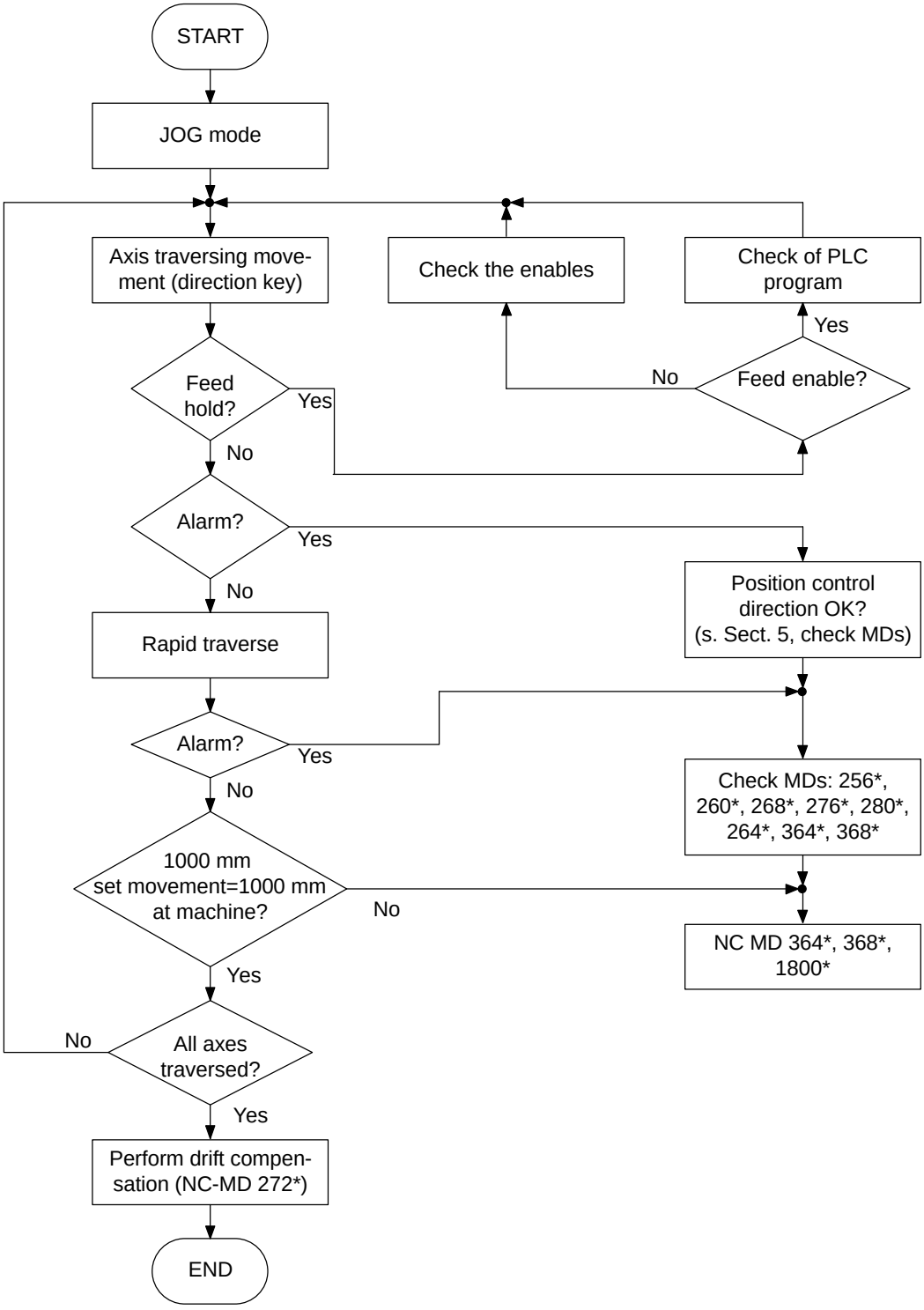
2.13 Axis installation (simplified, up to SW 2 only)



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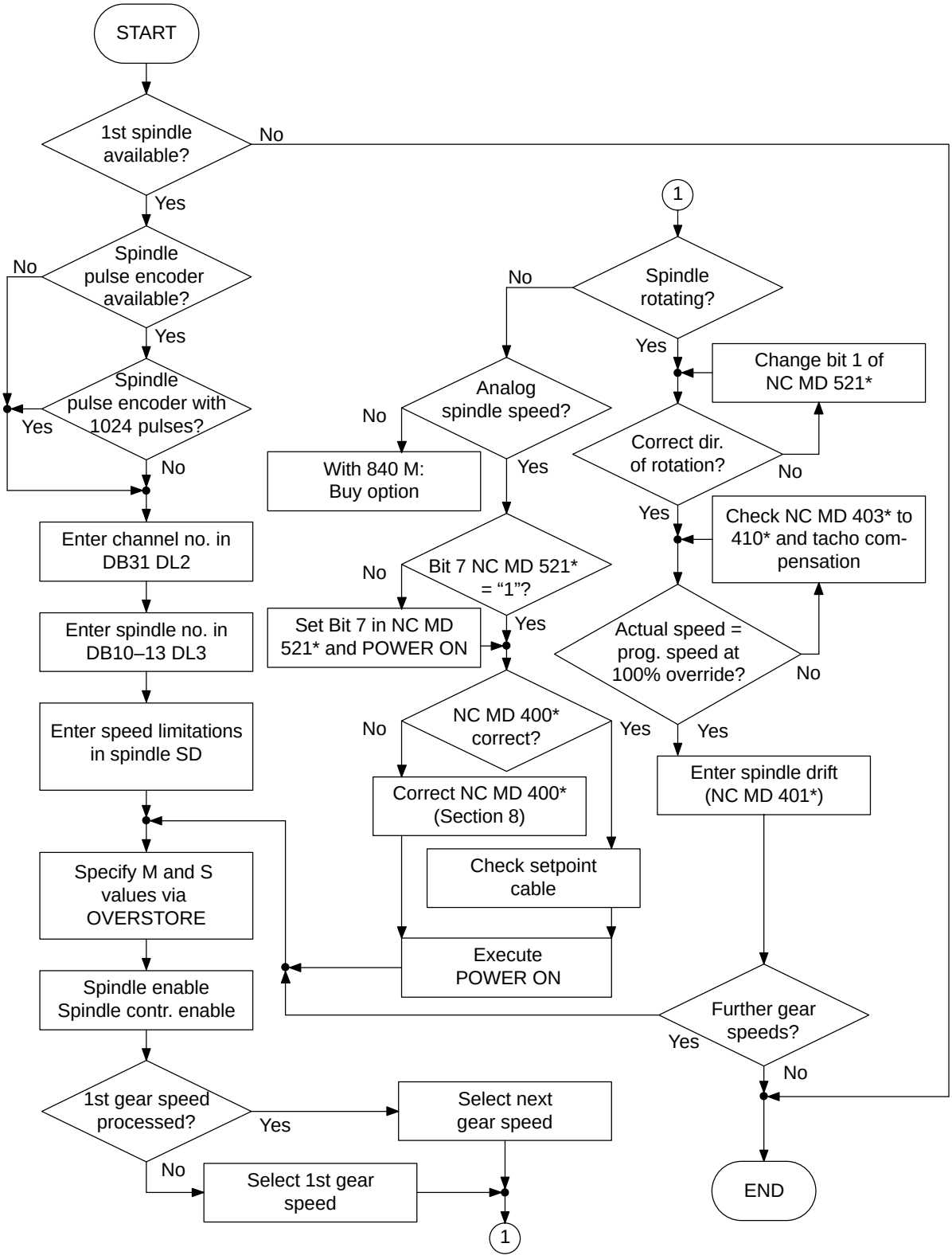
2.14 Spindle installation (Example: one spindle, up to SW 2 only)



END OF SECTION

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3 PLC Installation

3.1 General remarks

PLC CPU versions

Three different PLC CPU versions can be used in the SINUMERIK 840C:

- PLC CPU 135 WB2 with interface PLC and EPROM submodules for the operating system and the user program (the operating system and the user program are loaded from EPROM into RAM, up to software version 2 only)
- PLC CPU 135 WB2 with interface PLC and RESTART EPROM submodule (as from software version 3, the operating system and the user program are loaded from hard disk into RAM)
- PLC CPU 135 WD without interface PLC (as from software version 3, the operating system and the user program are loaded from hard disk into RAM)

Connection of the programming device

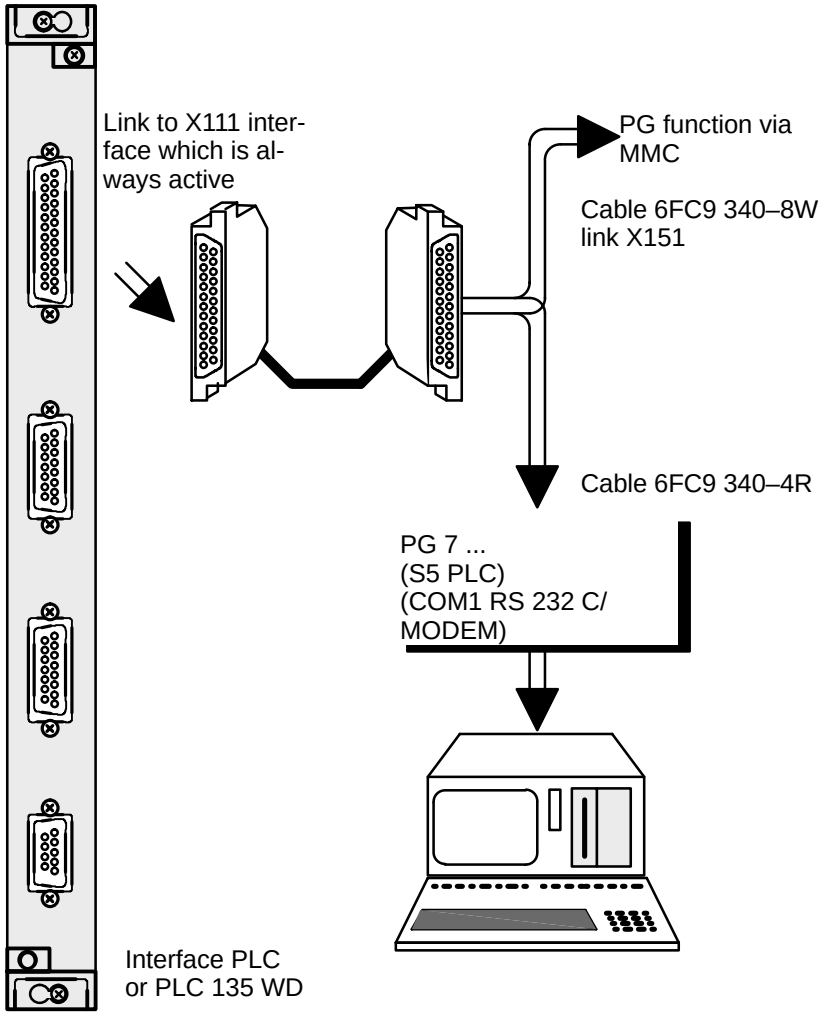

Fig. 3.1

Note

Only PG 7 ... programming devices may be used with the SINUMERIK 840C for programming and servicing the PLC.

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PG interface

Only the following values are permissible for the PG interface on the PLC 135 WD:

9600 BAUD
PARITY EVEN
2 STOP BITS
The PG interface is always active.

PG operation

Step	Activity	
1	Connect cable NC-PG	
2	PG 7xx	Start S5-DOS
3	PG 7xx	Select on-line mode

3.2 PG function via MMC

The function exists on SW 4 and higher and can be obtained as an option. It is mainly for servicing, testing and commissioning.

General notes

With this function you can use the functionality of the SIMATIC software STEP 5/MT level 6 on the SINUMERIK 840C control. PG functions can thus be executed on the operating panel or on an MF2 keyboard. Operation via the operator panel or MF2 keyboard is restricted compared with operation on the programmer.

For the connection between the MMC and the PLC (on-line operation), the following cable is required:

MMC-CPU, X151 <—— 6FC9340–8W ——> PLC CPU, X111
(see INTERFACE DESCRIPTION PART 2 CONNECTION CONDITIONS).

The PG function via MMC is mainly used for:

Support in servicing, testing, installation and start-up with the following functions:

- Status module
- Status variable
- Force PLC
- PLC info with BSTACK and USTACK and
- Cross-reference lists

Moreover, modules can be edited and loaded/stored from/to diskette (floppy FD–E2).

A programming device (e.g. PG 750) is still required to write large PLC user programs because operation is restricted.

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When the PG software is selected, the 1st serial interface is disabled. It is only enabled again when the PG mode is terminated.

Caution

With the PG software, it is possible to select other files as well (not S5 files) to delete or copy them etc. with the function: object\DOS file\. The user is responsible for using this function. System files can be deleted too.

Operation and application of the SIMATIC software STEP 5/MT level 6 is described in the relevant manual.

Installation

The function is supplied on tape and is installed in the BACKUP menu (see Section BACKUP).

Operation

Starting from the DIAGNOSIS area, the function can be selected using softkey PG function.

When operating the PG functions via the operator panel or MF2 keyboard, please note the following changes in the key functions.

Key on the operator panel	Key on the MF2 keyboard[1)]	Equivalent key/function on the programming device
SK1	F3	F1
SK2	F4	F2
SK3	F5	F3
SK4	F6	F4
SK5	F7	F5
SK6	F8	F6
SK7	F9	F7
RECALL	F2	F8 (Cancel, ESC)
Shift +SK1	Shift+F3	Shift+F1
Shift +SK2	Shift+F4	Shift+F2
Shift +SK3	Shift+F5	Shift+F3
Shift +SK4	Shift+F6	Shift+F4
Shift +SK5	Shift+F7	Shift+F5
Shift +SK6	Shift+F8	Shift+F6
Shift +SK7	Shift+F9	Shift+F7
	Shift+F1	Shift+F8

1) The keyboard must be connected to the interface on the MMC-CPU.

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	Backspace	Delete character
not possible [1]	. DEL	. DEL Delete char. to the left
Shift + not possible [1]	Shift + . DEL	Shift + . DEL Delete field
	0 INS	0 INSERT Enter
	ENTER	End of input (return)
	Pg Up	9 Scroll up
Shift +	Shift + Pg Up	Shift+ 9 Page up
	Pg Dn	3 Scroll down
Shift +	Shift + Pg Dn	Shift+ 3 Page down
	5	5 CORR Editing mode
no meaning	ESC no meaning	
no meaning	F11 no meaning	
no meaning	F12 no meaning	

1) Delete with the backspace key

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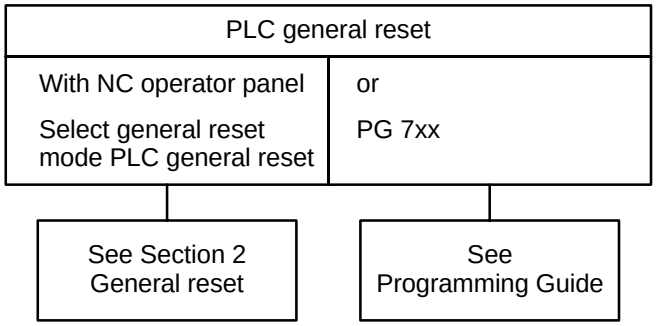
Restrictions

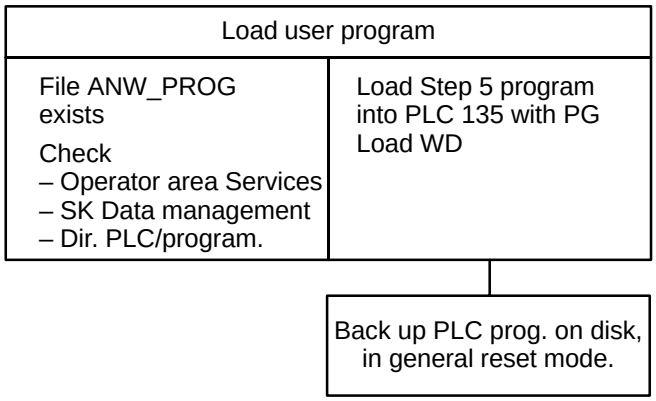
- The data management function BTRIEVE is not installed.
- For output on the printer via the parallel interface parallel 1 (Centronics, X122) on the MMC-CPU, LPT1 must be set in the printer parameters.
- The following characters cannot be displayed on the operator panel: “#”, “{”, “ }”, “~”, “`”, “$”, “&”, “ |”, “\”
- Data exchange with external PGs can only be performed with the FD-E2 diskette unit.

3.3 PLC general reset



3.4 Procedure for starting up the PLC

Overview



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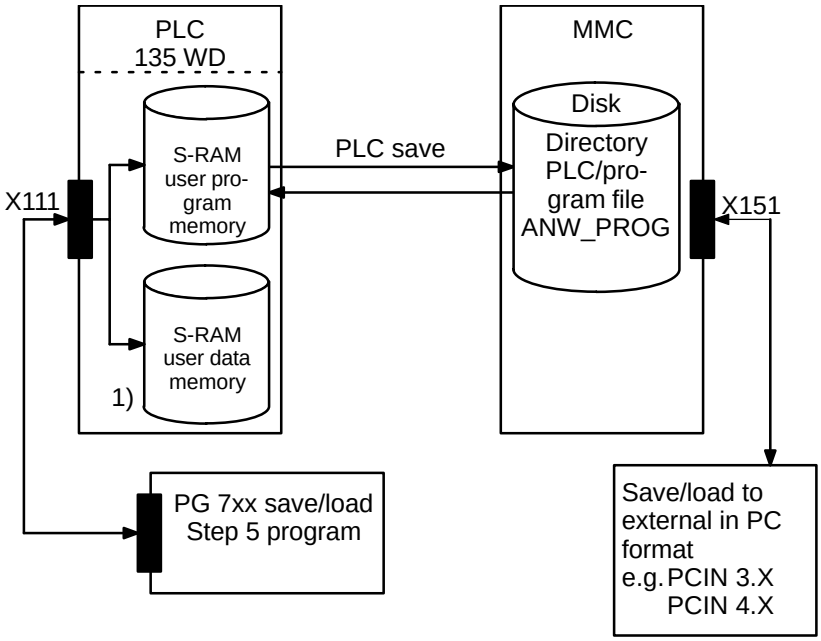
Save/load



Procedure up to SW 2

PLC 135 WB2 with EPROM submodules for the operating system and the user program

Prerequisites: The PLC user program is available either on diskette or hard disk, the RAM of the PLC CPU is clear.

Step	Description
1	For the initial installation of the PLC, the PLC user program must first be stored in the non-volatile memory of the control. For this purpose, the PLC user program must be transferred onto the appropriate EPROM submodule (6FC5 130–0CA01–0AA0), e.g. by means of the PG750 programmer. The EPROM submodule is then plugged into the X321 submodule slot (with the control being switched off).
2	Select general reset on the control: SK ”Diagnosis” –> SK “NC diagnosis” –> SK “NC start-up” –> SK “General reset”
3	Then the “PLC gen. reset” softkey in the “General reset” installation menu is pressed to select deletion of the user memory and subsequent copying of the PLC user program from the EPROM submodule into the RAM memory. The selection does not become effective until the “Start-up end” softkey is pressed.
4	The PLC user program is now in the RAM of the PLC CPU and is processed.

Note

If you press the “PLC gen. reset” softkey and then the “Start-up end” softkey in General reset mode, this causes the PLC user program in the RAM to be deleted and the user program stored on the EPROM submodule is then loaded in the RAM. If no EPROM submodule with a user program is plugged in, the RAM remains clear; no user program is loaded.

1) The user data are transferred from the PG to the user data memory using the PG segment switch

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Procedure as from SW 3

PLC 135 WB2 with RESTART EPROM submodule and PLC 135 WD

Prerequisites: The PLC user program should exist either on diskette or on the hard disk, the RAM of the PLC CPU is empty.

Step	Description
1	The Restart EPROM submodule must be plugged in the X231 submodule slot (PLC 135 WB2 only).
2	Connect PG7xx to the control and load the STEP5 program.
3	Select General reset mode on the control. SK “Diagnosis” –> SK “Start-up” –> SK “General reset mode”
4	Transfer the PLC user program from the PG7xx into the control. The PLC user program is now in the buffered RAM of the PLC CPU.
5	In order to prevent a loss of data, it is advisable to store the PLC user program on the hard disk of the MMC CPU. You can press the “Save PLC” SK to achieve this. The selection becomes effective as soon as the “End general reset mode” SK is pressed. The PLC user program is stored in the Services area under User/PLC/Programs as ANW_PRG file. You can also copy this program to another name. In this way you can store a number of different PLC user programs on the hard disk.

Note

If you press the “PLC gen. reset” softkey the PLC user program in the RAM is deleted and the user program stored on the hard disk as ANW_PRG is then loaded into the RAM. The data in the user data memory are also deleted.

The RAM remains clear if the ANW_PRG file is not in the User/PLC/Program directory or has been deleted; no PLC user program is loaded.

If the PLC user program is available in PC format, you must read in the program via the V24 interface. The PLC user program is then automatically stored under User/PLC/Program as ANW_PRG file.

- A PLC general reset must then be performed.

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3.5 PLC diagnostics

The following diagnostics displays exist:

	Displayed by	Brief description
1	LED	CPU hardware fault
2	–	System initialization program
3	USTACK detailed error coding	Displays programming errors
4	PLC status	Displays and changes (password) to PLC data (I, O, F, D, T, C)
5	Timeout	Timeout analysis of write access

3.5.1 LED display

After switching on the mains voltage, the interface control runs a self-diagnostics program. This program tests the most important hardware components and initializes the software required for continuing system start up.

If errors in the system are recognized, the LED on the front plate displays the error.

For a detailed error list, please refer to the “SINUMERIK 840C, Diagnostics Guide”.

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3.5.2 System initialization program

After the self diagnostics program has been run through, the system initialization program is requested.

In its first section, the data required for running the organization program are set up. This setting up includes:

- Stack organization,
- Segmentation for word processor and co-processor,
- Entries in the location dependent CPU interrupt table,
- Task priority lists,
- Setting up task data,
- Initialization of counts and periodic values.

In the second section the system initialization program defines the type of start up after switching on the mains voltage. The following points are checked:

- Whether the switch-on test pattern is missing (i.e. data lost)
- Whether there is a battery interrupt
- If the setting-up bit is set
- Request from the NC “automatic warm restart after setting-up overall reset”
- STOZUS operating status bit set (acquisition of interupt event or continuation of the STOP state, see Section 8)
- Cold restart or warm restart attempt aborted.

If the STOZUS identifier is set, the control remains in the STOP state.

If, in the second section, (testing of run-up after switching on the mains voltage) the STOZUS identifier is not set, but one of the other conditions is fulfilled, an automatic cold restart is executed; a warm restart of the control only occurs if none of the mentioned conditions are fulfilled.

Overall reset with subsequent bootstrapping of the user memory (ORLOE = 1) is always required

- If first setting up is instigated,
- Data loss has occurred by removing the PLC CPU or, in the case of power failure, due to simultaneous battery voltage failure.
- After forced boot (SW 3 and higher)

If the mains voltage fails during active processing checks, the processing checks are aborted by the programmer. The system initialization program instigates the cold restart.

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3.5.3 USTACK, detailed error coding

The operating system can detect malfunctioning of the central processor, errors in the system program or effects of incorrect programming by the user.

If the interpreter comes across an error during command processing or if another error occurs that cause a program interruption, the PLC enters the STOP loop.

A more precise analysis of the error can be obtained using the programmer or the detailed error coding integrated into the control. The interrupt stack and the detailed error coding are available for this, which are kept up-to-date in the Installation List up to SW4 and in the Diagnostics Guide for SW5 and higher.

Selection

- **Up to software version 2:**

  SK “Diagnosis” –> SK “NC diagnosis” –> SK “Service display” –> SK “PLC error detection”

- **On software version 3 and higher:**

  SK “Diagnosis” –> SK “Service display” –> SK “PLC service”

Fig. 3.2 Detailed error code for cause of PLC stop

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3.5.4 PLC status

In the “PLC STATUS” mode, the user can read out the contents of counters and timers and read out and write input words, output words, flag words, data words and data double words. These words can only be written when a password has been entered.

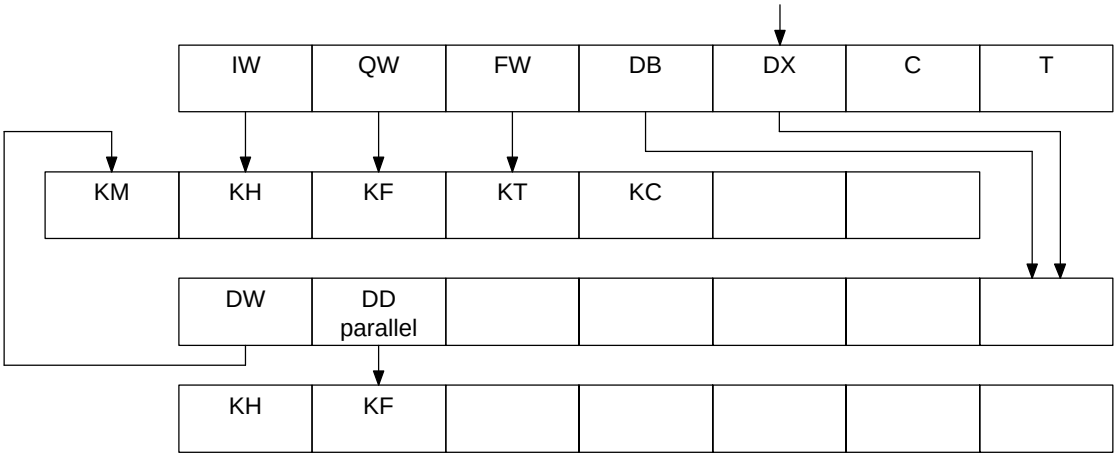
Selection

- **Up to software version 2:**

  SK “Diagnosis” –> SK “NC diagnosis” –> SK “Service display” –> SK “PLC error recognition”

- **Software version 3 and higher:**

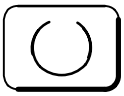
  SK “Diagnosis” –> SK “Service display” –> SK “PLC service”



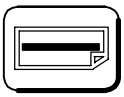
Data areas

	Read	Write	Data number
Input word	x	x	0–126
Output word	x	x	0–126
Flag word	x	x	0–254
Data word	x	x	0–254
Data double word	x	x	0–254
Times	x	–	0–255
Counter	x	–	0–255

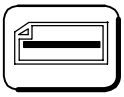
Operator entries in PLC STATUS mode



Any existing byte number may be preselected



Page DOWN: The byte number is incremented by one



Page UP: The byte number is decremented by one

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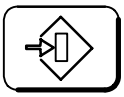


INPUT: Enter new value for the selected word or bit

RECALL: Return to preceding display

Example of operation

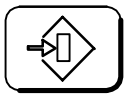
- Reading input, output and flag words

  Softkey: IW, QW, FW

  Keys Preselect word number 14

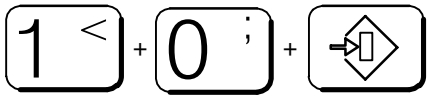
- Reading data words

  Softkey DB to select a DB
  Softkey DX to select a DX

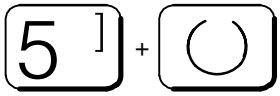
  Preselect DB (DX) with 

  Preselect data word with DB
  Preselect data words from two contiguous DBs (DXs) with DD

  Example:
  Selecting DW 5 in DB 10
  PLC Status softkey
  DW softkey

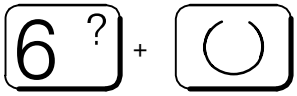
  Keys  to select DB 10

  Softkey DW 1)

  Keys  to preselect word no. 5

- Reading the contents of timers and counters

  Softkey: T or C

  Keys  Preselect timer or counter number 6

  The time is always displayed in seconds, regardless of how it was programmed in STEP 5. The count is displayed in BCD code.

  Display formats

KM:	Binary	numbers	0 and 1
KH:	Hexadecimal	numbers	0 to F
KF:	Fixed-point	numbers	0 to 9
KT:	Time	numbers	0.01 to 999
KZ:	Count	numbers	0 to 999

1) Actuation of the DD softkey selects data words from DB10 and DB11, e.g. DW5 in DB10 and in DB11.

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3.5.5 Timeout analysis

A write access to the communication or local bus is executed by the bus interface. The processor immediately receives an acknowledgement and continues. (Buffered access to communication/local bus). If a timeout occurs during such an access, the current state of the registers of the processor and coprocessor give no information as to the cause of the timeout.

The user can switch off buffered accesses to the communication and local bus (e.g. to test STEP 5 programs during the installation phase) via machine data (PLC operating system MD bits 6049.0). These accesses are then slower because the processor only receives an acknowledgement when the whole bus cycle has finished.

Machine data 6049.0 must be set in order to be able to determine the exact cause of a timeout.

3.6 Procedure for error search after PLC stop

The table below describes the procedure for an error search in the PLC after alarm: PLC CPU failure has been displayed on the operator panel.

Step	Description
1	Alarm display on operator panel: PLC CPU failure
2	LED on PLC CPU flashing: evaluate flashing frequency: for a description see error displays: “SINUMERIK 840C, Installation Lists”
3	LED on PLC CPU permanently lit: USTACK, read out detailed error coding, for operation see above in this section
4	If the contents of the 1st error code word are 00FFH an error has occurred in the FBs. For an error description see Diagnostics Guide, Section Error messages
5	If the contents of the 1st error code word are not equal to 00FFH, see error description in Diagnostics Guide, Section Error messages

END OF SECTION

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4 MMC Area Diagnosis

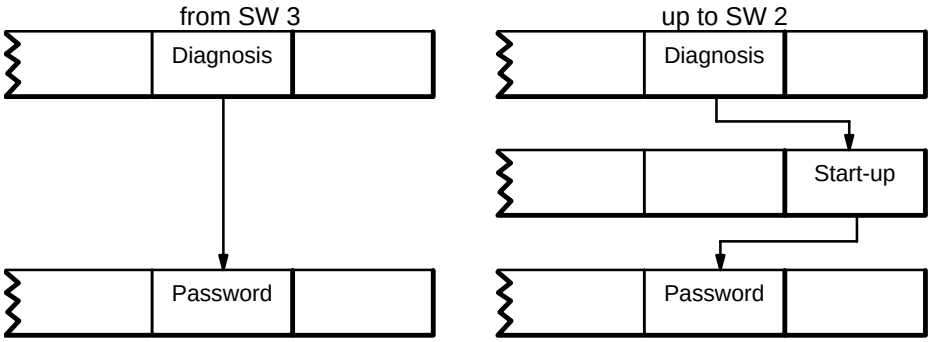
4.1 General notes/overviews

4.1.1 Password

A password protects data against unauthorized access.

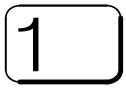
The MMC and NCK areas are password-protected.

Selection of the password in the MMC area

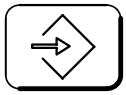


The password for the MMC area is defined with MD11 in the NCK area. Every additional value in MD11 must be 4 digits long. The standard value 0 corresponds to password

1 + 1 + 1 + 1



Enter digit 1 four times using the keyboard.



Confirm with the INPUT key.

Set the password with the SET key.

If the password is set correctly, the following text appears in the alarm line: “120000 PASSWORD SET”.

With the softkey DELETE, you can clear the password, the message “120001 PASSWORD RESET” then appears.

If the password was not enetered correctly, the message “120009 PASSWORD INCORRECT” appears. The display is acknowledged with the softkey OK.

Note: The password must be deleted after start-up.

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4.1.2 Simplified switchover between languages (as from SW 5)

In the Diagnosis area it is possible to changed the language of the input screens that appear subsequently. This is done with the softkey “Language/Sprache” in the initial display of the Diagnosis area.

Fig. 4.1

Toggle field (Language) In the areas System (MMC, NCK), WOP, Simulation and the PG (STEP5 Software) it is possible to switch over the language using the toggle field (Language). The current configuration is preselected. If any of the options (WOP, Simulation and PG-SW) is not installed, “–” appears in the Language field.

Installed languages The toggle fields only offer for selection the languages currently installed on the control in the area in question. A message text appears on the display (in German and English) indicating how to operate the toggle field.

Password Changing the language is password-protected, i.e. of you press the softkey “OK” it is possible to enter the password subsequently.

Softkey “OK” With the softkey “OK” you can take over the changed configuration which is activated on the next start-up. The diagnostics changes the reserved words LANGUAGE in the master control config file in the user branch. If there is still no master control config file in the user branch, it is copied from the Siemens branch.

Reserved words Assignment of the reserved words to the area

Area	Reserved word
System	LANGUAGE
WOP	LANGUAGE1
Simulation*	LANGUAGE2
PG	LANGUAGE3

“RECALL” With “RECALL”, you can exit the display without saving any changes.

* As from SW 5.4, also for Graphic Tool Path Simulation

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4.1.3 Printing screen hardcopies

The screen hardcopies are stored in a compressed TIFF or PCX format to reduce the transmission times via the RS 232 interface. The format is selected in two Bedconf entries. The formats can be interpreted with Windows tools, such as Word.

First entry, screen colour: //BCOLORMONO_DEF

a 15 1 CO for colour screen
or
a 15 1 MO for monochrome screen

Second entry, for output format: //BHARDCOPY_DEF

a 15 6 CO TIFF
or
a 15 6 MO PCX

With these settings you can create the following file formats:

Entry in BEDCONF		File format generated
a 151	a 156	
CO	PCX	X.PCX, compressed, color
MO	PCX	X.PCX, compressed, monochrome
CO	TIFF	X.TIF, compressed, color
MO	TIFF	X.TIF, uncompressed, monochrome

Note

With the entry in “a 151 CO” or “MO” the screen display is changed, to colour or monochrome.

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4.1.4 Selection of the Diagnosis area

Diagnosis

Select the DIAGNOSIS area with this softkey in the area menu bar. The initial display that appears shows you the alarms currently pending.

With the vertical softkey bar it is possible to switch to the display of the current messages.

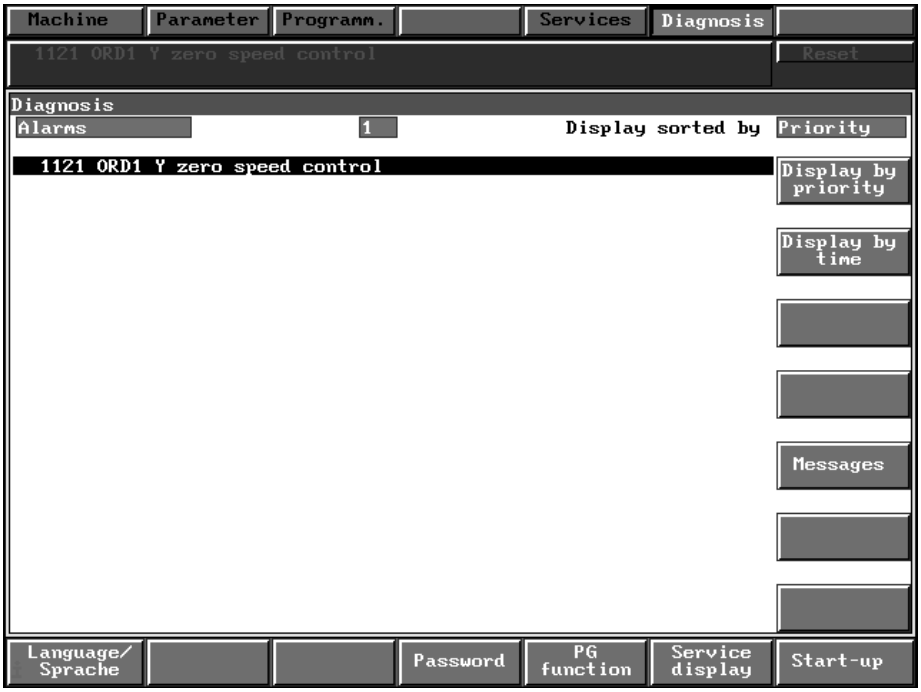

Fig. 4.2 Initial display of the diagnosis area

Display by priority

With these softkey functions you can sort the alarms/messages currently pending by priority or chronologically.

Display by time

Messages

Press this softkey to display the current messages

Alarms

Switch back to display of the alarms

Language/ Sprache

See Section “Simplified language switchover”

Password

See Section “Password”

PG function

See Section 3, Start-up PLC

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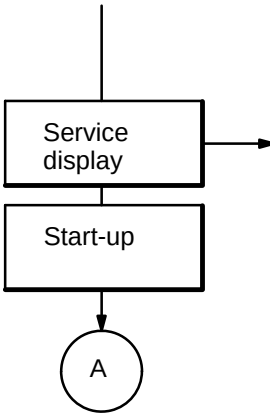


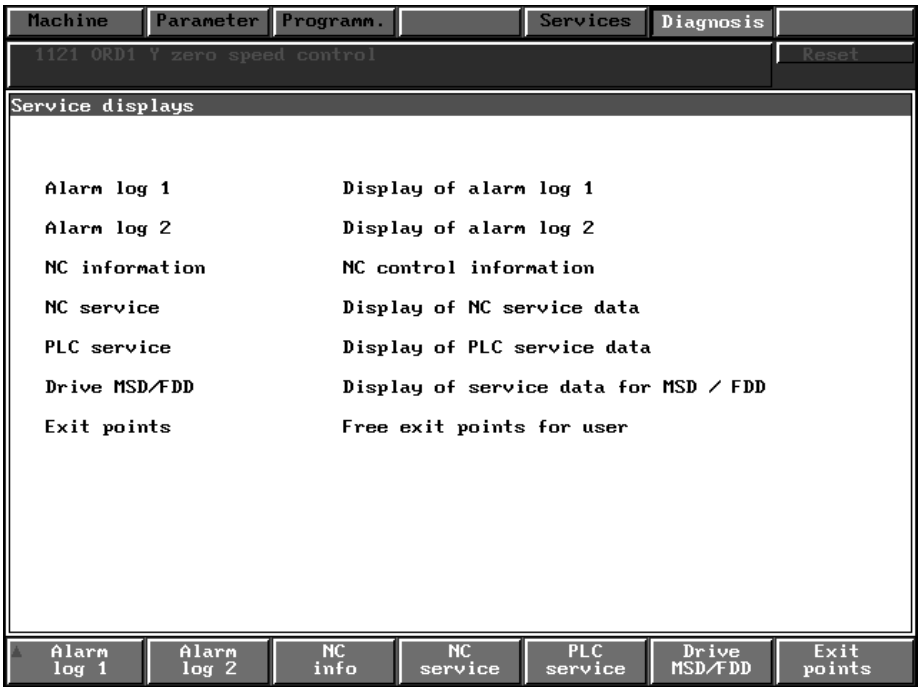
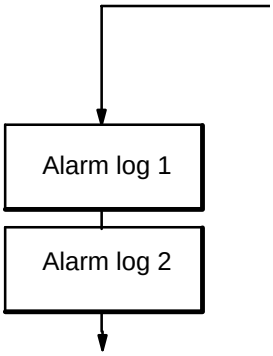


Fig. 4.3



Default setting: All alarms and messages are included.

Default setting: All reset and power ON alarms are included.
Note: Both files are configured in the CONFIG file.

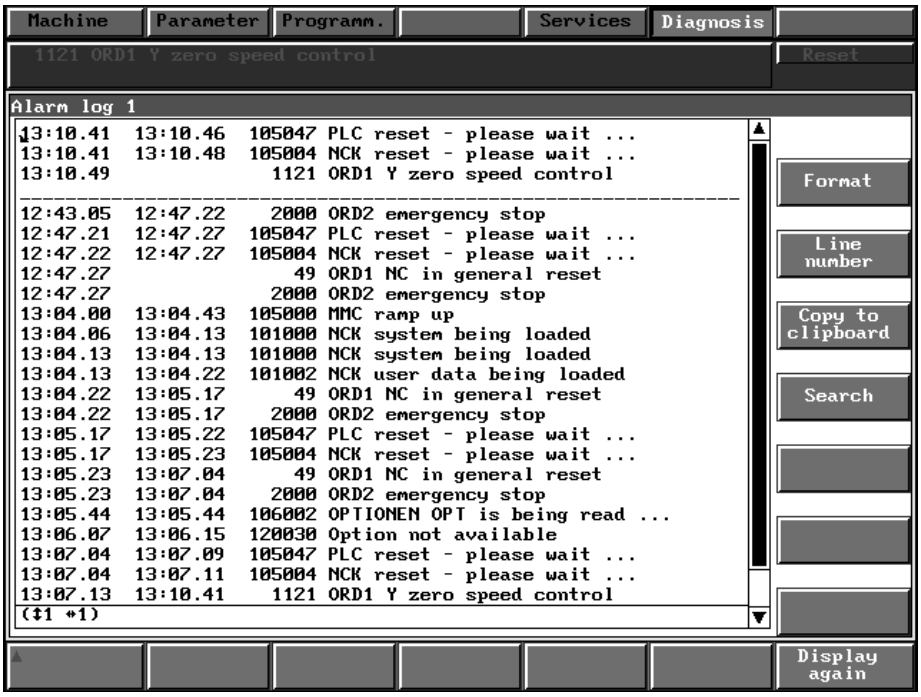


Fig. 4.4 Alarm log 1

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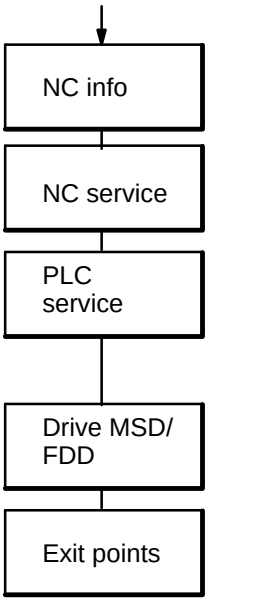


Display NCK software version

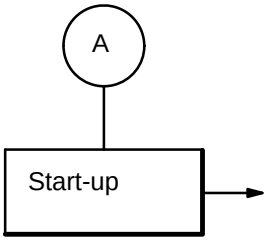
For description see NC service in this section.

The displays are used for debugging incorrect programs. The status display is used to show PLC data (e.g.: I, Q, ...).

For description see Section 3, Start-up PLC
Subsection ISTACK, detailed error coding, PLC status

For description see under subsection: Drive service displays for spindle and axis.

For OEM applications



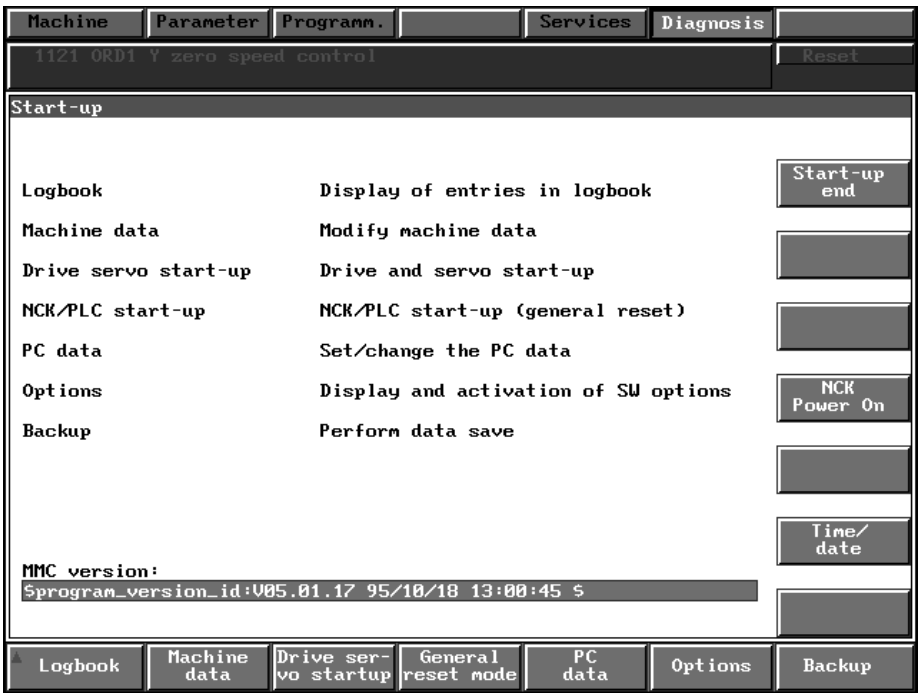
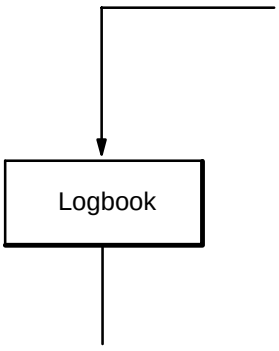


Fig. 4.5



In **SW4** the logbook contains the current version numbers of the software components installed on the hard disk.

As from **SW5**, the first line also indicates the sum software version.

Caution: As from SW4, no entries must be made in the logbook, because it would be overwritten on every software upgrade.

Up to and including SW3 information can be placed in the logbook which is important for service on the control.

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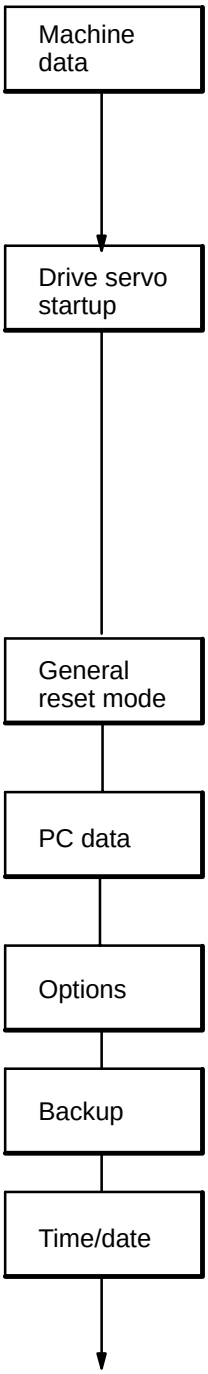


For a description of the machine data dialog MDD (on SW3 and higher) see Section 5, Machine data dialog (MDD).

For a description of NC-MD see Section 6, NC machine data (NC-MD), NC setting data (NC-SD).

For a description of the drive MD see Section 7, drive machine data (SIMODRIVE drive MD).

For a description of the PLC-MD see Section 8, PLC machine data (PLC-MD).

As from SW3:
The following functions can be selected:

Measurement of the drive servo loops

Set function generator, signal forms

Configure DAC and mixed I/O

Quadrant error compensation (QEC) and circularity test

Servo trace, freely programmable oscilloscope function (as from SW 4)

For a description see Section 9, drive servo startup application

For a description see Section 2, general reset and standard start-up.

On initial start-up or after data loss, e.g. because a module has been removed, hardware defect in a module or flat back-up battery on power failure, data can be assigned standard values in initial clear mode.

For a description see Subsection PC data.

The operation system can be set in configuration files. The files are preset to default values. They can be changed in the MMC area DIAGNOSIS using the ASCII editor (the ASCII editor is described in the Operator's Guide)

As from SW3: enabling options

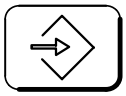
For a description see below under subsection : Enabling options.

A complete backup of all data can be made on magnetic tape using the VALITEK streamer.

For a description see below in subsection: BACKUP with Valitek streamer.

Possible input values are:

Hour	0 – 23
Minute	0 – 59
Day	1 – 31
Month	1 – 12
Year	80 – 99



The values are entered on the numeric keypad and confirmed with INPUT.

SET

With the softkey SET, the values are activated. The function is password protected.

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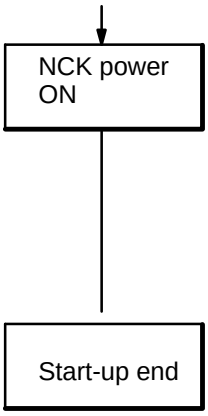

NCK power ON without voltage failure.

Features:

- MD are activated.
- Reference point values are lost.
- PC data are not updated.

Terminate the machine data dialog (MDD).

4.2 NC Service

For drive optimization and error diagnosis it is necessary to check the data transmitted from the NC to the axes or spindles and from the axis or spindles to the NC.

The following service data for axes are displayed:

- Following error in position control resolution (limit = 2 position control resolution units)
- Absolute actual value in position control resolution units
  True position of the axes on the machine.
- Setpoint in position control resolution units
  Default which has been determined by the control system on the basis of programming or setpoint position entered manually.
  Normally, setpoint and absolute actual value are identical. In standstill, the difference (following error) can be compensated with the drift compensation.
- Abs. compensation value
  Sum of IKA and temperature compensations.
- Speed setpoint in 0.01 % of the maximum speed
  Digital value which has been determined by the control system (maximum value see NC-MD 268*). This is converted into an analog value (0 V to 10 V) on the measuring circuit module and output as speed setpoint to the drive.
- Partial actual value in position control resolution units
  Pulses per interpolation clock sent by the measuring system (standard 16 ms).
- Partial setpoint in position control resolution units.
  Partial setpoints per interpolation time sent by the interpolator to the position control (standard 16 ms).
- Contour monitoring
  The current contour deviation is displayed with this value (fluctuations of the following error due to adjustments on the speed controller caused by settling due to load changes).
- Synchronous run error
  Deviation between leading axis and following axis.
- Parameter set position control.

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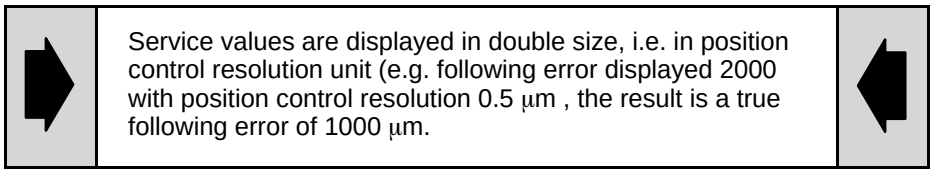
- Parameter set conversion
  Selected parameter set is displayed.
- Service no.
  See the Diagnostics Guide for the list of service nos.



Service values are displayed in double size, i.e. in position control resolution unit (e.g. following error displayed 2000 with position control resolution 0.5 μm , the result is a true following error of 1000 μm.

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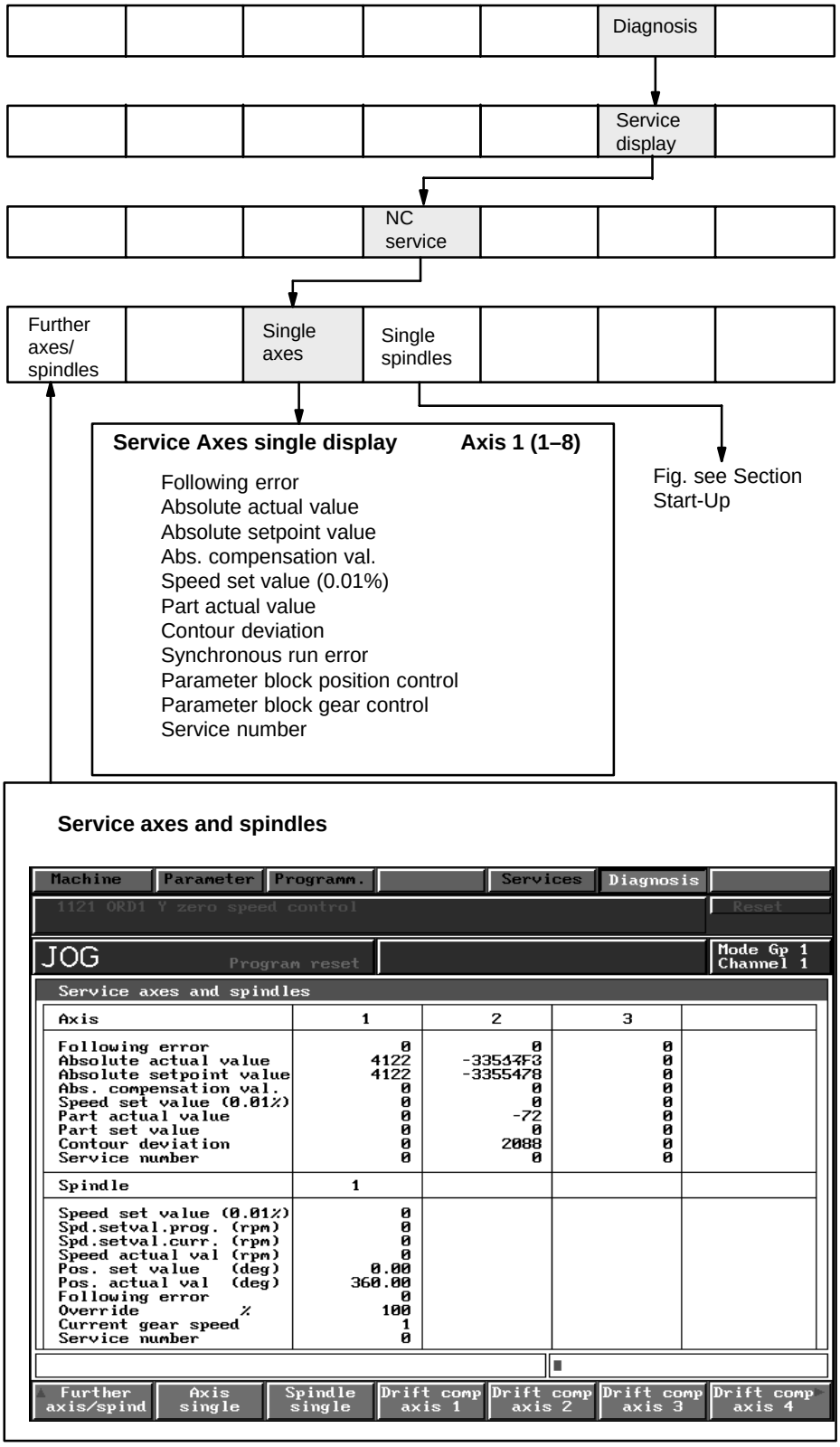
4.2.1 Selection of service data

Data range



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The figure for single display is updated more frequently than the figure for several axes and spindles.

Note Use the single figure for exact control.

Change to the following axes with “Page down” key.

If you enter the digit “8” and press the search key, e.g. axis 8 can be selected directly.

You can move back to the previous axes with the “Page up” key.

4.2.2 Service data for the spindle

For optimization and error diagnosis, it is possible to display the current spindle values.

- Speed set value (0.01%):
  Digital voltage output from the NC on the measuring circuit.
- Speed set value (rev/min) Progr.:
  Value entered by the user;
  e.g.: Input S 1000 Display: Speed set value 1000 (rev/min)
- Current speed set value:
  Currently effective correct-sign current speed set value with calculated override without speed limitation by setting data or MD.
- Actual speed value (rev/min):
  The pulses sent by the spindle encoder are evaluated by the NC and displayed as speed in rev/min.
- Position set value:
  The spindle position preset in degrees by the user is converted by the NC intop the corresponding number of pulses,

  e.g.: 0° = 0
  180° = 2048
  359° = 4059
- Actual position value
  The pulses sent by the spindle encoder are evaluated and displayed by the NC.
- Following error:
  Difference between position set value and actual position value. In standstill, the following error is a measure for the position deviation with active M19. A following error is also displayed in controlled operation.
- Error synchronism
  Deviation between leading spindle and following spindle
- Override:
  The position of the spindle override switch is displayed.
- Gear stage:
  The current gear stage is displayed (DB 31 DR K +1 bit 0 to 2).
- Parameter set position control
- Parameter set speed ratio
  Selected parameter set is displayed.
- Service No.
  The service numbers are listed in the Diagnostics Guide.

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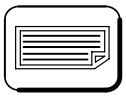
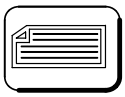
Selection of the spindle service data

The display of the service data is selected with the softkey Diagnosis, Service displays. Selection see also Section 5.4.



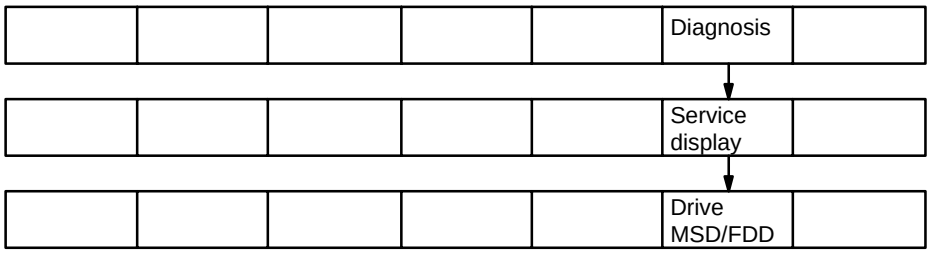
You change over to the following axes with the “Page down” key.

You enter the digit “4” and press the search key to select directly axis 4, for example.



If necessary, you move back to the previous axes with the “Page up” key.

4.3 Drive service displays for spindle (MSD) and axis (FDD) – (as from SW 3)



Explanation

Press the Diagnosis, Service display and Drive MSD/FDD softkeys to call up the drive service display **MSD 1st screen**

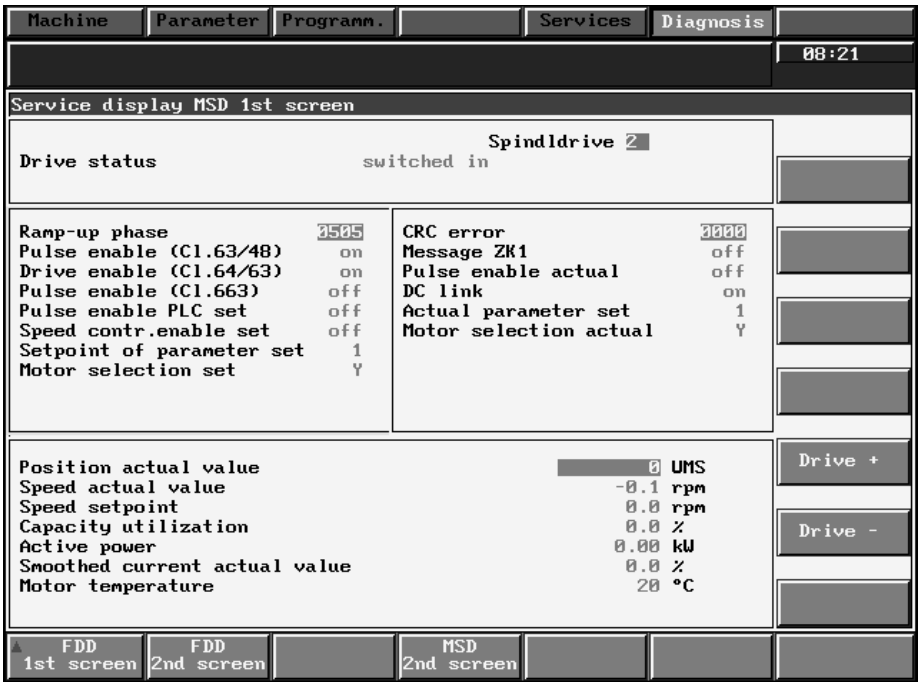


Fig. 4.6

Explanation

The drive service display **MSD 1st screen** gives you an overview of the signals and statuses of the MSD drives and is only a display. The specific drive data (NC, PLC, Drives) set, determine the contents of the display fields.

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Explanation of display fields MSD 1st screen

Drive status

This display field describes the ramp-up and operating status of the digital drives. This status is generated in the SERVO during start-up and then changed accordingly in the display (SW 4: Drive MD 11008).
Possible data:

0 ≙ OFF
1 ≙ On (after the drive has returned status signal to SERVO)
2 ≙ On-line (communication possible)
3 ≙ Bootstrap (drive must be rebooted)
4 ≙ Connected (drive ramp-up completed)
5 ≙ Ready (drive under closed loop control, Power On)

Main spindle drive

This display field describes the actual MSD drive, i.e. the one which has been selected using softkeys drive +/–.

Ramp-up phase

This display field contains the control word for the ramp-up control of the 611D components and exists for each logical digital drive number (drive MD 11000). The ramp-up state set by the SERVO is shown in the high byte and the state acknowledged by the drive is shown in the low byte (see description drive status).

Possible information:

High byte ≙ Set ramp-up status (SERVO)
Values: 0 – 5
Low byte ≙ Acknowledged ramp-up state (drive)
Values: 0 – 5

Possible display range: 0000 – 0505

Pulse enable (terminal 63/48)

This display field contains the status of terminal 63/48 of the infeed/regenerative feedback unit. (SW 3: drive MD 11.2 – pulse suppression for all drives – SW 4: MD 1700.2).
Possible display range: off or on.

Drive enable (terminal 64/63)

This display field contains the status of terminal 64 of the infeed/regenerative feedback unit (SW 3: drive MD 11.6 – for all drives – SW 4: drive MD 1700.6).
Possible display range: off or on.

Pulse enable (terminal 663)

This display field contains the status of terminal 663 (SW 3: drive MD 11.1 – module-specific pulse suppression – SW 4: drive MD 1700.1).
Possible display range: off or on.

Pulse enable PLC setpoint

This display field contains the status of the pulse enable PLC of the cyclic control word 2 (drive MD 11005.7).
Possible display range: off or on.

Speed controller enable setpoint

This display field shows the condition of the speed controller enable NC of cyclic control word 2 (drive MD 11005.9).
Possible display range: off or on.

Setpoint parameter set

This display field contains the current set parameter set of cyclic control word 2 (drive MD 11005.0–2).
Possible display range: 0 – 7

Motor selection setpoint

This display field contains the current motor type of cyclic control word 2 (drive MD 11005.3).
Possible display range: Y or D (≙ star or delta)

CRC error

This display field contains the number of bus transmission errors between NC and drive detected by the hardware (drive MD 11001).
Possible display range: 0000 – FFFF

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Message ZK1	This display field contains the state of message state class 1 of cyclic status word 1 (drive MD 11002.0). Possible display range: off or on.
Pulse enable actual	This display field contains the state of enabled pulses of cyclic status word 2 (drive MD 11003.7). Possible display range: off or on
DC link	This display field contains the status of the DC link (drive MD 11006.0). Possible display range: off or on
Actual parameter set	This display field contains the current actual parameter set of cyclic status word 2 (drive MD 11003.0–2). Possible display range: 0 – 7
Actual motor selection	This display field contains the actual motor type of cyclic status word 2 (drive MD 11003.3). Possible display range: Y or D (≙ star or delta)
Position actual value	This display field contains the current positional actual value (SW 4: drive MD 12000). It is dependent on the position control of the rotary axis (NC MD 5640.5) and position control resolution (NC MD 18000.0–3).
Speed actual value	This display field contains the current speed actual value of the motor (SW 3: drive MD 2/SW 4: drive MD 1707).
Speed setpoint	This display field contains the current speed setpoint of the motor (SW 3: drive MD 1/SW 4: drive MD 1706).
Capacity utilization	This display field shows the capacity utilization of the main spindle drive. Up to the rated speed, the ratio of torque to maximum torque is displayed, and above the rated speed the ratio of power to maximum power is displayed (SW 3: drive MD 4/SW 4: drive MD 1722).
Active power (SW 4)	This display field shows the current active power (drive MD 11011).
Smoothed current actual value (SW 4)	This display field shows the smoothed current actual value in percent (drive MD 1708).
Motor temperature	This display field shows the current motor temperature (SW 3: drive MD 10/SW 4: drive MD 1702).
Status of binary inputs (SW 3)	This display field contains the state of the binary input (drive MD 11). Possible display range: 0000 – FFFF
Display of active functions 1 (SW 3)	This display field contains the current status of active functions 1 (drive MD 254). Possible display range: 0000 – FFFF
Display of active functions 2 (SW 3)	This display field contains the current status of active functions 2 (drive MD 255). Possible display range: 0000 – FFFF

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Drive service display MSD 2nd screen

MSD
2nd screen

Press the **MSD 2nd screen** softkey in the service area for drive MSD/FDD.

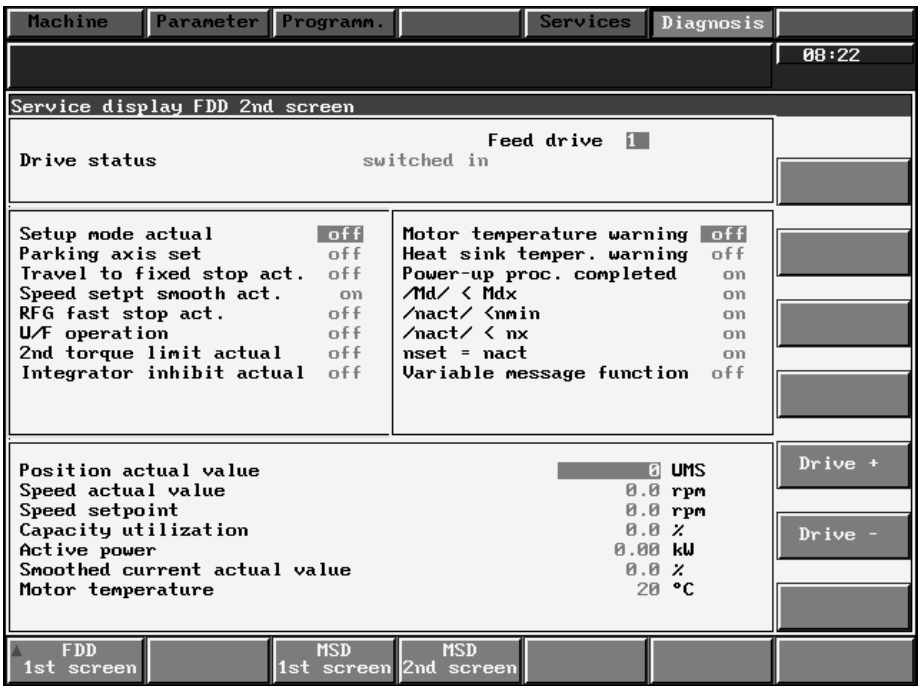

Fig. 4.7

Explanation

The drive service display **MSD 2nd screen** gives you an overview of the signals and statuses of the MSD drives and is only a display. The specific drive data (NC, PLC, Drives) set, determine the contents of the display fields.

Explanation of display fields MSD 2nd screen

Drive status

This display field describes the ramp-up and operating status of the digital drives. This status is generated in the SERVO during start-up and then changed accordingly in the display (SW 4: drive MD 11008).
Possible data:

0 ≙ Off
1 ≙ On (after the drive has returned status signal to SERVO)
2 ≙ On-line (communication possible)
3 ≙ Bootstrap (drive must be rebooted)
4 ≙ Connected (drive ramp-up completed)
5 ≙ Ready (drive under closed loop control, Power On)

Main spindle drive

This display field describes the actual MSD drive, i.e. the one which has been selected using softkeys drive +/–.

Set-up mode actual value

This display field shows the set-up mode status of cyclic status word 1 (drive MD 11002.8).
Possible display range: off or on

Parking axis setpoint

This display field shows the status of parking axis of cyclic control word 1 (drive MD 11004.1).
Possible display range: off or on

Travel to fixed stop actual value

This display field contains the status of travel to fixed stop of cyclic status word 2 (drive MD 11003.13).
Possible display range: off or on

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Speed setpoint smoothing actual value	This display field contains the status of speed setpoint smoothing of cyclic status word 1 (drive MD 11002.11).
Ramp-function generator rapid stop	This display field contains the status of ram-function generator rapid stop of cyclic status word 1 (drive MD 11002.9). Possible display range: off or on
V/F mode	This display field contains the status of V/F mode of cyclic status word 2 (drive MD 11003.12). Possible display range: off or on
2nd momentary limit actual value	This display field shows the status of 2nd momentary limit of cyclic status word 1 (drive MD 11002.10). Possible display range: off or on
Integrator inhibit actual value	This display field shows the status of the integrator inhibit of cyclic status word 1 (drive MD 11003.6). Possible display range: off or on
Motor temperature warning	This display field shows the state of the motor temperature warning (drive MD 11006.14). Possible display range: off or on
Heat sink temperature warning	This display field shows the state of the heat sink temperature warning (drive MD 11006.15). Possible display range: off or on
Programmable messages (SW 3)	This display field shows the status of programmable messages 1–6 (drive MD 11007.0–5). Possible display range: off or on
Ramp-up completed (SW 4)	This display field shows the current status of the message Ramp-function procedure completed (drive MD 11007.0).
$\|M_d\| < M_{dx}$ *(SW 4)*	This display field shows the current status of the message $\|M_d\| < M_{dx}$ (drive MD 11007.1).
$\|n_{act}\| < n_{min}$ *(SW 4)*	This display field shows the current status of the message $\|n_{act}\| < n_{min}$ (drive MD 11007.2).
$\|n_{act}\| < n_x$ *(SW 4)*	This display field shows the current status of the message $\|n_{act}\| < n_x$ (drive MD 11007.3).
$n_{set} < n_{act}$ *(SW 4)*	This display field shows the current status of the message $n_{set} < n_{act}$ (drive MD 11007.4).
Variable message function (SW 4)	This display field shows the current status of the message Variable message function (drive MD 11007.5).
Position actual value	This display field shows the current positional actual value (SW 4: drive MD 12000). It depends on the position control of the rotary axis (NC MD 5640.5) and the position control resolution (NC MD 18000.0–3).
Speed actual value	This display field contains the current speed actual value of the motor (SW 3: drive MD 2/SW 4: drive MD 1707).
Speed setpoint	This display field contains the current speed setpoint of the motor (SW 3: drive MD 1/SW 4: drive MD 1706).
Capacity utilization	This display field shows the capacity utilization of the main spindle drive. Up to the rated speed, the ratio torque to maximum torque is displayed and above the rated speed, the ratio performance to maximum performance is displayed (SW 3: drive MD 4/SW 4: drive MD 1722).
Variable message function (SW 4)	This display field shows the current status of the message Variable message function (drive MD 11011).
Smoothed current actual value (SW 4)	This display field shows the smoothed current actual value in percent (drive MD 1708).

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Motor temperature This display field shows the current motor temperature (SW 3: drive MD 1/SW 4: drive MD 1702).

Status of binary inputs (SW 3) This display field contains the state of the binary input (drive MD 11). Possible display range: 0000 – FFFF

Display of active functions 1 (SW 3) This display field contains the current status of active functions 1 (drive MD 254). Possible display range: 0000 – FFFF

Display of active functions 2 (SW 3) This display field contains the current status of active functions 2 (drive MD 255). Possible display range: 0000 – FFFF

Drive service display FDD 1st screen

FDD
1st screen

Press the **FDD 1st screen** softkey in the service area for drive MSD/FDD.

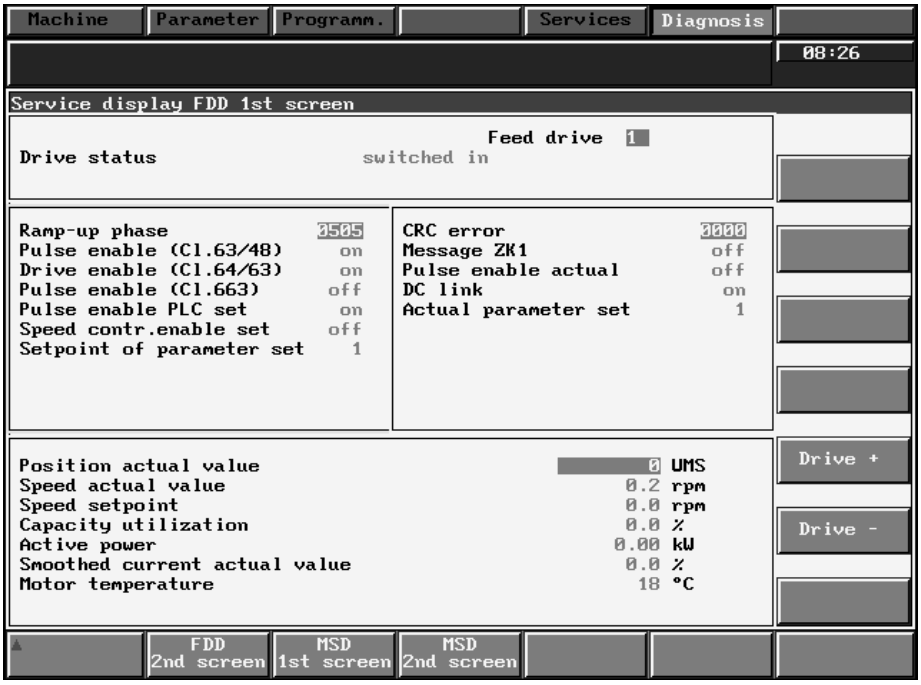

Fig. 4.8

Explanation The drive service display **FDD 1st screen** gives you an overview of the signals and statuses of the MSD drives and is only a display. This specific drive data (NC, PLC, Drives) set, determine the contents of the display fields.

Explanation of display fields FDD 1st screen

Drive status This display field describes the ramp-up and operating status of the digital drives. This status is generated in the SERVO during start-up and then changed accordingly in the display. (SW 4: drive MD 11008).
Possible data:

0 ≙ Off
1 ≙ On (after the drive has returned status signal to SERVO)
2 ≙
2 ≙ On-line (communication possible)
3 ≙ Bootstrap (drive must be rebooted)
4 ≙ Connected (drive ramp-up completed)
5 ≙ Ready (drive under closed loop control, Power On)

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Feed drive	This display field describes the currently selected FDD drive as selected via soft-keys drive +/–.
Ramp-up phase	This display field contains the control word for the ramp-up control of the 611D components and exists for each logical digital drive number (drive MD 11000). The ramp-up state set by the SERVO is shown in the high byte and the state acknowledged by the drive is shown in the low byte (see description drive status).
Pulse enable (terminal 63/48)	This display field contains the status of CI 63/48 of the infeed/regenerative feedback unit. (Drive MD 1700.2 – pulse suppression for all drives). Possible display range: off or on
Drive enable (terminal 64/63)	This display field contains the status of terminal 64 of the infeed/regenerative feedback unit. (Drive MD 1700.6 – for all drives). Possible display range: off or on
Pulse enable (terminal 663)	This display field contains the status of terminal 663 (drive MD 1700.1 – module-specific pulse suppression). Possible display range: off or on
Pulse enable PLC setpoint	This display field contains the status of the pulse enable PLC of the cyclic control word 2 (drive MD 11005.7). Possible display range: off or on
Speed controller enable setpoint	This display field shows the condition of the speed controller enable NC of cyclic control word 2 (drive MD 11005.9). Possible display range: off or on
Set of setpoint parameter	This display field contains the current set parameter set of cyclic control word 2 (drive MD 11005.0–2). Possible display range: 0 – 7
CRC error	This display field contains the number of bus transmission errors between NC and drive detected by the hardware (drive MD 11001). Possible display range: 0000 – FFFF
Message ZK1	This display field contains the state of message state class 1 of cyclic status word 1 (drive MD 11002.0). Possible display range: off or on
Pulse enable actual	This display field contains the state of enabled pulses of cyclic status word 2 (drive MD 11003.7). Possible display range: off or on
DC link	This display field contains the status of the DC link (drive MD 11006.0). Possible display range: off or on
Actual parameter set	This display field contains the current actual parameter set of cyclic status word 2 (drive MD 11003.0–2). Possible display range: 0 – 7
Position actual value	This display field contains the current positional actual value (SW 4: drive MD 12000). It is dependent on the position control of the rotary axis (NC MD 5640.5) and position control resolution (NC MD 18000.0–3).
Speed actual value	This display field contains the current speed actual value of the motor (drive MD 1707).
Speed setpoint	This display field contains the current speed setpoint of the motor (drive MD 1706).
Capacity utilization (SW 4)	This display field shows the capacity utilization of the feed drive. Up to the rated speed, the ratio of torque to maximum torque is displayed, and above the rated speed the ratio of power to maximum power is displayed (drive MD 1722).

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Active power (SW 4) This display field shows the current active power (drive MD 11011).

Smoothed current actual value This display field shows the smoothed current actual value in percent (drive MD 1708).

Motor temperature This display field shows the current motor temperature (drive MD 1702).

FDD drive service display 2nd screen

FDD
2nd screen

Select the **FDD 2nd screen** softkey in the service area for drive MSD/FDD.

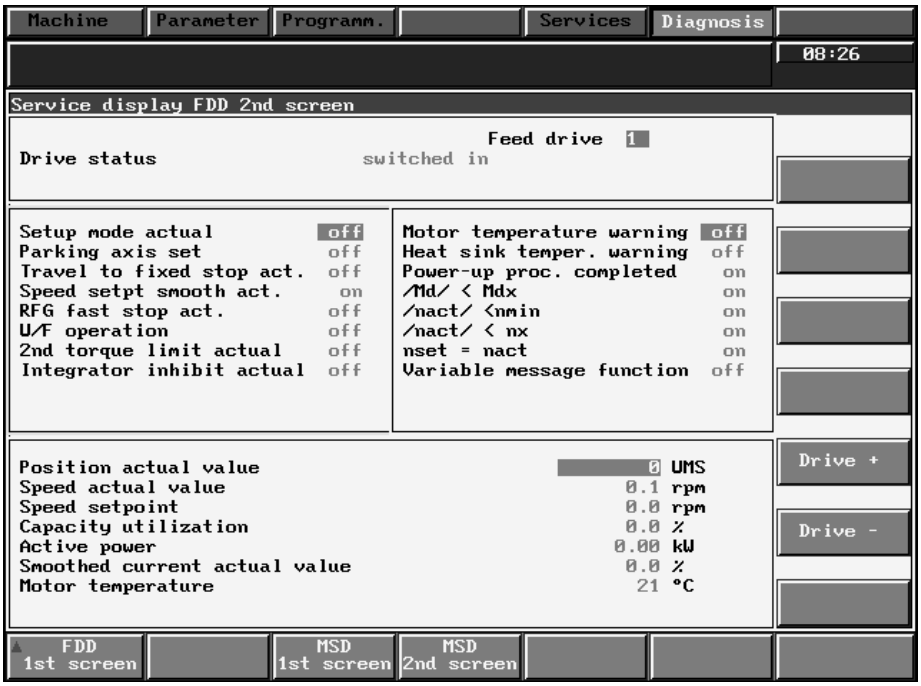

Fig. 4.9

Explanation The drive service display **FDD 2nd screen** gives you an overview of the signals and statuses of the MSD drives and is only a display. The specific drive data (NC, PLC, Drives) set, determine the contents of the display fields.

Explanation of display fields FDD 2nd screen

Drive status This display field describes the ramp-up operating status of the digital drives. This status is generated in the SERVO during start-up and then changed accordingly in the display (SW 4: drive MD 11008).
Possible data:

0 ≙ Off
1 ≙ On (after the drive has returned status signal to SERVO)
2 ≙ On-line (communication possible)
3 ≙ Bootstrap (drive must be rebooted)
4 ≙ Connected (drive ramp-up completed)
5 ≙ Ready (drive under closed loop control, Power On)

Feed drive This display field describes the currently selected FDD drive as selected via sofkeys drive +/–.

Set-up mode actual This display field shows the set-up mode status of cyclic status word 1 (drive MD 11002.8)
Possible display range: off or on

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Parking axis setpoint	This display field shows the status of parking axis of cyclic control word 1 (drive MD 11004.1) Possible display range: off or on
Travel to fixed stop actual	This display field contains the status of Travel to fixed stop of cyclic status word 2 (drive MD 11003.13) Possible display range: off or on
Speed setpoint smoothing actual value	This display field contains the status of speed setpoint smoothing of cyclic status word 1 (drive MD 11002.11).
Ramp-function generator rapid stop actual value	This display field contains the status of ramp-function generator rapid stop of cyclic status word 1 (drive MD 11002.9). Possible display range: off or on
V/F mode	This display field contains the status of V/F mode of cyclic status word 2 (drive MD 11003.12). Possible display range: off or on
2nd torque limit actual value	This display field shows the status of 2nd torque limit of cyclic status word 1 (drive MD 11002.10). Possible display range: off or on
Integrator inhibit actual value	This display field shows the status of the integrator inhibit of cyclic status word 1 (drive MD 11003.6). Possible display range: off or on
Motor temperature warning	This display field shows the state of the motor temperature warning (drive MD 11006.14) Possible display range: off or on
Heat sink temperature warning	This display field shows the state of the heat sink temperature warning (drive MD 11006.15) Possible display range: off or on
Ramp-up completed (SW 4)	This display field shows the current status of the message Ramp-function procedure completed (drive MD 11007.0).
$\|M_d\| < M_{dx}$ *(SW 4)*	This display field shows the current status of the message $\|M_d\| < M_{dx}$ (drive MD 11007.1).
$\|n_{act}\| < n_{min}$ *(SW 4)*	This display field shows the current status of the message $\|n_{act}\| < n_{min}$ (drive MD 11007.2).
$\|n_{act}\| < n_x$ *(SW 4)*	This display field shows the current status of the message $\|n_{act}\| < n_x$ (drive MD 11007.3).
$n_{set} < n_{act}$ *(SW 4)*	This display field shows the current status of the message $n_{set} < n_{act}$ (drive MD 11007.4).
Variable message function (SW 4)	This display field shows the current status of the message Variable message function (drive MD 11007.5).

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4.4 PC data

All data not documented in the following sections must not be changed.

Overview

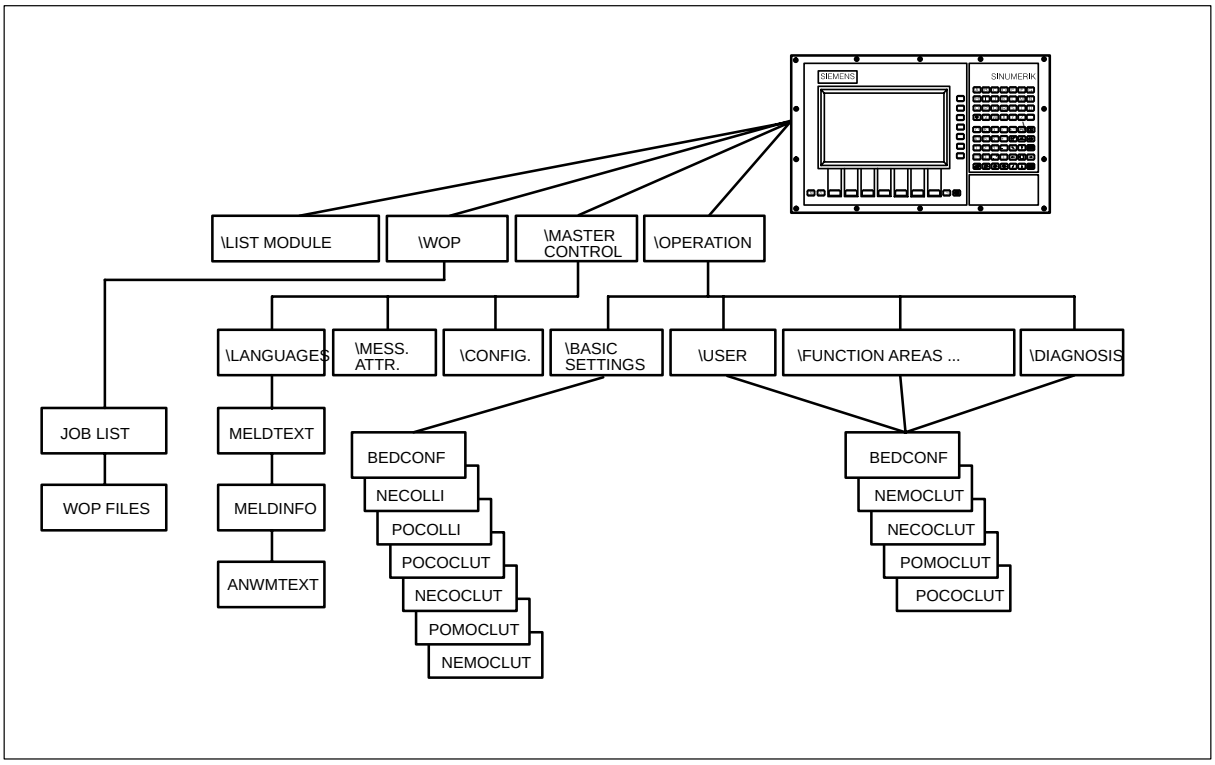

Fig. 4.10 MMC directories and files

Note \LIST_MODULE = directory, MELDTEXT = file

General notes

\List_module Configuration of the MDD using the list module is described in Section Machine data dialog (MDD SW 3 and higher)

Introduction The user interface of the 840C control is divided into MACHINE, PARAMETERS, PROGRAMMING, SERVICES, and DIAGNOSIS function areas. [1)]

You can set up the operator system using a configuration file and a series of other files. The files initially contain default values, but you can change these with the ASCII editor in the MMC area DIAGNOSIS (the ASCII editor is described in the Operator's Guide).

The file system is made up of two branches, SIEMENS and USER. SIEMENS contains the initial system settings which cannot be changed.

If the control does not find any data in the USER branch, it obtains its data from the SIEMENS branch.

1) As from SW 3 also SIMULATION, as from SW 4 simulation is stored in the PROGRAMMING area.

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Keyswitch

If the keyswitch is in position 3 when the system starts up, the control takes its data from the SIEMENS branch. All user data are password protected.

A case where this is necessary is, for example, after a system failure if the configuration files are wrongly parameterized.

Note

This does no apply to the CONFIG file in the directory Master Control.

If the PLC is in the stop state, it cannot read the input image of the machine control panel. In this case, the position of the keyswitch is not evaluated on start-up.

Keyswitch position 3 is set internally on PLC stop.

4.4.1 Copying and editing PC data

Selection

Pressing the softkeys DIAGNOSIS, START-UP and PC DATA will take you into the basic display for PC data.

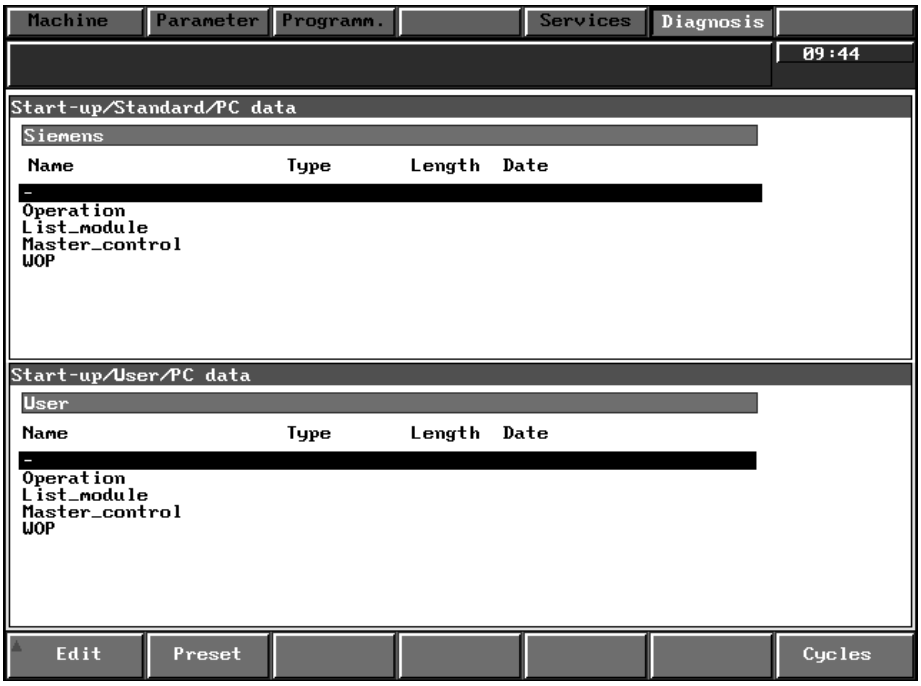

Fig. 4.11

The control is supplied with system data from the directories MASTER CONTROL and OPERATION:

The upper part of the basic display is the SIEMENS branch, containing the initial system settings. This data is protected and cannot be changed.

PRESET

Press the softkey PRESET to copy files from the SIEMENS branch to the USER branch.

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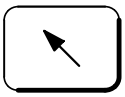
Danger

Up to SW 4:
The data in the USER branch are overwritten without confirmation.

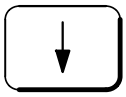
As from SW5:
When you press softkey PRESET you are asked whether you really want to overwrite the data in the USER branch.

Example

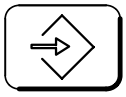
Suppose we want to copy the file CONFIG into the directory MASTER CONTROL.



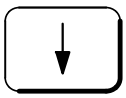
First press the Home key to select the SIEMENS branch in the basic display of the PC data.



Now press the cursor key to select the directory MASTER CONTROL



and confirm with the INPUT key.



Now press the cursor key to select the file CONFIG.

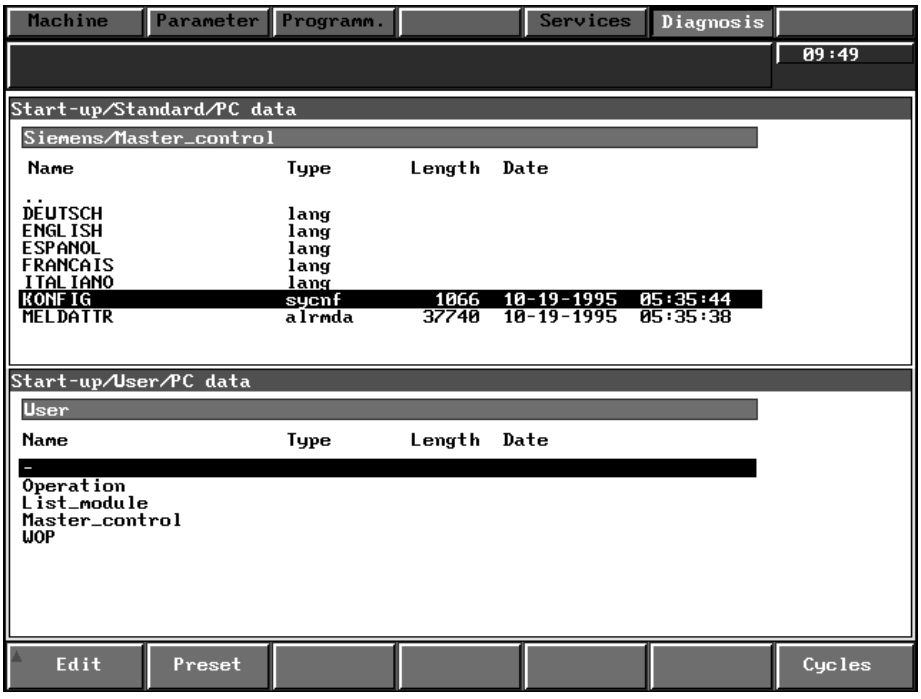


Fig. 4.12

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PRESET

Press the softkey PRESET to copy the file into the USER branch (from SW 5 a configuration window is also displayed).

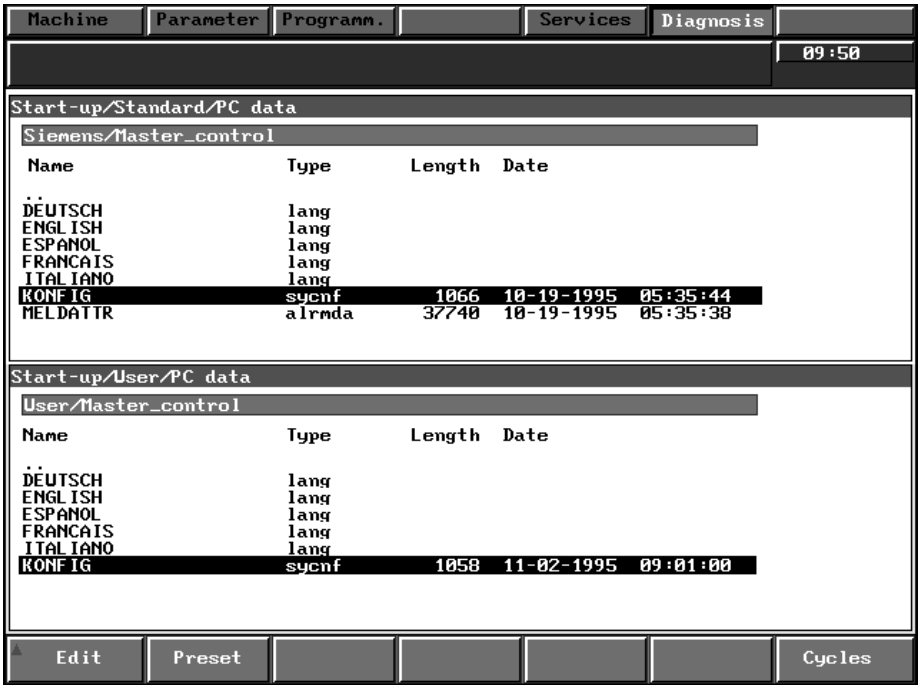

Fig. 4.13

It does not matter which branch is selected. The PRESET softkey always copies the file selected in the SIEMENS branch.

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4.4.2 Configuration file CONFIG

Any files which are not documented here must not be edited.

Selection: SK ... , PC data

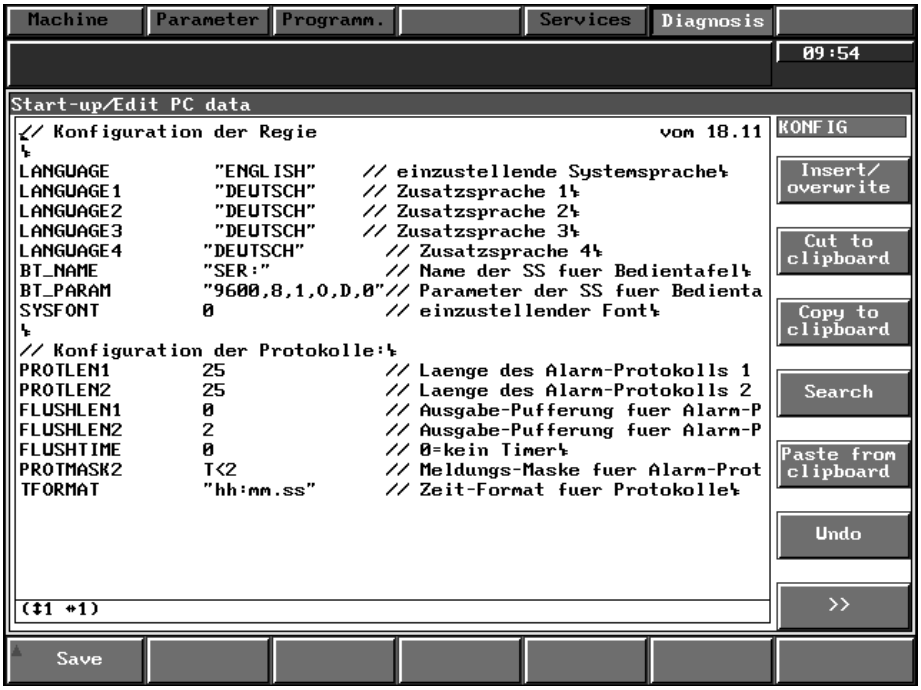

Fig. 4.14

Data format of the configuration file

The configuration file is stored in ASCII format. It consists of a series of lines of up to 80 characters each. Each line consists of a reserved word. Comments begin with the characters // and go on to the end of the line.

Description

The configuration file CONFIG contains the parameters for the following as reserved words (words reserved by the system)

- the language
- the operator panel interface
- the format and number of the entries in the alarm logs,
- the priority of the alarms, messages, comments [1)]
- the format of the time in the protocols.

1) Up to SW 2 only

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4.4.2.1 Keywords

Keywords are words reserved by the system.

The following keywords exist:

- LANGUAGE Language set for NCK and MMC
- LANGUAGE1 Language set for WOP 3)
- LANGUAGE2 Language set for simulation 3)
- LANGUAGE3 Language set for PG function 3)
- LANGUAGE4 Language set for user 3)
- BT_NAME FlexOS name of the operator panel interface
- BT_PARAM Name “”; operation without operator panel
- PROTLEN1 Size of the alarm log in number of messages
- PROTLEN2 Size of the service log in number of messages
- FLUSHLEN1 Maximum number of messages buffered for the alarm log
- FLUSHLEN 2 Maximum number of messages buffered for the service log
- FLUSHTIME Maximum buffering time for messages in milliseconds
- PROTMASK1 Type of messages to be entered in the alarm log 1)
- PROTMASK2 Type of messages to be entered in the service log
- PRIO_PO Display priority of NCK alarms with alarm type “power on” 1)
- PRIO_RE Display priority of NCK alarms with alarm type “reset” 1)
- PRIO_CA Display priority of NCK alarms with alarm type “cancel” 1)
- PRIO_PA Display priority of PLC alarms 1)
- PRIO_PM Display priority of PLC messages 1)
- PRIO_KO Display priority of NCK comments 1)
- SYSFONT Defines the character set in the configuration file of the master control 2)
- TFORMAT Format in which the times are to be written to the log

1) Up to SW 2 only
2) SW 4.4 and higher
3) SW 5 and higher

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4.4.2.2 Value ranges and default values

Keyword	Value range	Default value
LANGUAGE	String of max. 8 characters	“DEUTSCH”
BT_NAME	String of max. 8 characters	“SER:”
PROTLEN1	1 – 32767 (with PROTMODEDISK)	25
PROTLEN2	1 – 32767 (1–200 without PROTMODEDISK)	25
FLUSHLEN1	0 .. 10	0
FLUSHLEN2	0 .. 10	2
FLUSHTIME	0.1 – 32767	0
PROTMASK[1)]	Special format	K = OT < 4 K > 0
PROTMASK2	Special format	T < 2
PRIO_PO [1)]	0,1 – < 32000	10
PRIO_RE [1)]		110
PRIO_CA [1)]		210
PRIO_PA [1)]		310
PRIO_PM [1)]		350
PRIO_KO [1)]		510
SYSFONT [2)]	0, 1, 2	0
TFORMAT	String of max. 20 characters, see above	“hh:mm:ss DD.MM.YY”

Language

This defines the language.
The possible languages are:

- DEUTSCH
- ENGLISH
- ITALIANO
- FRANÇAIS
- ESPAÑOL

The default setting is DEUTSCH (upper case mandatory).
For certain software versions, SWEDISH, RUSSIAN and HUNGARIAN are available.

SYSFONT <character set number>

With SW 4.4 and higher, the character set is defined by an entry in the configuration file of the master control.
Possible character set numbers:
0 Standard character set
1 Cyrillic character set
2 Character set for Slavonic languages (and Hungarian)
3 Portuguese
With SW 5.* and higher, the SYSFONT is stored in the system when selecting the language.

1) Up to SW 2 only
2) SW 4.4 and higher

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BT_Name FlexOS name of the operator panel interface.
For operation without the operator panel enter “” only. The default setting is “SER” (upper case mandatory).

PROTLEN1 This defines the number of messages that are entered in alarm log 1.

PROTLEN2 This defines the number of messages that are entered in alarm log 2.

FLUSHLEN1 Maximum number of messages buffered for the alarm log (lost on voltage failure).

FLUSHLEN2 Maximum number of messages buffered for the service log (lost on voltage failure).

4.4.2.3 Format for log masks

Note As from SW3, the alarms are configured in the ‘MELDATTR’ and ‘MELDTEXT’ files. For configuring notes, please refere to Interface, Part 1.

You can define which messages are to be entered in the log by specifying the attributes of these messages and the limitations which apply to them. Each message attribute is abbreviated to its initial letter (**N**umber, **K**lasse = class), **T**ype, **P**riority). The limitations are specified using the characters ‘<’, ‘>’, ‘=’ and ‘–’. Examples:

N > 1000 Messages with a number greater than 1000 are logged
P < 5 Messages with a priority less than 5 are logged
P = 0 Messages with a priority of 0 are logged
N50 – 100 Messages with a priority between 50 and 100 are logged.

A ‘PROTMASK’ line can comprise several such limitations, which are then interpreted as logically ANDed. If several ‘PROTMASK’ lines (up to 5) are specified for one log they are logically ORed.

The values of type and class of a message are coded as follows:

Type of alarm	Coding
Power-on alarm	0
Reset larm	1
Cancel alarm	2
PLC alarm	3
PLC message	4
NCK comment	5 1)

Class	Coding
NCK	0
System / master control	1
Services	2
Diagnosis	3
Programming	4
User (OEM)	6

Table 4.1 Coding of message types and classes

1) Up to SW2

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For example, the interpretation of following configuration entry:

PROTMASK1 K = OT < 4
PROTMASK1 K > OP < 100
PROTMASK2 N1000 – 110000

All the NCK alarms with a message type smaller than 4 are entered in the alarm log (i.e. power-on until PLC alarm) and all non-NCK messages with a priority smaller than 100. All messages with numbers between 1000 and 110000 are entered in the service log.

TFORMAT

Format for times in the logs.
To define the format in which the times of message input and acknowledgement are entered in the logs, a string of up to 20 characters is specified in the configuration file.

The following patterns indicate the positions of time values:

- DD Day
- MM Month
- YY Year in two figures
- YYYY Year in four figures
- hh Hour
- mm Minute
- ss Second

For example, the pattern “DD.MM.YYYY – hh:mm.ss” generates times in the following format:
“17.05.1992 – 14:32.21”
and the pattern “hh:mm [MM/DD/YY]”:
“14:32 [05/17/92]”.

4.4.2.4 Reduce number of accesses to the hard disk (HD)

General

The SINUMERIK 840C system software allows you to reduce the number of accesses to the hard disk (HD) of the MMC CPU. This helps to extend the service life of the hard disk. The reduction of the number of accesses to the MMC CPU hard disk is particularly advisable for machines with a high rate of vibration.

Most accesses to the hard disk (HD) of the MMC CPU occur in the automatic mode and by entering alarms and messages into the alarm log 1 and log 2. The entries in the alarm logs should, therefore, be reduced to a minimum.

Reduction of entries in the alarm logs

The following applies to system software up to version 6:
You can assign the password PROTMASK1 and PROTMASK2 to the entries in question in the configuration file CONFIG of the master control. These entries are explained in section 4.4.2 ”Configuration file CONFIG” and in section 4.4.2.3 ”Format for log masks”.

The following applies to system software as from SW 6 and higher:
The alarm logs are stored in their basic setting in the RAM and are written to the hard disk (HD) of the MMC CPU through one of the following operator actions:

- Softkey function ”Save to disk”
- Display a log
- Redisplay a log

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You can reactivate the write enable function on the hard disk of the MMC CPU making an entry to the configuration file of the master control CONFIG (PROT-MODE DISK). This way you can provide for the same compatible behavior as is applicable to systems with SW 6 and lower.

In addition, a cache has been built in for alarm descriptions (SW 6 and higher). This reduces the read accesses to a minimum. The last 50 alarm occurrences are listed in the default memory setting of this cache. The number can be preset by entering the following command in the configuration file CONFIG:
MELDCACHE <n>

Be sure that a capacity of approx. 100 byte RAM is reserved for each item in the cache.

Use the command MELDCACHE 0 to provide for the same compatible behavior as is applicable to systems with SW 6 and lower.

4.4.3 BEDCONF configuration file

Description

Various BEDCONF files are available.

The configuration data stored in the file BEDCONF parameterize the operator system with the MMC areas to be managed and the globally set system characteristics. These files are ASCII files and can be edited. To edit it, press “PC data” in the MMC area DIAGNOSIS.

Caution

Errors in this file can cause system failure!
Unassigned parameters must not be changed.

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4.4.3.1 Configuration file BEDCONF in directory Operation/Basic Setting

```
// . 0 0 0  reftab.tb
a 2 5 3     'MASCHIN'  'PARAMET'  'PROGRAM'  'ANWENDE'  'DIENSTE'    \
            'DIAGNOS'  'ANWENDE'  'PROGSYS'  'PLC'      'PLC_DG'     \
            'PLC_PR'   'DG_PLC'   'MDD'      'IBN'      'SIMULAT'    // BAPPLDHNAM
i 1 1 15000 0                                                        // BAPPLIND
a 2 5 1     'BedNCSys'  'BedNCSys'  'BedASys'  'BedASys'  'BedASys'  \
            'BedASys'  'BedASys'  'BedWSys'  'BedNCSys'  'BedNCSys'  \
            'BedNCSys'  'BedWSys'  'BedASys'  'BedASys'  'BedASys'   // BBESYLIST
i 1 1 15000                                                          // BAPPLIND
a 2 5 2     'FK'   'FK'   'fd'   'fd'   'fk'                         \
            'fk'   'fd'   'FD'   'FK'   'FK'                         \
            'FK'   'fd'   'fk'   'fk'   'fd'                         // BAPPLTASTLIST
i 1 1 15000                                                          // BAPPLIND
a 2 5 0     'NCA'   'NCA'   'P_pr'   'bdappl'   'DI_pr'              \
            'DG_pr'   'bdappl'   'PS_pr'   'NCA'   'NCA'             \
            'NCA'   'S5_pr'   'mdd'   'IBSAI'   'Simreg'             // BAPPLIST
i 1 1 15000                                                          // BAPPLIND
a 2 5 5     'NCA.286' 'NCA.286' 'P_PR.286' 'BDAPPL.286' 'DI_PR.286'  \
            'DG_PR.286' 'BDAPPL.286' 'PROGSYS.386' 'NCA.286' 'NCA.286'\
            'NCA.286' 'S5_PR.286' 'MDD.286' 'IBSAI.286' 'SIMREG.286' // BAPPLRUNNAM
i 1 1 15000                                                          // BAPPLIND
a 2 1 3     '-100'     '-100'     '14'      '-100'      '-100'       \
            '9'        '-100'     '-2'      '-100'      '-5'         \
            '-2'       '-5'       '-5'      '-5'        '-2'         // BAPPLSONLIST
i 1 1 15000                                                          // BAPPLIND
a 2 1 0     '1'        '2'        '0'       '0'         '4'          \
            '0'        '0'        '0'       '3'         '0'          \
            '0'        '0'        '0'       '0'         '0'          // BAPPLSTARTLIST
i 1 1 15000                                                          // BAPPLIND
a 2 1 1     '0'        '0'        '0'       '0'         '0'          \
            '0'        '0'        '1'       '0'         '0'          \
            '0'        '0'        '0'       '0'         '2'          // BAPPLCLUTLIST
i 1 1 15000                                                          // BAPPLIND
a 2 1 5     '0'        '0'        '0'       '4'         '0'          \
            '0'        '4'        '1'       '0'         '0'          \
            '0'        '3'        '0'       '0'         '2'          // BAPPLLANLIST
i 1 1 15000                                                          // BAPPLIND
a 2 1 2     '0'        '0'        '0'       '0'         '0'          \
            '0'        '0'        '0'       '0'         '0'          \
            '0'        '0'        '0'       '0'         '0'          // BAPPLCLUSTLIST
i 1 1 15000                                                          // BAPPLIND
a 2 1 4     '0'        '0'        '0'       '0'         '0'          \
            '0'        '0'        '0'       '1'         '0'          \
            '0'        '0'        '0'       '0'         '0'          // BAPPLIMPLANWAHL
i 1 1 15000                                                          // BAPPLIND
i 2 5 15000 'd_ma_co:' 'd_pa_co:' '0'       '0'         '0'          \
            '0'        '0'        '0'       'd_pe_co:'  'd_dp_02:'   \
            'd_pp_02:' '0'        '0'       '0'         '0'          // BAPPLSWKKLIST
i 1 1 15000                                                          // BAPPLIND
i 2 5 15001 'd_ma_ft:' 'd_pa_ft:' '0'       '0'         '0'          \
            '0'        '0'        '0'       'd_pe_ft:'  'd_dp_01:'   \
            'd_pp_01:' '0'        '0'       '0'         '0'          // BAPPLSWKFTLIST
i 1 1 15000                                                          // BAPPLIND
i 2 5 15002 '0,0'  '0,0'  '0,0'  '0,0'  '0,0'  '0,0'  '0,0'         // BAPPLANWSKLIST
i 1 1 15000                                                          // BAPPLIND
i 2 2 15000 '0'        '0'        '0'       '0'         '0'          \
            '0'        '0'        '0'       '0'         '134'        \
            '138'      '0'        '0'       '0'         '0'          // BAPPLMENINDLIST
i 1 1 15000                                                          // BAPPLIND
i 2 2 15001 '0'        '0'        '0'       '0'         '0'          \
            '0'        '0'        '0'       '0'         '0'          \
```


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```
            '0'       '0'       '0'       '0'       '0'          // BAPPLMENMODLIST
i 1 1 15000                                                      // BAPPLIND
i 2 2 15002 '0'       '1'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '2'       '1'          \
            '1'       '0'       '0'       '0'       '0'          // BAPPLNCBERLIST
i 1 1 15000                                                      // BAPPLIND

a 2 1 100   '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiMachine
a 1 1 3      0
a 2 1 101   '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiParameter
a 1 1 3
a 2 1 102   '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'         // TermiProgramming
a 1 1 3
a 2 1 103   '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiUser
a 1 1 3
a 2 1 104   '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiServices
a 1 1 3
a 2 1 105   '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiDiagnosis
a 1 1 3
a 2 1 106   '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiUser
a 1 1 3
a 2 1 107   '14'      '11'      '12'      '13'      '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiWOP
//a 2 1 107 '11'      '12'      '13'      '0'       '0'          \
//          '0'       '0'       '0'       '0'       '0'          \
//          '0'       '0'       '0'       '0'       '0'          // TermiWOP
a 1 1 3
a 2 1 108   '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiPLC
a 1 1 3
a 2 1 109   '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiPLC_DG
a 1 1 3
a 2 1 110   '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiPLC_PR
a 1 1 3
a 2 1 111   '14'      '7'      '12'      '13'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiDG_PLC
a 1 1 3
a 2 1 112   '14'      '7'      '11'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiMDD
a 1 1 3
a 2 1 113   '14'      '7'      '11'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          \
```


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```
            '0'       '0'       '0'       '0'       '0'          // TermiIBN
a 1 1 3

a 2 1 114   '7'       '11'      '12'      '13'      '0'          \
            '0'       '0'       '0'       '0'       '0'          \
            '0'       '0'       '0'       '0'       '0'          // TermiSimulation
//a 2 1 114 '11'      '12'      '13'      '0'       '0'          \
//          '0'       '0'       '0'       '0'       '0'          \
//          '0'       '0'       '0'       '0'       '0'          // TermiSimulation
a 1 1 3

a 1 1 1   15          // BAPPLANZ
a 1 1 2   12          // BINPUTMODE
a 1 1 5   106         // BBUSY_FCOL
a 1 1 6   98          // BBUSY_BCOL
a 1 1 7   0           // BSK_NOT_CENTER
a 1 5 1   CO          // BCOLORMONO_DEF
a 1 5 2   PO          // BPOSNEG_DEF
a 1 5 4   MMCSYS:BIN/ // BPOSNEG_DEF
a 1 5 6   TIFF        // BHARDCOPY_DEF
a 1 5 7   0           // Hardcopy File Format
a 1 7 0   3600000     // BSCREENSAVE
i 1 2 15000  2        // BANZLINESMZ_DEF

i 1 2 2207   0        // BAEFGCOLOR_DFLT
i 1 2 2208   7        // BAEBGCOLOR_DFLT
i 1 2 2209   0        // BAESATZNR_FLAG_DFLT
i 1 2 2210   5        // BAESATZNR_STEP_DFLT
i 1 2 2211   5        // BAESATZNR_START_DFLT

l 1 2 16000 0         // Change to 1 only when MMC-CPU with 16MB RAM
l 1 2 16001 0         //

l 1 5 16002 0         // HD Bytes free
l 1 5 16003 .         // Name for search
l 1 6 16004 0         // Simulation

l 1 2 15010 0         // Icon 1
l 1 2 15011 0         // Icon 2
l 1 2 15012 0         // Icon 3
l 1 2 15013 0         // Icon 4
l 1 2 15014 0         // Icon 5
```

Note

The parameters described below are to be found in different lines of file BEDCONF depending on the software version.

BAPPL CLUTLIST

The parameter **BAPPL CLUTLIST** defines whether a CLUT list is assigned to the area in question. Enter a “1” to activate the CLUT list assigned to this area.

BSYSFONT

The parameter **BSYSFONT** assigns a character set to the language which is set in the KONFIG configuration file in the MASTER CONTROL area. The value 0 is assigned to the European languages (Standard languages). The value 1 is assigned to the Russian language (cyrillic character set). The value 2 is assigned to the scandinavian languages (Hungarian).

With SW 4.4 and higher, the character set is defined by an entry in the configuration file of the master control.

BSK_NOT_CENTER (as from SW 5.4)

This parameter defines whether the softkey texts are to be output centered or without any formatting. The default setting is centered. If the value is changed to 1, the centering is deactivated and the texts in the softkeys appear in the way they have been configured.

BCOLORMONO_DEF

The parameter **BCOLORMONO_DEF** defines whether the screen display is in monochrome mode (enter MO) or in color mode (enter CO).

You can enter MO or CO here but be sure to enter the parameter in capital letters.

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BPOSNEG_DEF

The parameter **BPOSNEG_DEF** sets whether the screen display is to be in positive mode (enter PO) or in negative mode (enter NE).

You can enter PO or NE here but be sure to enter the parameter in capital letters.

Positive mode means black lettering on a white background and negative mode means white lettering on a black background.

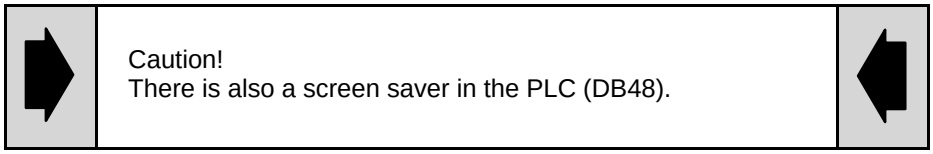
BSCREENSAVE

The parameter **BSCREENSAVE** defines the time after which the screen saver of the operator panel will darken the screen if no input has been made. The default 3600000 defines a time delay of two hours. The value must be positive,d a value of 500 represents a delay of one second.

You can switch off the screen saver by placing the comment characters in front of the value, (e.g. // **a 1 7 0 3600000**).

Note

CLUT : Color Look-up Table
MO : Monochrome mode
CO : Color mode
PO : Positive mode
NE : NEGATIVE mode



BANZLINESMZ_DEF

The parameter BANZLINESMZ_DEF

The number of lines in the message line, either one or two, is defined in **BANZLINESMZ_DEF**.

The following values are permissible:

1: one-line message line
2: two-line message line

	Values	
i 1 2 15000	2	BANZLINESMZ_DEF

BAEFCOLOR_DFLT

The ASCII editor is preset with the values. The value in **BAEFCOLOR_DFLT** defines the foreground color. Values from 0 to 7 are permissible (see color look-up table).

BAEBCOLOR_DFLT

The parameter **BAEBCOLOR_DFLT** line 134 defines the background color. Values from 0 to 7 are permissible.

Values recommended for monochrome display:

CLUT	POMOCLUT	POCOCLUT	NEMOCLUT	NECOCLUT
Foreground Line 133	5	0	7	7
Background Line 134	7	7	0	0

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The parameters below contain the preset values for block generation.

BEASATZNR_FLAG_DFLT The **BEASATZNR_FLAG_DFLT** word specifies the selection; block number YES parameter = 1 or block number NO parameter = 0.

BAESATZNR_STEP_DFLT The value specified in **BAESATZNR_STEP_DFLT** defines the block number steps.

BAESATZNR_START_DFLT The starting address is specified in **BAESATZNR_START_DFLT**.

These values can be changed temporarily in the ASCII editor. After power on, however, the preset values are valid.

If an MMC CPU with 16 MB is used, the following line must be inserted in Bedconf file (in the user branch) unless it already exists:

l 1 2 16000 1 // Change to 1 only when MMC-CPU with 16 MB RAM L_F

ICON 1–5 Three icon fields underneath the system clock are available for displaying the icons. The first icon field is assigned to the MMC area. (Icon fields 2 and 3 are assigned by the PLC, see Interface, Part 1).

Mutual exclusion of applications depending on the capacity of the main memory

Because the main memory capacity is not unlimited, some applications are mutually exclusive.

A “termination list” therefore exists for every application.

This list contains the applications that must be terminated to be able to start the selected application.

Example:

The possible applications are defined by the following lines in the file BEDCONF:

```
a 2 5 3     'MASCHIN'   'PARAMET'   'PROGRAM'   'ANWENDE'   'DIENSTE'   \
            'DIAGNOS'   'ANWENDE'   'PROGSYS'   'PLC'       'PLC_DG'    \
            'PLC_PR'    'DG_PLC'    'MDD'       'IBN'       'SIMULAT'   //BAPPLDH-
                                                                        NAM
```

where MACHINE is the 0th application, PARAMETER the 1st, SIMULATION the 14th.

In the WOP and SIMULATION applications the mutual exclusion is defined by the following lines from the BEDCONF file:

```
a 2 1 107   '14'    '11'    '12'    '13'    '0'     \
            '0'     '0'     '0'     '0'     '0'     \
            '0'     '0'     '0'     '0'     '0'     //TermiWOP

a 2 1 114   '7'     '11'    '12'    '13'    '0'     \
            '0'     '0'     '0'     '0'     '0'     \
            '0'     '0'     '0'     '0'     '0'     //TermiSimu-
                                                    lation
```

For simulation this means that if they are running, the following applications must be terminated before it can be started:

7	PROGSYS	(= WOP)
11	DG_PLC	(= S5 programming)
12	MDD	(= Machine data dialog)
13	IBN	(= Drive servo start-up)

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With a main memory capacity of 16 MB the mutual exclusion of certain applications can be cancelled.

This is the case for the mutual exclusion of the optional applications WOP and SIMULATION.

To cancel the exclusion of WOP, the following lines have already been inserted in the BEDCONF file:

```
/ / a  2  1  107   '11'      '12'      '13'      '0'      '0'      \
/ /                '0'       '0'       '0'       '0'      '0'      \
/ /                '0'       '0'       '0'       '0'      '0'      //TermiWOP

/ / a  2  1  114   '11'      '12'      '13'      '0'      '0'      \
/ /                '0'       '0'       '0'       '0'      '0'      \
/ /                '0'       '0'       '0'       '0'      '0'      //TermiSimulation
```

These lines are marked as comments by the characters // at the beginning of the line and therefore have no effect.

To activate them, remove the comment characters and place them in front of the three immediately preceding lines instead.

Because it is only possible to process the file in the user branch, the file BEDCONF is copied there by Preset.

4.4.3.2 Configuring file BEDCONF in directory OPERATION/PROGRAM

Example

The text in the toggle fields for the screen form channel information for setting the wait marks is configured in the BEDCONF file (variable a 45232).

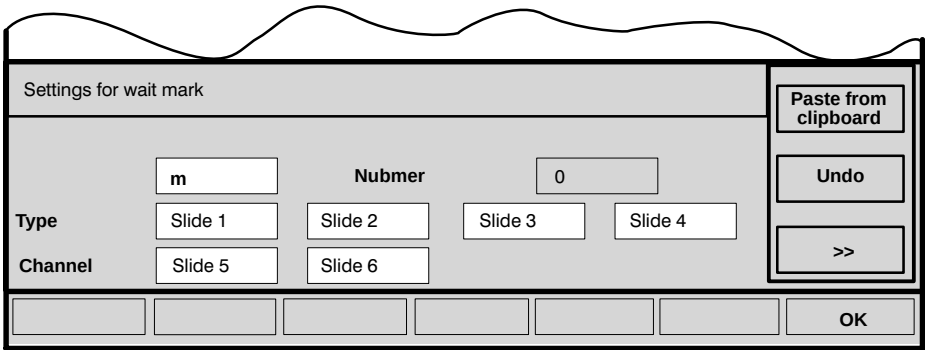

Fig. 4.15

PRESET

With the PRESET softkey, the file is copied to the user branch where it can be edited with the ASCII editor.

Caution

Any errors in this file can lead to system failure.

Any text of maximum 10 characters can be entered in line 37 between the speech marks.

SAVE

Any changes made are stored on the hard disk using the SAVE softkey.

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The configured texts are activated on Power on.

```
35 LF
36 a 4 5 232 \                                        // Values for
37 '– '  'Slide1' 'Slide2' 'PORTAL' 'Loader' LF
38 d 1 1 0 LF
39 LF
```

Fig. 4.16

4.4.3.3 Configuration file BEDCONF in directory/Operation/DIAGNOS

If changes are made in the system menus NC service, PLC service and NC info, line

d 2 5 51 127,0 105,0 102,0 // NC service PLC service NC info

must be replaced by

d 2 5 51 127,4 105,4 102,4 // NC service PLC service NC info

in this file.

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4.4.4 Color definition tables

4.4.4.1 10” color display (up to SW 4.4) 6FC5 103–0AB□2–0BA0

Introduction

In the color definition tables, you can define the individual colors by mixing RGB proportions. The operator system reserves a default color table for each of the possible system settings in the BEDCONF file combining positive or negative with color or monochrome mode. These default tables can be activated if this is defined in the configuration file for the relevant area.

Naming

The color tables are named according to the following rules: The last four letters of the name of all the tables are CLUT; The two letters preceding those are the code for color or monochrome mode (CO or MO) and the first two letters of the name are the code for positive or negative display mode (PO or NE). There is therefore always a set of four tables named: POCOCLUT, POMOCLUT, NECO-CLUT and NEMOCLUT.

Color tables are ASCII files that can be edited with the editor. A color table contains the definitions of 16 colors, each defined on a separate line. The example below shows POCOCLUT with its default values. There are global CLUTs and CLUTs. The global CLUTS are stored in the directory BASIC SETTINGS and the area CLUTs are stored in the individual areas (MACHINE, SERVICES etc.). By changing the data in the area CLUTs, you can assign a new color definition to an individual MMC area (e.g. MACHINE or DIAGNOSIS).

Example (Color and positive display modes)

Suppose we want to change the colors displayed in the MACHINE area. A zero is entered in the configuration file BEDCONF (in the global area) to indicate that no CLUT is defined for the area MACHINE in the “BAPPLCLUTLIST” (variable a211). If we now enter a 2 (or any other value >0), we indicate that we want an area CLUT to be used. If the same value has been entered at another point in the BAPPLCLUTLIST, CLUT is not reloaded when the area is changed.

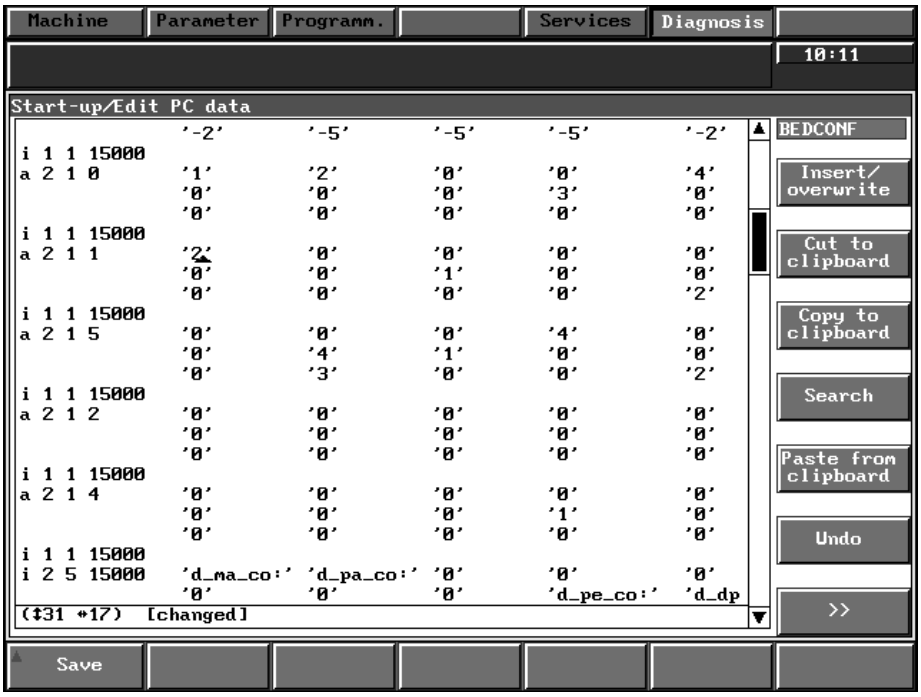

Fig. 4.17

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Changing the file POCOCLUT for the MACHINE area

PRESET

If no CLUTs are available in the user branch OPERATION/MACHINE, they must be copied from the Siemens branch to the user branch with the softkey.

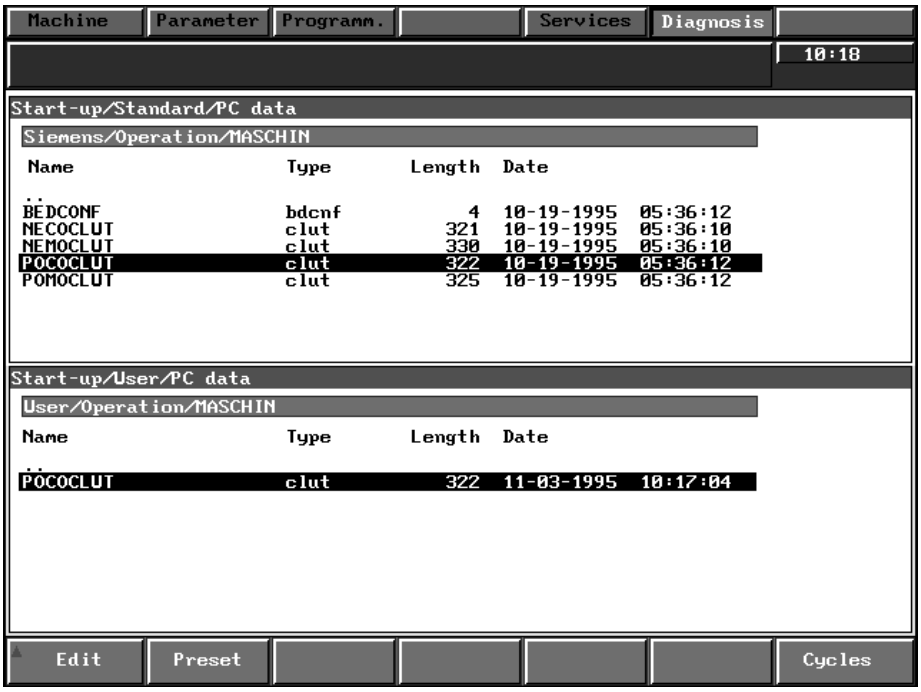

Fig. 4.18

The file POCOCLUT is selected with the cursor in the user area OPERATION/ MACHINE and softkey EDIT.

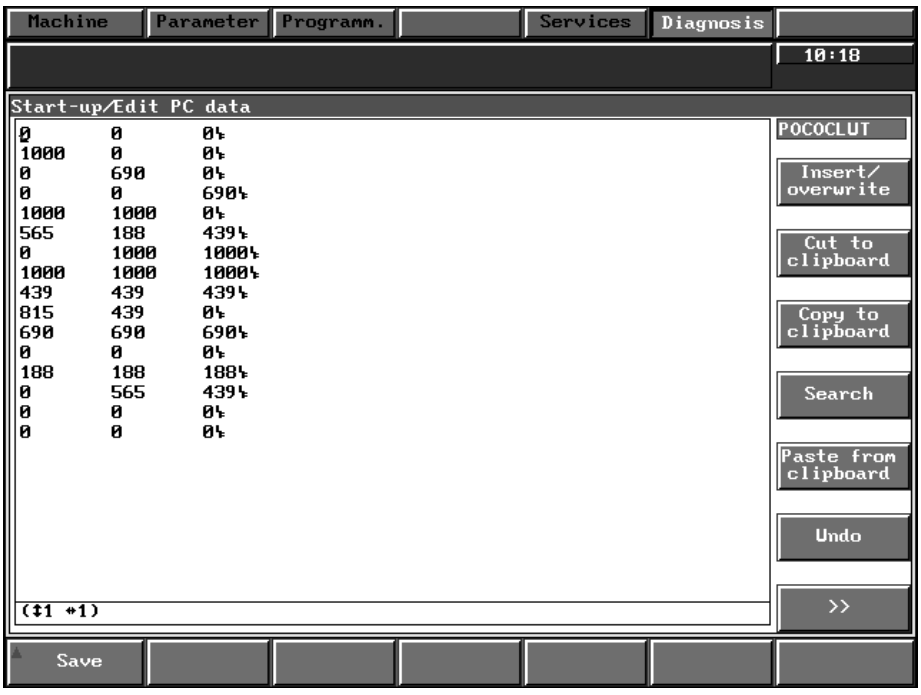

Fig. 4.19 Color table: POCOCLUT

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SAVE

The change is made in the ASCII editor and must be saved on the hard disk using the softkey save.

The new colors become active after the next POWER ON.

The value range for each primary color is between 0 and 1000. 1000 is the highest intensity of color.

Color table **POCOCLUT** **NECOCLUT**

Color index	Color	Red	Green	Blue	Color	Red	Green	Blue
0	black	0	0	0	black	0	0	0
1	red	1000	0	0	red	1000	0	0
2	green	0	714	0	green	0	714	0
3	blue	0	0	714	blue	0	0	1000
4	yellow	1000	1000	0	yellow	1000	1000	0
5	violet	524	111	397	violet	650 3)	0	650 3)
6	cyan	0	1000	1000	cyan	0	1000	1000
7	white	952	985	952	white	1000	1000	1000
8	grey	444	524	540	grey	444	524	540
9	orange	794	397	16	orange	1000	492	0
10 2)	free 2)	0	0	0	free	0	0	0
11 0)	free 1)	0	0	0	free	0	0	0
12	grey	159	159	159	grey	159	159	159
13	petrol	0	508	444	petrol	0	508	444
14	free	0	0	0	free	0	0	0
15	free	0	0	0	free	0	0	0

Color table **POMOCLUT** **NEMOCLUT**

Color index	Color	Red	Green	Blue	Color	Red	Green	Blue
0	black	0	0	0	black	0	0	0
1	grey	256	256	256	grey	794	794	794
2	black	0	0	0	white	1000	1000	1000
3	black	0	0	0	white	1000	1000	1000
4	black	0	0	0	white	1000	1000	1000
5	grey	413	413	413	grey	604	604	604
6	grey	698	698	698	grey	698	698	698
7	white	1000	1000	1000	white	1000	1000	1000
8	grey	524	524	524	grey	524	524	524
9	grey	413	413	413	grey	413	413	413
10 2)	free 2)	0	0	0	free 1)	0	0	0
11	free	0	0	0	free	0	0	0
12	grey	698	698	698	grey	159	159	159
13	grey	508	508	508	grey	508	508	508
14	free	0	0	0	free	0	0	0
15	free	0	0	0	free	0	0	0

0) As from SW 2 not available for users
1) As from SW 3 = 794
2) As from SW 3 = 720
3) As from SW 3 = 750

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4.4.4.2 New 19” operator panel as from SW 4.5 (5) 6FC5 103–0AB□□–□AA1

Standard CLUT table

There is a new standard POCOCLUT and NECOCLUT table for color. The values entered then apply to the 19” operator panel with a 14” color screen and the 19” slimline operator panel with a 9.5” color screen. The standard POMOCLUT and NEMOCLUT are also adapted to the new 19” slimline operator panel with a 9.5” monochrome screen.

If the old 19” monochrome slimline operator panel is used (with a red display) the settings must still be made as described in the section, Color settings for monochrome display.

Color table Standard setting

For **positive** screen display: **POCOCLUT**

For **negative** screen display: **NECOCLUT**

Color index	Color	Red	Green	Blue	Color	Red	Green	Blue
0	black	0	0	0	black	0	0	0
1	red	1000	0	0	red	1000	0	0
2	green	0	690	0	green	0	760	0
3	blue	0	0	690	blue	0	0	1000
4	yellow	1000	1000	0	yellow	1000	1000	0
5	violet	565	188	439	violet	690	0	690
6	cyan	0	1000	1000	cyan	0	1000	1000
7	white	1000	1000	1000	white	1000	1000	1000
8	grey	439	439	439	grey	439	439	439
9	orange	815	439	0	orange	1000	439	0
10	free	690	690	690	free	0	0	0
11	free	0	0	0	free	0	0	0
12	grey	188	188	188	grey	188	188	188
13	petrol	0	565	439	petrol	0	565	439
14	free	0	0	0	free	0	0	0
15	free	0	0	0	free	0	0	0

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Color table
Standard setting
8 tones of grey

For **positive** screen display: **POMOCLUT**

For **negative** screen display: **NEMOCLUT**

Color index	Color	Red	Green	Blue	Color	Red	Green	Blue
0	black	0	0	0	black	0	0	0
1	grey	0	0	0	grey	627	627	627
2	black	0	0	0	white	1000	1000	1000
3	black	0	0	0	white	1000	1000	1000
4	black	376	376	376	white	1000	1000	1000
5	grey	376	376	376	grey	627	627	627
6	grey	627	627	627	grey	627	627	627
7	white	1000	1000	1000	white	1000	1000	1000
8	grey	376	376	376	grey	376	376	376
9	grey	0	0	0	grey	376	376	376
10	free	627	627	627	free	627	627	627
11	free	0	0	0	free	0	0	0
12	grey	627	627	627	grey	376	376	376
13	grey	627	627	627	grey	627	627	627
14	free	0	0	0	free	0	0	0
15	free	0	0	0	free	0	0	0

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4.4.4.3 Defining individual color tables (as from SW 5.4)

Introduction

As from SW 5.4, the user can define his own color tables (for example, for different displays).

The names for the color tables (object type clut) of the applications are selectable; however, some rules must be observed.

As a convention, the names of the individual color tables are formed by combining the acronyms PO or NE (for positive/negative representation) and CO or MO (for color/monochrome representation) followed by the designation CLUT; this convention is extended by the selection of acronyms for color/monochrome representation. It is now possible to use not only the acronyms CO or MO, but also C0 to C9 (M0 to M9) and CA to CZ (MA to MZ). It is allowed to add name extensions to the acronyms C and M in the form of numbers 0 to 9 or letters A to Z (no special characters).

It is therefore possible to form color tables with the following names:

- POC[0–9, A–Z]CLUT
- POC[0–9, A–Z]CLUT
- POM[0–9, A–Z]CLUT
- NEM[0–9, A–Z]CLUT

The acronyms are stored as follows in the configuration file of the operator system:

a 1 5 1 MZ //BCOLORMONO_DEF

a 1 5 2 NE // BPOSNEG_DEF

Example 1 for entries in the configuration file:

a 1 5 1 MZ //BCOLORMONO_DEF

a 1 5 2 NE // BPOSNEG_DEF

The color table with the name POC1CLUT is loaded for the corresponding application if it is available there, otherwise the color table POCOCLUT is taken as standard setting.

Example 2 for entries in the configuration file:

a 1 5 1 MZ //BCOLORMONO_DEF

a 1 5 2 NE // BPOSNEG_DEF

The color table with the name NEMZCLUT is loaded for the corresponding application if it is available there, otherwise the color table NEMOCLUT is taken as standard setting.

Note

- When using the CLUT names, it must be observed that the corresponding file (e.g. POC1CLUT) must be available both in the file tree under the catalog Operation/Basic settings and in the catalog Operation/Function area, with the term Function area standing for the corresponding application, e.g. diagnosis or simulation.
- When selecting the acronyms, it must be observed that the numbers 0 to 9 and the letter O are reserved for the system (Siemens).
- When naming the color tables, you must also take into account the names for the icons. If necessary, the files moikone1 to moikone5 and modanger must be changed to mzikone1 to mzikone5 and mzdanger.

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4.4.5 Color mapping lists

Introduction

The operator system works with symbolic colors represented by numbers within the range 0 to 127. For example, the background of the softkey bars is in color 65. A real color (from the color table) is assigned to color 65 in a color mapping list.

A color mapping list consists of 127 entries. The position of each entry in the list corresponds to the number of a color. The value at that position is a reference to the color definition table.

The mapping tables POCOLLI and NECOLLI are shown below (named according to rules analogous to those of the definition tables).

You will find these files in directory Operation/Basic settings.

The parts of the display where the symbolic colors are used is defined in the table for assigning picture elements to symbolic colors.

Color mapping list **POCOLLI** [1)]

0 0	1 1	2 2	3 3	4 4	5 5	6 6	7 7	8 8	9 9	10 10	11 11	12 12	13 13	14 14	15 15
16 0	17 0	18 0	19 0	20 0	21 0	22 0	23 0	24 0	25 0	26 0	27 0	28 0	29 0	30 0	31 0
32 0	33 0	34 0	35 0	36 0	37 0	38 0	39 0	40 0	41 0	42 0	43 0	44 0	45 0	46 0	47 0
48 0	49 0	50 0	51 0	52 0	53 0	54 0	55 0	56 0	57 0	58 0	59 0	60 0	61 0	62 0	63 0
64 7	65 8	66 7	67 8	68 1	69 5	70 7	71 7	72 5	73 9	74 7	75 1	76 12	77 9	78 12	79 7
80 12	81 2	82 7	83 5	84 0	85 13	86 7	87 8	88 7	89 12	90 12	91 0	92 1	93 3	94 9	95 0
96 5	97 5	98 9	99 8	100 9	101 7	102 0	103 3	104 6	105 2	106 4	107 0	108 0	109 0	110 0	111 0
112 7	113 8	114 7	115 8	116 7	117* 7	118* 0 (7)	119* 0	120* 0	121* 0(13)	122* 0	123* 0	124 0	125 0	126 0	127 0

Color mapping list **NECOLLI**

0 0	1 1	2 2	3 3	4 4	5 5	6 6	7 7	8 8	9 9	10 10	11 11	12 12	13 13	14 14	15 15
16 0	17 0	18 0	19 0	20 0	21 0	22 0	23 0	24 0	25 0	26 0	27 0	28 0	29 0	30 0	31 0
32 0	33 0	34 0	35 0	36 0	37 0	38 0	39 0	40 0	41 0	42 0	43 0	44 0	45 0	46 0	47 0
48 0	49 0	50 0	51 0	52 0	53 0	54 0	55 0	56 0	57 0	58 0	59 0	60 0	61 0	62 0	63 0
64 7	65 8	66 7	67 8	68 1	69 5	70 0	71 7	72 5	73 4	74 0	75 1	76 12	77 4	78 12	79 7
80 12	81 2	82 7	83 5	84 0	85 13	86 7	87 8	88 0	89 12	90 12	91 7	92 1	93 2	94 4	95 3
96 6	97 5	98 9	99 8	100 14	101 7	102 0	103 6	104 3	105 2	106 4	107 0	108 0	109 0	110 0	111 0
112 7	113 8	114 12	115 11	116 11(8)	117* 11	118* 0(11)	119* 0	120* 0	121* 0(13)	122* 0	123* 0	124 0	125 0	126 0	127 0

* As from SW2 reserved by the system
( ) As from SW3
1) For an example of the contents of file POCOLLI see below.

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Example 1 (with color and positive display modes)

Suppose we want to change the background color of the softkey bar. In the **table for assigning picture elements to symbolic colors**, the symbolic color code for the softkey bar background is the number 65. In the color mapping list, a number 8 is entered at position 65. In the color definition table **POCOCLUT**, number 8 stands for grey. If we replace the 8 in the color mapping list **POCOLLI** by a number 1 the background of the softkey bar becomes red.

Example 2 (with color and positive display modes)

Suppose we want to change the text color of the alarms. In the **table for assigning picture elements to symbolic colors**, the symbolic color code for the text color of alarms is the number 75. In the color mapping list, a number 1 is entered at position 75. In the color definition table **POCOCLUT**, number 1 stands for red. The standard color for alarms is therefore red. If we replace the 1 by a 4 the color of the text of alarms changes to yellow.

Picture elements		Symbolic color				
		Back-ground color	Text color	Text back-ground	Border color	Border backgr.
MMC area bar normal		85	84	85	102	90
MMC area bar active		87	86	87	—	—
Message line for alarms		76	75	76	102	90
Message line for messages		78	77	78	102	90
Message line for comments		80	79	80	102	90
Input cursor blinking		—	100	—	—	—
Softkey bar normal		65	64	65	102	90
Softkey bar active		67	66	67	—	—
Borders for 3D display		—	—	—	99 101	—
Symbol for Recall		—	68	—	—	—
Symbol etc.		—	68	—	—	—
Symbol for Info		—	105	—	—	—
Border for active window		112	—	—	106	—
Input fields		113	—	—	—	—
Toggle field writeable		114	—	—	—	—
Toggle field not writeable		115	—	—	—	—
Data selector		116	—	—	—	—
Editor		117	—	—	—	—
Input values		—	73	88	—	—
Window header	MMC	—	60	97	—	—
	NCK	—	82	83	—	—
NC status		89	71	89	102	90
Mode		89	71	89	102	88
Function		—	71	98	—	—
PC status field		—	81	89	—	—
Channel status		—	81	89	—	—
Mode group + channel no.		89	71	89	102	88

Tab. 4.2 Assignment of picture elements to symbolic colors

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Picture elements	Symbolic color				
	Back-ground color	Text color	Text back-ground	Border color	Border backgr.
Configuration area 0 and 1	89	free	88	—	—
Application field	88	—	—	—	—
Cursor text in config. area	—	free	88	—	—
Dialog line	70	69	70	91	88
Cursor text in dialog line	—	free	70	—	—
Input line	74	72	74	91	88
Part program cursor	—	73	88	—	—
Pseudo part program cursor	—	83	88	—	—
Actual values	—	83	88	—	—
Other	—	91	88	91	88

Tab. 4.2 (continued): Assignment of picture elements to symbolic colors

Note

The colors 82 and 83 are used in the NCK displays.

In the MMC displays, color index 97 is used for the text background of the display header line and color index 60 is used for the text color.

Therefore, if changes are made to the POCOLLI, indices 82, 83, 97 and 60 must be changed.

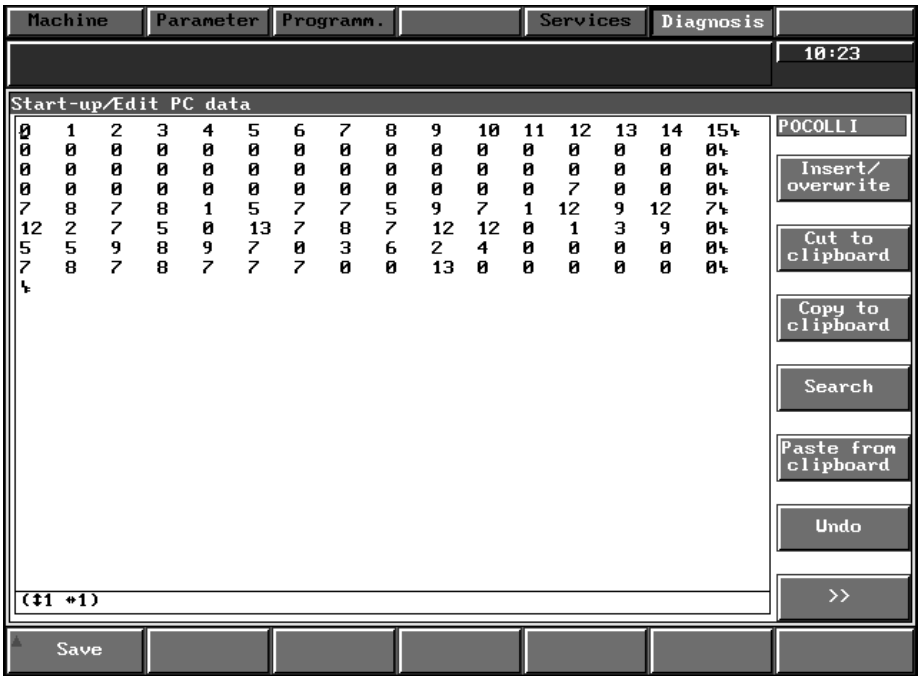

Fig. 4.20 Color mapping list: POCOLLI

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4.4.6 Color settings for monochrome display

4.4.6.1 10” monochrome display (up to SW 4.4) 6FC5 103–0AB□2–0AA0

Introduction

The BEDCONF, **NECOLLI** and **NEMOCLUT** files have to be edited for improving the quality of the screen display.

In addition, an anti-reflex filter for the screen has to be installed, order number 6FC5148–0AC01–0AA0.

Color setting

BEDCONF

```
a 1 1 1 11                  // BAPLANZ
a 1 1 2 12                  // BINPUTMODE
a 1 5 1 MO                  // BCOLORMONO_DEF
a 1 5 2 NE                  // BPOSNEG_DEF
a 1 7 0 450000              // BSCREENSAVE
```

Color setting

NECOLLI

0 0	1 1	2 2	3 3	4 4	5 5	6 6	7 7	8 8	9 9	10 10	11 11	12 12	13 13	14 14	15 15
16 0	17 0	18 0	19 0	20 0	21 0	22 0	23 0	24 0	25 0	26 0	27 0	28 0	29 0	30 0	31 0
32 0	33 0	34 0	35 0	36 0	37 0	38 0	39 0	40 0	41 0	42 0	43 0	44 0	45 0	46 0	47 0
48 0	49 0	50 0	51 0	52 0	53 0	54 0	55 0	56 0	57 0	58 0	59 0	60 0	61 0	62 0	63 0
64 0	65 14	66 7	67 0	68 0	69 14	70 0	71 7	72 5	73 4	74 0	75 2	76 0	77 4	78 15	79 7
80 11	81 2	82 0	83 4	84 2	85 15	86 15	87 14	88 0	89 12	90 8	91 7	92 1	93 2	94 4	95 3
96 6	97 5	98 12	99 8	100 4	101 7	102 0	103 6	104 3	105 0	106 4	107 0	108 0	109 0	110 0	111 0
112 1	113 8	114 12	115 11	116 11	117 11	118 11	119 0	120 0	121 13	122 0	123 0	124 0	125 0	126 0	127 0

Color setting

NEMOCLUT

```
0          0          0
794        794        794
1000       1000       1000
1000       1000       1000
1000       1000       1000
604        604        604
698        698        698
1000       1000       1000
524        524        524
413        413        413
0          0          0
0          0          0
159        159        159
508        508        508
950        950        950
80         80         80
```

4.4.6.2 9.5” monochrome display (as from SW 4.5)

In the case of a positive display the basic setting of the ASCII editor must also be changed.

In file **BEDCONF**

Entry i 1 2 2207 **0**//BAEFGCOLOR_DFLT
replace with i 1 2 2207 **5**//BAEFGCOLOR_DFLT

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4.4.7 Cycles

Press the DIAGNOSIS and PC DATA softkeys to select the cycles area.

This area is password-protected.

Save as cycle

SPF .. subroutines stored in a workpiece in the LOCAL or GLOBAL directory can be copied into the NC/data directory in the user branch, which defines them as user cycles. They can then be protected in the same way as standard cycles via cycle disable (see Interface, Part 1).

User cycles in the NC/DATA directory cannot be edited. It is possible to read in and out via the RS 232 C in PC format from SW 5.

Delete cycle

Deletes user cycles in the NC/DATA directory.

Note

Cycle disable must be configured in the PLC user program.

For load instructions for cycles, please refer to the Operator's Guide, Section 5.

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4.5 Activating options (as from SW3)

Press the DIAGNOSIS/START-UP/OPTIONS softkeys to change over to the Options basic display.

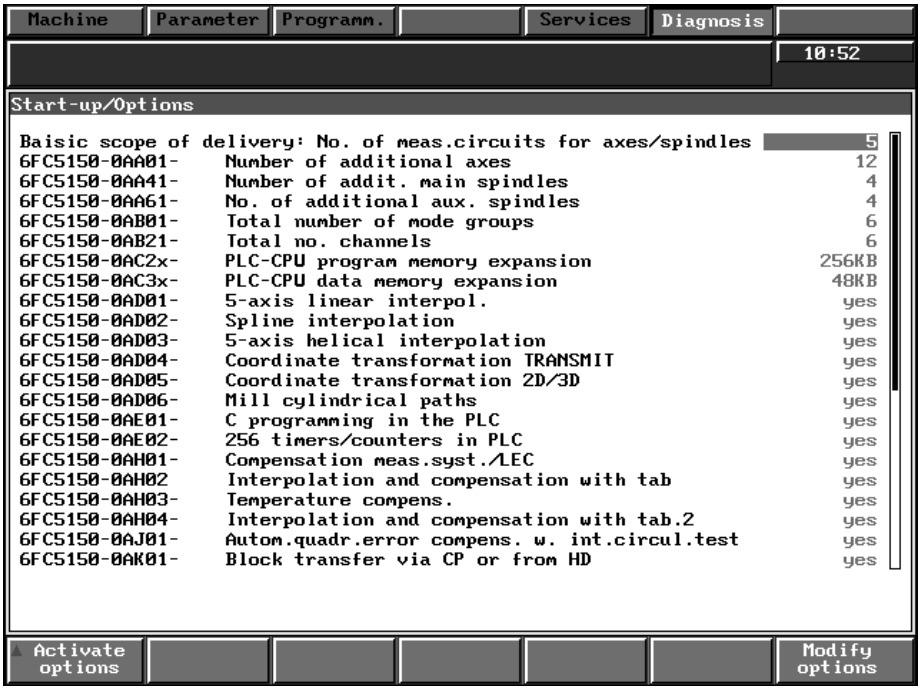


Fig. 4.21

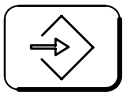
Note A PLC cold restart is required before you can implement PLC expansions.

Note The total number of real axes limits the entry “Axis exists” in the menu NC configuration

This also applies to spindles, channels and mode groups.

MODIFY OPTIONS

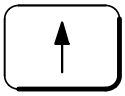
Press the MODIFY OPTIONS softkey to select the function.

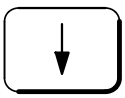


Press the INPUT key to save the option password.
If the password is not entered correctly, the message WRONG OPTION PASSWORD is displayed.
Press the OK softkey to acknowledge.

OK

Pressing the OK softkey activates the option screen form.





The cursor keys are used for selecting the required option.

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Press the select key to select.

ACTIVATE OPTIONS

Press the ACTIVATE OPTIONS key for activating the selected option.

Notes

The options Graphic Programming System Turning/Milling, DIN simulation, PG software and special languages cannot be activated via the menu **Start-up/Options**.

This installation is always performed via menu item “Install MMC system” in the BACK-UP menu (see Section 4.6, BACKUP with Valitek streamer).

If the system software is updated all of the above mentioned software options must be reinstalled from magnetic tape.

4.6 BACKUP with Valitek streamer/PC link

The function BACKUP backs up all the data on the hard disk using a VALITEK streamer/PC link, i.e. the system software (SIEMENS), the user software (e.g. customer UMS), part programs and machine data are all stored on a magnetic tape cartridge or external PC.

Up to SW 1 it is not possible to store any user data using the VALITEK streamer (hardware option). With SW 2 and higher user data can be stored separately.

It is necessary to perform a BACKUP after every start-up, otherwise all data would be lost if there were a fault on the MMC CPU! The choice of VALITEK streamer or PC link can be made via the menu Set I/O device.

Caution!
The software for the BACKUP function is suitable for use with the VALITEK streamer or PC link.

Caution! For Valitek streamers only!
Save system data and user data on separate cartridges since backup overwrites any data already existing on the cartridge.

Installation of the VALITEK streamer:

The VALITEK streamer can only be connected to the **parallel** interface (CENTRONICS interface) of the MMC CPU with Siemens cable 6FC9 344–4X□. It is not possible to connect another streamer because the software is only suitable for the VALITEK streamer.

If you connect to the interface SERIAL1 or SERIAL2 instead of the interface PARALLEL1, you will destroy the MMC CPU!

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Accessing the CD ROM via PC link software (SW 6 and higher)

Installation sequence

A software update can be made with PC link (SW 6 and higher). The software is delivered on CD ROM.

10. Install the PC link on the external PC by starting the file ”install.bat”
11. The control is connected to the external PC via parallel cable.

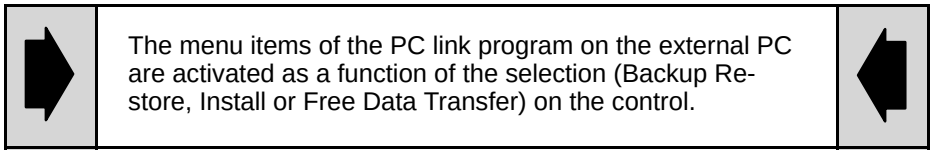
Note

The PC link cable required for installation and startup procedures does not comply with the electromagnetic compatibility requirements for cables used during normal operations. It may therefore only be used for service purposes (parallel transmission cable, Order No. 6FX2 002–1AA02–1AD0).

12. More about the installation sequence is explained in the ”readme.txt” file in the root directory of the CD ROM.

Note

Select the respective menu item (Backup or Restore) in the control menu before starting backup or restore on the external PC.



The menu items of the PC link program on the external PC are activated as a function of the selection (Backup Restore, Install or Free Data Transfer) on the control.

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Selecting BACKUP

Press the softkeys DIAGNOSIS then START-UP [1] then BACKUP to obtain the basic display for BACKUP.

When BACKUP is selected, the entire MMC area is stopped. The NC must be in the RESET state.

When you have pressed the softkey BACKUP the following screen appears:

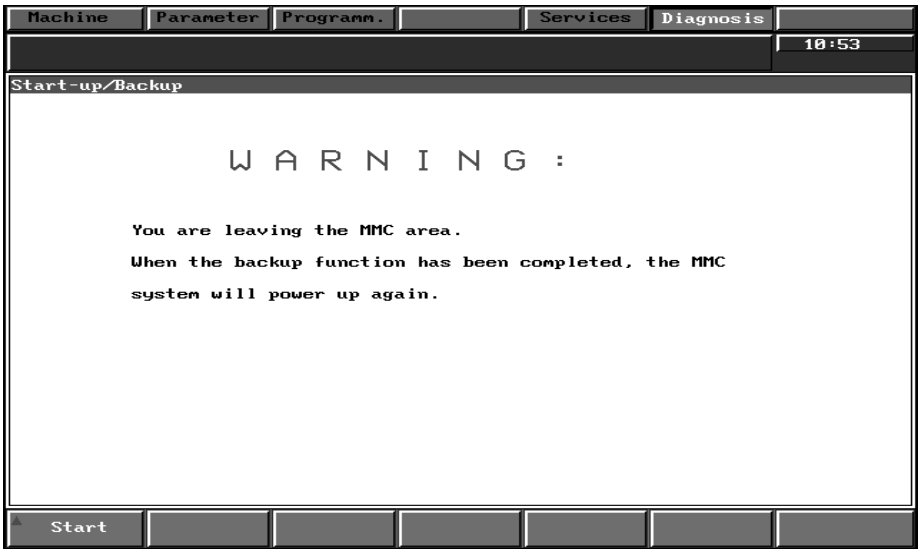

Fig. 4.22

START

Press the softkey START to activate the function BACKUP. The main menu is displayed, from which you can choose between the following functions:

As from SW 4, you are prompted to enter the correct time and date. Press the Input key to confirm your input. The values are activated after Power ON.

1) Up to software version 2, this softkey is called PC START-UP.

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Backup menu tree

1 **Restore/backup (first install correct streamer with Item 2/Item3 set streamer type)**

- 1 **Install MMC system**

  When you select menu item 1, new MMC software, SW options (e.g. graphic programming) or software updates are transferred to and installed on the hard disk.

- 2 **Backup system**

  With the 2nd menu item it is possible to perform a complete system BACKUP, i.e. all the software (operating system – software, user software and software options) are transferred from the hard disk to the streamer.

- 3 **Restore system**

  With the function SYSTEM RESTORE it is possible to transfer a complete previous BACKUP from the streamer to the hard disk of the MMC CPU. Any existing user data of the same name are overwritten.

  Note:

  Other user data are not deleted.

- 4 **Backup user data**

  With the function BACKUP USER DATA all data in the user branch are transferred from the hard disk to the streamer.

- 5 **Restore user data**

  With the function RESTORE USER DATA it is possible to transfer a complete previous BACKUP copy of the user data from the streamer onto the hard disk of the MMC CPU. Any existing user data of the same name are overwritten.

  Note:

  Other user data are not deleted.

- 6 **Free data transfer**

  - 1 **Uninstall NCK**

    If you select the function UNINSTALL NCK the entire NCK system software is erased from the hard disk.

  - 2 **Uninstall PG software**

    If you select the function UNINSTALL PG software, the PG software is erased.

  - 3 **Uninstall the complete system**

    If you select the function UNINSTALL THE COMPLETE SYSTEM the entire system software and all **user data** are erased.

  - 4 **Return to previous menu**

  Note:

  Up to SW 4, menu item 6 exists under the designation **Setup Streamer**. This menu item is installed for service only and is password-protected. For further information please refer to the VALITEK MANUAL. This menu item must not be used to select the type of streamer!

- 7 **Uninstall MMC system**
- 8 **Set streamer device**
- 9 **Return to main menu**

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- 2 **Setup / Configure options**
  - 1 **Setup WOP options**

    See Configuring Guide Graphic Programming System
  - 2 **Create WOP working file**

    Service function for creating a new WOP working file
  - 3 **Set I/O device**
    - 1 **Valitek PST–160**
    - 2 **Valitek PST2 – M1200**
    - 3 **Valitek PST2 – M1200 to read PST–160 tapes**
    - 4 **PC link**
  - 4 **Set disk check**

    Settings for checking the consistency of the file system on the hard disk (similar to the DOS command CHKDSK).
    - 1 **Set new configuration**

      To set the intervals at which the check file system procedure is to be performed when the control is booted.
    - 2 **Reset to default configuration**

      Restore default setting, i.e. file check every 24 hours.
    - 3 **Return to previous menu**
  - 5 **Adjust display (as from SW 5.6, for service only)**
  - 6 **Return to previous menu**
- 3 **DR DOS shell**

  For service task only (password protected)
- 4 **MMC system check (SERVICE mode)**

  Check sum of all the system software installed on the hard disk
- 5 **OEM**

  For more detailed information please refer to the OEM documentation.
- 6 **End (load MMC)**

  Starts the MMC

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Activating the hard disk options (up to SW 3 only)

The hard disk is configured with 5 Mbytes for user data. It is possible to use more memory area if one or several hard disk options are activated. A hard disk option makes one of three areas of the hard disk available for additional user data: an area of 5 Mbytes, an area of 10 Mbytes and an area of $\geq$ 20 Mbytes.

How to activate hard disk options

First press the softkey PC START-UP/BACKUP in MMC area DIAGNOSIS under menu item **Setup/Add Options**; **Add user memory options**.

Passwords

The following passwords have been allocated:

Menu item	1	MEMO1
	2	MEMO2
	3	MEMO3

When upgrading to software version >2, these options must first be enabled.

4.7 Customer UMS

General remarks

The customer UMS is created using the SW 800A workstation.

The UMS data are given the identifier “%UMS” and assigned to a language directory (e.g. ENGLISH) in the SERVICES area. Several UMS files with different names can exist side-by-side in the language directory. On POWER OFF and ON, only the file with the name UMS can be loaded from the current language directory (set language) to the NCK.

An exact description of the operating sequences for loading data from an external data storage device is to be found in the Operator’s Guide.

Up to SW 3

Up to SW 3 the customer UMS is enabled with an entry (ASMLEN) in the CONFIG file under Master control.

As from SW 4

With SW 4 and higher, please follow the description “Flexible memory configuration”, see Section “Functional Descriptions”.

Note

The standard UMS is contained in the scope of supply of the SINUMERIK 840C. If the user configures his own UMS, the standard UMS is not loaded in the NCK.

Menu 48, RECALL Key

The system setting may not allow you to leave menu 48 in the programming area using the RECALL key. If this happens, the setting in the BEDCONF file must be changed. See the entry BAPPLMENMODLIST in the following figure:

```
23  i  2 2 15000   '0' '0' '0' '0' '0' '0' '0' '0' '0' '134' '48' // BAPPLMENINDLIST
24  i  1 1 15000                                                   // BAPPLIND
25  i  2 2 15001   '0' '0' '0' '0' '0' '0' '0' '0' '0' '0' '4' // BAPPLMENMODLIST
26  i  1 1 15000                                                   // BAPPLIND
27  i  2 2 15002   '0' '1' '0' '0' '0' '0' '0' '0' '2' '1' '1' // BAPPLNCBERLIST
```

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4.8 Functions up to SW 2

4.8.1 NC data management (up to SW 2)

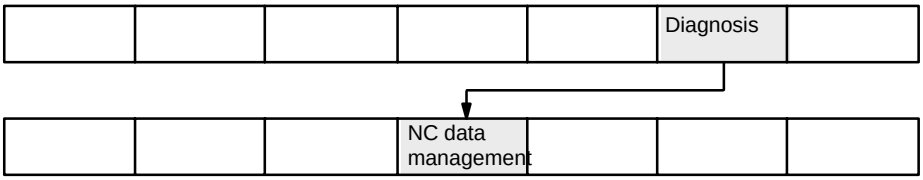
As from SW 3 NC data management has been moved to the Services area. Please refer to the Operator's Guide for more detailed information. The description below applies to SW 1 and SW 2.

In the area DIAGNOSIS/NC DATA management, data for the NCK can be saved to hard disk or loaded from the hard disk into the NCK memory. It is also possible to edit them in the ASCII editor.

- NC machine data (TEA1)
- Cycle machine data (TEA4)
- Setting data (SEA)
- Cycle setting data (SEA4)
- R parameters (RPA)
- Zero offsets (ZOA)
- Tool offsets (TOA)

The correct sequence of operation is described in the Operator's Guide up to SW2

- Selecting NC data



To obtain the basic display for NC data, press the softkeys DIAGNOSIS, START-UP then NC DATA MANAGEMENT.

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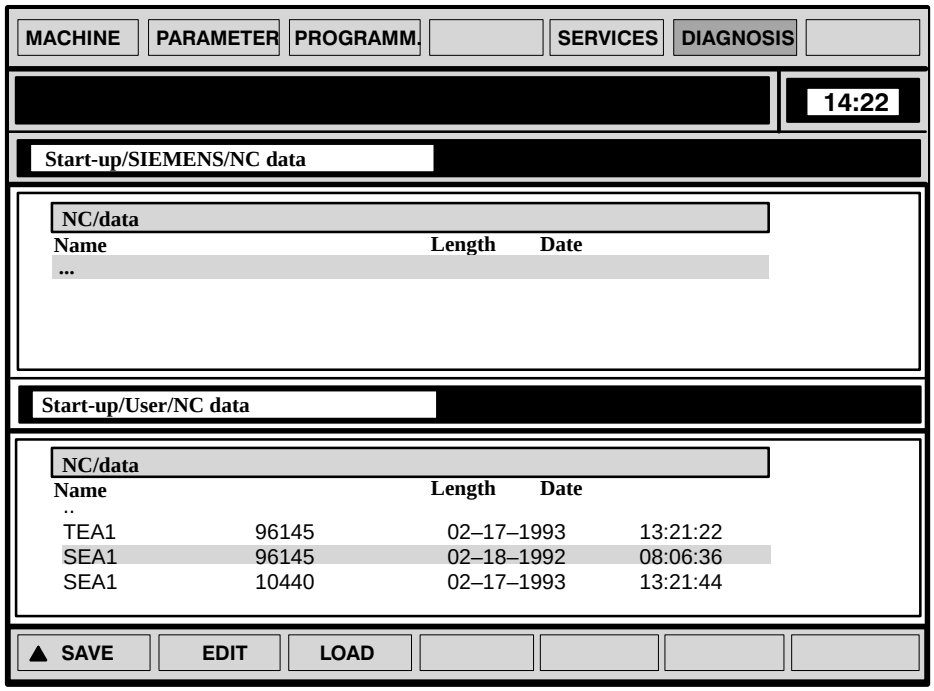

Fig. 4.23

You can only save, edit and load in the user branch. This function is password protected.

SAVE

The data are loaded from the NCK CPU to the hard disk. Press the softkey SAVE to obtain the following screen form. You select the desire file by moving the cursor keys and the INPUT key:

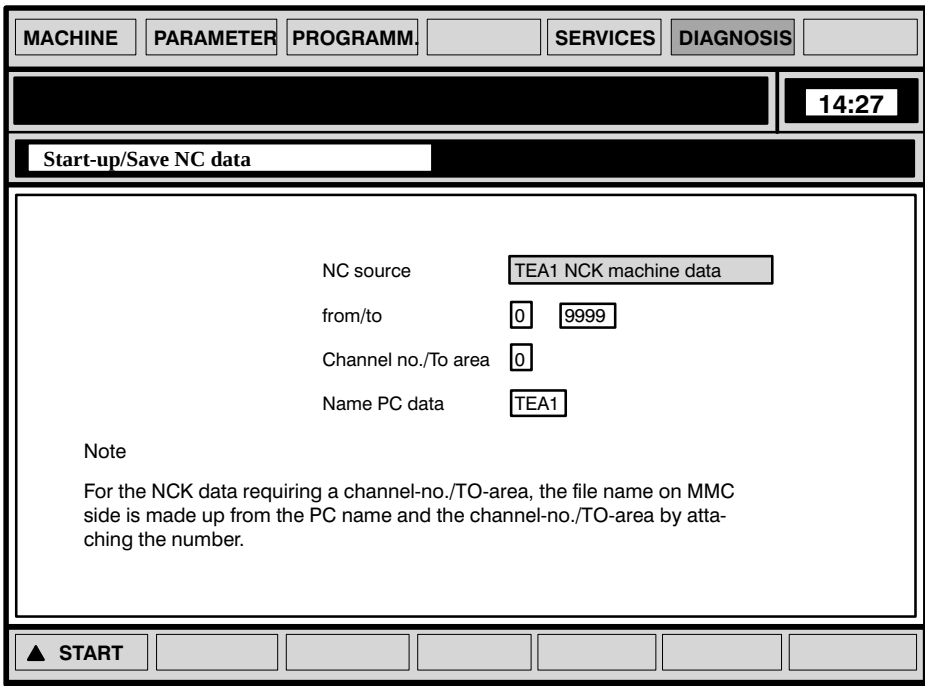

Fig. 4.24

START

Press the START key to load the data selected from the NCK CPU onto the hard disk.

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During data transmission the following dialog text appears:

!!! Transmission of NC to PC active !!!

If a file of the same name already exists, you are asked if you want to overwrite this file:

PC data exist. Overwrite ?

OK

You acknowledge with the OK softkey.

LOAD

Press the softkey LOAD to load the data selected into the NCK CPU. The password must have been entered in the NCK area.

The following dialog text appears during data transmission.

!!! Transmission from PC to NC active !!!

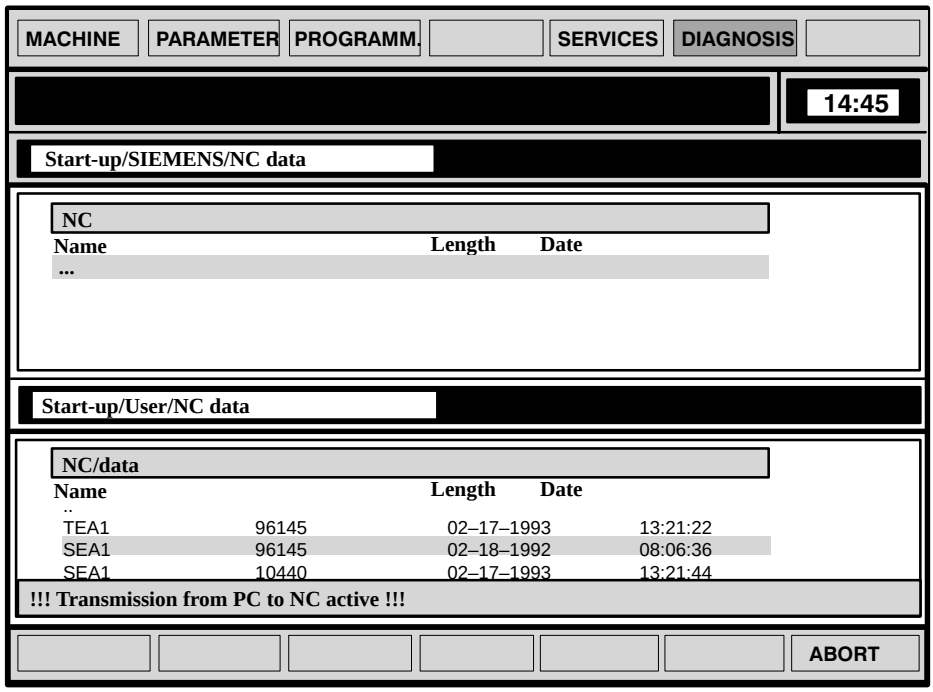

Fig. 4.25 SW 1

EDIT

The Operator's Guide describes how to edit NC data.

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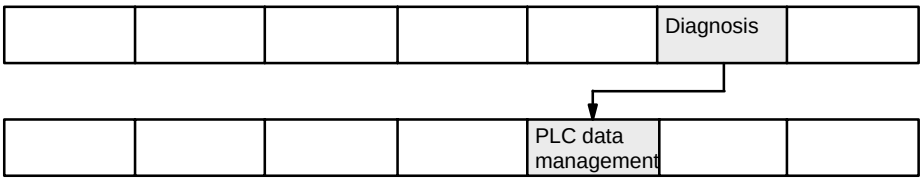
4.8.2 PLC data (up to SW 2)

As from SW 3 NC data management has been moved to the Services area. Please refer to the Operator's Guide for more detailed information.

In the DIAGNOSIS PLC data management area you can save PCF files or PLC machine data on the hard disk or load them from the hard disk into the NCK memory. You can also edit them in the USER branch.

- PCF files (PCF)
- PLC machine data (TEA2)

Selecting PLC data



Press the softkeys DIAGNOSIS and PLC DATA management to obtain the basic display for PLC data.

Operation continues as described in section: NC data management (up to SW 2).

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4.8.3 PCF files (up to SW 2)

From SW 3 the files MELDDATR and MELDTEXT are responsible for the entire alarm concept. Configuration is described in the Interface Description Part 1, Signals.

PCF files are files in which the user can store alarm texts and messages. The files are assigned to the language defined in the configuration file KONFIG.

On POWER ON, PCF files are automatically loaded from the current language directory (set language) to the NCK if the file name is between PCF1 and PCF9999.

Example of PCF files

In the directory DEUTSCH you will find the file PCF1

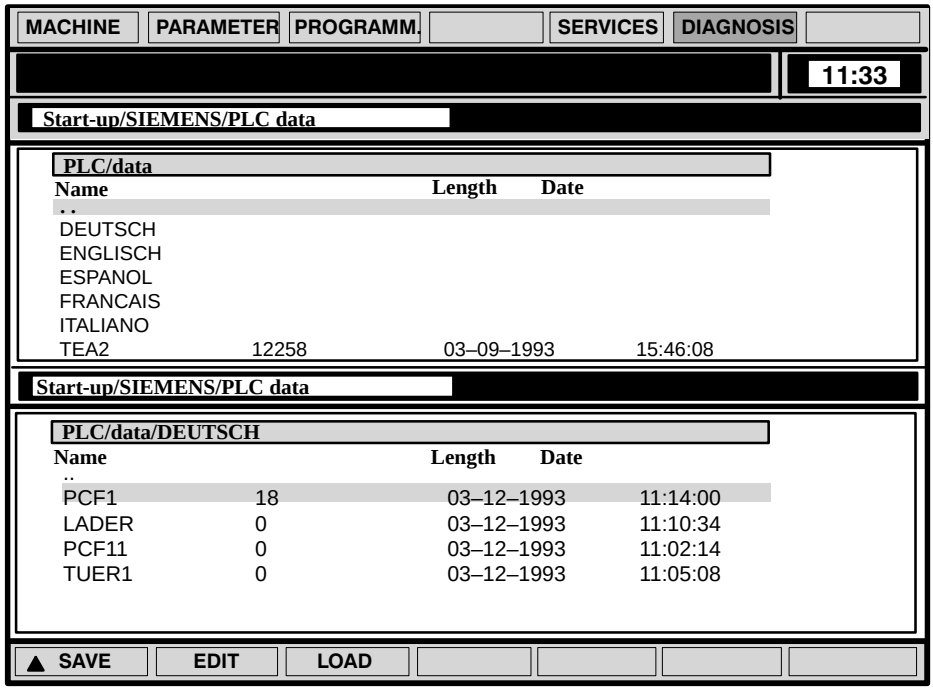

Fig. 4.26 PCF files in the directory DEUTSCH in the range DIAGNOSIS

If no PCF files yet exist in the language directory, they must first be created. You can open and edit files in the following ways:

- Create and edit a PCF file in the SERVICES area
- Create and edit a PCF file in the PROGRAMMING area
- Read in a file via V24 in the SERVICES area

With software version 2 and higher, message texts can also be configured using the files MEDEATTR. and MELDETEXT in the DIAGNOSIS PC DATA/MASTER CONTROL area.

A detailed description is to be found in Section 12 of the Interface Description Part 1, Signals.

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Creating a file in the SERVICES area

SERVICES

Select the SERVICES area.

MANAGEMENT

Press the MANAGEMENT softkey.

NEW

Press NEW softkey.

Select PLC in the directory of all possible subdirectories in the user branch using the cursor keys and accept with INPUT.

Position the cursor on DATA and accept with INPUT.

The directory of all available languages is displayed.

You select the required language directory using the cursor keys and accept with INPUT.

A directory of files which have been stored under the selected language is displayed.

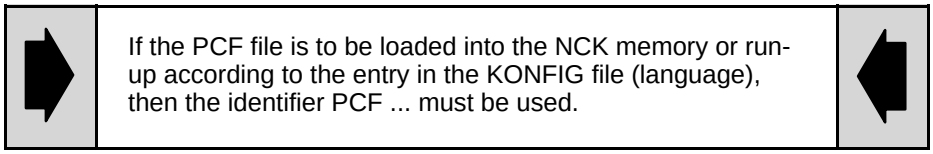
Creating a new file

NEW

Press softkey NEW.

You can then enter any name (maximum 8 characters) in the input field.

The input is accepted with INPUT and OK.



If the PCF file is to be loaded into the NCK memory or run-up according to the entry in the KONFIG file (language), then the identifier PCF ... must be used.

If PCF is not used as the identifier, this file is not loaded into the NCK on POWER ON.

These files can be loaded into the NCK memory using the softkey function LOAD in the DIAGNOSIS area.

Operating sequence LOAD

The area DIAGNOSIS PLC DATA MANAGEMENT/DEUTSCH is selected in the user area.

Select the files to be transferred using the cursor and the input key.

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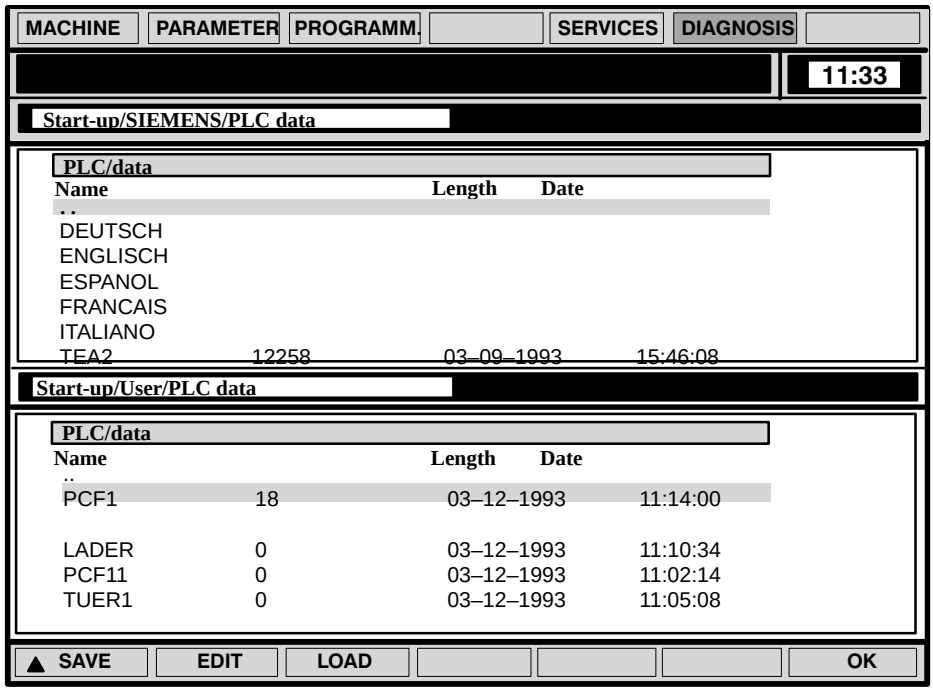


Fig. 4.27

LOAD

Press LOAD softkey.

You must enter a program number which does not yet exist in the NCK memory in the input field.

OK

When you press the softkey OK, the PCF file is loaded into the NCK memory.

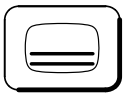
If a file with this identifier already exists, the following message appears:

PLC error texts exist. Overwrite?

OK

You overwrite the file by acknowledging with the OK softkey.

Editing the PCF files:



Press the area switchover key.

DIAGNOSIS

Select DIAGNOSIS area.

PLC data management

Press the PLC DATA MANAGEMENT softkey.

Switch to the user branch with the HOME key (the active window is marked).

Keep pressing the CURSOR keys and INPUT key in the DATA directory until you reach the directory containing the language files. Select the language required. You will find the PCF file you created in the SERVICES area in the selected language directory.

You select the PCF file using the cursor and the EDIT softkey.

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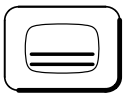
You can create the PCF file with the ASCII editor, configuring is described in Interface Description Part 1. The ASCII editor is described in the Operator's Guide.

SAVE

You store the file onto the hard disk with the SAVE softkey.

Creating and editing PCF files in the programming area (NCK area)



Press the area switchover key.

Programm.

Press programming key.

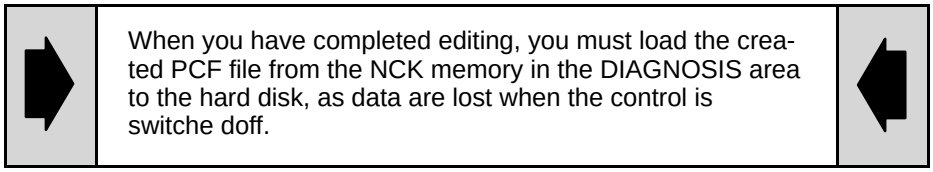
EDIT NC

Press the edit NC softkey.

SELECT PROGRAM

Enter the required program with the identifier "%PCF..." in the input line and accept with the PROGRAMMING softkey.

The DIN editor is displayed. Please refer to the Interface Description Part 1, Signals, for notes on configuring. The DIN editor is described in the Operator's Guide.



When you have completed editing, you must load the created PCF file from the NCK memory in the DIAGNOSIS area to the hard disk, as data are lost when the control is switche doff.

Saving the PCF file

Enter passwords in the NCK and MMC area.

Select the DIAGNOSIS/START-UP/PLC DATA area with the cursor and the input key and keep pressing the keys until you reach the directory of language files, select and accept the required language.

SAVE

Press the SAVE softkey. A dialog screen form with a toggle field and 4 input fields appears.

You select the PCF data type with the horizontal cursor keys in the PLC SOURCE toggle field. The input fields are filled in according to the entries in the NCK memory.

START

You initiate transmission with the START softkey. The following message appears:

!!! Transmission from NC to PC active !!!

If a PCF file of the same name already exists you are asked whether you wish to overwrite it:

PC data exists. Overwrite?

OK

The PC data are overwritten when you press the softkey OK.

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Setting data for PCF files:

You define the active PCF file in the general setting data.

The setting data are described in the Operator's Guide.

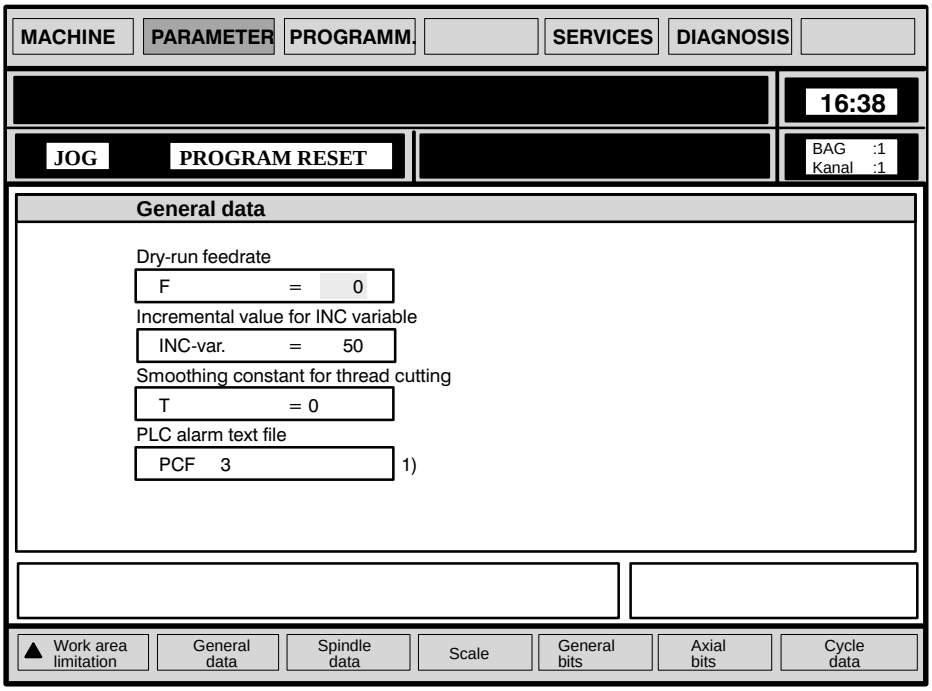

Fig. 4.28 SW 1

Example **PCF file**

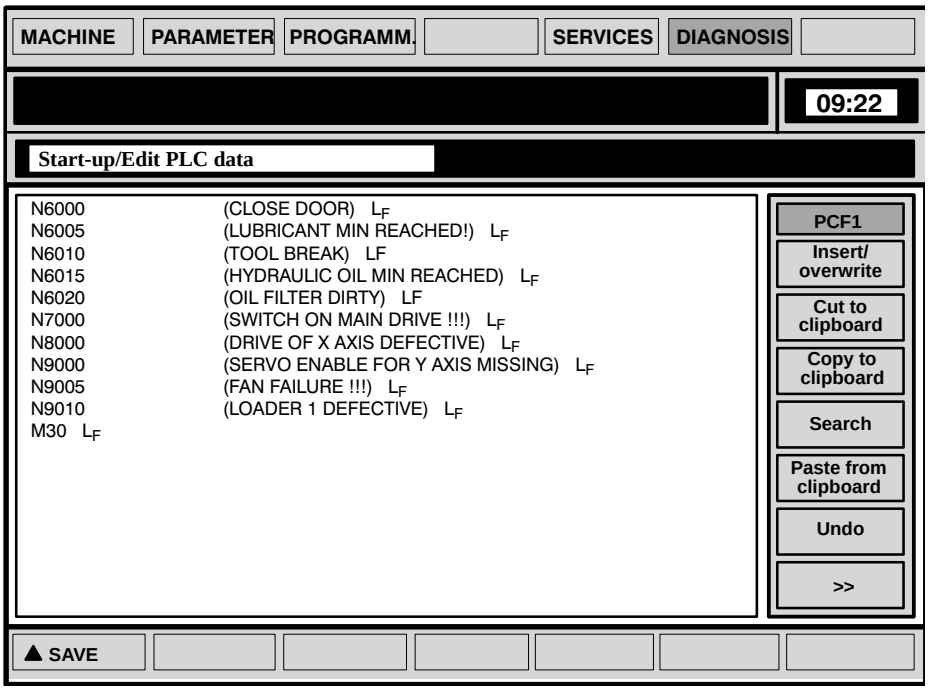

Fig. 4.29 ASCII editor with PCF 1 file

1) Not in SW 1

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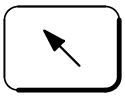
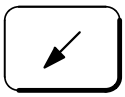
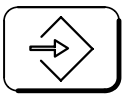
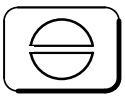
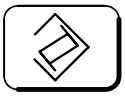
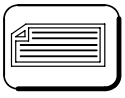
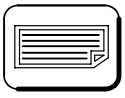
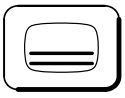
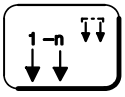
4.9 Equivalent keys on the PC keyboard and the operator panel

The following table lists all keys that have a different form on the PC keyboard and the operator panel control but the same function.

PC keyboard	Operator panel	Function
Home, POS1		Home key
End		End key
⇦		Backspace key
DELETE		Delete key
↵		Return key
ESC		Escape key
INSERT		Insert key
PageUp		PageUp key
PageDown		PageDown key
F3 – F9	Softkey 1 to 7 below	Selection of menu points below
Shift + F3 – F9	Softkey 1 to 7 right	Selection of menu points right
Shift + F1		Call up help screen
F11		Area switchover key
F12		Channel and mode group switchover

END OF SECTION

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5 Machine Data Dialog (MDD – as from SW 3)

5.1 General remarks

Introduction

The SINUMERIK 840C and Machine Data Dialog operation.

The Machine Data Dialog replaces the conventional method of entering machine data via lists. Wherever possible, the machine data are represented in their real units. Complicated relationships are represented and input via configuring displays. The machine data are sorted into groups and are displayed together with the MD no., text, value and unit. The logical procedure for entering the MD (for example during initial startup) is to work through the menu lists from left to right.

Example NC MD (procedure)

NC configuring data

↓

General NC MD –> Geometry/motion –> Channel MD –> etc.

In addition to entering machine data individually it is also possible to load complete MD records and to save data that already exist. A data management system has been implemented for organizing the different machine data records. Machine data can be processed **online** (data sets in the machine) and **offline** (machine data file).

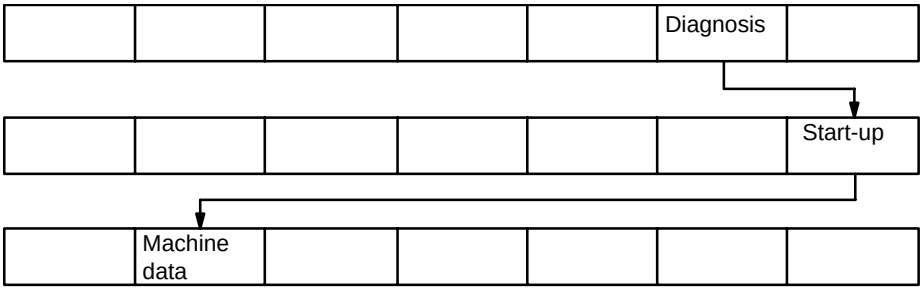
You can select the Machine Data Dialog by pressing the softkeys Diagnosis/ Start-up/Machine data.

Machine data (SW 3 and higher)

The **Machine data** area is found by pressing the Diagnosis and Start-up softkeys. The machine data are divided up into the following areas:

- Machine configuration
- NC configuration and NC machine data
- PLC configuration and PLC machine data
- Drive configuration and drive machine data
- Cycle machine data
- IKA data (interpolation compensation with tables)
- User displays

Section



Note

It takes several seconds to load the function **Machine data** during which time the flashing message “Wait” is displayed.

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Note

Press the info key to display a short description of the machine configuration.

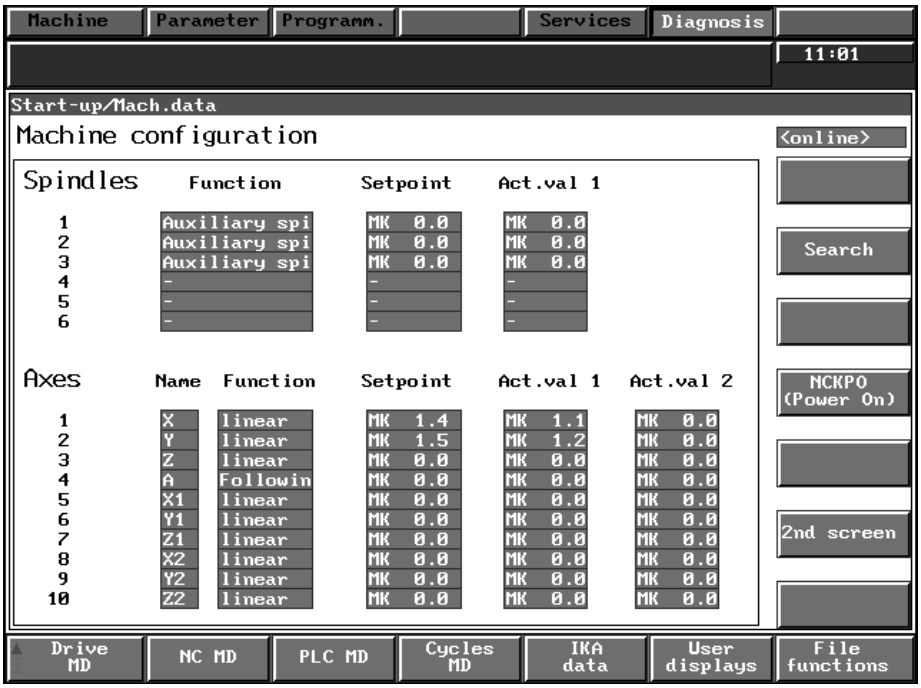

Fig. 5.1

Explanation

The machine configuration display gives you an overview of the current data record and is only a display. The functions and setpoint/actual value assignment for each of the spindles and axes are displayed for the data that you have entered in the data record. The contents of the display fields is determined by the following machine data.

Spindles

- Function:
  The display text “Spindle” or “Following spindle” appears when NC MD 5210.7 ff (spindle available) and/or NC MD 5250.0 is set.
- Setpoint:
  The connection location of the setpoint appears in this window when NC MD 4600.6–7 ff (drive/ measuring circuit module number) is set.
  For analog drives: “MS x.x”
  and digital drives: “DIG x.x” or “MSD x.”
- Actual value 1:
  The connection location of actual value 1 appears in this window when NC MD 4000.6–7 ff (drive/ measuring circuit module number) is set.
  For analog drives: “MS x.x”
  and digital drives: “DIG x.x” or “MSD x.”

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Axes

- Name:
  The name of the axis appears in this window when NC MD 5680 ff (axis name) is set. Possible input values are: X–X15, Y–Y15, Z–Z15, A–A15, B–B15, C–C15, U–U15, V–V15, W–W15, Q–Q15, E–E15.
- Function:
  Possible display texts are (when NC MD 5640.7 ff – axis exists–input = yes)
  - "Linear" : NC MD 5640.5 ff (rotary axis)
    Input = No
  - "Rotary": NC MD 5640.5 ff (rotary axis)
    Input = Yes
  - "Following" : NC MD 18440.0 ff (axis can be following axis) Input = Yes
  - "Facing": NC MD 5720.1 ff (facing axis) Input = Yes
- Setpoint:
  The connection value of the setpoint appears in this window when NC MD 3840.6–7 ff (drive/measuring circuit module number) has been set.
  For analog drives: "MC x.x" (Measuring circuit in measuring circuit modules)
  and digital drives: "DIG x.x" or "FDD x."
- Actual value 1:
  The connection value of actual value 1 appears in this window when NC MD 2000.6–7 ff (drive/
  measuring circuit module number) has been set.
  For analog drives: "MC x.x" (Measuring circuit in measuring circuit modules)
  and digital drives: "DIG x.x" or "FDD x."
- Actual value 2:
  The connection value of actual value 2 appears in this window when NC MD 13880.6–7 ff (drive/
  measuring circuit module number) has been set.
  For analog drives: "MC x.x" (Measuring circuit in measuring circuit modules)
  and digital drives: "DIG x.x" or "FDD x."

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5.1.1 General notes on operation

Search

Search (SW 3 and higher)
Select the Search function with this key.

Explanation

With this function you can either search for a “Term” (e.g. following spindle) or a machine data. When you have selected the function an input field appears, in which you enter either the term or the machine data which you then acknowledge with the input key. You can choose between softkeys **Search global** and **Search local**.

Search global means that you search all data lists, i.e. of the drive, NC, PLC, Cycles and IKA for the term or MD you are looking for. Once the term or the MD has been found, the list display showing the data appears on the screen. It can be altered immediately. The softkey path under which the list display with the data can be found is also displayed. You can continue the search with the softkey **Continue search** and you can terminate it with the softkey **Search end**.

Search local means that you can look for the term or machine data within a list display. This corresponds to the search in the NC lists available until now.

Notes

Please note the text under the input column:
“Input: Text or data number (without ‘.’ and ‘:’!)”. You cannot search for the bit or parameter set in SW 3**.**

In **SW 4** it is possible to search for the bit, parameter set or select a digit.

You can use the wildcard character * for symbols or characters (used in foreign languages) which are not on the operator
panel.

Password

Password (SW 3 and higher)
You select the function Password with this softkey.

Explanation

The password in the NCK, PLC and MMC areas is defined with machine data 11. You can alter the password (MD 11) via the **User displays** and **Edit list** softkeys. Default value 0 corresponds to the password 1111. Any other value entered in machine data 11 must be 4 digits long.

You will automatically be asked to enter the password for certain functions in the machine data dialog or if you have operated the softkey **Password**. An input field appears with the command “Enter password”.
You enter the password and confirm your entry with the softkey **Set**. You can clear the password with the softkey **Delete**.
The message “Wrong password” appears if an incorrect password has been entered. Acknowledge with **OK** and enter the correct password.

Notes

Machine data 11 (password) is **not** named when you call it up in the function user displays.

In **SW 3** the password is deleted on Power on Reset or NCK Reset and in **SW 4** with Control off/on (hardware).

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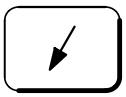
MD info window (SW 3 and higher)



Select the MD info window function with the “End” hardkey.

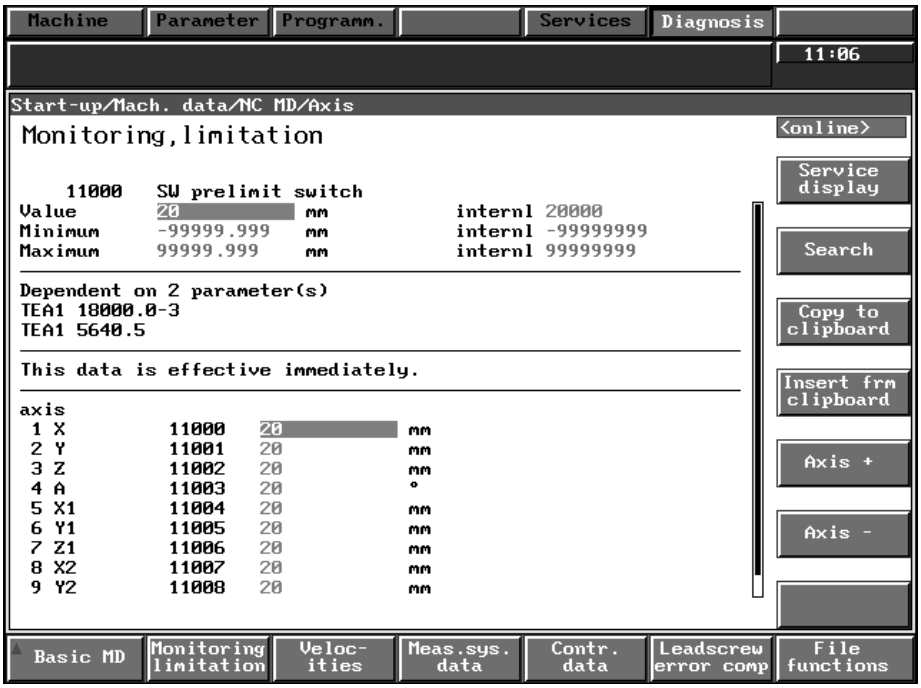


Fig. 5.2

Explanation

With the “End” hardkey you can call up an info window for any machine data on which the cursor is placed (not in Machine configuration). Minimum and maximum values, the internal representation, any relationships with other machine data and any inputs if they exist (e.g. yes/no) are displayed next to the text and number.

In **SW 4** and higher, an optional fixed text can be assigned to any individual machine data, viewed and values entered or toggled.

In SW 4 it is also possible to select transformation blocks and configurations.

Increment/decrement function (SW 3 and higher)

The values of certain machine data can be altered either in percent or by predefined values using the hardkeys + (increment) and – (decrement). Operate the **End** hardkey to find out which changes can be made. Under possible inputs you will find the next value in the + and – direction.

“+/–” function (SW 3 and higher)

You can select the available (configured) drives, axes, spindles, channels and numbers (e.g. IKA) using the +/– function.

Calc. controll. data

Calculating controller data (SW 4 and higher)
Press this softkey to select the function **Calculate controller data**.

As from SW 4, it is possible to load the standard data from the hard disk for motor selection (previously: data for MSD from EPROM). When the standard data have been loaded some of the controller data are automatically calculated and set in the drive. If a motor from a different manufacturer is used no guarantee can be made that this procedure will be carried out. First, the specific motor data must be entered manually and then the following controller data must be calculated and set by pressing the **Calculate controller data** softkey:

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Current controller:
MD 1120 P gain current controller (FDD/MSD)
MD 1121 Reset time current controller (FDD/MSD)

Flux controller:
MD 1150 P gain flux controller (MSD)
MD 1151 Reset time flux controller (MSD)

Torque and output limits:
MD 1230 1st torque limit (FDD)
MD 1235 1st output limit (FDD)

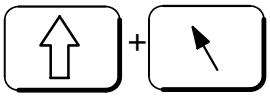
Speed interface normalization:
MD 1401 Speed for max. motor working speed (FDD/MSD)

Speed controller:
MD 1147 Speed limitation (FDD/MSD)
MD 1405 Monitoring speed motor (FDD/MSD)
MD 1407 P gain speed controller (FDD/MSD)
MD 1408 P gain upper adaptation speed (MSD)
MD 1409 Reset time speed controller (FDD/MSD)
MD 1410 Reset time upper adaptation speed (MSD)
MD 1411 Lower adaptation speed (MSD)
MD 1412 Upper adaptation speed (MSD)
MD 1413 Selection adaptation speed controller (MSD)

AM operation:
MD 1451 P gain speed controller AM (MSD)
MD 1453 Integral action time speed controller AM (MSD)
MD 1466 Changeover speed closed/open loop control AM (MSD
MD 1465 Changeover speed MSD/AM (MSD only when MD 1011.5=1)
MD 1608 Fixed temperature (MSD only when MD 1011.5=1)

v/f operation:
MD 1127 Voltage with f=0 V/F-mode (MSD)

Please note that any controller data entered manually will be overwritten when softkey **Calculate controller data** is pressed!



Selecting displayed data in header (SW 4 and higher)
You select the displayed parameter number (top left) for position control, ratio and drive and the displayed axis number for the axis by pressing the Shift and the Home hardkeys simultaneously.

Explanation

With these keys it is possible to enter the data directly in all displays in which the current data are displayed in the header. It is also possible to toggle and move forwards/backwards with the +/– and select keys. The cursor remains positioned on the parameter number in the header until either a correct number has been entered or the Enter, Shift-Home, Backspace, Delete, Cursor key has been operated and the field is exited without making any changes.

Note

This function replaces the previous **Search local** function for IKA 2 (IKA curve pointer) and IKA 3 (IKA error points).

Copy to clipboard

Example of application:
Copying data from one axis into another axis.

Paste from clipboard

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5.1.2 Fast switching between MDD and service display (as from SW 5)

Service displays for axes

In all axis specific displays it is possible to select the axis service display with the highest vertical softkey.

The data are requested via I code 20E. The refresh rate is 59 ms in a state of rest.

Axis service display

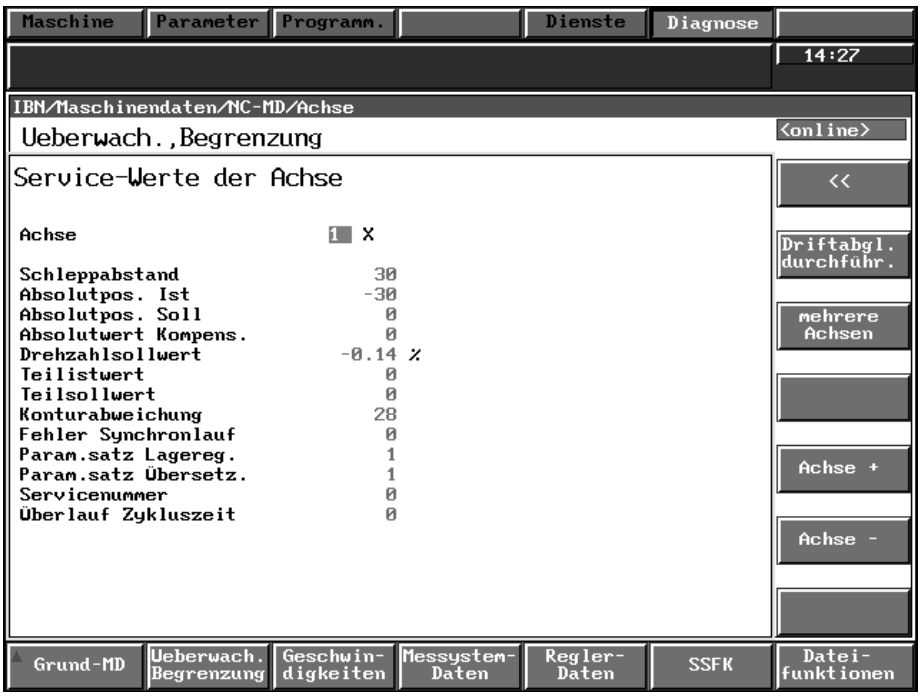

Fig. 5.3

Horizontal softkey bar

As in other displays you can access the other axis displays directly using the horizontal softkeys.

Input disabled

Because all values of this display are interlocked against input, the cursor is positioned on the axis number (new feature of the list displays).

Softkey axis +
Softkey axis –

Here, it is not only possible to select the axis with the softkeys “Axis +” and “Axis –” but also with the toggle key or with “+” or “–”.

Softkey <<

You can return to the previous display with the vertical softkey “<<”.

Softkey perform drift comp

With the vertical softkey “Perform drift compensation”, it is possible to initiate I code 419. This performs a drift compensation for the axis currently selected. The following errors can occur:

- The currently selected axis does not exist internally:
  Alarm 165049 Axis does not exist internally
- The currently selected axis is moving:
  Alarm 165050 Axis is not in reset state
- Other errors:
  Alarm 165048 Drift compensation is not performed.

Softkey several axes

It is possible to change to a display via the vertical softkey “several axes” in which the service values of any three axes are displayed.

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Service display for several axes

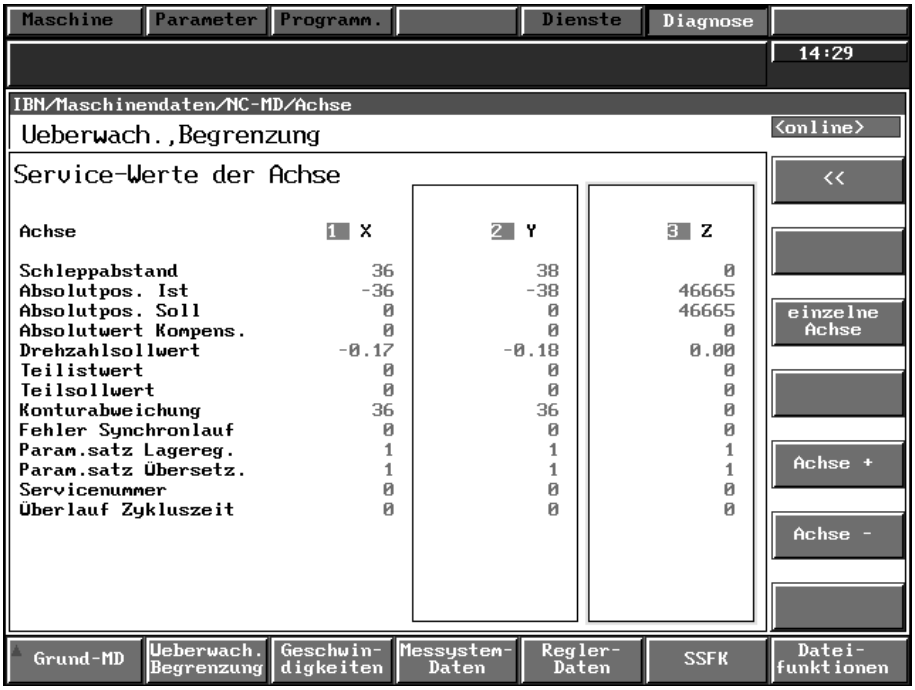

Fig. 5.4

In the three-axis display, the units column is omitted for space reasons.

Selecting columns

The columns are selected using the home key. In each column which is selected, the axis can be selected as in the single-axis display.

Softkey <<

You can return to the previous axis display with the vertical softkey “<<”.

Softkey single axis

The vertical softkey “single axis” is used to return the single axis display to increase the refresh rate.

Service displays for spindles

A spindle service display that works on the same principle has been set up and can be accessed via the top vertical softkey.

The spindle service display is similar to the axis service display with the only difference that there is no softkey “Drift compensation”.

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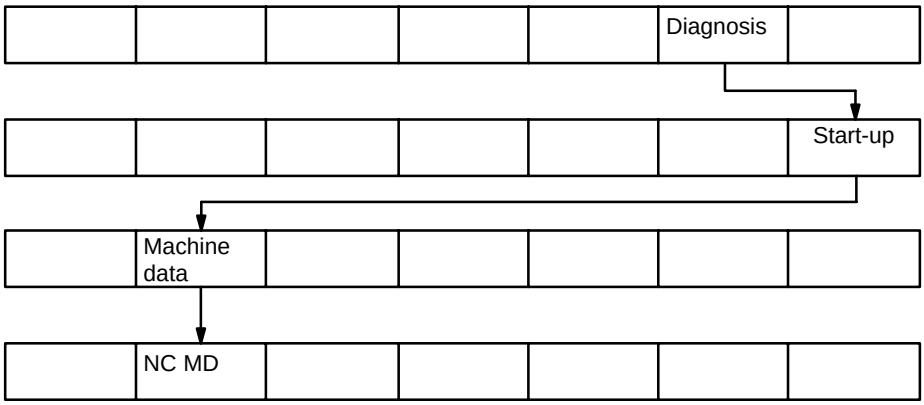
5.2 NC configuration and NC machine data (as from SW 3)

5.2.1 NC configuration

Selection



Press the Diagnosis, Start-up, Machine data and NC MD softkeys to call the NC configuration display.

Note

A brief description of the NC configuration and NC machine data is displayed when you press the info key.

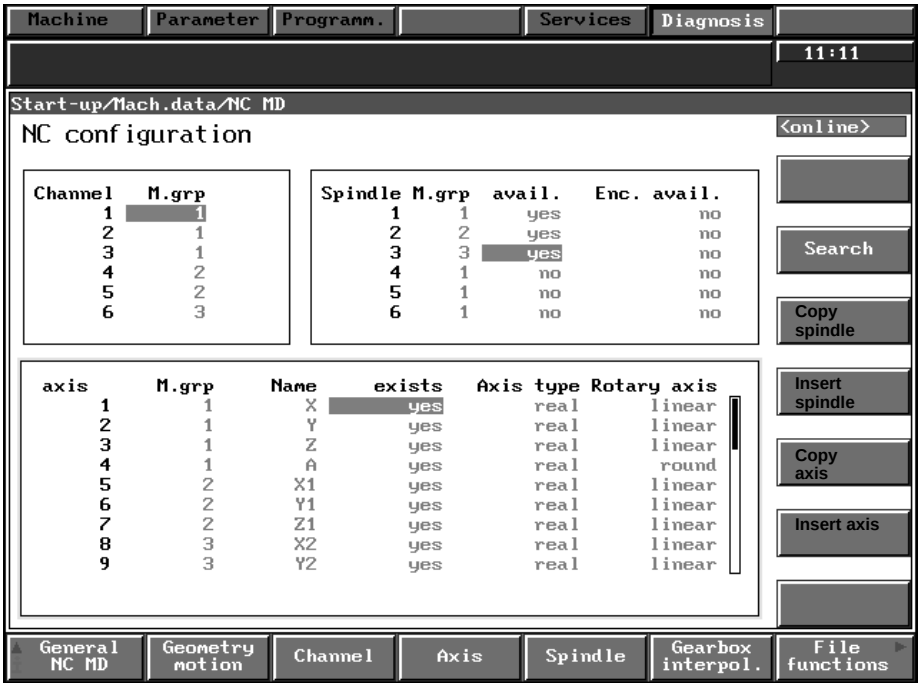


Fig. 5.5

Explanation

In this display you enter the current assignments (mode group, name, axis type, exists) for channel, spindle and axis number. The contents of the display fields show the settings of the following machine data.

Channel

- Mode group:
  The assignment of mode group to channel is determined by the setting in NC MD 1000 ff (channel valid in mode group).

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Spindle

- Mode group:
  The assignment of mode group to spindle is determined by the setting in NC MD 4530 ff (spindle valid in mode group).
- Available:
  The spindle is displayed as existing when NC MD 5210.7 ff (spindle exists) is set.

Axis No.

- Mode group:
  The assignment of mode group to axis no. is determined by the setting in NC MD 3600 ff (axis no. valid in mode group).
- Name
  The name of the axis appears in this window when NC MD 5680 ff (axis name) is set.
  Possible inputs are: X–X15, Y–Y15, Z–Z15, A–A15, B–B15, C–C15, U–U15, V–V15, W–W15, Q–Q15, E–E15.
- Available:
  The axis is displayed as existing when NC MD 5640.7 ff (axis exists) is set.
- Axis type:
  The display tells you whether the axis is real or fictitious, as set in NC MD 5640.6 ff.
  real: Input = No
  fictitious: Input = Yes
- Rotary axis:
  The display tells you whether the axis is a linear or rotary axis, as set in NC MD 5640.5 ff.
  linear: Input = No
  rotary: Input = Yes

Notes

Only the channels, axes and spindles defined in the NC configuration display are also displayed in the following displays (channel, axis, spindle MD softkeys).

You must execute a PLC cold restart via the **General reset mode** function if you wish to alter the number of channels, spindles and axes.

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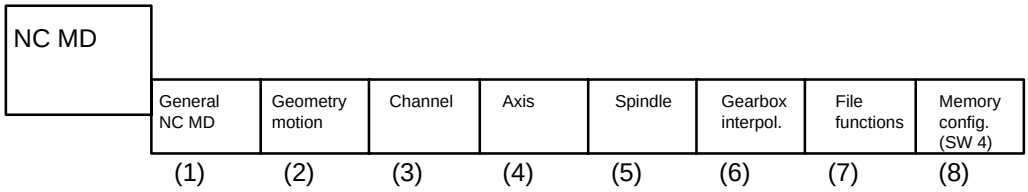
5.2.2 NC machine data

Menu tree



(1)

General Basic MD	Face axis functions	Modes	Keyswitch	Techno-logy MD	Computer link	File functions

(2)

Geometry MD	Coupl. axis combin.	Coord. transform.	Override	Tool offset		File functions

(3)

Basic MD	Auxiliary functions	Multichannel display	Gen. reset G groups			File functions

(4)

Basic MD	Monitoring limitation	Velocities	Meas. sys. data	Controller data	LEC	File functions

(5)

Basic MD	Monitoring limitation	Rotational speeds	Meas. sys. data	Controller data		File functions

(6)

			GI axis	GI spindle		File functions

(8)

DRAM data (SW4)	SRAM data (SW4)				Reconfig. memory (SW4)	File functions

See next pages for explanations to (1) to (8).

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Note A list of the individual NC machine data is given on the following pages. The machine data are grouped according to their functions within these areas. The functions of the individual machine data are described in the section entitled “NC Machine Data” where they are listed alphanumerically. A number of machine data depend on the parameter set (see “Selecting a displayed parameter number”).

(1) NC MD/General NC MD

Softkey General basic MD	This softkey contains dimension unit, system clock, general basic and PLC function machine data.
Softkey Face axis functions	This softkey contains various face axis function machine data.
Softkey Modes	This softkey contains various operating mode machine data.
Softkey Keyswitch	This softkey contains various keyswitch machine data for defining the input disable.
Softkey Technology MD	This softkey contains function activation, thread, programming, position signal, mixed I/O and KISP machine data.
Softkey Computer link	This softkey contains different computer link machine data.

(2) NC-MD/Geometry motion

Softkey Geometry MD	This softkey contains various geometry machine data.
Softkey Coupled motion combination	This softkey contains various coupled motion combination machine data.
Softkey Coordinate transformation	This softkey contains various coordinate transformation machine data.
Softkey Override	This softkey contains feedrate override and spindle override machine data.
Softkey Tool offset	This softkey contains various tool offset machine data.

(3) NC-MD/Channel

Softkey Basic MD	This softkey contains various channel basic machine data.
Softkey auxiliary functions	This softkey contains output auxiliary function, fast auxiliary function and block search machine data.
Softkey Multichannel display	This softkey contains axis assignment and spindle assignment multichannel display machine data.
Softkey Initial setting G group	This softkey contains initial setting machine data for various G groups.

(4) NC-MD/Axis

Softkey Basic MD	This softkey contains units of measurement, system clock, setpoint/actual value assignment, general basic, face axis, rotary axis, indexing axis, mixed I/O switchover signal and leading axis machine data.
Softkey Monitoring limitation	This softkey contains referencing, software limit switch, general monitoring and measuring loop machine data.
Softkey Velocities	This softkey contains various velocity machine data.
Softkey Measuring system	This softkey contains adaptation actual value 1/actual value 2 and encoder/absolute encoder machine data.

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Softkey Controller data	This softkey contains position controller, compensation, feedforward control, filter setting and travel to fixed stop machine data. **SW 4** also contains quadrant error compensation (from SW 4.4) machine data.
Softkey LEC	This softkey contains various leadscrew error compensation machine data.

(5) NC-MD/Spindle

Softkey Basic MD	This softkey contains dimension unit, system clock, setpoint/actual value assignment, general basic, mixed I/O switchover signals and leading spindle machine data.
Softkey Monitoring limitation	This softkey contains speed range and measuring loop monitoring machine data.
Softkey Speeds	This softkey contains various speed machine data for the gear stages.
Softkey Measuring system data	This softkey contains various adaptation actual value 1 measuring data.
Softkey Controller data	This softkey contains position controller, oriented spindle stop M19 and (as from SW 4.4) feedforward control machine data.

(6) NC-MD/gearbox interpolation

Softkey GI axis	This softkey contains controller parameter following axis, traversing range following axis and setting gearbox interpolation machine data.
Softkey GI spindle	This softkey contains controller parameters following axis, traversing range following spindle and setting gearbox interpolation machine data.

(7) No explanation here

(8) NC-MD/memory configuration (as from SW 4)

Softkey DRAM data (SW 4)	This softkey contains general configuration, number of block buffers in block memory and number of measuring value buffer memories for axis machine data.
Softkey SRAM data (SW 4)	This softkey contains various general data II machine data.
Softkey Reconfigure memory (SW 4)	The function ”Flexible memory configuration” is introduced with **SW 4**. The **Reconfig. memory** softkey is used to activate a previously set configuration for which several conditions **must** be fulfilled (see the section entitled “Functional Descriptions”).

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5.2.3 Setpoint-Actual value matching for axes and spindles

The following NC machine data still have to be set before you can operate the drives after drive installation. You will find them by pressing the Diagnosis/Start-up/Machine data/NC MD softkeys for the **Axes** (FDD) or **Spindles** (MSD) and then **Basic MD** softkey.

Note In the case of digital drives you should first enter the drive configuration before the axis/spindle assignment.

Example axis (FDD)

Setpoint/actual value	**Axis1**	**analog**	**digital**
MD 3840	Setpoint output	MC1.4	FDD1.0
MD 3840/2–3	Setpoint on digital drive	No	Yes
MD 3840/6–7	Drive/measuring circuit module number	1	1
MD 3840/4–5	SPC/HMS setpoint output	4	0
MD 18240.2	Multiple assignment setpoints (611D)	No	No
MD 2000	1st measuring system connection	MC1.1	FDD1.1
MD 2000/2–3	Actual value of digital drive	No	Yes
MD 2000/6–7	Drive/measuring circuit module number	1	1
MD 2000/4–5	Measuring circuit connection number	1	1

Example spindle (MSD)

Setpoint/actual val. assign. spindle 1		**analog**	**digital**
MD 4600	Setpoint output	MC1.6	MSD1.0
MD 4600/2–3	Setpoint on digital drive	No	Yes
MD 4600/6–7	Drive/measuring circuit module number	1	1
MD 4600/4–5	SPC/HMS setpoint output	6	0
MD 5220.2	Multiple assignment setpoints (611D)	No	No
MD 4000	Measuring system connection	MC1.3	MSD1.1
MD 5200.1	Sign change actual value	No	No
MD 4000/2–3	Actual value of digital drive	No	Yes
MD 4000/6–7	Drive/measuring circuit module number	1	1
MD 4000/4–5	Measuring circuit connection number	3	1

Note Machine data MD 3840, MD 2000, MD 4600 and MD 4000 display the assignments of each of the setpoints and actual values.

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5.2.4 Measuring system adaptation for axes and spindles (as from SW 4)

Explanation

This function is used to automatically calculate the position control resolution and measuring system resolution (optimization of the closed position control loop).

You will find the function under the softkey path Machine data/NC MD/Axis (or Spindle) measuring system data. After you have entered the parameters (see table below), move to the NC machine data **Pulses var. incremental weighting** (Axis: NC MD 3640/Spindle NC MD: 4550) or **Traversing path var. incremental weighting** (Axis: NC MD 3680/Spindle: NC MD 4560) and trigger calculation by pressing the **toggle key**.

Notes

If the data do not correspond, a number sign "#" is displayed next to the machine data "Pulses var. incremental weighting" and "Traversing path var. incremental weighting". As soon as the values have been calculated a tick "✓" is displayed.

Machine data **f: Pulse multiplication EXE/611D/HMS** (Axis: NC MD 11160/Spindle: NC-MD 4580) should be matched in such a way that the condition measuring system resolution < position control resolution is given.

Parameter table

This table lists the parameters for the measuring system adaptation.

Parameter	Symbol	NC-MD axis/spindle	Meaning
Position control resolution	b	18000.0–3/5240.0–3	Internal computational resolution of control
Pulse multiplication EXE/611D/HMS	f	11160/4580	Multiplier input
Grating constant	g	39120/–	Distance between marks on a linear scale
Spindle pitch	l	39120/–	Leadscrew pitch
Measuring system resolution	m	–	Maximum resolution of measuring system- The value is used as the basis
Pulses per revolution	p	39080/24220	Number of encoder pulses per revolution
Gear factor	r	–	Speed ratio between number of revolutions on load side (r1) and number of revolutions on motor side (r2)
Number of revolutions on load site	r1	39000/24200	Actual speed of axis or spindle
Number of revolutions on motor side	r2	39040/24210	Actual speed of motor for axis or spindle
Pulses variable incremental weighting	u	3640/4550	Position control resolution weighting
Traversing path variable incremental weighting	v	3680/4560	Measuring system resolution weighting

Note

Machine data 39000–39120 and 24210–24220 are used for internal calculations only.

Formulas used for calculation

Measuring system resolution (axis) : $m = \frac{r \times l}{4 \times p \times f}$

or $m = \frac{r \times g}{4 \times p \times f}$

Measuring system resolution (spindle) : $m = \frac{r \times 360\ \text{degr.}}{4 \times p \times f}$

Ratio : $\frac{\text{Measuring system resolution}}{\text{Position control resolution}} \Rightarrow \frac{m}{b} = \frac{v}{u}$

Gearbox factor : $r = \frac{r1}{r2}$

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Motor measuring system example

Information required: $m = \frac{r \times l}{4 \times p \times f}$

Gearbox factor: $\mathbf{r} = \frac{r1\ (leadscrew)}{r2\ (motor)}$

Leadscrew pitch: **l**

Pulses per revolution: **p**

Pulse multiplication: **f**

Linear measuring system example

Information required: $m = \frac{r \times g}{4 \times f}$

Gearbox factor: $\mathbf{r} = \frac{r1}{r2} = 1$

(≙direct measuring system)

Grating constant: **g**

Pulse multiplication: **f**

Rotary axis example

Information required $m = \frac{r \times 360\ degrees}{4 \times p \times f}$

Gearbox factor: **r**
(depends on whether direct or indirect measuring sysem is used)

Pulses per revolution: **p**

Pulse multiplication: **f**

Note

Additional information about measuring system adaptation is given in machine data NC MD 3640 (Pulses var. incremental weighting) and NC MD 3680 (Traversing path var. incremental weighting).

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5.2.5 Copying a complete machine data block (as from SW 5.6)

General
The “NC configuration” basic screen contains the softkeys for copying and inserting complete spindle and axis data blocks. The “Drive configuration” basic screen contains the softkeys for drive data blocks.

Precondition
The password is set.

Select axis/spindle
You can call the NC configuration screen by selecting softkeys **Diagnosis**, **Startup**, **Machine data** and **NC-MD**.

Copy spindle
By selecting softkey **Copy spindle**, you can copy the data of the spindle selected in the spindle sub-window to the clipboard. The dialog text
!!!Transfer from NC to PC in progress!!!
is output during the copy process.

Insert spindle
By selecting softkey **Insert spindle**, you can copy the data stored in the clipboard to the spindle selected in the spindle sub-window. The dialog text
“Insert from clipboard?
(overwrite whole axis/spindle/drive)
then appears. The data is transferred when you select softkey **OK**.

Copy axis
Insert axis
Axis data blocks are copied and inserted in the same way as spindle data blocks (see above).

Select drive data
You can go to the drive configuration display by selecting softkeys **Diagnosis**, **Startup**, **Machine data** and **Drive MD**. When you select softkey **Copy/Insert**, the softkeys **Copy to clipboard** and **Insert from clipboard** are added on the right of the softkey bar.

Copy to clipboard
When you select softkey **Copy to clipboard**, the data of the selected slot is copied complete to the clipboard. The dialog text
!!!Transfer from NC to PC in progress!!!
is displayed during the copy operation.

Insert from clipboard
When you select softkey **Insert from clipboard**, the data from the clipboard is copied to the selected slot. The dialog text
“Insert from clipboard?
(overwrite whole axis/spindle/drive)”
then appears. The data is transferred when you select softkey **OK**.

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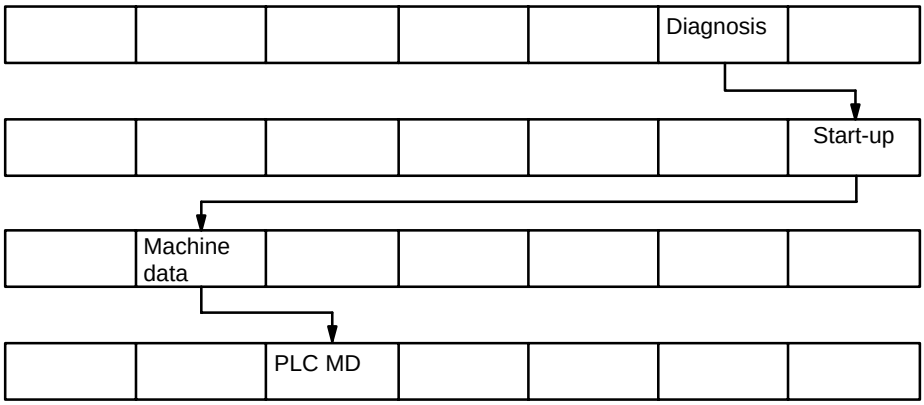
5.3 PLC configuration and PLC machine data (as from SW 3)

5.3.1 PLC configuration

Selection



The PLC configuration display appears on the screen when you press the Diagnosis, Start-up, Machine data and PLC MD softkeys.

Note

A brief description of the PLC configuration and PLC machine data appears on the screen when you press the info key.

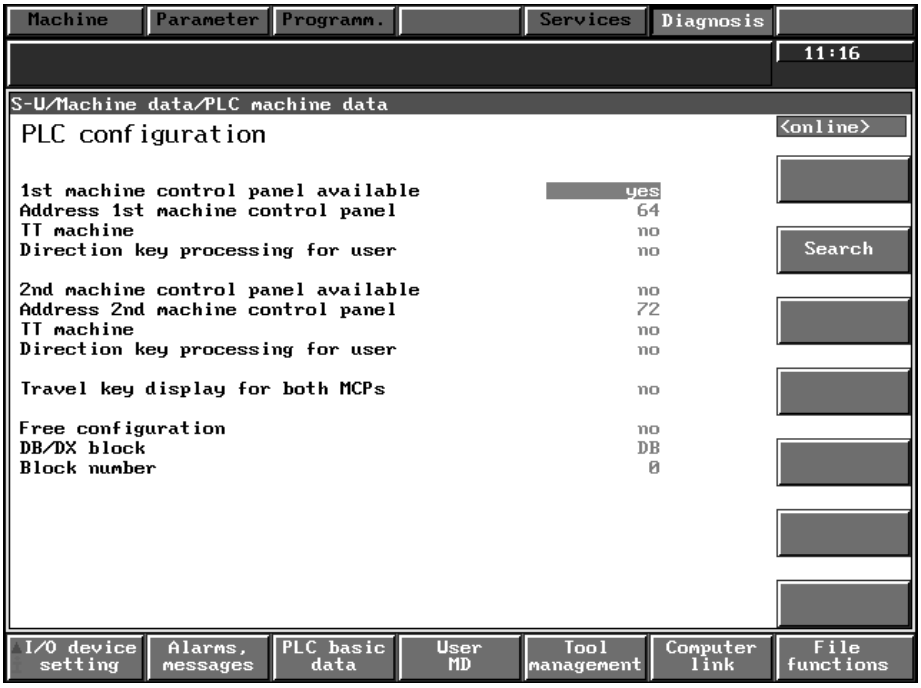


Fig. 5.6

Explanation

In this display you configure the current assignments (control panel available, address, TT machine, etc.) for the 1st and 2nd machine control panel. The contents of the display fields show the settings in the following machine data.

1st machine control panel (MCP)

- Available:
  The 1st machine control panel is displayed as available when PLC MD 6066.0 (machine control panel available) is set.

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- Address:
  The address assignment for the 1st machine control panel is determined in PLC MD 128 (initial address for 1st machine control panel).
- TT machine:
  The setting in PLC MD 6066.4 (configuration 1st machine control panel TT machine) determines whether the machine is a T or a TT machine (double slide).
  T machine: Input = No
  TT machine: Input = Yes
- Direction key processing:
  The setting in PLC MD 6066.5 (processing of direction keys by user) determines whether the direction keys are processed by the PLC operating system or the user.
  PLC operating system: Input = No
  User: Input = Yes

2nd machine control panel (MCP)

- Available:
  The 2nd machine control panel is displayed as available when PLC MD 6067.0 (machine control panel available) is set.
- Address:
  The address assignment for the 2nd machine control panel is determined in PLC MD 129 (initial address for 2nd machine control panel).
- TT machine:
  The setting in PLC MD 6067.4 (configuration 2nd machine control panel TT machine) determines whether the machine is a T or a TT machine (double slide).
  T machine: Input = No
  TT machine: Input = Yes
- Direction key processing:
  The setting in PLC MD 6067.5 (processing of direction keys by user program) determines whether the direction keys are processed by the PLC operating system or the user program.
  PLC operating system: Input = No
  User program: Input = Yes

Travel key display

- For both machine control panels:
  The setting in PLC MD 6065.0 (travel key display) determines whether the travel key display comes from the PLC operating system or the user program.
  The LEDs receive a signal from the user program.
  Input = No
  The LEDs receive a signal from the PLC operating system: Input = Yes

Free configuration

- Selection Yes ↔ No (PLC MD 136)
- Block type:
  The input field for the block type is displayed with PLC MD136 (No. of project block).
  There are two types:
  DB: Numbered 1 to 255
  DX: Numbered 1000 to 1255
- Block No.
  The input field for the block number appears with PLC MD136 (No. of project block).
  Possible input values:
  for DB: 1 to 255
  for DX: 0 to 255

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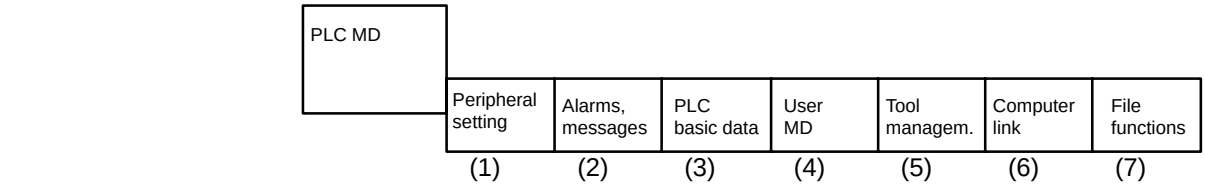
5.3.2 PLC machine data

Menu tree



(1)

DMP config.	Interrupts	Process alarms				File functions

(2)

General		Channel	Axis	Spindle		File functions

(3)

Program	Interface					File functions

(4)

				Edit list	Edit texts	File functions

(5)

Basic data	Maga-zine 1	Maga-zine 2	Maga-zine 3	Maga-zine 4		File functions

(6)

System setting	General functions	Tool dialog code carr.				File functions

Note

A list of the individual PLC machine data areas is given on the following pages. The machine data are grouped according to their functions within these areas. The functions of the individual machine data are described in the section entitled “PLC Machine Data”, where they are listed alphanumerically.

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(1) PLC MD/Peripherals setting

Softkey DMP configuration	This softkey contains various interface DMP interface and PLC 135 WD user machine data.
Softkey Interrupts	This softkey contains central and distributed interrupt machine data.
Softkey Process alarms	This softkey contains various process alarm machine data.

(2) PLC MD/Alarm messages

Softkey General	This softkey contains general message and alarm machine data.
Softkey Channel	This softkey contains channel message and channel alarm machine data.
Softkey Axis	This softkey contains axis message and axis alarm machine data.
Softkey Spindle	This softkey contains spindle message and spindle alarm machine data.

(3) PLC MD/PLC basic data

Softkey Program	This softkey contains operation block and program machine data.
Softkey Interface	This softkey contains various interface machine data.

(4) PLC MD/User MD

Softkey User MD	This softkey contains user value and user bits machine data.
Softkey Edit list/texts	The User MD softkey offers facilities to the user for putting together machine data with his own list and texts in the PLC MD area. This means that the user can see all the PLC machine data relevant to his needs at a glance. The lists are created by pressing the **Edit list** softkey and then entering texts under the **Edit texts** softkey (see functional description of User displays – Edit list).

(5) PLC MD/Tool management

Softkey Basic data	This softkey contains various tool management machine data.
Softkey Magazine 1–4	This softkey contains various tool management machine data for magazines 1 – 4.

(6) PLC MD/Computer link

Softkey System setting	This softkey contains various system setting machine data for the computer link.
Softkey General functions	This softkey contains various function machine data for the computer link.
Softkey Tool dialog/code carrier	This softkey contains tool identifier and code carrier machine data.

(7) No explanation here

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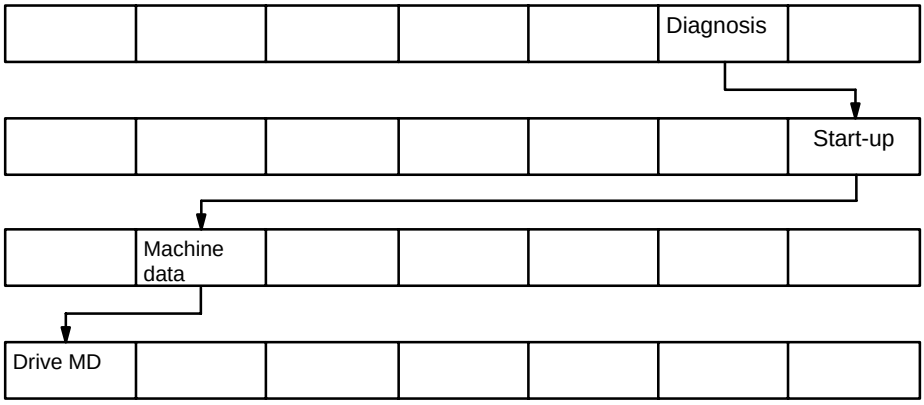
5.4 Drive configuration and drive machine data (as from SW 3)

5.4.1 Drive configuration

Selection



Press the Diagnosis, Start-up, Machine data and Drive MD softkeys to display the drive configuration display.

Note

Press the info key for a short description of the drive configuration and drive machine data.

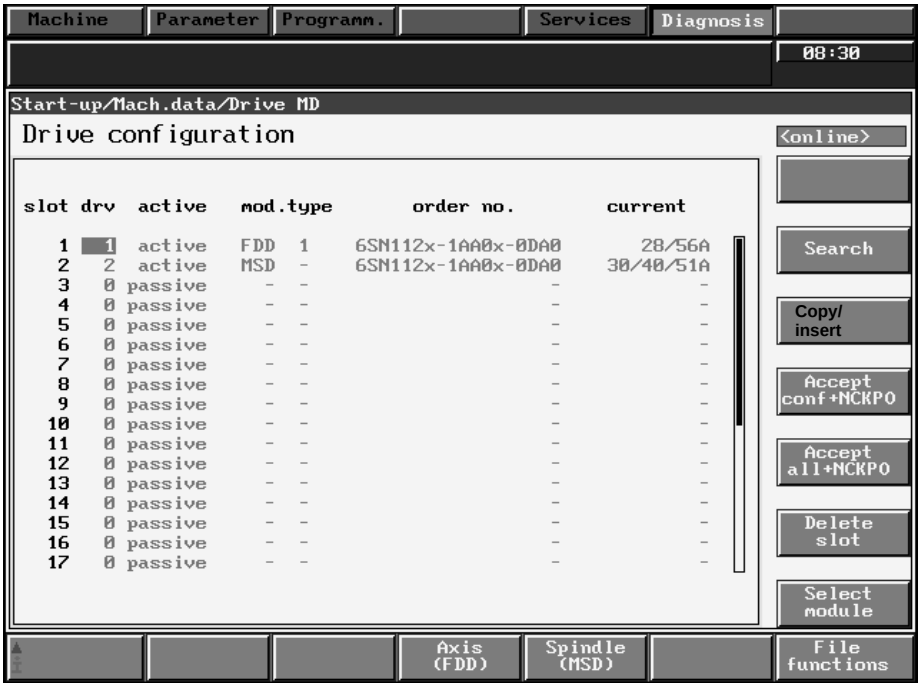


Fig. 5.7

Explanation

The actual drive modules for the FDD and MSD motors are entered and activated in this drive configuration display. The drive number is assigned the same number as the module slot and the modules are selected using the **Select module** softkey. This configuration must then be backed up in the boot file with **Accept conf + NCKP0** softkey**.**

Note

When selecting the module please ensure that the **order no.** taken from the **selection list** and **hardware** coincide. Some order numbers are nearly identical. For example, MSD module 45/60/76A:
1. Order no.: 6SN112x–1AA0**0**–0GA0
2. Order no.: 6SN112x–1AA0**1**–0GA0

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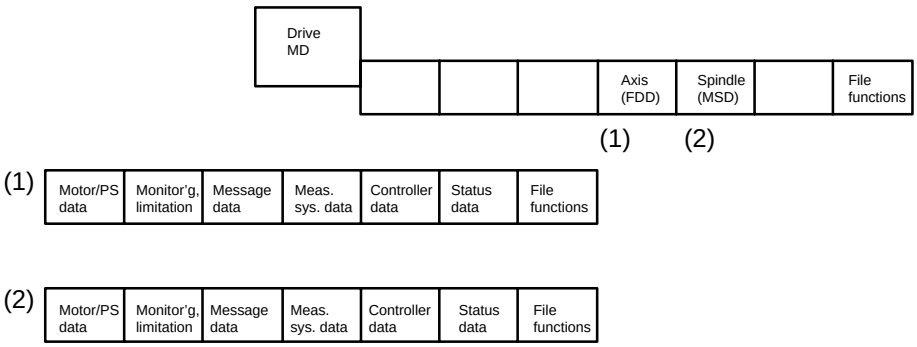
5.4.2 Drive machine data for axes (FDD) and spindles (MSD)

Menu tree



Note

A list of the individual drive machine data areas is given on the following pages. The machine data are grouped according to their functions within these areas. The functions of the individual machine data are described in the section entitled "Drive Machine Data" where they are listed alphanumerically.

(1) Drive MD/Axis (FDD)

Softkey Motor/PS data

This softkey contains the drive system and motor/power section machine data.

Softkey Monitoring/limitation

This softkey contains the monitoring, limitation, concealable alarm, cutout behaviour on alarm, emergency retraction and generator mode machine data.

Softkey Message data

This softkey contains various message machine data.

Softkey Measuring system data

This softkey contains various measuring system machine data.

Softkey Controller data

This softkey contains speed controller, speed setpoint smoothing, current setpoint filter, limitation I component, reference model speed control loop, adaptation speed controller, current controller, speed torque feedforward control and RFG automatic control machine data.

Softkey Status data

This softkey contains status display, current values (drive, servo), status register, min., max. memory, monitoring function, I/F mode, dn/dt monitoring and diagnostics servo machine data.

(2) Drive MD/Spindle (MSD)

Softkey Motor/ PS data

This softkey contains the drive system and motor/power section (motor 1 and 2) machine data.

Softkey Monitoring/limitation

This softkey contains monitoring, limitation and concealable alarm machine data (motor 1 and 2).

Softkey Message Data

This softkey contains several message machine data (motor 1 and 2).**SW 3** contains additional selectable relay function and programmable message machine data.

Softkey Measuring system data

This softkey contains various measuring machine data (motor 1 and 2).

Softkey Controller data

For **SW 4** this softkey contains speed controller (motor and 2), speed setpoint smoothing, current setpoint smoothing, limitation I component, reference model speed control loop, adaptation speed controller (motor 1 and 2), current controller (motor 1 and 2) and flux controller (motor 1 and 2) machine data. **SW 3** contains speed controller, filter setting and current controller machine data.

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Softkey Status Data

This softkey contains status display, current values (drive/servo), status register, motor encoder diagnostics, min., max. memory, monitor function, I/F mode, diagnostics servo and communications servo/611D machine data. **SW 3** also contains monitoring memory location and transient recorder function machine data.

Note

Some of the machine data are parameter set dependent (see ”Selecting a displayed parameter number”).

5.4.3 Axis/spindle start-up for the digital drive (as from SW 3)

Note

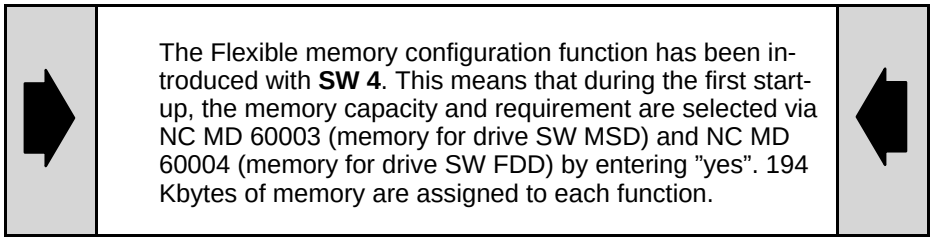
Two different drive installation versions exist:

- Installation for **analog drives** is performed as usual by setting parameters and potentiometer in the drive (for a more detailed description see Section Start-up Axis and Spindle).
- **Digital drives** are started-up by entering and installing the module and motor type. The drive data are preset with standard data from the control by this method.

See also Section 10.

Procedure

The digital drives can be started up via the file functions by loading one of the available TEA3 files or via standard start-up procedure with module and motor selection.



The Flexible memory configuration function has been introduced with **SW 4**. This means that during the first start-up, the memory capacity and requirement are selected via NC MD 60003 (memory for drive SW MSD) and NC MD 60004 (memory for drive SW FDD) by entering ”yes”. 194 Kbytes of memory are assigned to each function.

Standard start-up

Select the **Drive MD** area via the Diagnosis/Start-up/Machine data softkeys. You are now in the drive configuration screen. The order of the slots symbolizes the arrangement of the FDD/MSD modules in the control cabinet:
First of all for **SW 3**, for example, you enter number **1** in the field **Slot for module selection**. As a result, the display cursor jumps to the drive number input field. Here you enter the **Drive No.** (e.g. No. 1). For **SW 4** only the drive number has to be entered. Now switch the drive from **Passive** to **Active** using the **Toggle key**. Now select the current module type via the **Select module** softkey. Acknowledge your selection with **ok**.

Note

When selecting the module please ensure that the **order no.** taken from the **selection list** and **hardware** coincide. Some order numbers are nearly identical. For example, MSD module 45/60/76A:
1. Order no.: 6SN112x–1AA0**0**–0GA0
2. Order no.: 6SN112x–1AA0**1**–0GA0

Follow the procedure above to enter several modules. Enter a consecutive number for the drive number for the next module.
Please note: With **SW 3** you must also select a slot no.

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Note

Any number from 1 to 15 (up to SW 4, from SW 5, 1-30) in any order can be used for the drive number.

Power-up is performed and the bus initialized using the softkey **Accept conf + NCKPO**. The message **Start-up necessary** is also displayed, i.e. the individual axes and spindles connected to the drive bus do not have a machine data record. The motor is selected via the Diagnosis/Start-up/Machine data/Drive MD softkeys and axis (FDD) or spindle (MSD) in the motor/PS data display. In the case of the axis (FDD), the order number of the connected motor is selected via the **Select motor** softkey.

When you have confirmed the selection with **ok**, the message **Transfer from PC to NC in progress** appears. All the FDD machine data, and with **SW 4** and higher, all MSD machine data, have now received standard preset values.

For the spindle (MSD), two motors and the number of pulses per revolution must be entered under the menu **Select motor**. Only when the number of pulses per revolution has been confirmed with **ok** are the other machine data preset (general reset) from the list (SW 3 only) stored for the spindle (MSD) for the motor selected. If **2nd motor not available** is selected when the second motor is selected, the general reset for the second motor is executed with the previously entered motor (default value). This also applies to SW 3 only. With SW 4, no machine data are preset if a 2nd motor is not available.

Now use the **Recall key** to call up the drive configuration display and then press the softkey **Accept all + NCKPO**. The boot file on the hard disk is updated.

Note

In **SW 3** the MSD data are backed up in the FEPROM. As from **SW 4**, the boot data records for the FDD and MSD are backed up on the **NCK** hard disk only.

After start-up the drives are ready for operation (LED has gone out on the individual modules). A drive that has already been installed can be reinstalled by deleting the boot data record (delete boot drives) using the file functions and then pressing the softkey **NCK Power On**.

Start-up: Loading a user data record

Load the user data record configuration in the drive configuration display using the **Load from disk** and **Area config** file functions. **Accept conf + NCKP0** starts up and initializes the bus. The message **Start-up necessary** then appears. Now load the drive data using the **Load from disk** and **Area drives** file functions. Complete this step by pressing the **Accept all + NCKP0** softkey. After executing an NCK Power On you must enter the password again (SW 3 only).

The following conditions apply when entering drive machine data:

- The machine data are divided up into Power On and online data. The online data are active immediately, whereas the Power On data are not activated until a NCK Power On.
- The described start-up procedure (select motor, load standard data) can be executed at any time.
- If the motor selection is executed for the spindle (MSD) after a successful power-up (power-up status 5), the online active machine data are **not** overwritten by the default values (SW 3 only).

Entering data for a non-Siemens motor

If the spindle (MSD) is to be driven by an non-Siemens motor, i.e. the motor data have to be altered, the machine data first have to be entered and then set to the motor in question via Select motor (SW 3 only).

With **SW 4**, first the non-Siemens motor must be selected with **Select motor**, then the corresponding machine data must be entered and start-up concluded with the function **Calculate controller data**.

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On **SW5** and higher, it is possible to enter non-Siemens motors for which only the rating plate data of the motor is known and not the equivalent circuit diagram data (motor data).

After you have pressed the softkey **Non-Siemens motor 1 (Non-Siemens motor 2)** and confirmed the query with the OK softkey the control enters **code number 99** for non-Siemens motors. If you press the softkey of the selected **Non-Siemens motor 1 (Non-Siemens motor 2)** again and confirm the query with the **OK** softkey, the input form for rating plate data appears. After you have entered the data and pressed the softkey **Calculate eq. Ct. diag** the equivalent circuit diagram data (motor data) are calculated from the rating plate data. With the function **Calculate controller data**, the controller data are calculated from the equivalent circuit diagram data. An exact adaptation of the data to the machine requirements can then be made manually.

Data loss

The configuration data drives and MD drives are changed in the non back-up DRAM, i.e. the data are lost if the power supply fails.

Saving data

Save the configuration and drive machine data to the boot file with the softkey “Accept all” and NCKPO (NCK Power On).

The drive configuration and drive machine data must also be backed up to a user file.

Boot file

The boot file is stored on disk and contains only the drive and configuration machine data. When the control is switched on, the drives are automatically configured with the data from the boot file and the MD transferred to the drive.

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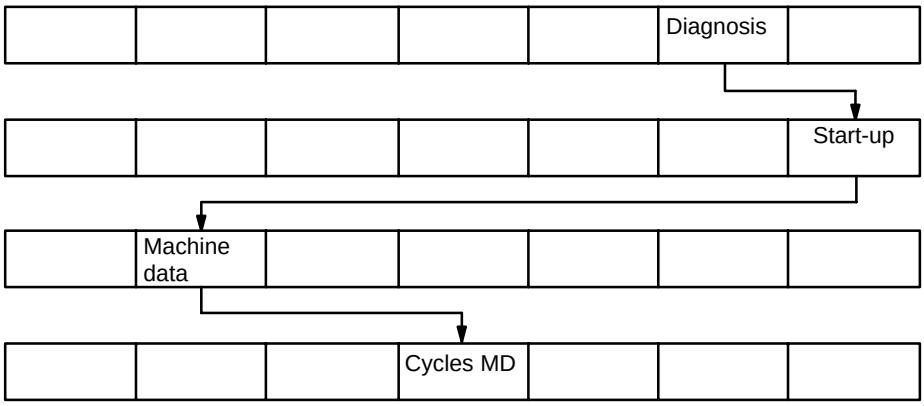
5.5 Cycles machine data (as from SW 3)

Selection



Press the Diagnosis, Start-up, Machine data and Cycle MD softkeys to call up the cycles machine data display.

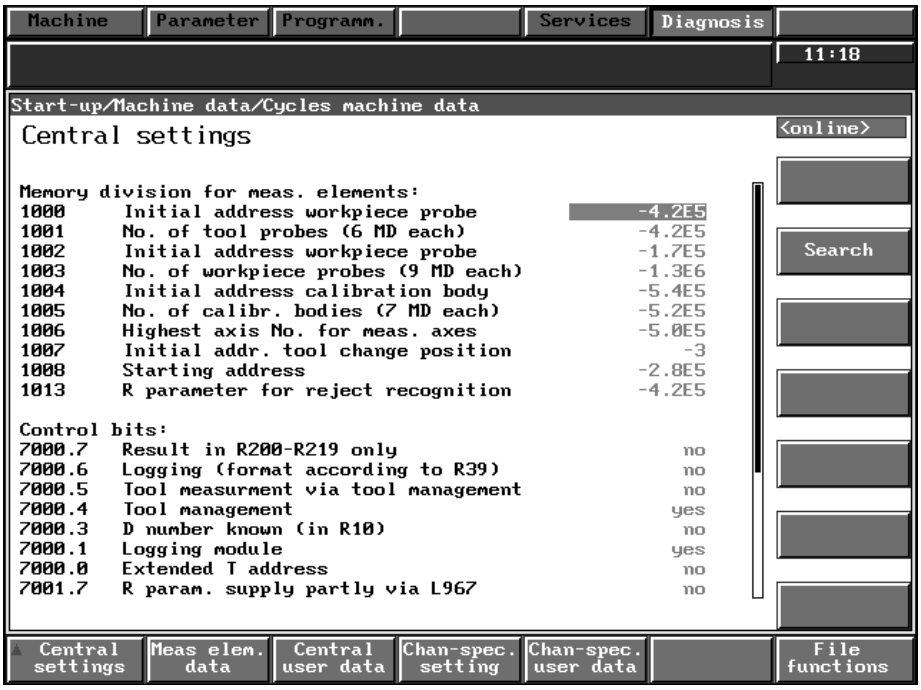


Fig. 5.8

Explanation

Measuring cycles and machining cycles are available for standard machining routines that are repeated several times. The cycles can be assigned the required machine data via the **Cycles MD** softkey. In this area you will find central and channel-dependent cycle machine data. The **Central cycles MD** are divided up into memory groups for measuring elements, measuring element data, control bit, user data and user bits. The **Channel-dependent cycles MD** are divided into values for measuring cycles, control bits for measuring cycles, user data and user bits.

Note

The functions of the individual machine data are described in the Installation Guide, User Guide and Programming Guide for cycles.

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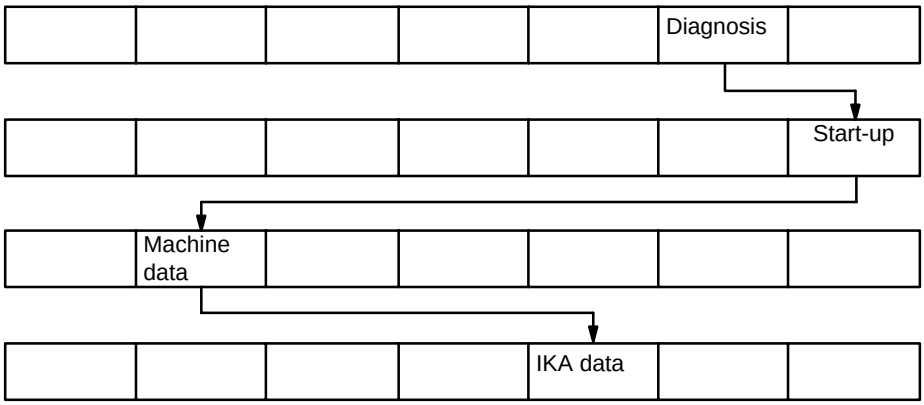
5.6 IKA data (interpolation and compensation with tables – as from SW 3)

Selection



Press the Diagnosis, Start-up, Machine data and IKA data softkeys to call up the IKA data display.

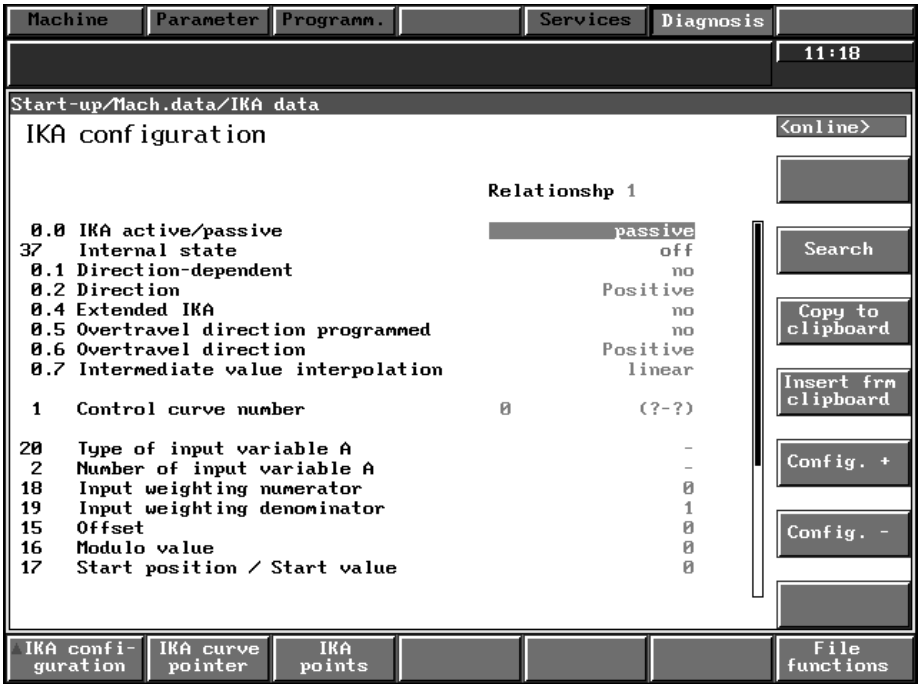


Fig. 5.9

Explanation

Machine tools are expected to meet ever increasing demands which in turn calls for improved functionality between machine and measuring system to compensate for errors. The IKA data (interpolation compensation with tables) are used for the following complex functions:

- Compensation function: Leadscrew error compensation and sag
- Interpolation function: Table-controlled geometry and velocity profile (SW 4 and higher)

Note

A list of the individual IKA data areas is given below. The IKA data (T parameters) are grouped together according to their functions within these areas. New IKA data (T parameters) are additionally available with **SW 4**.The functions of the

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individual data are described in the functional description of “Interpolation and compensation with tables” (Installation Guide).

IKA data

Softkey IKA configuration

This softkey contains various IKA data (T parameters) that define the configuration.

Softkey IKA curve pointer

With this softkey it is possible to input different curves with a start and end pointer which can then be calculated by pressing the **Calculate curve** softkey.

Softkey IKA points

With this softkey it is possible to enter points, the intermediate points of the input variable with its assigned interpolation values in order to determine the output variable.

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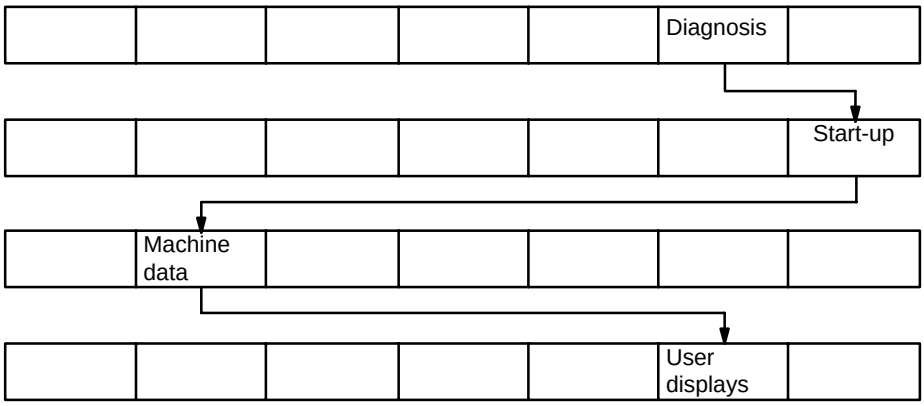
5.7 User displays (as from SW 3)

Selection



Press the Diagnosis, Start-up, Machine data and User MD softkeys to call up the User displays screen.

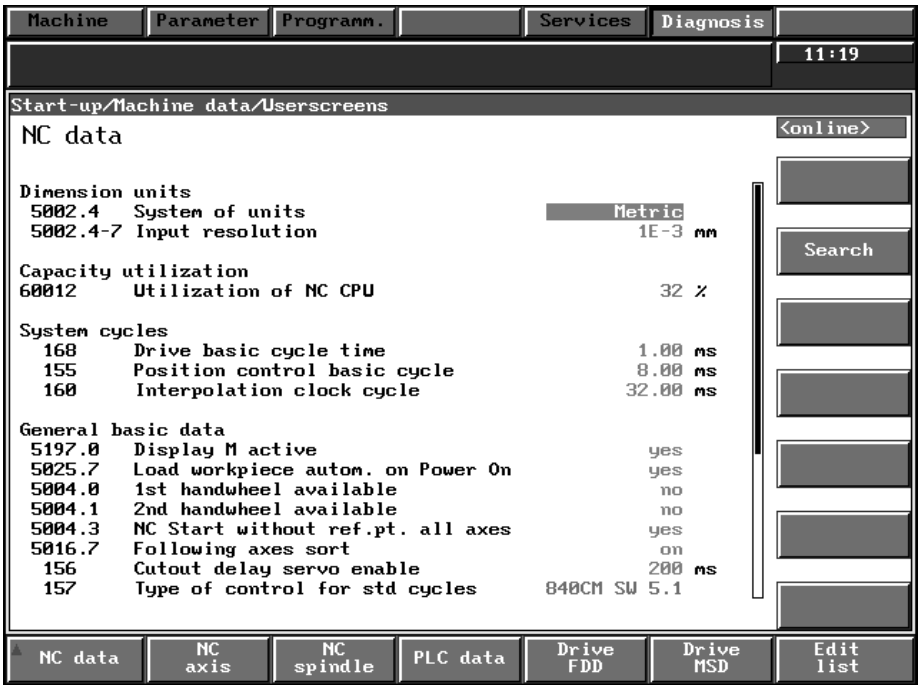


Fig. 5.10

Explanation

The user can configure his own lists of machine data in the NC data, NC axis, NC spindle, PLC data, Drive FDD and Drive MSD areas which are accessed by operating the User displays softkey.

This means that the user can look at all the machine data of the individual areas that are important to him at a single glance. The lists can be configured under the **Edit list** softkey.

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5.7.1 Edit list

Edit list

Select the softkey edit list in the User display area.

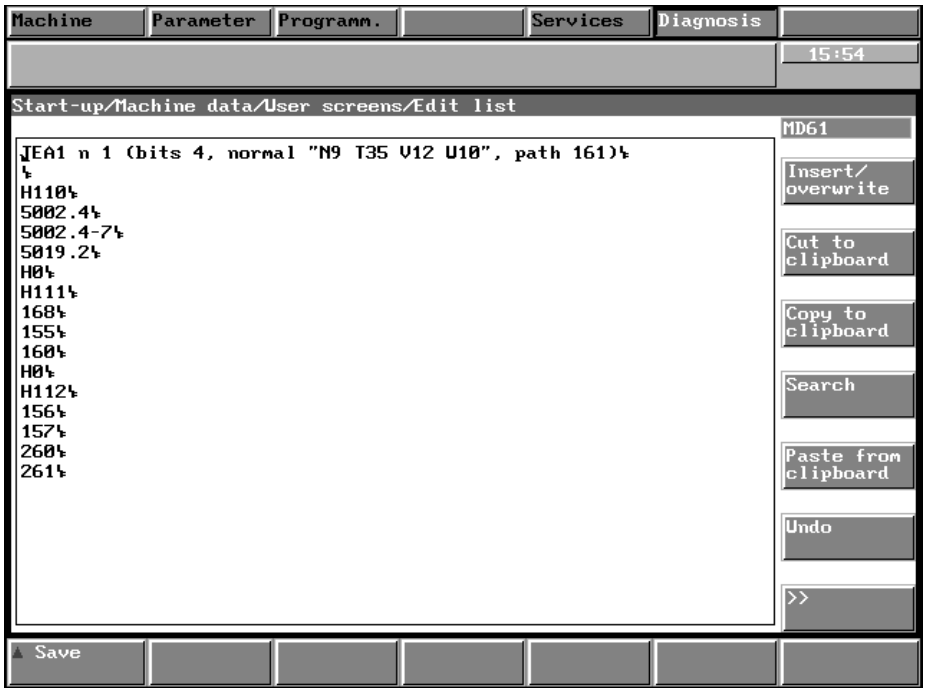

Fig. 5.11

Explanation

The header contains information about the display format and addressing the data.

Only the parameters for the display layout in the header may be altered.

Parameters that must not be altered

TEA1 ≙ NC MD – additional possibilties TEA2, TEA3
a ≙ axis-specific – additional possibilities:

n	=	General NC MD
k	=	Channel (c)
s	=	Spindle
vsa	=	Digital feed drive (fdd)
hsa	=	Digital main spindle drive (msd)

Parameters that can be changed (for display layout)

N9 T35 V12 U10: Column widths:

Date number	N = 9
Text	T = 35
Value	V = 12
Unit	U = 10

Explanation

The machine data to be displayed must first be entered in the correct list (axis-specific, spindle-specific etc.). The data of the first axis or spindle (e.g. NC MD 3840) must always be entered for axis/spindle-specific NC data. When entering a

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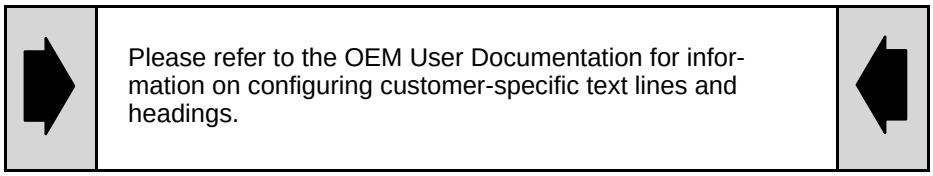
machine data, place the cursor on a free or an occupied line. Then select the required function using the softkey **Insert/overwrite** and then enter the machine data number.

Jump back to the user displays using the **Save** softkey and the Recall key and the machine data is then displayed with text.

You can define customer-specific intermediate headings in the list. These headings are marked with H+No., e.g. H0 ≙ you insert a space line.

List of header texts H...

With the softkey VIEW ONLY under SERVICES/DATA MANAGEMENT and the paths
SIEMENS/list module/TEA1/ENGLISH/tea1head
SIEMENS/list module/TEA2/ENGLISH/tea2head
SIEMENS/list module/TEA3/ENGLISH/tea3head
you can view and select one of the existing header texts.



Please refer to the OEM User Documentation for information on configuring customer-specific text lines and headings.

Note

The display and the MDD data displayed can be reconfigured using the function “Configure list module”.

Please refer to Section 4, subsection “Configuring the list module for the MDD”.

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5.8 File functions (as from SW 3)

5.8.1 1st level: Machine configuration (as from SW 3)

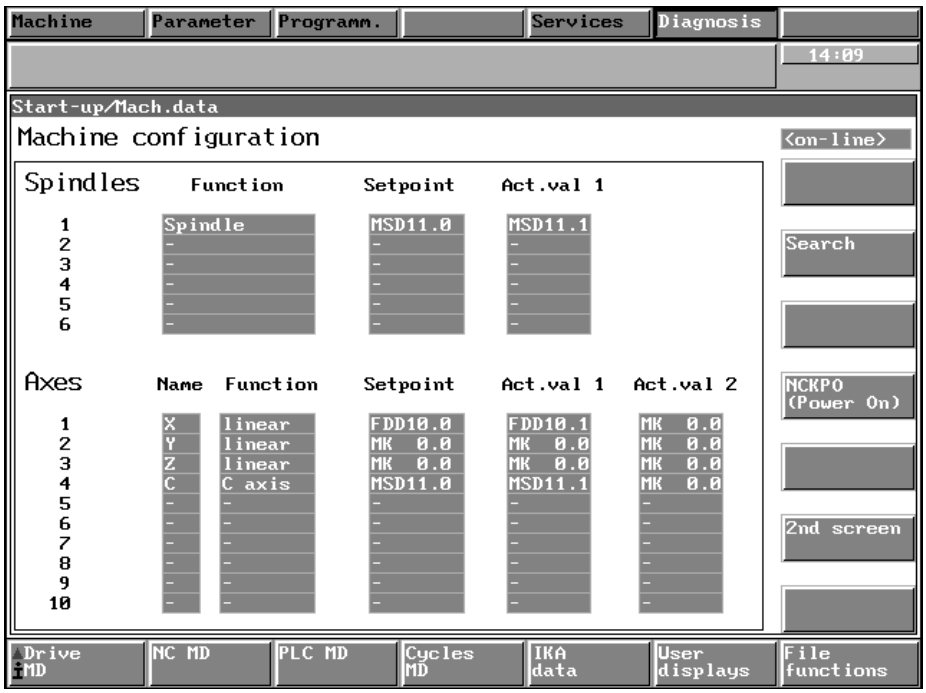

Fig. 5.12

Drive MD	NC MD	PLC MD	Cycle MD	IKA data	User MD	File functions

Explanation

On the first level the file functions refer to all the machine data areas (Drives, NC, PLC, Cycles, IKA). The data selector always displays the relevent files (TEA3, TEA1, TEA2, TEA4, IKA1, IKA2, IKA3).

Notes

When saving the cycles MD (TEA4), always make sure that the TEA4 file can consist internally of up to 7 files. This is because the channel-dependent cycles MD are saved in one file per channel, the central MD are stored in another file. The channel number is added to the file name, i.e. the name of the file to be stored is limited to 7 letters on the first level.

The steps required to load the files containing the drive data, “Accept config. + NCKP0” and “Accept all + NCKP0”, are executed automatically. Such a file must therefore always contain a complete drive file (configuration + drive).

When the drive files are being loaded the display jumps back to the basic display (JOG) after the configuration has been automatically saved and NCK Power On. The message “Start-up necessary – Power On” appears. The drive data are then loaded and NCK – Power On is repeated. The message “Start-up necessary – Power On” disappears.

When loading files on the first level, the message “Start-up necessary – Power On” must not be acknowledged with “Power On” (switch on/switch off).

An NCK Reset must be executed when TEA3 data are loaded (drive machine data) even if no drive exists.

Saving and loading NQEC data

The MDD functions “Save all” and “Load all” have been expanded to include the NQEC data.

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In the case of “Save all” the NQEC parameterization including the measured values from the NCK/servo are read out and stored in ASCII files under the selected name.

In the case of “Load all”, the selected NQEC ASCII files are read in and stored as boot files. A backup mechanism which is similar to that of TEA2-Load-all is implemented which is able to recover the NQEC boot files automatically on a power failure, emergency stop, if the hard disk is full or the abort key has been operated etc.

New alarms for this function: 165051 to 165054.

5.8.2 2nd level: Configuring the individual machine data areas (SW 3 and higher)

Drive machine data (TEA3)

			Axis (FDD)	Spindle (MSD)		File functions

NC machine data (TEA1)

General NC MD	Geometry motion	Channel	Axis	Spindle	Gearbox interpol.	File functions

Memory config.						▶

PLC machine data (TEA2)

I/O device setting	Alarms messages	PLC basic data	User MD	Tool manage-ment	Computer link	File functions

Cycle machine data (TEA4)

Central cycle MD	Chan. dep. cycle MD					File functions

Interpolation compensation machine data (IKA1 – IKA3)

IKA con-figuration	IKA curve pointer	IKA error points				File functions

Explanation

On the 2nd level the file functions refer to the data of the individual machine data areas. If the same file names are assigned to data records in different areas, they appear on the first level (machine configuration) under one data selector and can be loaded together from there.

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5.8.3 3rd level: Configuring within the machine data areas of individual machine data displays (as from SW 3)

Motor/ PS data	Monitoring limitation	Message data	Meas. sys. data	Controller data	Status data	File functions

Axis (TEA3)

Motor/ PS data	Monitoring limitation	Message data	Meas. sys. data	Controller data	Status data	File functions

Spindle (TEA3)

Motor/ PS data	Monitoring limitation	Message data	Meas. sys. data	Controller data	Status data	File functions

General NC MD (TEA1)

General basic MD	Face axis functions	Modes	Keyswitch	Technology MD	Computer link	File functions

Geometry motion (TEA1)

Geometry MD	Coupled axis comb.	Coordin. transform.	Override	Tool offset		File functions

Channel (TEA1)

Channel basic MD	Auxiliary functions	Multichannel display	Gen. reset G groups			File functions

Axis (TEA1)

Basic MD	Monitoring limitation	Velocities	Meas. sys. data	Controller data	Leadscrew error comp.	File functions

Spindle (TEA1)

Spindle basic MD	Monitoring limitation	Speeds	Meas. sys. data	Controller data		File functions

Gearbox interpolation (TEA1)

			GI axis	GI spindle		File functions

Memory configuration (TEA1)

DRAM data	SRAM data				Reconfig. memory	File functions

I/O device setting (TEA2)

DMP config.	Interrupts	Process alarms				File functions

Alarms messages (TEA2)

General		Channel	Axis	Spindle		File functions

PLC basic data (TEA2)

Program	Interface					File functions

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User MD (TEA2)

				Edit list	Edit texts	File functions

Tool management (TEA2)

Basic data	Magazine 1	Magazine 2	Magazine 3	Magazine 4		File functions

Computer link (TEA2)

System setting	General functions	Tool dialog code carr.				File functions

Central cycle MD (TEA4)

Central cycle MD						File functions

Channel dependent cycle MD (TEA4)

	Chan. dep. cycle MD					File functions

IKA configuration (IKA1)

IKA con-figuration						File functions

IKA compensation points (IKA2)

	IKA comp. points					File functions

IKA error points (IKA3)

		IKA error points				File functions

Explanation

On the 3rd level it is possible to select individual parts of a data record. If data is saved into an existing file only, the data referring to the contents of the display are overwritten, e.g. Axis basic MD (TEA1).

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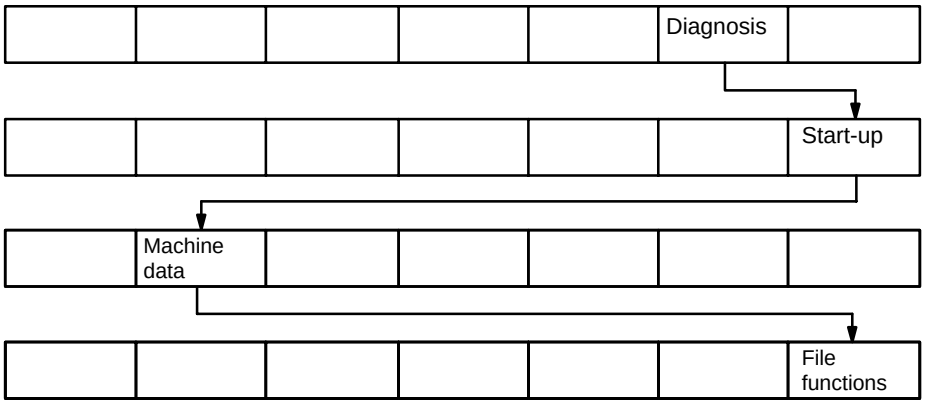
5.8.4 File functions (sequence of operation – as from SW 3)

5.8.4.1 1st level: File functions



Explanation

Press the Diagnosis, Start-up, Machine data and File functions softkeys to call the 1st level file functions display.

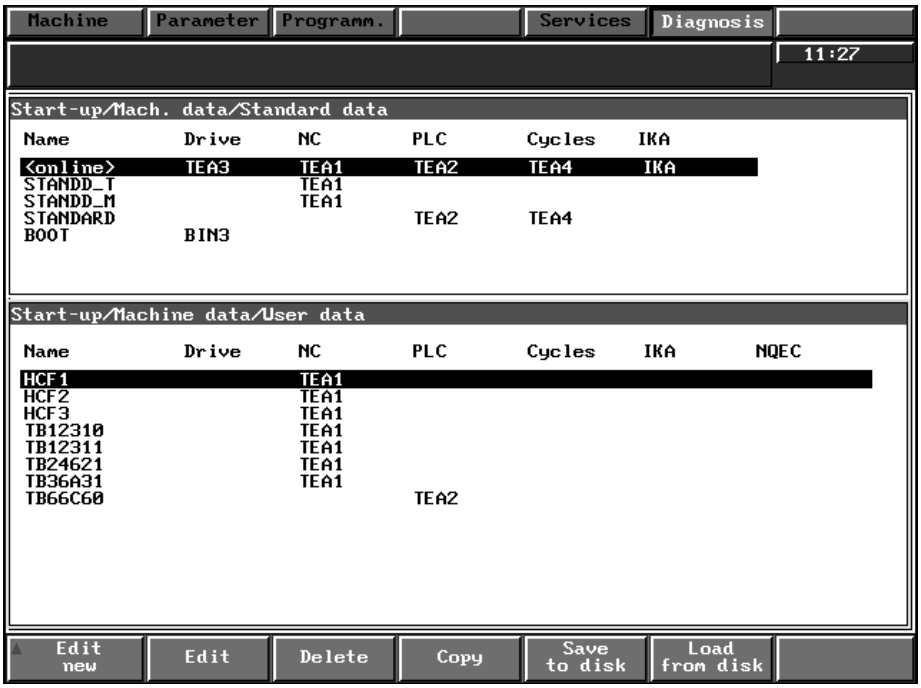


Fig. 5.13

Edit New

A new file can be created. You are prompted to enter a name.

Edit

Select a file that already exists from the manufacturer (Siemens) or user field. Only the BOOT file cannot be selected. It is a special file required for the drive installation. The selected file is displayed in the data record field in the configuration display.

Delete

Files already existing can be deleted together with their contents in the display field. First select the file to be deleted. Caution, if you select the BOOT file in the Siemens branch (above) you will delete its contents!

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Copy

Selected file can be copied.

Save to disk

The on-line file data are saved into the selected file. Here again the BOOT file has a special status (see drive installation/start-up).
The lower user data area must be selected.

Load from disk

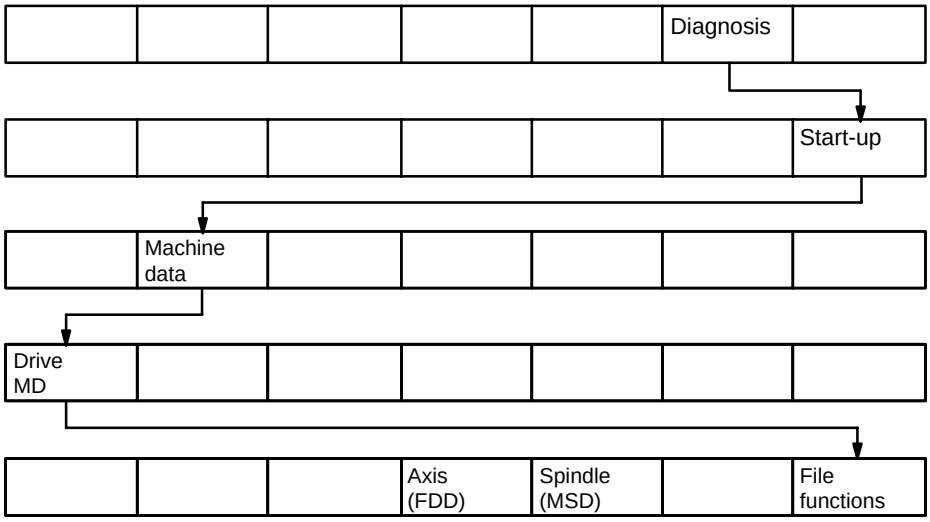
The selected file is loaded into the NCK. The on-line file and the BOOT file cannot be loaded.

Note

If the file functions are selected after an NCK Power On, the password has to be entered again.

5.8.4.2 2nd level: File functions

Selection/ (Example drive MD)



Explanation

Press the Diagnosis, Start-up, Machine data, Drive MD (e.g.) and File functions softkeys to call up the 2nd level file functions display.

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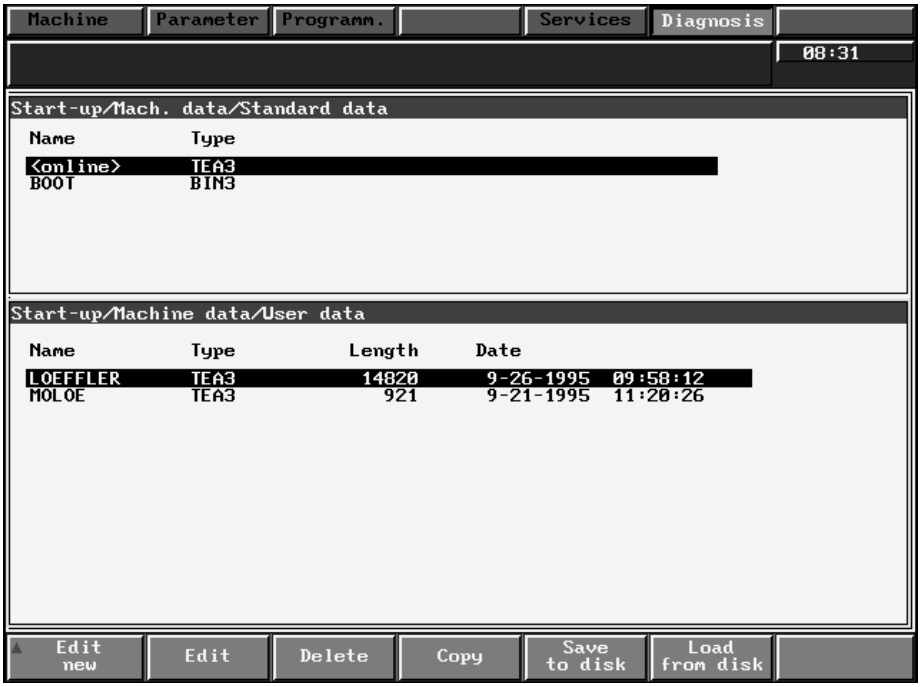

Fig. 5.14

Explanation

The functions of the individual softkeys are the same as for the first level.

Notes

With the **Save to disk** softkey**,** you can choose between **Conf** (≙ drive configuration only) and **All**.
With the **Load from disk** softkey**,** you can choose between **Conf** (≙ drive configuration only) and **Drives** (≙ drive MD without configuration), i.e. loading of a TEA3 file (drive) in the 2nd level is always carried out in 2 stages (see drive installation/start-up).

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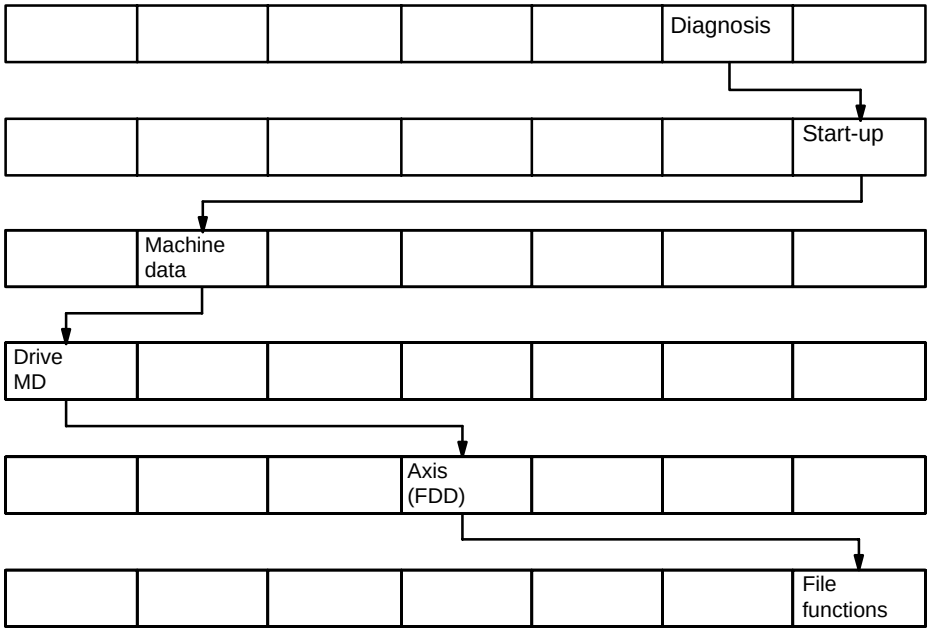
5.8.4.3 3rd level: File functions

Selection (Example drive MD axis)



Explanation

Press the Diagnosis, Start-up, Machine data, Drive MD (e.g.), Axis (FDD) and File functions softkeys to call up the 3rd level file functions display.

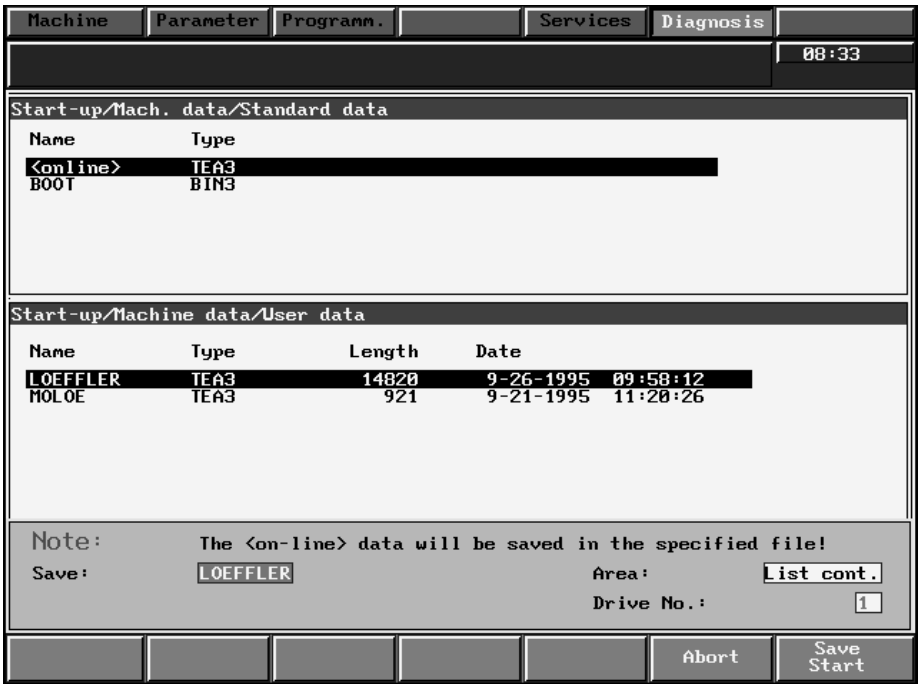


Fig. 5.15

Explanation

The functions of the softkeys are the same as for the first level. However, the functions of the two softkeys Save and Load can be expanded.

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Example: File function 3rd level NC MD
This can be seen from the example of the NC machine data structure. On the 3rd level, in each case the display contents (selected list display) are saved or loaded, and this can be extended to include (for instance) all the data of an individual axis or all axes.

Example A

If only the controller data of the 2nd axis (shaded field ①) are to be saved, then the file functions must be set as follows:

– Select Axis/Controller data file functions/Save to disk
– Area: Select display contents with toggle key
– Enter axis No. 2

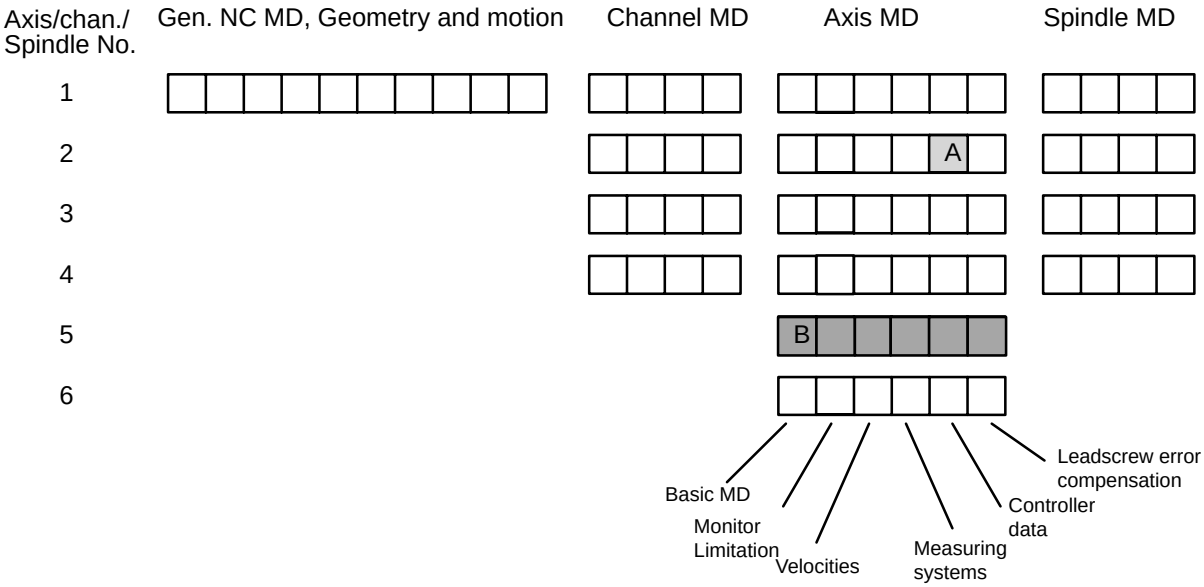
Example B

If all the data of axis 5, for example, are to be stored, the settings are as follows (shaded field B)

– Select axis
– Call file functions

  in Area: Select “All data” with toggle key

  under Axis No.: enter number 5



NC machine data structure

Explanation

When saving you can select either “display contents”, (selected area) or “all data” call areas of the SK bar) in “Area”.

Notes

If the number 0 is set for channel, axis, spindle, drive etc., all data (e.g. for velocities of all axes are loaded or saved!

Data that are stored at this level (e.g. axis 1 only) should also be reloaded at this level. If these data are loaded on the 1st level some MD bits might get lost.

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5.9 Procedure for altering configurations

5.9.1 Standard installation of digital drives (as from SW 3)

Specifications (Example) Drive modules
1 double axis FDD module
2 single axis FDD module
1 MSD module

Module slots:	Slot 1:	MSD module
(Installation location)	Slot 2:	free
	Slot 3:	free
	Slot 4:	2 axis FDD module
	Slot 6:	1 axis FDD module

Entering the drive configuration

Set the configuration from the specified values in the configuration display. Select the actual module type using the **Select module** softkey. Confirm these settings with the **Accept Conf + NCKP0** softkey.

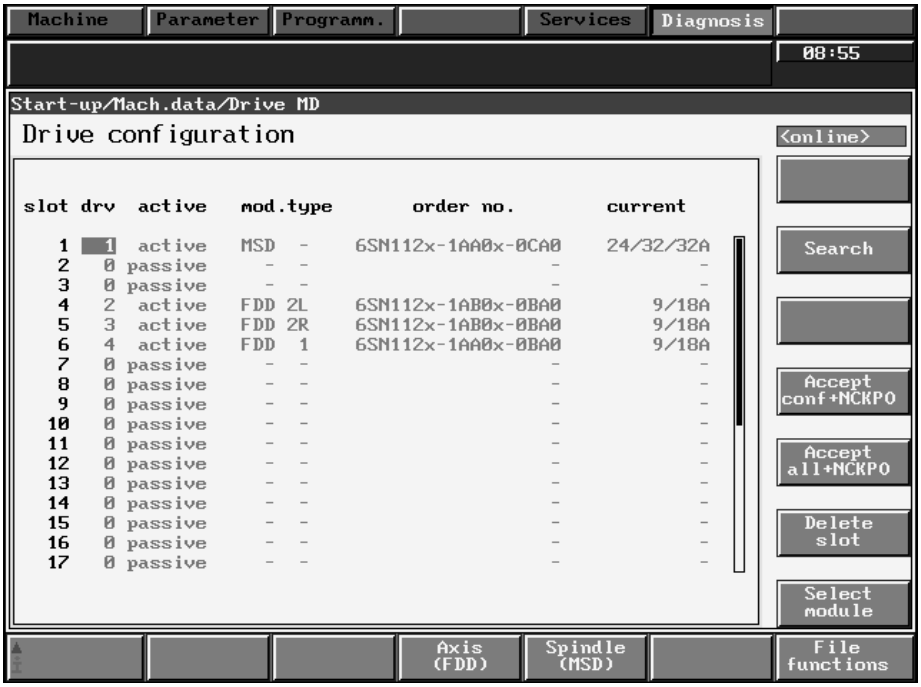

Fig. 5.16

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Motor selection

Press the Diagnosis/Start-up/Machine data/Drive MD and Axis (FDD) or Spindle (MSD) softkeys to call up the display motor/PS data to make the motor selection. Select the actual motor type with the **Enter motor** softkey. Once you have selected all the motors confirm these settings with the **Accept all + NCKP0** softkey in the previous display.

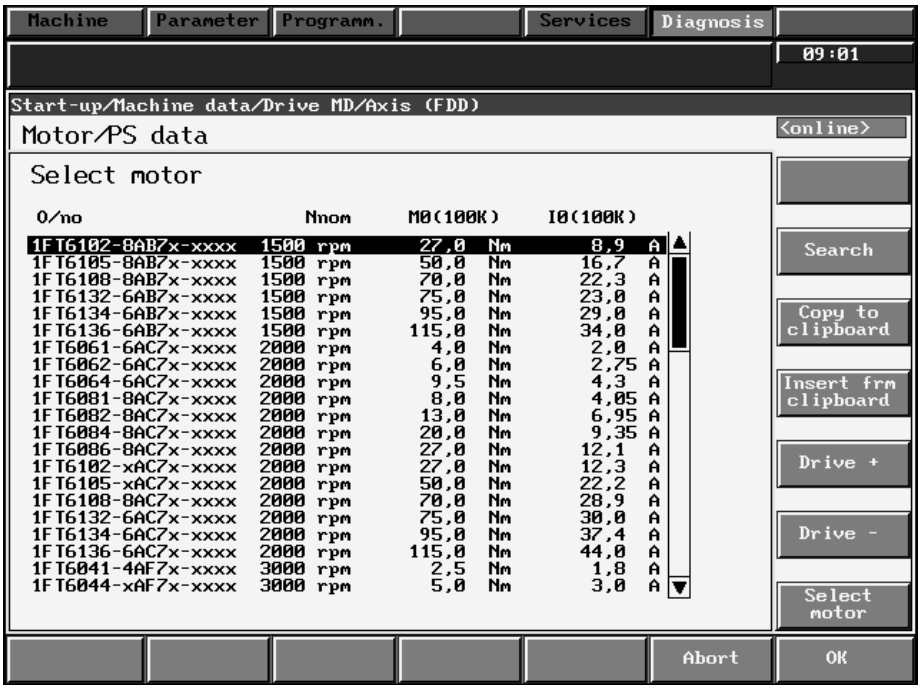

Fig. 5.17

Note

Please make sure that you enter the NC MD

- MD 3840, MD 2000 (FDD)
- MD 4600, MD 4000 (MSD)

correctly (assign).

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5.9.2 Adding a 1-axis FDD module (as from SW 3)

Specifications

Module slots:	Slot 1:	MSD module
(Installation location)	Slot 2:	free
	Slot 3:	free
	Slot 4:	2 axis FDD module
	Slot 6:	1 axis FDD module

Entering the drive configuration

Enter the additional 1 axis FDD module for slot 2 (installation location) in the drive configuration display. Select the actual module type with **Select module** softkey. Confirm these settings with the **Accept Conf + NCKP0** softkey.

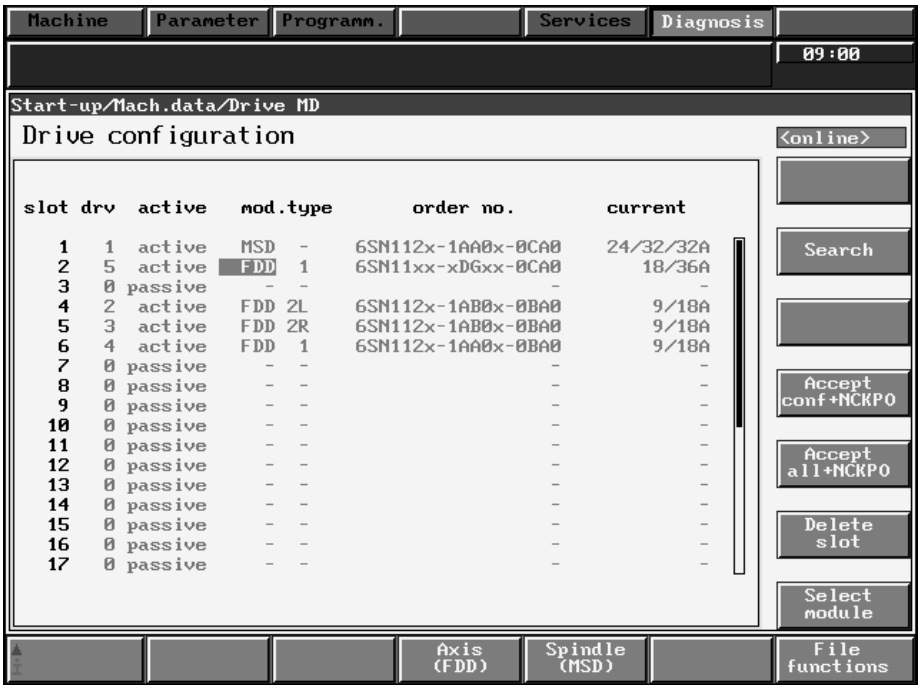

Fig. 5.18

Motor selection

Select the actual motor type with the **Enter motor** softkey. Confirm this setting with the **Accept all + NCKP0** softkey.

Notes

Please make sure that you enter NC MD 3840 and 2000 correctly (assign).

The drive numbers of drives already installed must **not** be changed, i.e. a new drive must be given a new drive number.

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5.9.3 Replacing a 1-axis FDD module with a 2-axis FDD module (as from SW 3)

Requirement

A 1-axis FDD module is to be replaced by a 2-axis FDD module with the **same** current rating.

Module slots:	Slot 1:	MSD module
(Installation loc.)	Slot 2:	1-axis FDD module (9/18 A)
	Slot 3:	free (if not, slot 3 is overwritten)
	Slot 4:	2-axis FDD module

Entering the the drive configuration

Delete slot 2 with the **Delete slot** softkey.
Confirm this setting with the **Accept Conf + NCKP0** softkey.
Now enter the actual 2-axis FDD module (9/18 A) for slot 2 with the **Select module** softkey. If no motor exists for the 3rd slot, switch it to passive. Again confirm this setting with the **Accept Conf + NCKP0** softkey.

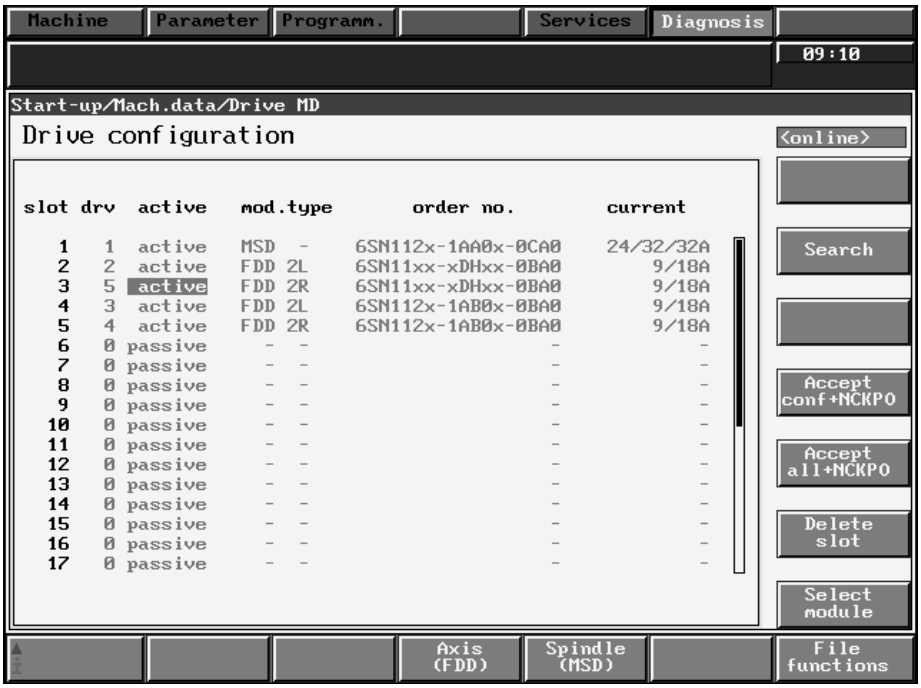

Fig. 5.19

Motor selection (only for new motor type)

Select the actual motor with the **Enter motor** softkey. Confirm this setting with the **Accept all + NCKP0** softkey.

Notes

Please make sure that you enter NC MD 3840 and 2000 correctly (assign).

The drive numbers of drives already installed must **not** be changed, i.e. a new drive must be given a new drive number.

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5.9.4 Replacing a 2-axis FDD module (9/18 A) with a 2-axis FDD module (18/36 A) (as from SW3)

Specifications

A 2-axis FDD module (9/18 A) is to be replaced by a 2-axis FDD module (18/36 A) with a higher current rating.

Module slots:	Slot 1:	MSD module
(Installation loc.)	Slot 2:	1-axis FDD module
	Slot 3:	free
	Slot 4:	2-axis FDD module (9/18 A)

Entering the drive configuration

Delete the slot for the 2-axis FDD modules with the **Delete slot** softkey. Confirm this setting with softkey **Accept Conf + NCKP0**.
Now enter the actual 2 axis FDD module (18/36 A) for the correct slot using softkey **Select module**. Again, confirm this setting with the **Accept Conf + NCKP0** softkey.

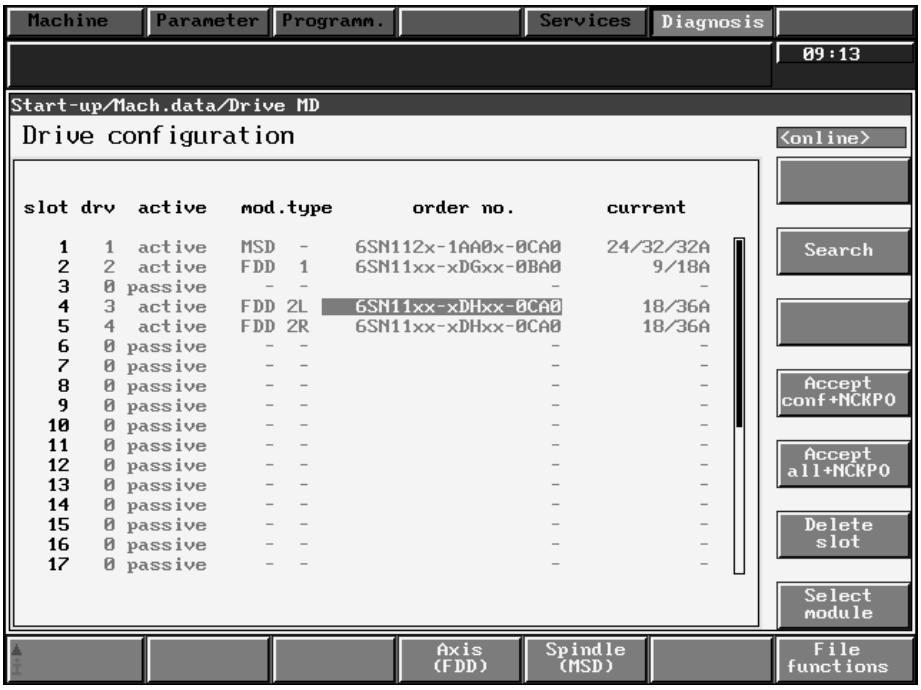

Fig. 5.20

Motor selection

Select the current motors with the **Enter motor** softkey. Confirm the settings with the **Accept Conf + NCKP0** softkey.

Note

Please make sure that you enter NC MD 3840 and 2000 correctly (assign).

The drive numbers of drives already installed must **not** be changed, i.e. a new drive must be given a new drive number.

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5.9.5 Drive active or passive (as from SW3)

Application

For example, when using a 2-axis FDD module, one of the axes is disconnected from the bus temporarily.

Procedure

Switch the axis from the **active** to the **passive state** in the drive configuration display. Confirm this setting with the **Accept Conf + NCKP0** softkey.
You return to the previous state by switching the axis back to **active** and confirming this setting with the Accept Conf + NCKP0 softkey.

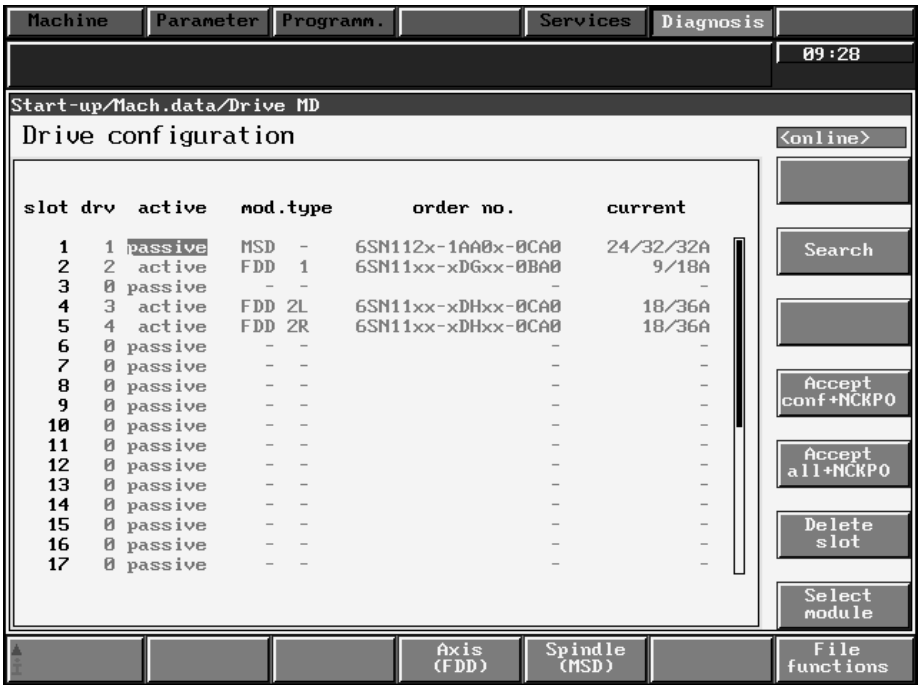

Fig. 5.21

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5.9.6 Using a new motor type (as from SW 3)

Application

A new motor type is to be installed on the machine tool. The same drive module is used.

Procedure

Operate the **Enter motor** softkey in the Motor/PS data display. Select the type of motor you want. If you are using a motor made by a different manufacturer, you must adapt the motor data from a data sheet. Confirm this setting with the **Accept Conf + NCKP0** softkey.

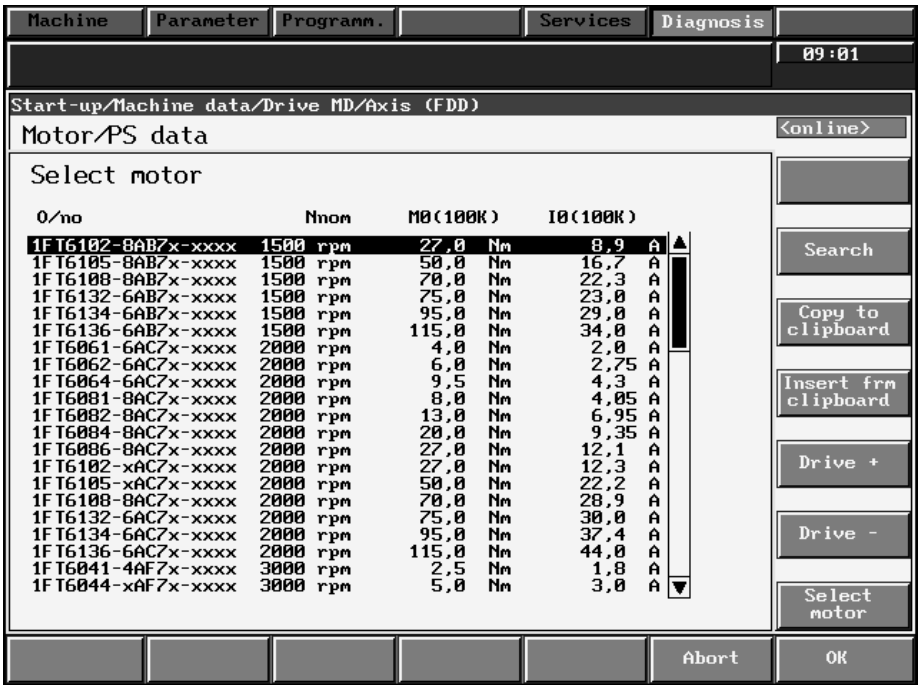

Fig. 5.22

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5.9.7 Reinstallation of existing and new drive components using the existing drive files (TEA3)

Application

You require a two-tier configuration, i.e. a 2nd module group is to be added. TEA3 user files already exist for the individual modules and motors.

Procedure (1st method)

Select the **File functions** softkey in the configuring display and then operate the **Load from disk** softkey. A menu bar appears in which you enter the existing TEA3 files together with the file names and then select the **Config** area with the toggle key.
Operate the **Load start** softkey. The data are loaded into the drive. Confirm these settings with the **Accept conf + NCKP0** softkey.

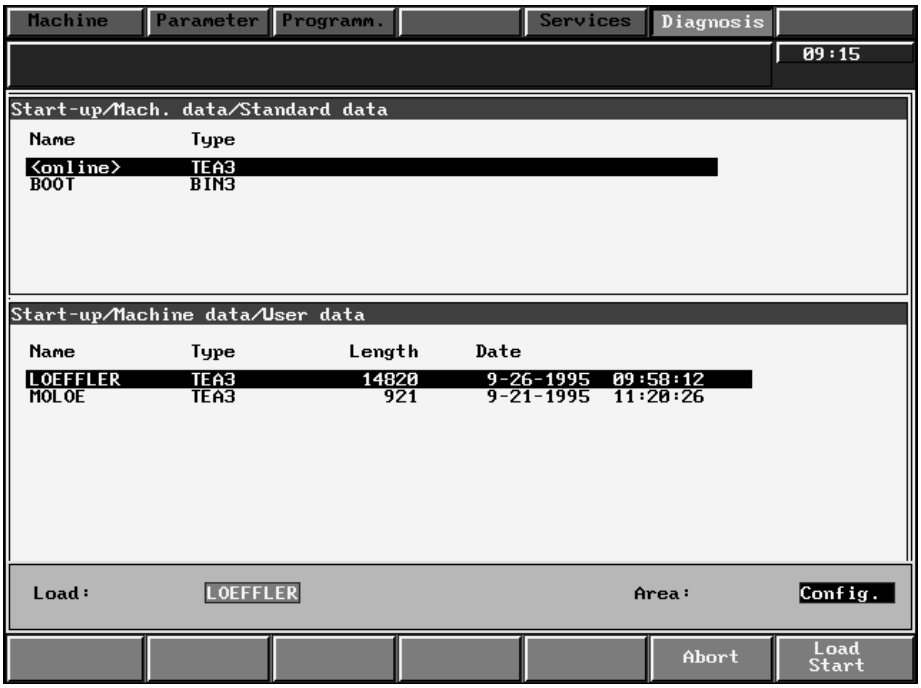

Fig. 5.23

Procedure 1 (2nd method)

Again select the drive configuration display and the **File functions** softkey. Using the **Load from disk** softkey, load the TEA3 files in the **Drives** area into the drive using the **Load start** softkey. Confirm this setting with the **Accept all + NCKP0** softkey.

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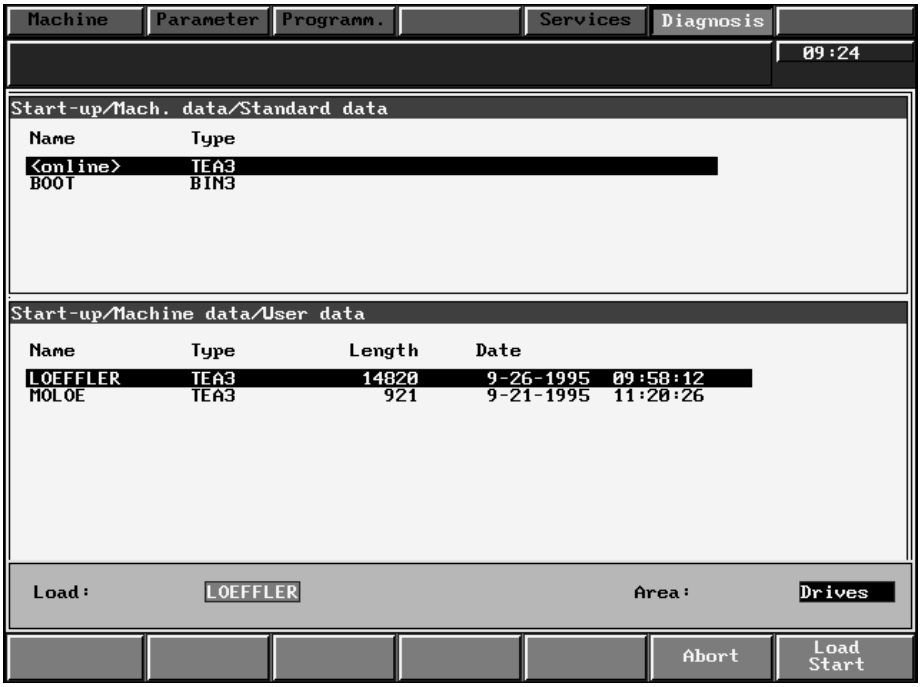

Fig. 5.24

Procedure 2

Select the **File functions** softkey in the machine configuration display and operate the **Load from disk** softkey. A menu bar appears into which you enter the required TEA3 file together with file name and select the **All MD** area with the toggle key. Press the **Load start** softkey. The data are loaded into the BOOT file. Confirm these settings with the **Accept all + NCKP0** softkey.

Note

Please make sure that you correctly enter (assign) the NC MD

- MD 3840, MD 2000 (VSA)
- MD 4600, MD 4000 (HSA)

5.9.8 Additional information when altering the configuration (as from SW 3)

Notes

If one of the 1-axis modules in the grouping is faulty and is to be replaced by a 2-axis module, it is possible that a display line for the 2nd axis does not exist in the drive configuration display. You must therefore move the following modules on by 1 slot. However, it is important that you keep the drive number. The advantage of this is that you will not have to reload the motors. Confirm these settings with the **Accept conf + NCKP0** softkey.

It is very easy to remove a module from the grouping temporarily. Enter the number 0 for the drive number, i.e. the data for the deselected module are retained in the boot file. Confirm this setting with the **Accept conf + NCKP0** softkey.

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5.10 Configuring the MDD

5.10.1 Description

The MDD is configured with the list module (as from SW4). The texts in the screens can be edited.

The data that are to be displayed in the screens have been configured.

As from SW 5, it is possible to print out the list module.

Introduction

The list module is configured by means of 3 ASCII lists:

Data lists

For each list display, there is a data list in which the

- display title
- column width
- data to be displayed

are described.

Text lists

The text lists are organized language specifically. They contain one text for each data and additional texts for headings, units etc.

Semantics list

For each item of data, this contains information on

- internal format
- display format
- input limits
- special treatment

Separate text and semantics lists exist for each machine data area (e.g. NC MD).

Help texts/info lists

The info lists are organized language specifically. They contain one text for each data which can consist of several lines.

Explanation

The list module looks in these lists for all information regarding display structure and the data to be displayed and stores them in a compressed file (binary file). If this file already exists it is accessed as soon as the list display is called up,
i.e., the ASCII lists are not used.

The list module first looks for the **data lists** in the user path. If it does not find them here, it uses the data lists in the Siemens path.

If the data list exists in the user area the text and semantics lists are taken from the user AND Siemens area.

If the data list only exists in the Siemens area the text and semantic lists are only taken from the Siemens area.

If the keyswitch is in **position 3**, only the lists in the **Siemens** path are used. If the password is not set the keyswitch is re-evaluated every time a display is selected. The keyswitch position is ignored with “Set password”.

If you wish to display other data or use other texts or input limits, you can copy the data lists from the Siemens path into the user path and edit them as necessary.

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The paths and file names and simple examples of file contents (configuring data) are explained in the points below. Other configuration possibilities are given in the lists in the control.

List module paths and files (e.g. TEA1 MD)

ASCII lists:

- Data lists (e.g.)
  SIEMENS list module/TEA1/LB data lists/nc11
  User list module/TEA1/LB data lists/nc11
- Text lists (e.g.)

  SIEMENS list module/TEA1/ENGLISH/tea1txt
  User list module/TEA1/ENGLISH/tea1txt
- Semantic lists (e.g.)

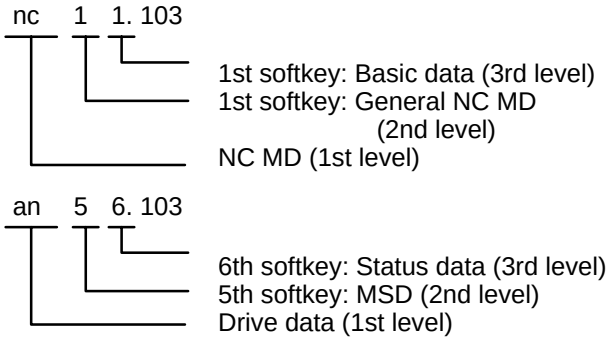
  SIEMENS list module/TEA1/LB-Semantics lists/tea1sem
  User list module/TEA1/LB-Semantics lists/tea1sem
- Helptexts/infolists

  SIEMENS list module/TEA3/ENGLISH/tea3help
  User list module/TEA3/ENGLISH/tea3help

List contents: Data lists

The **data lists** contain the data to be displayed in each display. The file names are such that the contents of the lists can be recognized from the name.

Examples:



The file contents of 42.103, for example, are structured as follows:

TEA1 a 1 (bits 3, normal “N9 T36 V10 U10”,
headline “B40 S11 p2 L0”, path 42)

H421	Contains the intermediate heading (of file tea1head.106)
2400	Contains machine data (e.g. MD 240* becomes MD 2400)

The header can be interpreted as follows:

TEA1	NC MD
a	axis-specific (n = normal, k = channel, s = spindle)
1	to file function “Edit” linked, 0 = always on-line
“N9 T36 V10 U10”	Column width for Data number: 9 Text: 36 Word: 10 Unit: 10
path 42	Softkey path of display (stored in file tea1...). It is evaluated when “search” and “global” are selected.

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List contents: Text lists The texts for all data are stored in the **text lists**.

Examples:

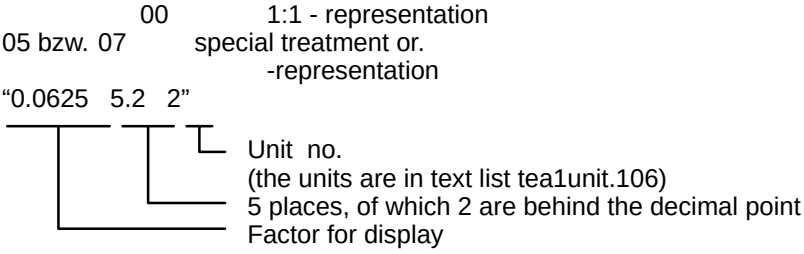
2040	“Exact stop limit coarse”
2080	“Exact stop limit fine”
5600.0	“No measuring circuit monitoring”
5600.2	“Rounding to whole/half degrees”

List contents: Semantic lists The data type (L = long, C = 8 bits, S = short, etc.) and the display format, any special treatment and input limits are stored in the **semantics lists**.

Examples:

Data	Type	Treatment	Input limits
160	L	05	
164	L	00	! (write-protected)
168	L	“0.0625 5.2 2”	[2.32]
208	L	72	[1.99999999]

The information under “Treatment” is interpreted as follows:



List contents: Info lists Explanations for all the data that appear in the information display (key ↙) can be stored in the **information lists**.

Example: 2040 “This data is not active until Power On”.

5.10.2 Practical example for user adaptation list display

Problem “PLC machine data 2007 is supplied with the text ”Number of assigned magazine” and with input limits 0 to 4

The user wishes to change this text to the following:
“Number of assigned tool turret”
and the input limits to 1 to 99.

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Solution

The following steps are necessary:

1. The file list of the display in which the data is to appear must be copied completely from the Siemens branch to the user branch (“Services” area) so that the user semantics and user text lists are used.

   Data 2007 is contained in display “PLC MD/Tool management/Magazine 1” when supplied. Data list plc52.103 also belongs here.

   Softkey DEFAULT under ”Diagnosis/Startup/PC data”.

2. Create new file
   A new text list must be created in the user area under “Services”. This is done by copying a text list from the Siemens area into the clipboard and giving it a new name on execution of “Insert from clipboard”. This file is then edited and the existing text is deleted.

   File contents:
   Only the following line is entered under the “Diagnosis” area:

   2007 “Number of assigned tool turret”

   All other information is then taken from the Siemens file.

3. A semantics list containing the altered input limits must be created in the user branch.

   File contents:
   The following single line is enough:

   2007 L 00 [1 , 99]

   All other information is then taken from the Siemens file.

4. All the changes have now been made. When the display “PLC MD/Tool management/Magazine 1” is next called up, the message “106001 List display [User/TEA2/Data lists/plc52] is being generated...” will appear and the changes stored in a compressed binary file.
5. **Subsequent** changes could be any of the following:

   a) **Data lists already copied** into the user branch are to be changed (e.g. machine data sequence).
   These changes are automatically observed the next time the display is generated. Message “106001 List display [name] is being generated...”.

   b) The characteristics of a data that appear in a **display other** than the one already altered are to be changed.
   The text required by the user is stored in a user text list and the input limits required by the user are stored in a user semantics list.
   In order to make **these** changes active, the **data list of this additional display** must now be **copied** from the Siemens branch to the user branch. Only then will the user characteristics of the data be observed. When the display is next generated the message “106001 List display [name] is being generated ...” appears.

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c) The **already altered characteristics** of a data are to be changed again or the characteristics of another data in the same display are to be changed. If the **data list** of this display was **already copied** into the user branch when the first change was made and if the **data list was not changed** when the texts and input limits were changed again, these new changes to the texts and input limits will **not automatically be included**.
In order to save time during display generation only one alteration to the data list is automatically recognized (**by the date in the file**).
The changes made to the text or semantics list are accepted with the key combination “@” and “!” (in the list display).
The message “106001 List display [name] is being generated ...” appears and the display is generated again.

6. Please note:
The message “106001 List display [name] is being generated ...” may in some cases be hidden by higher priority alarms, or be displayed for too short a time. However, under Diagnosis/Service displays/Alarm log 1 it is possible to find out whether the message has already been issued. It is thus possible in the cases mentioned above to check whether an alteration has been included for the display generation.

5.10.3 Configuring the parameter set switchover in the list display

Introduction

Three parameter set groups are supported by SW 4 and higher:

1) Parameter set position control (G1)
2) Parameter set speed ratio (G2)
3) Parameter set drive (G3)

For each of these groups exactly one parameter set is always selected for display in the list displays. This selection is valid for all displays, i.e. when the display is changed the selection remains valid and also applies to displays subsequently selected.

All three parameter set groups each have 8 parameter sets.

Displaying the data of all parameter sets

If all the parameter sets of a data are to be displayed one above the other, the usual procedure is followed:

The data numbers are displayed in a data list.

Example:
2040
15400
15440
15480
15520
15560
15600
15640

In the drive machine data list the parameter set number is displayed with a colon.

Example:
1500:1
1500:2
1500:3
1500:4
1500:5
1500:6
1500:7
1500:8

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for which the following short-hand notation can now be used (SW 4 and higher):

Example:
1500:1–8

By resorting it is possible to display in the usual way first all the data of the first parameter set, then the data of the second parameter set, etc.

Example:
1407:1
1409:1
1500:1
...
1407:2
1409:2
1500:2
...
1407:3
1409:3
1500:3
...

Displaying the current parameter set only

A special function now makes it possible to display one data at a time, in each case that of the selected parameter set.

This function is used in the supplied system displays.

The individual data remain intrinsically independent, i.e. they can all have different texts and characteristics.

In order to apply this function, the data numbers in the data list are enclosed in parentheses and a “G” is placed before the number of the parameter set group.

Example:
G1 (2040
15400
15440
15480
15520
15560
15600
15640)

As a result, of these 8 data only the one belonging to the active parameter set of the group “Position control” is displayed.

The arrangement (one above the other, next to one another) is irrelevant.

The abbreviated notation used in the past can be used in the brackets.

Example:
G3 (1500:1–8)

Displaying the current parameter set selection

Definition of term: The axis number, channel number, spindle number, transformation block number, drive number, slot number, IKA relation number, IKA curve number and IKA point number are all referred to below as “Parameter number”.

Display of the current parameter set selection is configured in the same way as the current parameter number in the headline of the data list using the command “headline”.

Previously, it was possible to configure the parameter designation and the current parameter number here. As from SW 4, the axis name can also be displayed.

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Example:
headline “S16 P3 N7”

This reserves 16 characters for the parameter name (e.g. the word “axis”), 3 characters for the current parameter number (e.g. axis number) and 7 characters for the number of the current parameter (e.g. “C2”).

In the same way it is now possible to display the name of the parameter set group and the current parameter set number in additional fields. The letters “S” and “P” together with a length are added in the same way. They must be preceded, however by the relevant G number of the required parameter set group (see above).

Example:
headline “G2 S30 P3”

The text “Parameter set ratio” “n” now appears on the screen, “n” representing the current parameter set number.

If the above configurable information such as parameter number etc. are to appear without “G” with “S”, “P” and “N” after the parameter set information, they must be introduced with “G0”.

Example
Parameter number: headline “S16 P3 N7”
Parameter set number: headline “G2 S30 P3”
Parameter number and parameter set number:
headline “S16 P3 N7 G2 S30 P3”
Parameter set number and parameter number:
headline “G2 S30 P3 G0 S16 P3 N7”

Selecting the parameter set

It is possible to jump to the parameter set number in the same way as to the parameter number using the key combination <shift> +<home> (shift key and left diagonal up arrowkey – new as from SW 4).

Here, a number can be entered directly or the toggle key can be used to switch to the next value.

The arrow keys can be used to jump between several input fields in the headline (e.g. parameter number and parameter set number).

Note

No guarantee can be given regarding future alterations and expansions to the structure of the lists.

No liability can be accepted if the contents of the lists are altered.

Please refer to the OEM documentation for additional configuring information.

5.10.4 Printing the list module data (as from SW 5)

As from SW 5.1 it is possible to store the contents of a list module in a print file.

@P

This function is triggered with @P in the appropriate list display. The entire list display is stored, not only the section visible on the screen.

File name

The print file is stored in the user branch in directory Start-up/Logs. The file name is generated from the selected data area (TEA1, TEA2, ...) and a sequence number, e.g. TEA1_001.

Output in PC format

These files can be output via Services “Print serial” or Data output (in PC format).

END OF SECTION

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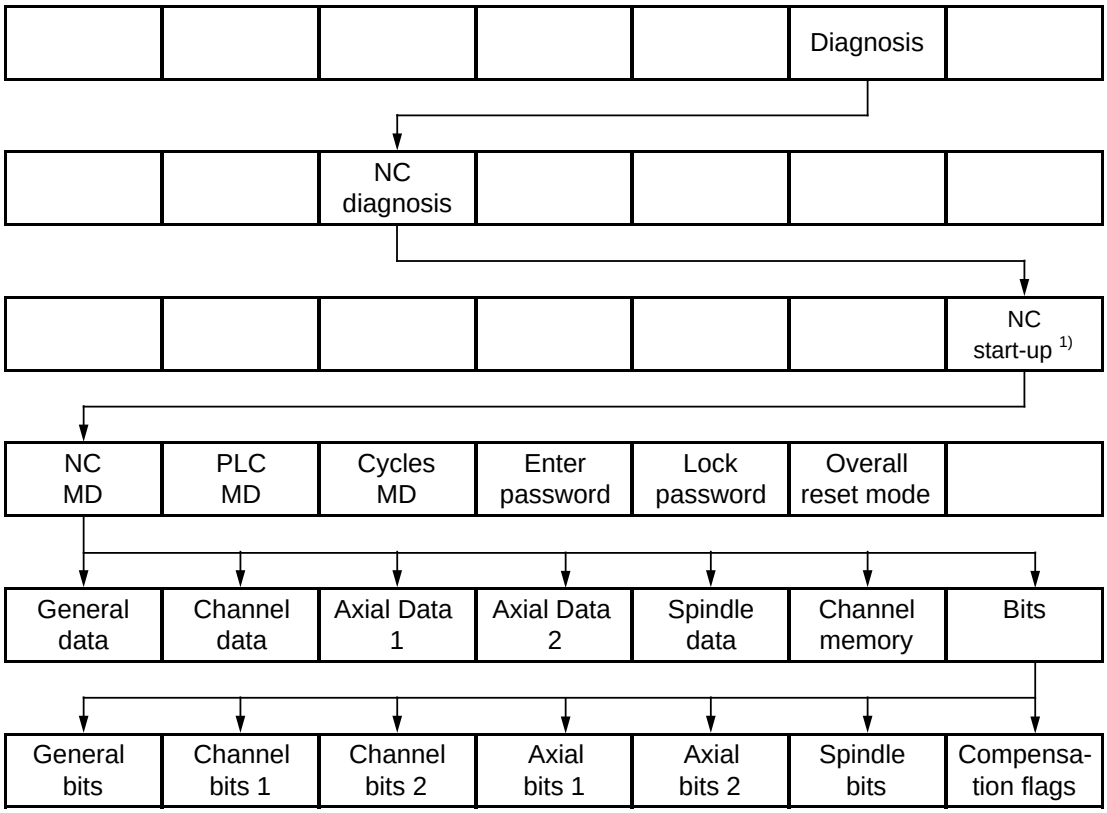
6 NC Machine Data (NC MD) NC Setting Data (NC SD)

6.1 NC machine data (NC MD)

6.1.1 Entering NC machine data

NC machine data are used to adapt the NC to the machine tool. It is up to the person installing to ascertain and optimize all items of machine data not preset by the manufacturer or end user.

Selection: Data area (up to SW 2)



A password must be entered before machine data can be modified.

1) Start-up can be locked out with the keyswitch when bit 5 of NC MD 5006 is "1".

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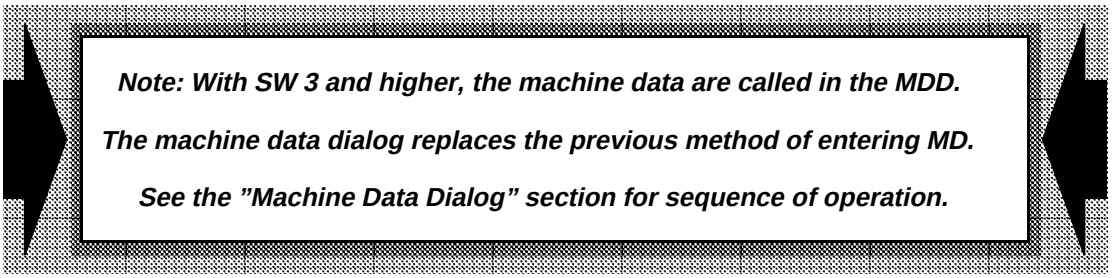

Notes:

- The meaning of an NC MD bit always refers to the **set** state of that bit. The statement (name) must be negated when the bit is **not** set.
- Items of machine data for which there are no descriptions are either set to 0 when the standard machine data are loaded or the control installed, or are preset according to the control's configuration. In "Overall Reset" mode, the standard machine data are preset when the NC MD are loaded.
- Once the machine data have been entered or modified, the input enable must be revoked via the "Inhibit Password" softkey.
- The following applies to machine data that become active after "NC Stop":
  - Channel-specific machine data are active after a change if the signal "NC Start possible" has been set in the relevant channel after NC Stop.
  - Axis**/**spindle-specific and general machine data are active after a change if the channel-specific signal "NC Start possible" has been set in all the channels of the relevant mode group after NC Stop.

6.1.2 NC configuration

The configuration can be defined during installation and in some cases during operation (warm restart). See also ”Flexible memory configuration” function.

With the basic software scope a total of five axes, main spindles or auxiliary spindles can be controlled with SINUMERIK 840C. If analog drives systems are used, one servo loop module is required for every three axes, main spindles or auxiliary spindles and must be ordered separately.

Number of axes + number of spindles = 15 (up to SW 4)

30 data blocks are available for axes and 6 data blocks are available for spindles.

Every axis can be used either as a linear axis or as a rotary axis.

Number of axes + number of spindles = 30 (as from SW 5)

Up to 30 servo loops (measuring circuits) can be defined (611D).

Example:

30 axes or 24 axes plus 6 spindles/18 axes plus 6 spindles plus 6 C axes

No fictitious axes can be defined in addition to the 30 "Axes". The limitation to max. 15 real axes or spindles (axes/spindles with servo loops) for analog drives still applies.

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6.1.3 Configuring information

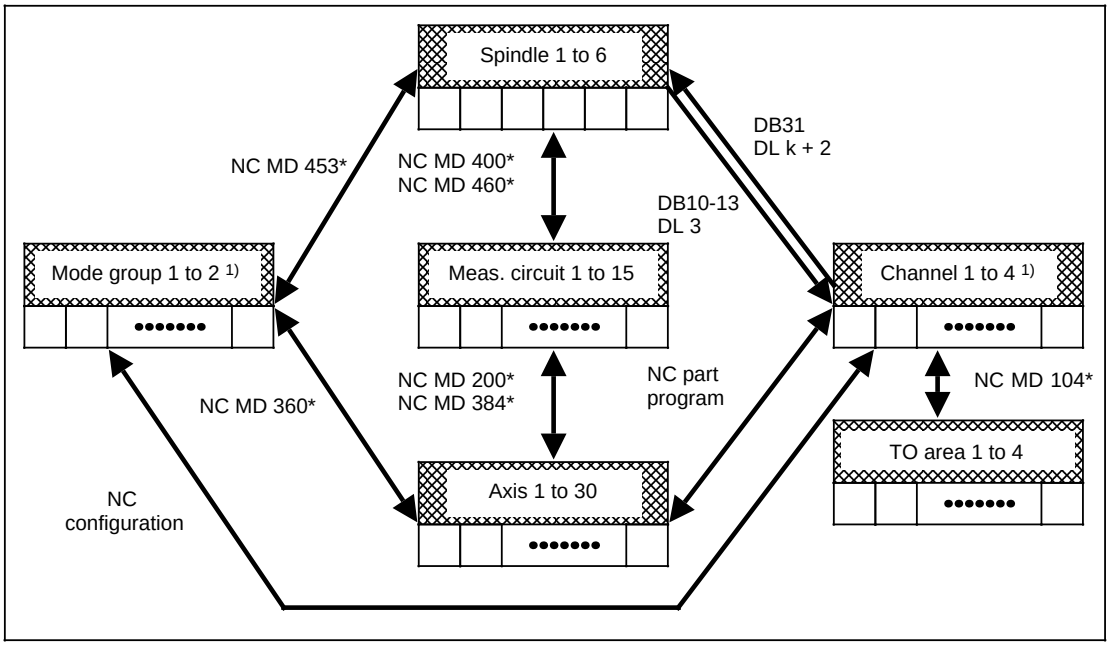
Two 1) mode groups and four 1) channels can be implemented on the SINUMERIK 840C. The channels are allocated to the mode groups via machine data, i.e. the channels are subordinate to the mode groups. The available axes are also allocated to the mode groups via machine data.

Basically, each channel is comparable to a separate machine. Each channel can execute its own program under PLC control. All channels allocated to one and the same mode group must all be operated in the same mode, while channels assigned to different mode groups via machine data can be operated in different modes simultaneously. However, a channel can only be assigned to one mode group.

The axes are allocated to the channels in the part program rather than via machine data. This means that an axis can operate in different channels within a mode group, but not simultaneously.

In order to prevent collisions based on programming errors, it is possible to prohibit operation of a particular axis in a specific channel (NC machine data). The operator can select the various mode groups and channels via the operator panel keyboard. Each mode group must be assigned at least one channel and one axis. Mode groups without spindles are allowed. Gaps in the channels are not allowed.

A channel can traverse only the axes in the mode group assigned to it. An axis can be traversed only in its assigned mode group. The warm restart function can be used to modify the configuration (mode group assignments) without having to reapproach the reference points (for a detailed description of the warm restart function, refer to Section Functional Descriptions).



Note:

Up to SW 4:	The limitation to max. 15 real axes or spindles (axes/spindles with servo loops) for analog drives still applies.
SW 5 and higher:	Up to 30 servo loops can be defined (611D). Example: 30 axes or 24 axes plus 6 spindles/C axes No fictitious axes can be defined in addition to the 30 "Axes".

1) As from SW 4: 6 channels, 6 mode groups

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Tasks performed by the master channel

Within a mode group, the channels are processed in ascending order. Internally, the first channel of a mode group (the channel with the lowest number) assumes the role of master channel.

If the signals

- mode group
- DRF

are specified in the master channel (DB 10 to DB 13) [1)], they then also apply to all other channels of this mode group.

Effects of Signal Reset:

Software version 1:

A reset command via the interface can only be defined in the master channel.

Effects of a reset command via the PLC in the master channel.

- Processing of all channels in this mode group is aborted.
- Any active channel and mode group specific reset alarms are acknowledged if the cause of the alarm has been remedied.

Software version 2:

The function Channel Specific Reset is implemented with Software version 2 and higher.

This function makes it possible for the user to abort channel-specific processing via his PLC user program without affecting processing in other channels in the mode group.

Mode group and DRF selection are still only possible in the master channel of the mode group.

Effects of a reset command via the PLC in a specific channel:

- Processing in the channel is aborted.
- Any active channel-specific reset alarms such as, for example, alarm 2062 ”Feedrate missing” are acknowledged.
- Mode group specific reset alarms such as, for example, alarm 122* ”Software limit switch approached” are **not** acknowledged.

All channels of the mode group must receive a reset command at the same time to make it possible to acknowledge mode group specific reset alarms such as, for example, alarm 148* ”Zero speed monitoring”.

Note:

The channel-specific reset command should only be executed via the PLC user program in AUTOMATIC mode.

In all other modes and with alarms that acknowledge operating mode ready, the reset command should be given to all channels of the mode group.

---

1) As from SW 4 DB10 - DB15

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6.1.4 Breakdown of NC MDs/drive machine data

NC MD	Description	Softkey	Section
0 to 999	General MD	General data	6.2
1000 to 1599	Channel-specific MD	Channel data	6.3
2000 to 3999	Axis-specific MD 1	Axial data 1	6.4
4000 to 4999	Spindle-specific MD	Spindle data	6.5
5000 to 5199	General MD bits	General bits	6.6.1
5200 to 5399	Spindle-specific MD bits	Spindle bits	6.6.2
5400 to 5599	Channel-specific MD bits 1	Channel bits 1	6.6.3
5600 to 5999	Axis-specific MD bits 1	Axial bits 1	6.6.4
6000 to 6999	Leadscrew error compensation bits	Compensations flags	6.6.5
9000 to 9299	Channel-specific MD bits 2	Channel bits 2	6.6.6
11000 to 17969	Axis-specific MD 2	Axial data 2	6.7
18000 to 18599	Axis-specific MD bits 2	Axial bits 2	6.7.1
20400 to 20449	MD for multi-channel display	Channel memory	6.8
2400* to 3944*1)	MD for parameter set switchover Dyn. software limit switch Collision monitoring	Various axial data	——
6000* to 6200*1)	MD for flexible memory configuration	Memory configuration	6.10
1 to 18000	SIMODRIVE drive MDs (SW 3 and higher)	——	——
4000* to 4740*1)	Safety Integrated (SW 5 and higher)	Safety functions (see Functional Description, Safety Integrated)	——

1) *As from SW 4*

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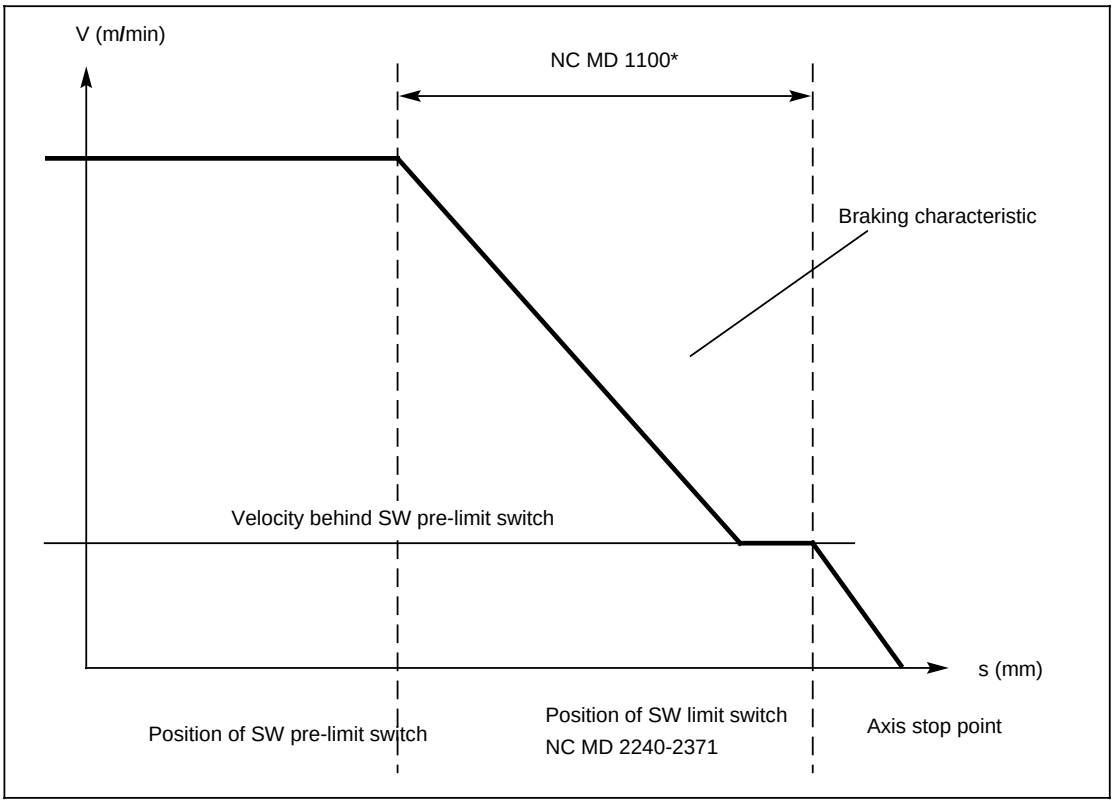
6.2 General machine data (general data)

1	Velocity behind pre-limit switch		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
500	**+0**	**100 000**	**1 000 units/ min (IS)**



Velocity diagram on crossing the software limit switch with circular interpolation

Note:

NC MD 1 has no effect when 0 is entered in NC MD 1100*.
See also NC MD 2240-2371, NC MD 1100* and NC MD 5003.7.

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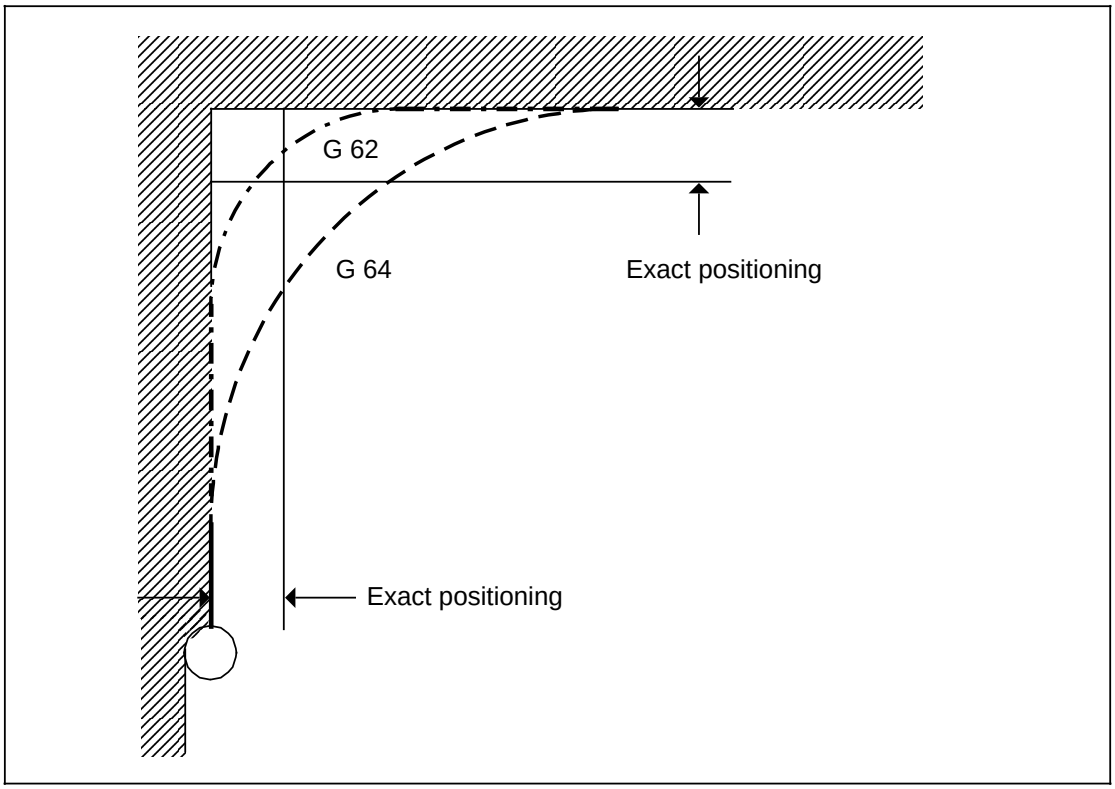
3	Corner deceleration rate		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
500	**+0**	**100 000**	**1 000 units/ min (IS)**

In continuous-path operation (G64), block transitions are covered without feedrate reduction, i.e. the path is rounded at points of discontinuity in the contour to an extent that depends on the traversing rate.

As a result of function G62 (continuous-path operation with feedrate reduction), the tool path feedrate is reduced to the rate entered in NC MD 3, provided the selected feedrate was greater.

The rounding radius is thus reduced at discontinuous block transitions.



Practical application:

When the traversing rate must not become zero on a block change (exact positioning) but the feedrate in continuous-path operation is too high.

Note:

With SW 5 and higher, separate values can be set for G620/G00, G62/G01 and G62/G36. See MD 146*, MD 148*, MD 150*.

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Note:

The reduction speed with G62 is not quite reached. The error tolerance band is described as follows.

FG62 = Reduction speed
Fact = ”Actual reduction speed” reached
Fdecel = Braking step (speed reduction per Ipo cycle)

FG62 F_{act} (FG62 + F_{decel})

where F_{decel} is calculated from:

a = acceleration (see NC MD 276*]
tipo = IPO cycle [ms]

$$\frac{F_{decel}}{min} = \frac{a}{\frac{m}{s^2}} \times \frac{tipo}{ms} \times 60$$

No speed reduction takes place at the first block limit if F1 FG62 + F_{decel}.

No speed reduction to F3 takes place at the second block limit if F2 FG62 + F_{decel}.

FG62 values (MD3) smaller than F_{decel} are not sensible.

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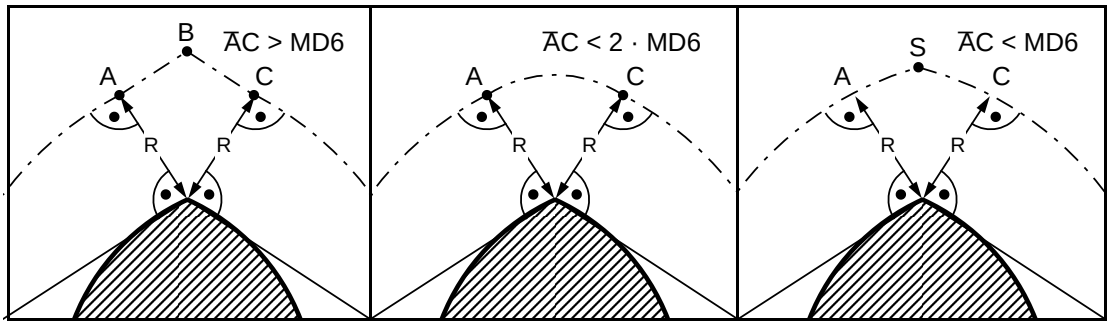
6	Threshold for switchover intersection *		Active in **next block**
Default value	Lower input limit	Upper input limit	Units
1 000	**+0**	**16 000** **2 000 (as from SW 4)**	**units (IS)**

One or two intermediate blocks are inserted for circle intersection (straight line/arc, arc/straight line and arc/arc) with external contours with circle intersections and obtuse angles (90° < < 180°) (see Programming Guide Section 10.4).

If the angle is nearly 180°, the paths to be traversed in the intermediate blocks become very small and can cause a standstill in continuous path mode. The control can suppress the intermediate blocks to prevent this. It either switches from ”TRC with intersection” to ”TRC with transition circle” to avoid an intermediate block or it approaches the intersection of the two blocks. In this case no intermediate block is generated.



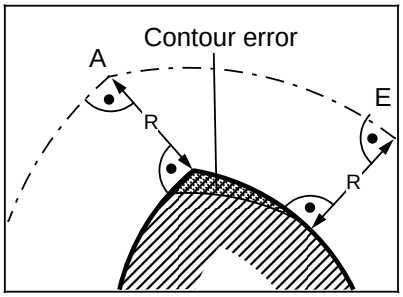
Before switching over, the distance A to C is compared with machine data 6 (MD6). If the distance from A to C is smaller than MD6, the intersection of the two blocks is traversed (applies to all circle transitions with ”TRC with transition circle” G450 and ”TRC with intersection” G451).

If the distance from A to C is smaller than 2 · MD6, the control switches from ”TRC with intersection” G451 and transition arc/arc to ”TRC with transition circle” G450.

Caution:

When approaching the intersection of the two blocks the programmed arc(s) is (are) increased. If the circle is enlarged to beyond 360°, only the section above 360° is traversed.

If there is no intersection or the intersection is located too far from the contour (> 1.5 . tool radius), intermediate blocks are again inserted in the angular range 90° < <170° as otherwise a major contour error may occur. In the angular range 170° < < 180° the normal circular block is approached and movement is then continued. Only a slight contour error occurs.



No intermediate block. The correct compensation is not reached until the end (E) of the block has been reached.

* *As from SW 2*

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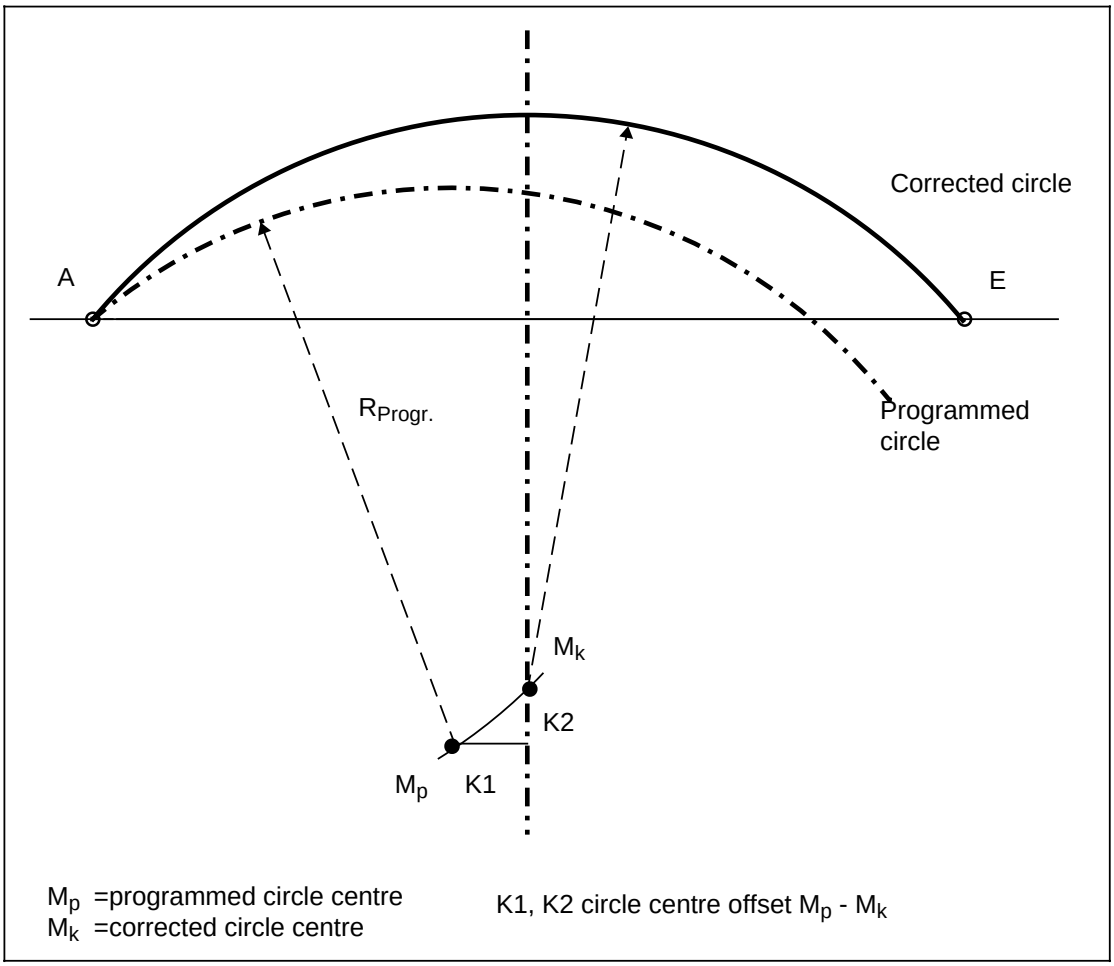
7	Circle end position monitoring		Active in **next block**
Default value	Lower input limit	Upper input limit	Units
5	**+0**	**32 000**	**units (IS)**

Before a circular block is processed, the NC checks the "correctness" of the programmed values by determining the difference between the radii for the starting and end positions. If the difference exceeds the upper limit defined above, the block is not cleared for processing and alarm 2048 (circle end position error) is displayed.

If the difference is less than but not equal to zero, the circle centre parameters are corrected, as it is then assumed that the end position has been correctly programmed. The circle is then traversed on the basis of the new centre point.



M_p =programmed circle centre
M_k =corrected circle centre

K1, K2 circle centre offset M_p - M_k

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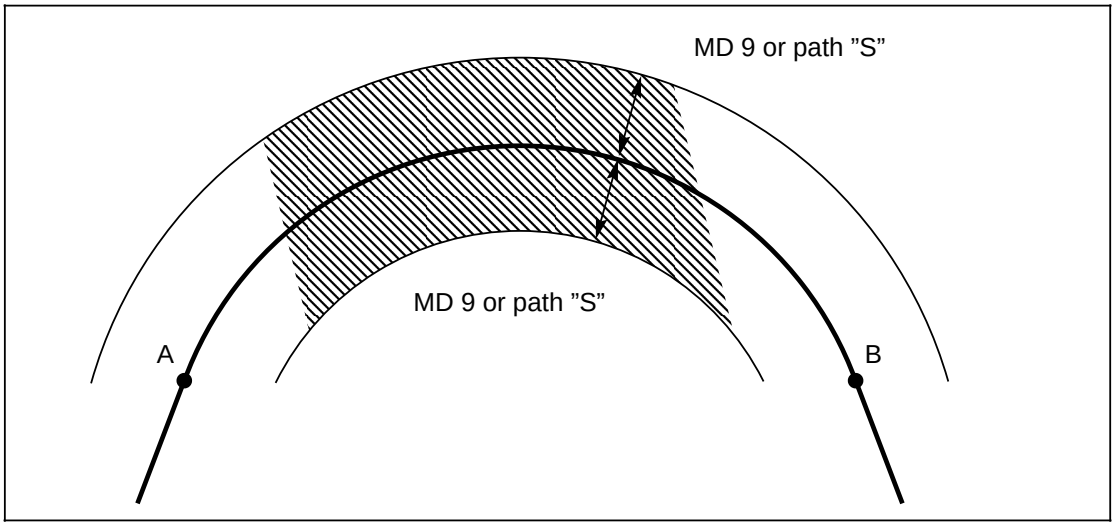
9	Error window for repositioning on circle contour		Active in **next block**
Default value	Lower input limit	Upper input limit	Units
200	**+0**	**32 000**	**units (IS)**

An automatic interruption during circular contouring (G2/G3) results in departure from the contour in JOG mode.

Prior to a new NC start, the contour must be reapproached in JOG mode.

If the axis is not within the tolerance limits (shaded area) specified in NC MD 9 following the NC start, alarm 3018 is displayed and the program is not started.



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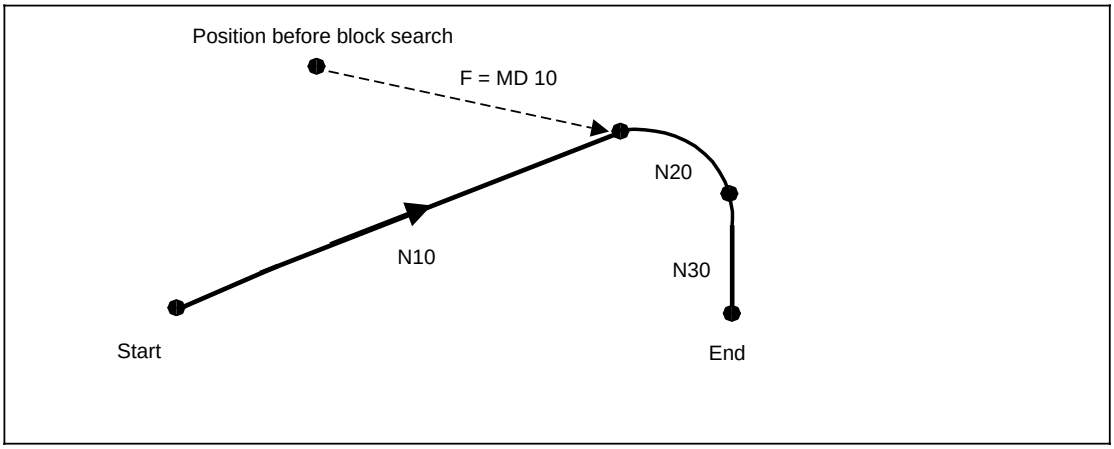
10	Feed after block search		Active in **next block**
Default value	Lower input limit	Upper input limit	Units
1 000	**+0**	**100 000**	**1 000 units/ min (IS)**

If the machining program is started via a block search at a particular block rather than from the beginning, it is possible that the programmed rate will not match the travel (G95 or G96 active although no spindle is rotating; extremely low F value programmed).

Should the axes be at any position other than at the starting point of the first block selected in the block search, the control would output the programmed rate of the traversing block. Since this could result in some very unusual situations, the axes are traversed to the first start position following a block search with the value specified in NC MD 10 (with G94).



Example

Note carefully!

MD 10 has no effect on a block search with G00.

The programmed feedrate from the part program is always used to traverse to the end point of the target block if the value 0 is entered in NC MD 10.

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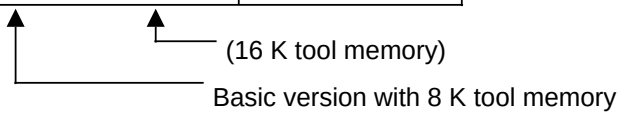
13	Number of TO parameters		Active **see below**
Default value	Lower input limit	Upper input limit	Units
10	**10**	**32**	**–**

Normally, each tool offset has up to ten permanently allocated TO parameters. When required, the user can upgrade the number of parameters to 32, and must allocate the added parameters (10 to 32) using the configuring terminal. The greater the number of TO parameters allocated to a tool offset, the lower the number of tool offsets available to the user, as the memory space available for tool offsets is limited.

Parameter	TO		Comments
10	204	409	Initial setting
11	186	372	
12	170	341	
13	157	315	
14	146	292	
15	136	273	
16	128	256	
17	120	240	
18	113	227	
19	107	215	
20	102	204	
21	97	195	
22	93	186	
23	89	178	
24	85	170	
25	81	163	
26	78	157	
27	75	151	
28	73	146	
29	70	141	
30	68	136	
31	66	132	
32	64	128	



Note carefully:

Modifications do not take effect until user memory has been formatted.

User memory is formatted in "Overall Reset" mode with either the "Format User Data" or the "Format TO Data" softkey. For inform. on selecting "Overall Reset" mode, refer to Section General Reset.

$$\text{Number of D memories} = \frac{\text{Memory configuration [BYTES]}}{\text{Number of TO parameters} * 4}$$

For SW 4 and higher see functional description "Flexible Memory Configuration".

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14, 15	Password-protected R parameters	Active **at once**
16, 17	**Keyswitch-protected R parameters**	Active **at once**

Default value	Lower input limit	Upper input limit	Units
0	**0**	**999 * 1 299 (as from SW 4)**	**–**

Appropriate specifications NC MD 14/15 and**/**or 16**/**17 make it possible to protect general and channel-specific R parameters. Channel-specific specifications apply to all channels. The parameter area defined in MD 14-15 is password-protected, the area defined by MD 16-17 is protected via the keyswitch. The latter is effective only when bit 3 of NC MD 5005 is "1". If exceeded, range MD 16-17 has priority.

18	Zero offset group (L 960)	Active –

Default value	Lower input limit	Upper input limit	Units
1	**0**	**10**	**–**

MD 18 is of significance in conjunction with Siemens cycle L960 only, and may not be modified.

20	Basic angle for nutating head	Active **in n. block**

Default value	Lower input limit	Upper input limit	Units
0	**0**	**±180 000**	**10^{-3} deg**

Please observe NC MD 5010 (5D tool length compensation).

23	Number of buffer pairs CP 231-A	Active on **Power On**
24	**Number of buffer pairs CP 315-1**	Active on **Power On**
25	**Number of buffer pairs CP 315-2**	Active on **Power On**

Default value	Lower input limit	Upper input limit	Units
16	**1**	**16**	**–**

See Computer Link for details.

26	AP useful data length for CP 231	Active on **Power On**
27	**AP useful data length for CP 315-11-16**	Active on **Power On**
28	**AP useful data length for CP 315-2**	Active on **Power On**

Default value	Lower input limit	Upper input limit	Units
234	**0**	**256 254 (as from SW 4)**	**characters**

See Computer Link for details.

1) As from SW 4 see Flexible Memory Allocation

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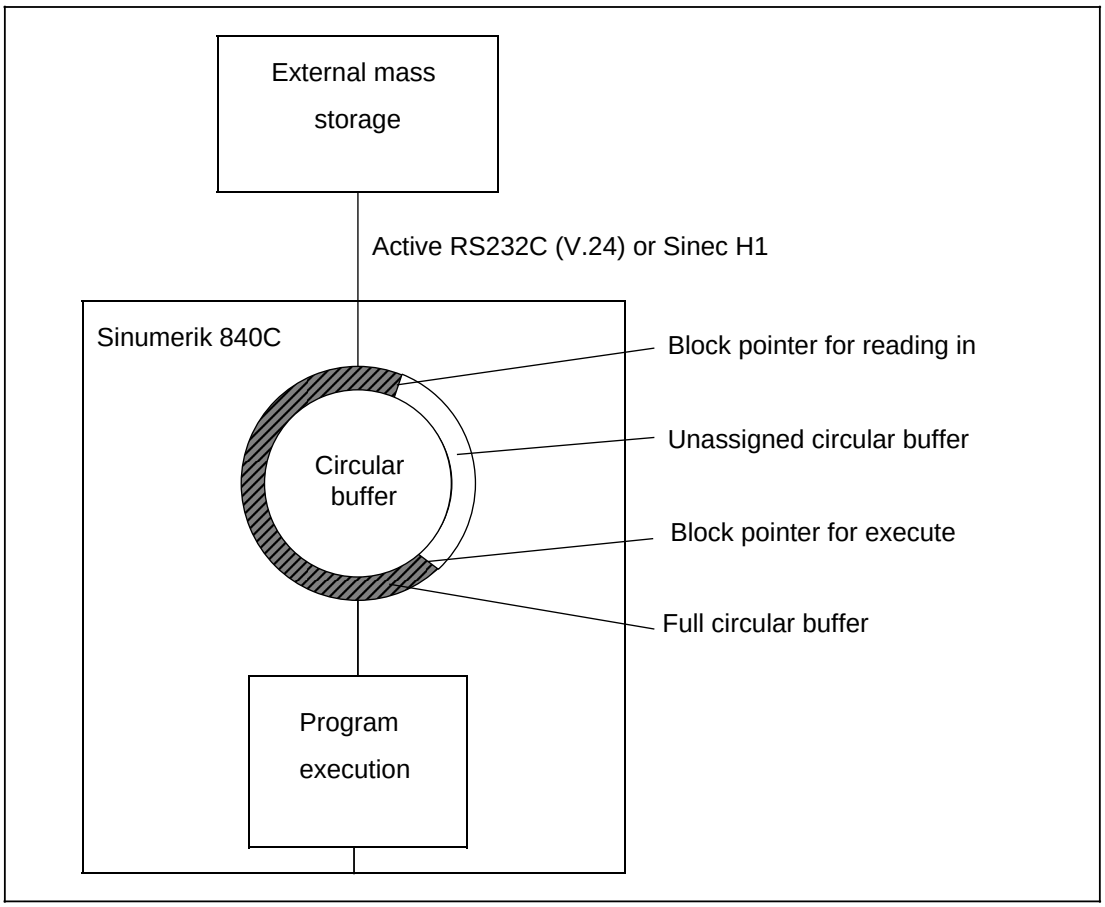
30	Number of Execution Memory Sectors		Active on **Power On**
Default value	Lower input value	Upper input value	Units
10	**5**	**1 000**	**Sector**

Active: on POWER ON

When ”Working from external” or from the hard disk, the part program is read into a circular buffer which executes the program at the same time. The circular buffer is part of the part program memory. The size of the circular buffer is defined in NC MD 30 as number sectors (1 sector = 507 bytes).



If the specified sectors are not available to the circular buffer on NC Start (either occupied by part programs or part program memory too small), the circular buffer is reduced to the maximum possible number of sectors by the control.

Additional machine data: (MD 130*, MD 5148-5152, option bit)

If processing is to take place from more than 1 interface, an appropriate area is reserved for each of these interfaces.

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100 - 130	Positions 2 to 32 of the feedrate override switch		Active **at once**
Default value	Lower input limit	Upper input limit	Units
see below	**0**	**150**	**%**

Use can be made of a feedrate override switch with up to 32 positions. The percent figures may be allocated as required except the far left (i.e. first) position, which is always 0 %. In contrast to position 1, FST (Feed Stop) is not shown in the on-screen channel status field when 0 % is allocated to another switch position.

Allocations exceeding 150 % are possible, but 150 % is set in the NC as internal limiting value.

Default values:

1, 2, 4, 6, 8, 10, 20, 30, 40, 50, 60, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, the remaining NC MD (NC MD 122 to 130) are set to zero.

131 - 146	Positions 1 to 16 of the spindle override switch		Active **see below**
Default value	Lower input limit	Upper input limit	Units
see below	**50**	**150**	**%**

Active: when all channels of the mode group are in STOP status.

Percentages may be assigned as needed to the max. 16 spindle override switch positions.

Default values:

50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120.

147 - 154	Positions 1 to 8 of the rapid traverse override switch		Active **at once**
Default value	Lower input limit	Upper input limit	Units
see below	**0**	**100**	**%**

Default values: 1, 10, 50, 100, 0, 0, 0, 0.

Rapid traverse override must be activated via PLC interface signals. Also refer to the description of NC MD 5004, bit 4.

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155	Position control basic cycle time		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
4	**1** [1)]	**40**	**Multiple of drive basic cycle time**

The sampling interval is defined as the time after which the control outputs a new setpoint speed to the axes. For axes or spindles, this NC MD can be additionally influenced, i.e. slowed down by means of a multiplier (NC MD 1396* and 466*).

See Section Axis (Analog) and Spindle Installation.

Table with possible input values

System cycle ms (MD 168)	Servo cycle ms (MD 155)	IPO cycle ms (MD 160)	MD 168	MD 155	MD 160
1 ms	8 ms	32 ms	16	8	4
1 ms	4 ms	16 ms	16 *	4 *	4 *
0.75 ms	3 ms	12 ms	12	4	4
0.625 ms	2.5 ms	10 ms	10	4	4
0.5 ms	2 ms	8 ms	8	4	4
0.5 ms	1 ms	4 ms	8	2	4
0.5 ms [2)]	1 ms [2)]	3 ms [2)]	8 [2)]	2 [2)]	3 [2)]
0.125 ms [3)] as from SW 4	0.125 ms [3)] as from SW 4	1 ms [3)] as from SW 4	2 [3)] as from SW 4	1 [3)] as from SW 4	8 [3)] as from SW 4

156	OFF delay for servo enable		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
200	**0**	**1 000**	**ms**

The enable signal for the speed controller (servo enable) on the measuring circuit is removed when the programmed delay time has elapsed. There is a separate servo enable signal on the measuring circuit for each axis; the control supplies these signals on a mode group basis.

The programmed delay time has the following effects:

1. Once the interpolator has reached the programmed position, the clamping tolerance (MD 212*) is activated when the delay time has elapsed. The following error must therefore be smaller than the clamping tolerance at this instant. The delay must be chosen so that it is possible to reduce to zero the largest possible following error (rapid traverse). In the event of an error, the servo enable signal is revoked on the measuring circuit and alarm 112* (zero-speed monitoring) activated.

   This applies only when NC MD 372* (zero-speed monitoring delay) is 0.

---

* *Standard value*

1) *The lower limits only apply if the control is operated with one channel and 3 axes.*

2) *486 CPU only.*

3) *486 DX2 or DX4 only.*

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2. Delay for removal of the servo enable signal on the measuring circuit following "EMERGENCY STOP" and other errors resulting in immediate shutdown of the axes (e.g. contour monitoring).
3. Delay for removal of the servo enable signal on the measuring circuit when the PLC revokes the servo enable for an axis.
4. MD 156 is only active if MD 1224* is set to zero (servo enable delay).

157	**Types of control for standard cycles**		Active –
Default value	Lower input limit	Upper input limit	Units
see below	**–**	**–**	**–**

		Identifier	Software version	Entry in MD 157
SINUMERIK	840CT	61	1.1	6111
”	840CM	62	1.1	6211

MD 157 is loaded by the NC software, and must **not** be changed manually.
It is used by the standard cycles, i.e. measuring cycles for the relevant control.
The applicable Software Version is only displayed in on-line mode, it is entered by the NCK system software during runup.

160	**Interpolation cycle**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
4	**2 ***	**32**	**–**

In order to compensate for the fact that a machine's axes frequently differ in dynamic response, the SINUMERIK 840C has been designed so that the operator can specify the ratio of interpolation to position control (sampling interval = MD 155). The interpolation time is the product obtained by multiplying the contents of MD160 with the contents of MD155. See Section Axis (Analog) and Spindle Installation.

161	**Number of IKA configurations via PLC/DB48**		Activve **immediately**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**32**	**–**

By means of MD161 the number of IKA configurations is limited which can be controlled via the PLC interface DB48. This MD is only effective with or released by MD 5189 bit 7=1.
Example: MD161=3
In DB48, the data words DW 16 to 73 are no longer processed. The interface is only updated for IKA 1 to 3 (DW 10 to 15). The IKA center DW8 still applies only to DW10 to DW15. See also the table below.

DW k	**DW k+1**	**IKA n**	**DW k**	**DW k+1**	**IKA n**
10	11	1	2n+8	2n+9	N
12	13	2	...	...	...
14	15	3	72	73	32
…	…	...			

Explanation of the table (extract from DB48):

n= IKA number (IKA1 ... IKA32), k= data word number of DB48 (DW k)
The following is valid for all data words DW 'k'=10, 12, 14...72 (input signals: PLC to NCK):
k=2n+8 or n=(k-8)/2
The following is valid for all data words DW 'k+1'=11, 13, 15...73 (output signals: NCK to PLC):
'k+1'=2n+9 or n=('k+1'-9)/2

* *The lower limits only apply if the control is operated from a channel.*

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164	Dead time for calculation for extended thread		Active –
Default value	Lower input limit	Upper input limit	Units
36 28 (SW 5 and higher)	**–**	**48**	**1/8 of the IPO cycle**

This machine data is preset by the system and should not be altered by the user. The function EXTENDED THREADING PACKAGE is required.

168	Drive basic cycle time		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
16	**8 * 4 (as from SW 4)**	**32**	**62.5 µs**

MD 168 is set as the first MD. MDs 155 + 160 are dependant on MD 168, i.e. the input resolution of MD 155 is determined by MD 168.

Permissible values: 8, 10, 12, 16, 32

If the machine data contains a value for the drive basic cycle time which is outside the permissible range, the NC software automatically enters the default value 16 (1 ms) during start up. The value is automatically entered in the machine data.

Note:

In the case of the 840C, the drive basic cycle time must be set to 1 ms or 2ms, taking the larger value of 2 ms for a large number of axes.

208	Maximum tool wear P5, P6		Active **at once**
209	Maximum tool wear P7		Active **at once**
Default value	Lower input limit	Upper input limit	Units
999 999	**1**	**999 999 999 999.99 (as from SW 4)**	**0.00001**

NC MD 208 and 209 can be used to restrict the maximum value in the tool offset wear memory. Specification of 999 999 limits the maximum entry in tool wear memory to 9.99999 units.

Entries made via the Input and Edit keys are subjected to a limit check.

210	Number of TO areas		Active **see below**
Default value	Lower input limit	Upper input limit	Units
1	**1**	**4**	**–**

Note

The TO memory can be subdivided into as many as four TO areas for pallet changing or dual-slide machines, the advantage being that the individual TO areas can be invoked for the various channels over D-numbers D0 to Dx, i.e. the slides on a dual slide machine can interchange programs, as both tool turrets can be referenced over D-numbers D0 to D8.

It may prove practical as a protective measure to prevent certain channels from accessing specific TOs.

* *The lower limits only apply if the control is operated from a channel.*

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The number of areas is specified in NC MD 210. The number of TO areas is limited to between 1 and 4. One TO area is provided when a value of 0 is entered. If the specified value exceeds 4, it is set to 4 internally and alarm 47 triggered.

The limits of the TO areas are defined by specifying the TO start numbers in NC MD 211 to 214. The last TO area extends from the last value specified in NC MD 211 - 214 to the maximum tool offset number (observe NC MD 13 and 104x).

Caution!

A modification does not become effective until user memory is formatted. In "Overall Reset" mode, user memory is formatted with the "Format User Data" or "Format TO Data" softkey. For detailed information on invoking the "Overall Reset" mode, refer to Section General Reset.

211	**Initial D no. for TO area 1**	Active same **as MD 210**
212	**Initial D no. for TO area 2**	Active same **as MD 210**
213	**Initial D no. for TO area 3**	Active same **as MD 210**
214	**Initial D no. for TO area 4**	Active same **as MD 210**

Default value	Lower input limit	Upper input limit	Units
see below	**1**	**809 ***	**–**

Default value: 211 = 1, 212, 213, 214 = 0

The data location numbers for TO areas 1 to 4 must be given in ascending order. Only one TO area will be set internally and alarm 47 triggered if this rule is not observed. The TO areas are allocated to the channels in NC MD 104*.

Example

NC MD	13	10	Number of TO parameters	
NC MD	210	4	Number of TO areas	
NC MD	211	1	Initial D no. for TO area	1
NC MD	212	30	Initial D no. for TO area	2
NC MD	213	55	Initial D no. for TO area	3
NC MD	214	150	Initial D no. for TO area	4

*) *As from SW 4 see Flexible Memory Allocation*

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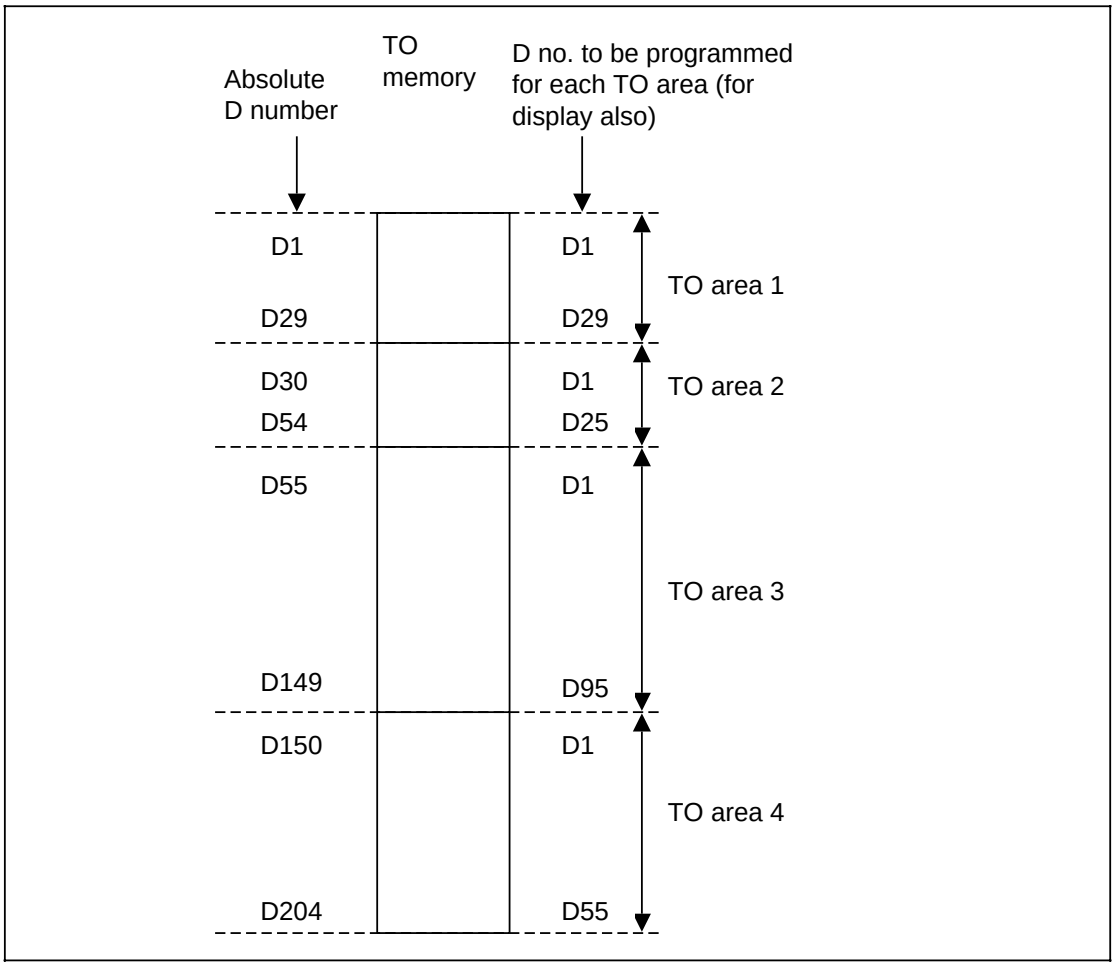

228	**User menu for MDA**	Active **see below**
229	**User menu for JOG**	Active **siee below**
230	**User menu for TEACH-IN**	Active **see below**
231	**User menu for AUTOMATIC**	Active **see below**
232	**User menu for JOG/REFPOINT**	Active **see below**

Default value	Lower input limit	Upper input limit	Units
0	**0**	**1 000**	**–**

If a mode is selected and the standard system basic menu for this mode does **not** appear on the screen, it is possible to define any user menu as the new basic menu for this mode by entering the user menu number.

If value 0 is entered, the standard system basic menu when this mode is selected.

Note:

A change of NC MD 228 - 232 becomes valid the next time this mode is selected.

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250	Language switchover 1)		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1**	**–**

SINUMERIK 840C can display two languages at option.
The following entries are possible:

0 = Language 1
1 = Language 2

The following language combinations are available:

Language 1	Language 2
German	English
German	French
German	Italian
German	Spanish
English	French
English	Italian
English	Spanish

You can check which combination has been ordered and implemented via the ”Control info” softkey.

260	M function ”C axis on”		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
- 1	**- 1**	**9 999**	**- 1**

261	M function ”C axis off”		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
- 1	**- 1**	**9 999**	**-**

Active: when all channels of the mode group are in STOP status.

C axis operation is selected and deselected via M functions. The numbers of these M functions can be allocated on a customer-specific basis.

1) Up to SW 1

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When allocating the numbers, make sure that there is no collision with other M functions. Generally, the following values are permissible:

0, 1, 2, 3, 4, 5, 17, 19, 30, 37

Example

```
MD 260 = 123
MD 261 = 456

M1 = 123 LF        Selection of C axis operation for spindle 1
M3 = 456 LF        Deselection of C axis operation for spindle 3
```

Note:

After C axis mode has been selected, all axes involved in the functions G02, G03, G12, G13, G33, G34, G35, G36 must first have been traversed with G90.

Example

```
N10  M70                  (Selection of C axis operation)
N20  G0 C0 Z5             (Traverse axes involved in thread cutting operation)
N30  G36 C0 Z-15 K3 F200  (Thread cutting position-controlled axes)
```

300	**TO allowance for protection zone adjustment**		Active on **Power On**
	Lower input limit	Upper input limit	Units
0	**0**	**9999 9999**	**IS**

Note:

For further information see description of the function collision monitoring.

310	**Output byte to user interface 1)**		Active on **Power On**
	Lower input limit	Upper input limit	Units
0	**0**	**91, 92, 93 and 94 999 (as from SW 4)**	**-**

311	**Output byte to MIXED I/O**		Active on **Power On**
	Lower input limit	Upper input limit	Units
0	**0**	**11, 12, or 21, 22 999 (as from SW 4)**	**-**

With NC MD 310 and 311, the cam signals can be assigned to an output byte of a certain HW MIXED I/O. Enter either 11 or 91 if using the 1st output byte of the 1st MIXED I/O. Entering 22 or 92 gives an analog assignment of the output byte to the 2nd byte of the 2nd MIXED I/O. The decimal values for the synchronous interface to the PLC are entered in the same way. Both MDs have a default setting of 0. If illegal values are entered, alarm 45 is triggered.

312 - 317	**Assignment of MIXED I/O module for emergency retraction to a mode group 2)**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**22, 94 (as from SW 4)**	**–**

A signal can be output via a MIXED I/O group to trigger a fast emergency retraction if a fault is caused by external HW. One output byte is used for each mode group.

1) As from SW 3

2) MD 314 to MD 317 as from SW 4

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MD 312: Mixed I/O assignment for first mode group
MD 317: Mixed I/O assignment for sixth mode group

The first decimal place (units) defines the output byte of the module. Mixed I/O (1, 2) PLC 1-4. The second decimal place (tens) defines the number of the mixed I/O module (counting from left to right). Mixed I/O (1, 2) PLC 9.

After Power On or Reset all the outputs of the selected output byte are set to 1 (24 V).

If an emergency stop is triggered by a following axis/following spindle, the bits which are set to 1 in MD 588*/528* of the following axis/following spindle change to 0 in the mixed I/O. (See description for these MDs).

On the Mixed I/O module, there is a switch that switches over the address coding betweeen PAD (for NC) and DIP switch (PLC). In NC mode, this switch must be on ”PAD”.

318 - 323	**Assignment of inputs of Mixed I/O module for retraction of one mode group 1)**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**81, 94 1) 8 2)**	**–**

A signal can be read in via a mixed I/O module or CSB board to trigger a retraction. One input byte is used for each mode group.

MD 318: Mixed I/O assignment for first mode group
MD 323: Mixed I/O assignment for sixth mode group

The first decimal place (units) defines the input byte of the module. Mixed I/O (1, 2) CSB 1, PLC 1-4.

The second decimal place (tens) defines the number of the mixed I/O module. Mixed I/O (1, 2) CSB 8, PLC 9.

Module identifier 8 stands for the CSB board (number of inputs is limited to 6: right-justified in input byte).

Active: On Power On

324	**Time for interpolator-controlled continuation 1)**		Active on **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1 000 16 000 (as from SW 4.4)**	**ms**

This MD defines for how much longer the parameterized axes are traversed by the interpolator after Mode Group Stop has been recognized. Interpolator-controlled deceleration starts after this time has elapsed (T1: see Section entitled ”Stop”).

Active: On Power On

325	**Maximum time for interpolator-controlled deceleration 1)**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1 000 16 000 (as from SW 4.4)**	**ms**

This MD defines for how much longer the parameterized axes are decelerated by the interpolator after Mode Group Maximum has been recognized (Time T2: see Section entitled ”Stop”) before travel is continued with a speed setpoint zero injection and correction or controlled follow-up (previous SW 3 ”Stop”).

Active: Power On

---

1) As from SW 4
2) As from SW 5

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330	Deadtime compensation for dwell referred to axis Actual value (SW 4 and higher)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
550	0	16 000	in % of the IPO cycle

331	Sine of angular range for tangential transitions TRC		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
2 (≙appr. 0.0005 degr.)	1 (≙appr. 0.0003 degr.)	16 000 (≙approx. 4.5 degr.)	$0.5x10^{-5}$

This MD defines which angular range the tool radius compensation recognizes as the tangential transition (180° ± MD 331). No intermediate blocks are inserted with tangential transitions.

332	Deadtime compensation for dwell referred to axis setpoint (SW 5 and higher)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
450	0	16 000	in % of the IPO cycle

333	Deadtime compensation for dwell referred to spindle actual value (SW 5 and higher)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
550	0	16 000	in % of the IPO cycle

334	Deadtime compensation for dwell referred to spindle setpoint (SW 5 and higher)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
450	0	16 000	in % of the IPO cycle

With the ”Dwell referred to an axis” (G24), a time corresponding to the machine data above is compensated statically. This data is used to observe the internal execution times in the control.

If the value is 0, there is no deadtime compensation.

With dwell on absolute position (G90) the speed of the axis/spindle must not become greater than Dmax, so that overtravel of the dwell position is recognized reliably.
If the speed is greater than or equal to D_{max}, dwell is terminated in the next IPO cycle.

$$D_{max}[rpm] < 30000 / (Tab[ms] * (1 + K_{dead}[\%] / 100))$$

Tab: IPO sampling time in ms
K_{dead}: Deadtime compensation value in %

Example of standard machine data:

Tab = 16 ms, K_{dead} = 450%:
D_{max} < 30000/(16 *(1+4.5)) rpm = 340 rpm

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335	Minimum reduction factor (as from SW 6)		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**0**	**100**	**%**

The minimum reduction factor is entered as a percentage in the general machine data.

The actual path velocity is adapted to the new set path velocity by way of the actual path acceleration.

336	Velocity increase factor (as from SW 6)		Active on **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**10 000**	**0.01·%/T_{IPO}**

The velocity increase factor is the value in percent per IP cycle by which the reduction factor is again increased to 100% after failure to reach the hysteresis threshold of the following axis velocity.

337	2nd MCS offset in X coordinates (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	**0**	**99 999 999**	**MS**

Note:

For further information see description of the function collision monitoring.

338	2nd MCS offset in Y coordinates (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	**0**	**99 999 999**	**MS**

Note:

For further information see description of the function collision monitoring.

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339	2nd MCS offset in Z coordinates (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	**0**	**99 999 999**	**MS**

Note:
For further information see description of the function collision monitoring.

340	3rd MCS offset in X coordinates (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	**0**	**99 999 999**	**MS**

Note:
For further information see description of the function collision monitoring.

341	3rd MCS offset in Y coordinates (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	**0**	**99 999 999**	**MS**

Note:
For further information see description of the function collision monitoring.

342	3rd MCS offset in Z coordinates (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	**0**		**MS**

Note:
For further information see description of the function collision monitoring.

343	4th MCS offset in X coordinates (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	**0**	**99 999 999**	

Note:
For further information see description of the function collision monitoring.

344	4th MCS offset in Y coordinates (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	**0**	**99 999 999**	

Note:
For further information see description of the function collision monitoring.

345	4th MCS offset in Z coordinates (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	**0**	**99 999 999**	

Note:
For further information see description of the function collision monitoring.

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730 - 739	1st transformation, parameters 1 to 10*		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

740 - 749	2nd transformation, parameters 1 to 10		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

750 - 759	3rd transformation, parameters 1 to 10		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

760 - 769	4th transformation, parameters 1 to 10		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

770 - 779	5th transformation, parameters 1 to 10		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

780 - 789	6th transformation, parameters 1 to 10		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

790 - 799	7th transformation, parameters 1 to 10		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

800 - 809	8th transformation, parameters 1 to 10		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

The transformation parameters are required for the 2D/3D coordinate transformation. Refer to NC MD 5060 to 5069 and Section Functional Descriptions for more detailed information.

MD 739, 749, 759, 779, 789, 799, 809, axes numbers for G96.

Only values for defined fictitious axes are permitted for these MDs. Any other values lead to undefined behaviour of formation with G96.

* *For more detailed information about parameters 1-10 see the Installation Lists.*

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876 - 899	Leading axis coupled axis		Active on **Power On** [1]
Default value	Lower input limit	Upper input limit	Units
0	**0**	**9**	**–**

The definition of these **coupled axis groupings** determines which axis is to be coupled when a leading axis is traversed in Jog mode or under program control.

It is possible to define a maximum of 9 coupled axis groupings. See also MD 5019, bit 3.

	Coupled axis	Leading axis	Coupled axis	Leading axis	Coupled axis	Leading axis	Coupled axis	Leading axis
	883	882	881	880	879	878	877	876
NC MD								
	891	890	889	888	887	886	885	884
NC MD								
	899	898	897	896	895	894	893	892
NC MD								

The number of the relevant axis must be entered as follows in the MD:

0 No axis
1 1st axis (NC MD 5640 bit 7 = 1)
2 2nd axis (NC MD 5641 bit 7 = 1)
:

The **coupled motion combinations** (NC MD 5156 to 5182) determine how coupled axis groupings are to perform (coupled motion in same direction **/**in opposite directions**/**...) and the G functions with which they can be activated. All coupled-axis groupings are activated with G151 ... G159. All the axes that have been declared as leading axes in the MD can be programmed, even if they have been declared as coupled-motion axes in the grouping.

For coupled axis groupings the following must be observed (alarm 84 is issued if an error occurs):

a. The axes in a coupled axis grouping must be in the same mode group.

b. The axes in a coupled axis grouping must have the same position control resolution and display resolution.

c. The axes in a coupled axis grouping must be of the same axis type:

Rotary axis . . . . . : MD 564*, 5
Actual value display modulo 360 ° . . . . . : MD 560*, 7
Modulo programming for rotary axes . . . . : MD 572*, 2
Rotary axis . . . . . : MD 560*, 3
Grounding to whole**/**half degrees . . . . . : MD 560*, 2
Auxiliary axis . . . . . : MD 572*, 0
Transverse axis . . . . . : MD 572*, 1

---

1) Use of the Warm Restart function enables activation of other assignments without the necessity of a Power On. Refer to Section Functional Descriptions for a detailed description of the Warm Restart function.

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d. It must be possible to program the axes of one coupled axis grouping in the same channels MD 576* bits 7 to 0 and MD 580*, bits 7 to 0.

e. The axes in a coupled axis grouping must be available (NC MD 564* bit 7 = 1).

f. None of the axes of a coupled axis grouping is allowed to be a fictitious axis (NC MD 564* bit 6 = 0).

g. One leading axis can couple several axes.
Example:

	Coupled axis	Leading axis	Coupled axis	Leading axis	Coupled axis	Leading axis	Coupled axis	Leading axis
NC MD	883	882	881	880	879	878	877	876
	0	0	6	1	5	1	4	1

Please also refer to the Programming Guide.

h. The leading axis of a coupled axis grouping **cannot** at the same time be the coupled axis of the same grouping (observe also NC MD 5156 to 5188).

	Coupled axis	Leading axis	Coupled axis	Leading axis	Coupled axis	Leading axis	Coupled axis	Leading axis
NC MD	883	882	881	880	879	878	877	876
	0	0	0	0	3	2	2	1

not possible

i. The leading axis of a coupled axis grouping can also be the coupled axis of another grouping (observe also NC MD 5156 to 5183).

j. A leading axis **cannot** couple itself.

	Coupled axis	Leading axis	Coupled axis	Leading axis	Coupled axis	Leading axis	Coupled axis	Leading axis
NC MD	883	882	881	880	879	878	877	876
	0	0	0	0	0	0	1	1

k. A coupled axis can be coupled with several leading axes if the leading axes are in other coupled-axis groupings and these coupled-axis groupings are not active at the same time.

The definition of the coupled-axis groupings can be changed with warm restart without POWER ON (see Section Functional Descriptions for a more detailed description of warm restart).

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6.3 Channel-specific MD (channel data)

100*	Mode group		Active on **Power On Warm restart**
Default value	Lower input limit	Upper input limit	Units
1	**1** **0 (SW 4 and higher)**	**2** **6** 1)	**–**

MD 1000 must be set to "1" (default).

Gaps are not allowed in MD 100*. If an error occurs, alarm 79 ”Mode group no. of channel invalid” is issued.

Example

1000	1	1001	2	allowed
1002	0	1003	0	
1000	1	1001	0	**not** allowed
1002	2	1003	0	

104*	TO area for channel		Active **at once**
Default value	Lower input limit	Upper input limit	Units
1	**1**	**4** **6** 1)	**–**

The TO area for each channel is entered in NC MD 104*. The maximum value must accord with NC MD 210. A TO area must be allocated to each channel. Also refer to NC MD 210 to 214.

106*	No. of the enabled program		Active in **next block**
Default value	Lower input limit	Upper input limit	Units
0	**±see below**	**± see below**	**–**

If 0 is entered, all programs are enabled in the first processing level for this channel. The program number must be entered if only a particular program may be started in a channel in the **first processing level**.

This may serve a practical purpose particularly when only a specific motion may be executed in a channel, i.e. with respect to loaders, tool palleting, and the like.

Main programs:	1	to	+9999
Subprogram*/*cycle:	–1	to	–9999
All main programs and subprograms:	0		

1) *As from SW 4*

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108*-122*	Reset state G group		Active in block **prior to decodg**
Default value	Lower input limit	Upper input limit	Units
see below	**see table of input values**	**see table of input values**	**–**

The reset state for G groups 1, 3, 6, 8, 12, 15 and 25 may be defined on a channel-specific basis.

Only those G functions shown in the table below may be specified in NC MD 108* to 122* for the relevant G group.

The reset state for G group 9 (G70/G71) is defined together with the input resolution in NC MD 5002.

Default value			
	T	**M**	**G group**
108*	1	1	1
110*	18	17	3
112*	54	54	6
114*	64	60	8
116*	0	0	9
118*	95	94	12
120*	150	150	15
122*	450	450 1)	25

Table of input values

Internal G group	G functions														
0	00 MD	01 M/T MD	10 MD	11 MD	02 MD	03 MD	33 MD	34 MD	35 MD	06 MD	12 MD	13 MD	36 MD		
1	09														
2	17 M MD	18 T MD	19 MD	16											
3	40 M/T	41	42												
4	53														
5	54 M/T MD	55 MD	56 MD	57 MD											
6	04	25	26	58	59	92	74								
7	60 M MD	63 MD	64 T MD	62 MD											
8	70	71													

1) As from SW 2

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Internal G group	G functions														
9	80 M/T	81	82	83	84	85	86	87	88	89					
10	90 M/T	91	68												
11	94 M MD	95 T MD	96 MD	97 MD		98 MD	295 1)								
12	147	247	347	148	248	348	48	110	111	112					
13	50 M/T	51													
14	150 M/T MD	151 MD	152 MD	153 MD	154 MD	155 MD	156 MD	157 MD	158 MD	159 MD					
15	130	131		133		135									
16	230	231		233		235									
17	330	331		333		335									
18	931	932	933	934	935										
19															
20	171														
21	175	176													
24	450 M/T MD	451 MD													
25	455	456													
26															
27 1)	420	421	422	423	424	425	426								
28 1)	600		640	620											
30 2)	431 M	432 T													

Refer to the Programming Guide for a detailed description of G groups and G functions.

With the 840 C, data can be read into the NCK circular buffer ("Execution from external") from the hard disk and via the computer link file transfer. The device with which the data transfer is executed is defined in the machine data (channel-specific 130* and 132*). The following settings are possible:

130*	Device type for Execution from external		Active –
Default value	Lower input limit	Upper input limit	Units
0	**0**	**5**	**–**

NC MD 130* defines the type of interface used to read in data for "Execution from external" for each channel. The default value 0 defines the hard disk on the MMC.

Other possible values are:

MD 130* = 5 defines the computer link file transfer as the interface. The receiver has to be defined in more detail in machine data 5148 to 5152 (see machine data description).

---

1) As from SW 4

2) As from SW 5

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132*	Device No. for Execution from external		Active –
Default value	Lower input limit	Upper input limit	Units
0	**0**	**0**	

NC MD 132* defines the device type number used to read in data for "Execution from external" for each channel. The device number defines the device type in MD 130* in more detail (e.g. 1st or 2nd interface). This machine data is not necessary for software versions 1 and 2.

134*	Cycle number on program start (as from SW 5)		Active **At once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**9 999**	**Subroutine no.**

136*	Cycle number on end of program (as from SW 5)		Active **At once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**9 999**	**Subroutine no.**

0 : No cycle is called on start**/**end of program
1-9 999 : Cycle no. 1- 9999 is called on start**/**end of program

With the increasing number of functions in the SINUMERIK 840C, on certain machines a series of recurring functions must be considered when writing part programs (e.g. functions like ELG, IKA and emergency retraction; initial settings of machine data, G16 plane etc.).

To simplify the handling for the programmer in such cases, the NC can execute a program start cycle (cycle with channel-specific default settings) immediately after the selected program is started before the first block in this program is executed.

An end cycle (e.g. deselection of the preset functions) is executed at the end of the part program M02**/**M17**/**M30 after the selected part program has been executed on the main program level.

Features:

- Any functions programmed in the M02/M17/M30 are executed first.
- The program start and end cycles are only called on the main program level in AUTOMATIC, MDA and TEACH-IN modes, but not in "extended overstore".
- No end cycle is called on a key reset.
- Single block, DEC single block, M00/01 also apply in the cycles.
- In the program start and end cycles, all functions can be programmed as previously. See the Programmer's Guide.
- The program start and end cycles can be transferred as cycles during control start-up. This activates a cycle disable.
- If the cycle set does not exist, alarm no. 2041 "Program not in memory" is triggered.

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- The function can also be switched off via the PLC (Program control, DB10-15, DR14, bit 3, DL2, bit 3).

The channel-specific initial settings for ZO (G54 - G57) and TO (D number 0 - 819) after POWER On are defined in NC MD 140* and 142*. With these values it is possible to determine the state of the control (in terms of ZO and TO) after Power On.

Note:

See Programming Guide, Workpiece-related Actual Value System.

140*	**Initial setting of 6th G group 1)**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
54	**54**	**57**	**–**

142*	**Initial setting of tool offset block 1)**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**819**	**–**

146*	**Corner deceleration speed with G620/G00 (as from SW 5)**		Active on
Default value	Lower input limit	Upper input limit	Units
0	**0**	**100 000**	**1 000 units/min**

148*	**Corner deceleration speed with G62 not including G36 (as from SW 5)**		Active on
Default value	Lower input limit	Upper input limit	Units
0	**0**	**100 000**	**1 000 units/min**

150*	**Corner deceleration speed with G62 with G36 (as from SW 5)**		Active on
Default value	Lower input limit	Upper input limit	Units
0	**0**	**100 000**	**1 000 units/min**

See machine data 3 for a description of MD 146* to 150*

Note for MD 146*, 148* and 150*:

If the value of the machine data in question is 0, machine data 3 is used for that corner deceleration speed.

1) As from SW 3

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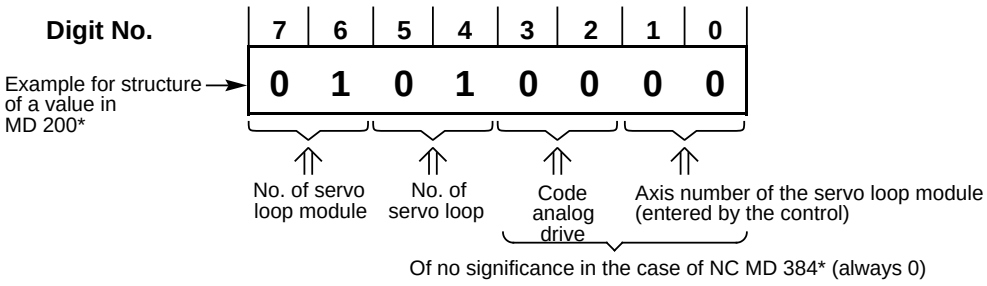
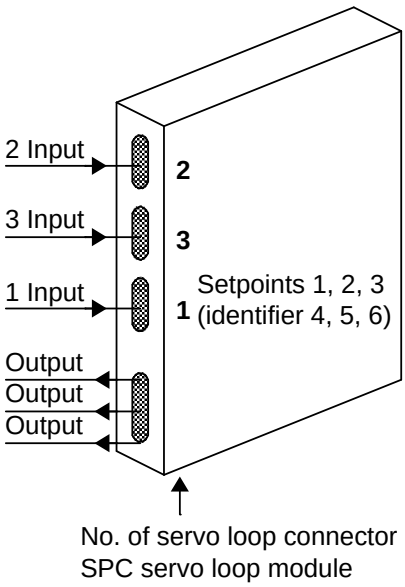
6.4 Axis-specific MD 1 (axial data 1)

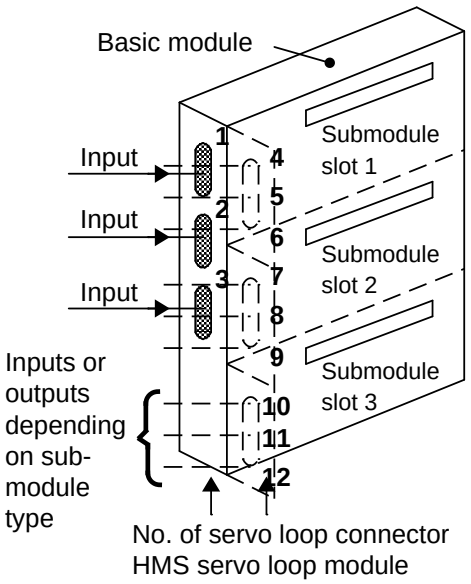
200*	Assignment of axis to actual-value port (analog)		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**05030000**	**–**

Simulation axes and spindles are defined if no measuring system has been parameterized (no servo loop and encoder defined in MD 200* and MD 400*).

The simulation axis derives the partial actual values from the partial setpoints and therefore "traverses" without any following error. Reference point approach with simulation axes is not possible. Contour monitoring and P feedforward control are always inactive.







MD 200* specifies the servo loop module or input for incoming actual position values.

All servo loop modules are interfaced to the same bus and are therefore numbered automatically from left to right by the software on POWER ON. There is no wiring block for these modules.

NC MD 384* is used to define the setpoint outputs.

Note:

See Section 5, Machine Data Dialog, for the servo loop assignment.

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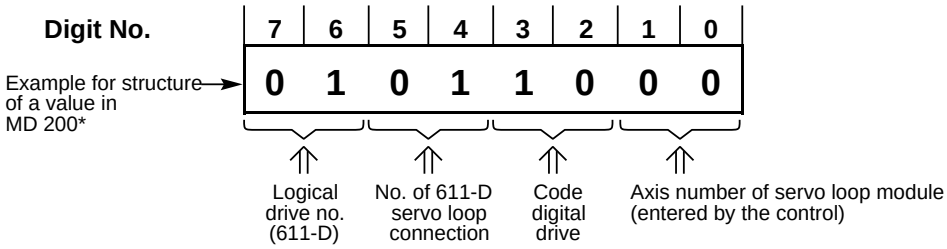
200*	1st measuring system connection (as from SW 3)		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**15021015 (up to SW 4)** **30021030 (as from SW 5)**	**–**



Digit No. 1, 0: Local axis number

The control automatically enters the local number of the axis here.

Digit No. 3, 2: Code digital drive

Code 10(-15) assigns the address to 611-D (611-D servo loop or digital setpoint channel).

Codes 1-9, 11-15 are reserved for expansions in the future and are interpreted as for 00 or 10.

The code must be entered by the user.

Digit No. 5, 4: SPC/HMS setpoint output

Permissible values for digital drives are the values 01 and 02:

01: PCU slot 1 (for MSD permanent indirect measuring system)
02: PCU slot 2 (free direct or indirect measuring system)

Digit No. 7, 6: Logical drive number / Servo loop module number

The logical drive number is entered here for digital drives.

Input range (00..15):	00:	No submodule available
	01..15:	According to logical drive number For more detailed information see MDD
Input range (00..30): (SW 5 and higher)	00:	No submodule available
	01..30:	Logical drive number

Notes:

- See Section 5, Machine Data Dialog, for the servo loop assignment.
- Up to SW 4: Only 14 real axes can be defined with a fictitious axis.

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204*	Coarse stop tolerance range		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
40	**+0**	**16 000**	**units (MS)**
40	**+0**	**99 999 999 (as from SW 4.4)**	**units (MS)**

The value defining the ”Coarse stop tolerance range ”can be higher than that defining the ”Fine stop tolerance range”. Consequently, a block change to the next machining block will be initiated correspondingly sooner.

If this function is not required, it can be rendered ineffective by entering identical values in the machine data locations for coarse exact stop and fine exact stop.

The coarse stop tolerance range is effective in the following cases:

- G00
- Block preceding G04
- Block preceding setting data
- Block ahead of which only auxiliary functions have been programmed
- Single block without G60/G09
- Jog
- Incremental feed
- End of program

Note:

The coarse stop tolerance range is not approached in continuous-path operation G64 (exception: G00 G64 coarse exact stop). There is no secondary error as a result of a large number of consecutive positioning operations, as position control is not "deactivated" by the stop tolerance range; instead, the second block is processed before the end position of the first block is reached.

The current traversing path is now the remainder of block 1, block 2 and so on.

If the axis stops for an instant, e.g. because another axis is about to move or because there is no axis movement in this program block, compensation is such that the following error is 0 and the axis is precisely positioned. Also refer to NC MD 208* and 272*.

Note:

As from SW 4, for 8 parameter sets

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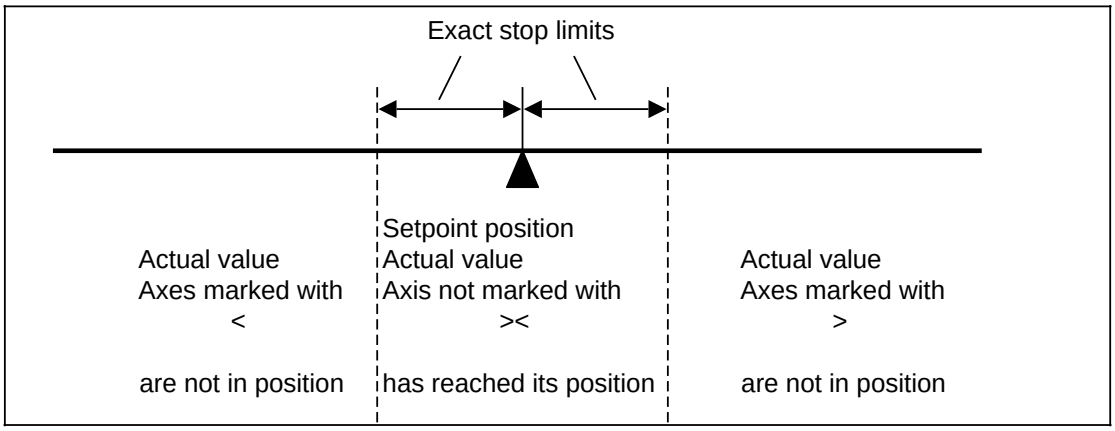
208*	Fine stop tolerance range		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	
10	**+0**	**16 000**	**units (MS)**
10	**+0**	**99 999 999 (as from SW 4.4)**	**units (MS)**

A traversing movement is completed when the axis has reached the setpoint position + - the entered exact stop limit fine.

Corrective action:

e.g. drift compensation (see Section entitled ”Axis (Analog) and Spindle Installation”).



The fine exact stop limits operate for:

- G09/G60
- Block before G33 and G63

Note

In continuous-path operation (G64), neither the coarse nor the fine exact stop tolerance range is approached (exception: G00).

Actual values are marked with < > in the machine display to indicate that an axis is not in position.

Example: 840C screen (X axis not in position, Z axis in position)

Actual value < X -12.560 Z 10.000	

Note: As from SW 4, for 8 parameter sets

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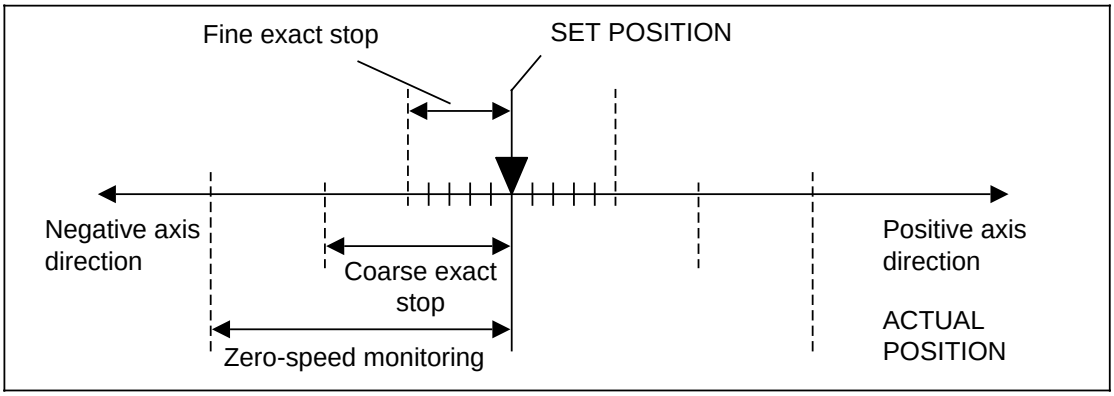
212*	Zero-speed monitoring		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
100	**0**	**16 000**	**units (MS)**
100	**0**	**99 999 999 (as from SW 4.4)**	**units (MS)**



The NC monitors the position at zero speed (holding of position). If the zero-speed monitor is timed out after the waiting time for the position monitor (NC MD 156**/**NC MD 372*) has elapsed, alarm 112* is issued.

The following situations may occur:

a) If the interface controller revokes the servo enable signal for an axis, the NC can no longer hold that axis in position. The interface controller must hold the axis in position itself by means of clamping. However, the clamped axis may be forced out of position as a result of mechanical forces.

b) The axis may be forced out of position as a result of major mechanical forces or faults in the drive.

The value for zero-speed monitoring must be **greater** than the **tolerance ranges for fine stop and coarse stop**.

Note:

As from SW 4, for 8 parameter sets

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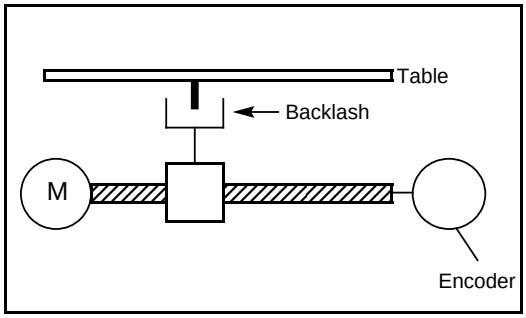
220*	Backlash compensation 1st measuring system		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**–16 000**	**16 000**	**units (MS)**

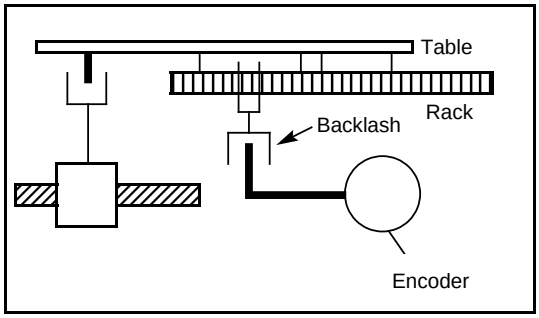
In the case of axes with indirect measuring systems, mechanical backlash results in corruption of the traversing path. When the direction is reversed, traverse is either shortened or extended by the amount of backlash, depending on the design.

Positive backlash (normal case)



Actual encoder value ahead of real actual value (table): Too little table travel

Negative backlash



Real actual value (table) ahead of actual encoder value: Too much table travel

The compensation value (amount of backlash) entered must be positive for positive backlash and negative for negative backlash.

The control compensates the backlash specified in NC MD 220* (in all operating modes and in all interpolation modes) each time the relevant axis changes its direction of travel.

Note:

As from SW 4, for 8 parameter sets
From SW 4 onwards interface signal "Reference point reached" is reset if MD 220* is changed.

224*	1st software limit switch plus		Active on **NC Stop**
228*	**2nd software limit switch minus**		Active on **NC Stop**
232*	**3rd software limit switch plus**		Active on **NC Stop**
236*	**4th software limit switch minus**		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
±99 999 999	**±0**	**99 999 999**	**units (MS)**

Default value

For 224*, 232* + 99 999 999
For 228*, 236* – 99 999 999

A software limit switch may be used in addition to the customary range limit switch (hardware limit switch). The operator enters the absolute position of the positive range limit for each axis.

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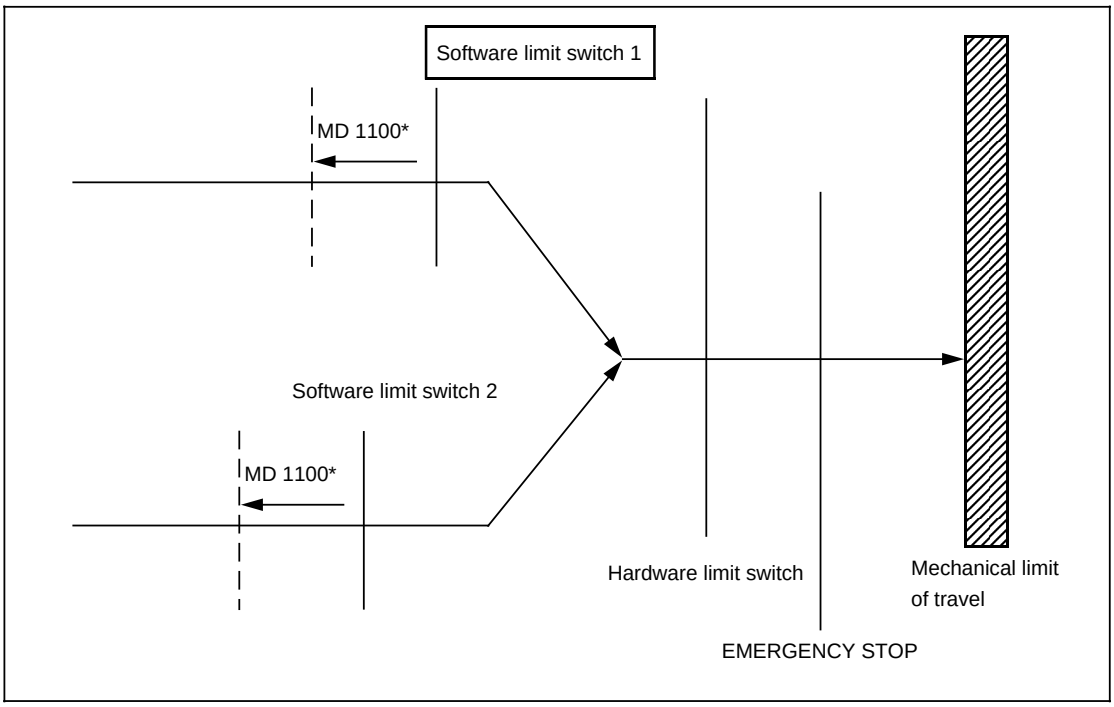
The software limit switches cannot fulfil their function correctly until the reference point has been approached and NC MD 560 * 5 has been set to "1".

The software limit switches are always approached at the speed defined in NC MD 1 unless a lower speed was selected in the current motion block. Deceleration to zero speed begins so far ahead of the software limit switch that the limit switch is reached with absolute accuracy but not overrun (in jog mode). The software limit switch can also be overrun under certain conditions (see NC MD 1100*). (Traverse with handwheel, reference point approach mode)

Customary travel limits



Note

When axes are traversed with interpolation, all axes are shut down upon reaching the limit of any one of the axes. Stopping without a contour violation, however, can be guaranteed only when bit 7 of NC MD 5003 ("No deceleration at limit switch") is not set, i.e. when the acceleration ramp is used for braking.

A second software limit switch position can be specified in a clockwise direction. The PLC selects either software limit switch 1 or 2 on the basis of an interface signal (refer to Part 1 of the Interface Description, DB32, DL m + 1, bit 1).

e. g. DB32 DL1	Bit 1 = 0	. . . . .	1st switch for 1st axis
	Bit 1 = 1	. . . . .	2nd switch for 2nd axis

Example of application

Reduction of the permissible traversing range with a retracted tailstock.

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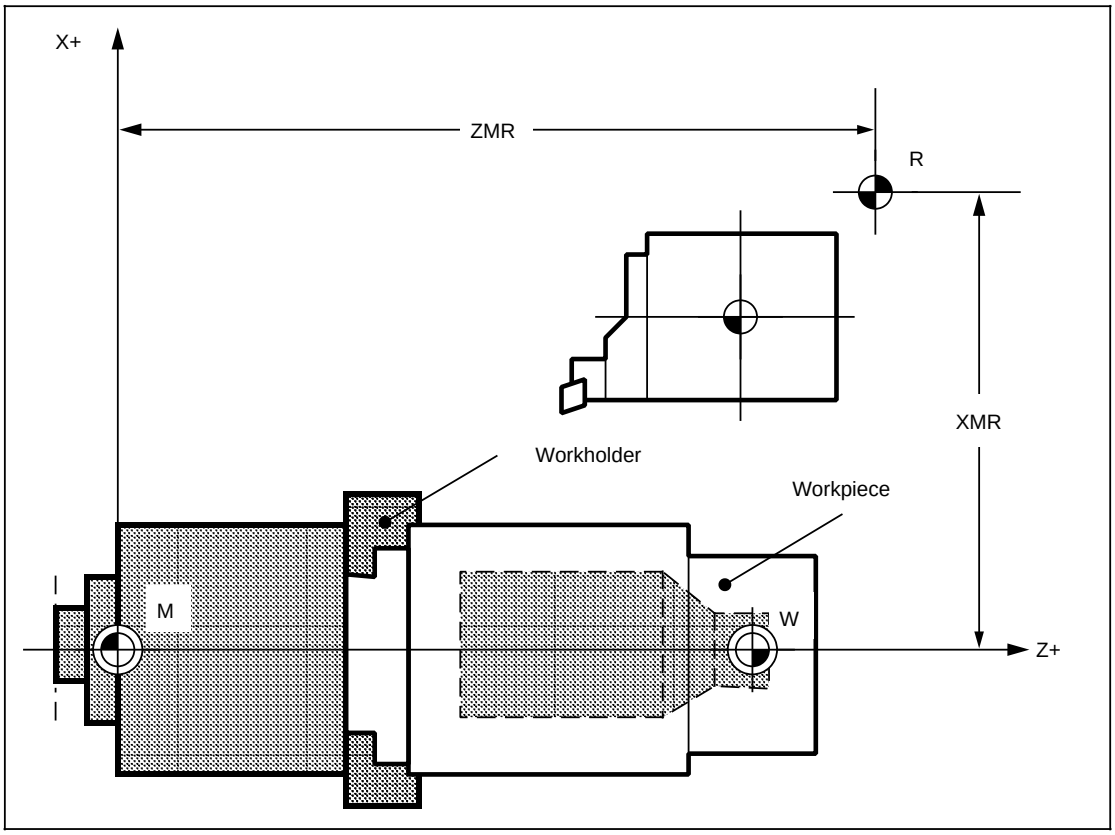
240*	Reference point value		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**±0**	**99 999 999**	**units (MS)**

The difference between absolute machine zero and the fixed reference point is entered for the respective axis. These values are set as actual values for reference point approach (also refer to Section entitled ”Axis (Analog) and Spindle Installation” for a detailed description of reference point approach).



Example: Turning machine

M ... Machine zero
W ... Workpiece zero
R ... Reference point
XMR ... Reference point coordinate in X direction
ZMR ... Reference point coordinate in Z direction

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244*	Reference point shift		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**- 99 999 999**	**99 999 999**	**units (MS)**

Reference point shift is used to shift the reference points of the measuring system. Instead of mechanical shifting or rotating of the measuring equipment (and thus of the "deceleration" cam), the reference point can be shifted electrically by up to ±9 999 units.

The reference point shift path is traversed at the cutoff speed (NC MD 284*), which must already have been reached at the operating cam (also see Section Axis (Analog) and Spindle Installation for details on reference point approach).

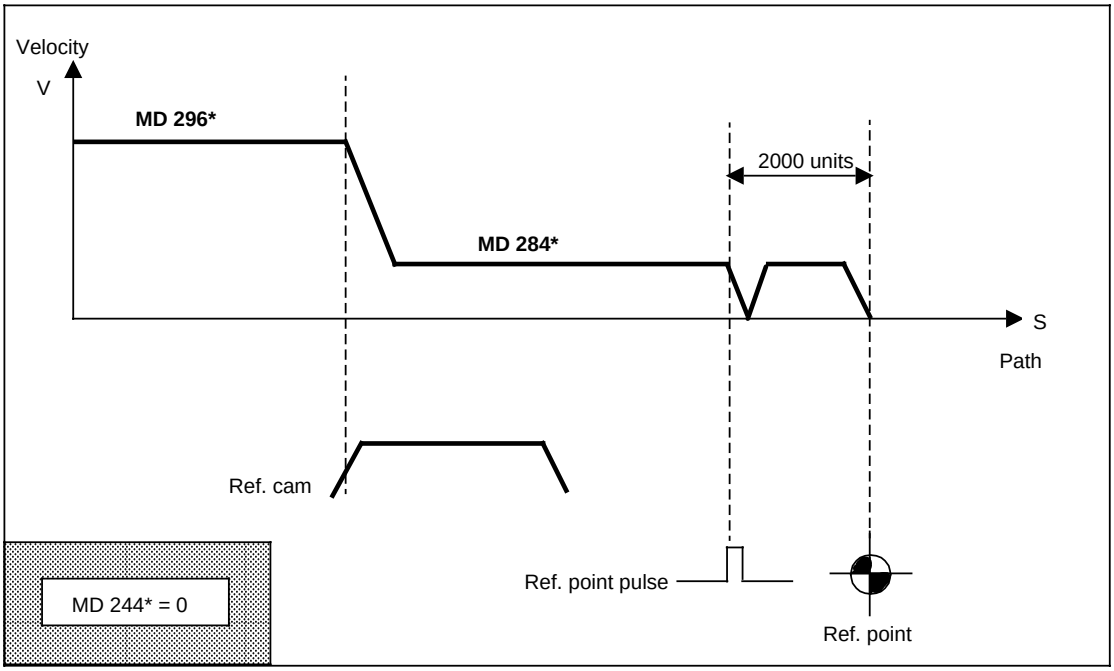
The reference point shift is also effective in conjunction with automatic reference point approach (NC MD 560*, bit 6).

Without reference point shift, the reference point is 2000 units behind the first zero mark after the operating cam has become free again.

If the entry in NC MD 244* is **positive**, the axis travels the specified number of units beyond the normal reference point (2000 units beyond the zero mark) in a positive direction.

If the entry in NC MD 244* is **negative**, the axis, after overrunning the zero mark, travels to the value represented by the difference between 2000 units and the input value. In the event of a reference point shift of more than approximately 2000 units, the axis reverses its direction of travel (backlash on reversal).

Reference point pulse = zero marker from encoder



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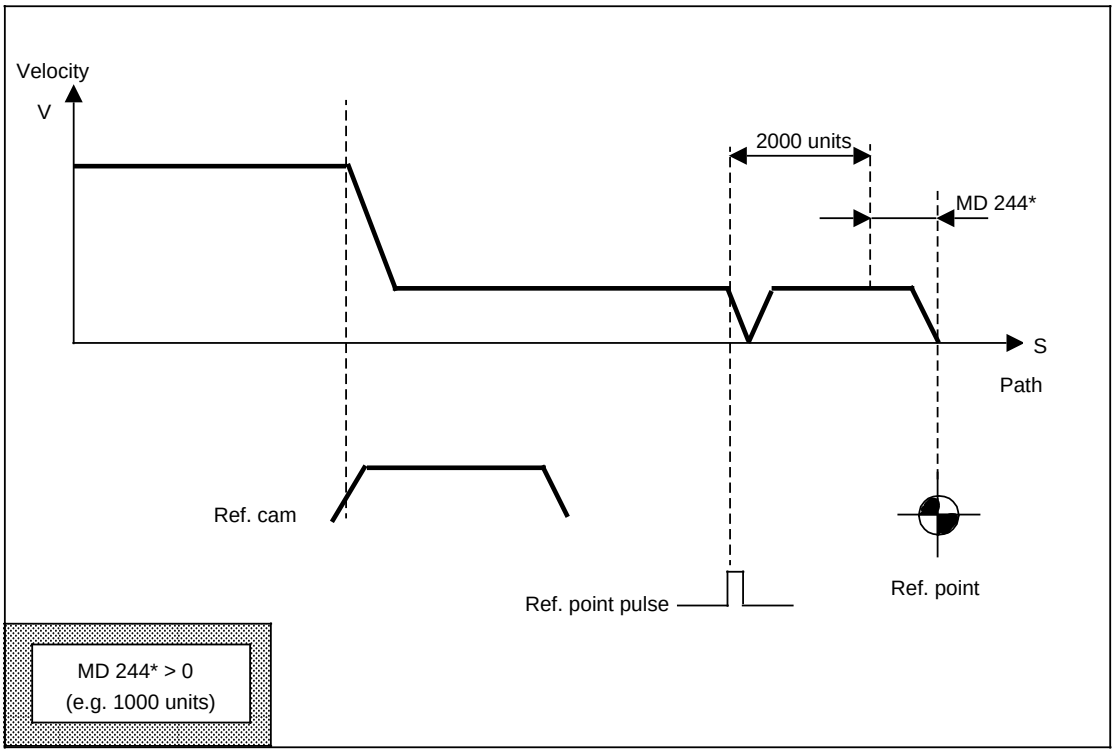

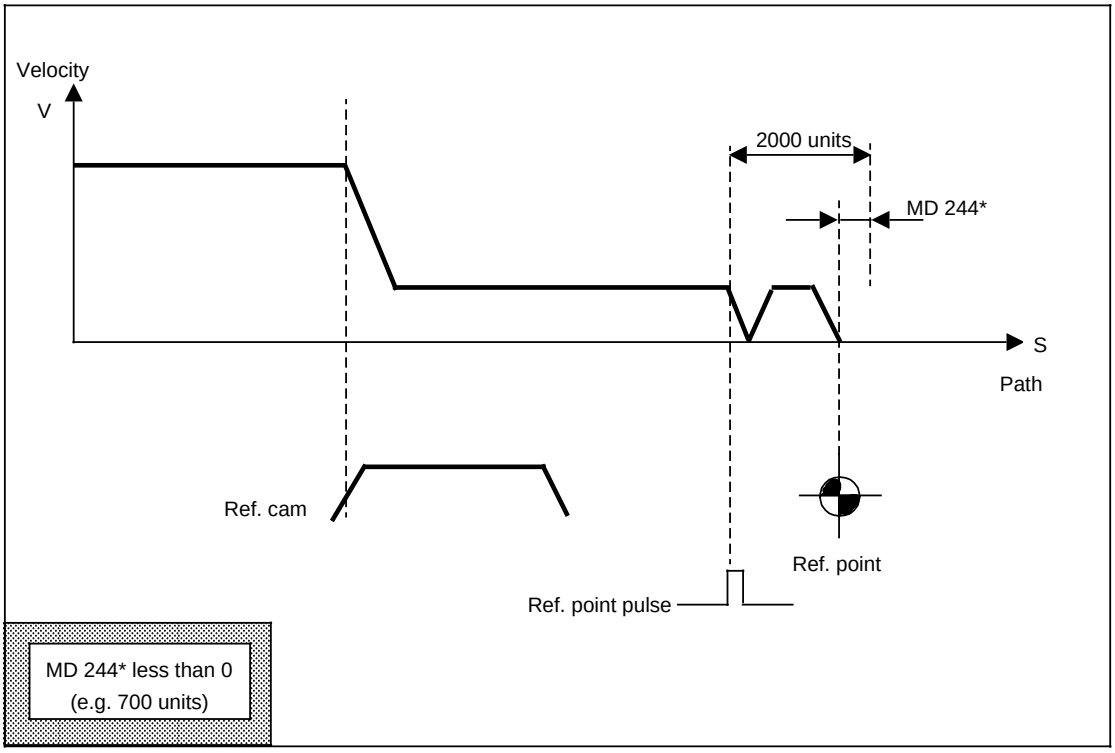

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252*	K_V factor		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
1 666	**0**	**10 000** **80 000 (as from SW 5)**	**0.01 s^{-1}**

When specifying the K_V factor, attention must be paid to the fact that the gain factor for the entire position control loop is dependent on other controlled system parameters. Strictly speaking, a distinction must therefore be made between the "required K_V factor" (which is specified in NC MD 252*) and the "actual K_V factor" (obtained at the machine). Only when all control loop parameters have been correctly attuned to one another are these two K_V factors identical. The parameters in question are:

- Max. velocity (MD 280*)
- Speed setpoint adaptation MD 256*, 260*
- Tacho compensation on the speed controller
- Tacho-generator on the drive

An input value of 1 666 is equivalent to a K_V factor of 1.

The position controller loop is broken if the value 0 is entered.

Note:

Axes which are to interpolate and perform a machining operation together must exhibit precisely the same gain in the position control loop (i.e. at the same speed they must exhibit the same following error = 45 degree inclination).

Any deviations will result in contouring errors!

Only axes which **never** contribute to continuous-path operation may be defined with different values.

The actual K_V factor can be checked on the basis of the following error (in the Service displays). Note that the drift must be compensated before carrying out the check.

Note:

As from SW 4, for 8 parameter sets

256*	Scaling factor max. velocity		Active for all **channels of mode groups in STOP**
Default value	Lower input limit	Upper input limit	Units
10 000	**1**	**99 999 999**	**$\frac{mm}{min}$** **$\frac{inch}{min}$** **$\frac{degr.}{min}$**

The maximum load velocity is calculated from the maximum motor speed, the mechanical gear and/or the spindle pitch.

with r = transmission [1]
n_{max} = max. motor speed [$^{V}/_{min}$]
s = spindle pitch [mm]

For linear axes: max. load velocity = $n_{max} \cdot s \cdot r$

For rotary axes: max. load velocity = $n_{max} \cdot r \cdot 360$ degrees

See Section Axis (Analog) and Spindle Installation.

Note:

As from SW 4, for 8 parameter sets

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260*	Scaling factor maximum speed setpoint		Active for all **channels of mode groups in STOP**
Default value	Lower input limit	Upper input limit	Units
8 000 1) **10 000 2)** **9 000 3)**	**1** **0** **1**	**99 999 999** **20 000** **20 000**	**0.01 % of max. setpoint**

Active: for all channels of mode group in stop

The multgain factor is used to match the controlled system to the K_V factor specified in NC MD 252*. The multgain is a pure multiplier for the specified K_V factor, and should be used for **precision digital tacho-generator matching** in view of the very fine adjustment capabilities.

Following the correct entry or matching of the multgain, the K_V factor produced for the relevant axis must correspond precisely to the specified value.

Note:

Matching of the actual K_V factor via NC MD 252* (K_V factor) is not to be recommended, as different input values would be obtained for the various axes despite identical gain in the position control loop.

Where U_{max} is the speed setpoint voltage at maximum motor speed

Multgain = U_{max} [mV]

If problems of precision or restrictions caused by input limits occur, the factors between MD 256* and 260* can be reduced or increased. See Section entitled ”Axis (Analog) and Spindle Installation”. See MD 141 for digital drive.

264*	Threshold value for drive errors		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
9 600 1) **12 000 2)**	**+0** **0**	**15 000** **20 000**	**VELO 0.01% of max. motor speed**

The specified setpoint speed is monitored; if it is too high (control loop and drive errors), alarm 156* is triggered.

The specified value must be greater than the highest maximum setpoint speed specified in NC MD 268*.

Recommended value

Approx. 20 % higher than the value in NC MD 268*

See also Section entitled ”Axis (Analog) and Spindle Installation”.

---

1) Up to SW 2
2) As from SW 3
3) As from SW 4

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268*	Maximum setpoint speed (IPO stop)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
8 192 1) **10 000 2)** **10 000 3)**	**+0** **0** **0**	**8 192** **20 000** **20 000**	**VELO** **0.01 % of max. motor speed**

This entry defines the maximum voltage value to be output as setpoint speed. This value depends on the setpoint limiting values, if any, in the speed controller (normally 10 V). Alarm 104* (speed setpoint alarm limit) is triggered when the limiting value is exceeded.

Note carefully

It must be possible, however, to reach the maximum speed (rapid traverse) safely, i.e. tacho compensation must be such that the IPO Stop limit is not reached because of reading and adjustment inaccuracies resulting from fluctuations in speed during operation (e.g. maximum speed = 9.5 V setpoint speed).

See also Section entitled ”Axis (Analog) and Spindle Installation”.

272*	Drift compensation		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0 1) **0 2)**	**- 500** **- 500**	**500** **500**	**VELO 1)** **0.01 % of max. motor speed 2)**

The temperature drift in analog electronic components (primarily in the motor control unit) causes the axes to wander from their set position until the following error produces a counter-setpoint that corresponds to the temperature drift.

Failure of the > < characters next to the actual values in the Machine display to disappear from the screen although the axes are at a standstill indicates that the following error brought about by the drift has reached a value that is so high that the axes can no longer be moved until the drift has been compensated.

Refer to Section entitled ”Axis (Analog) and Spindle Installation” for details on drift compensation.

---

1) Up to SW 2
2) As from SW 3
3) As from SW 4

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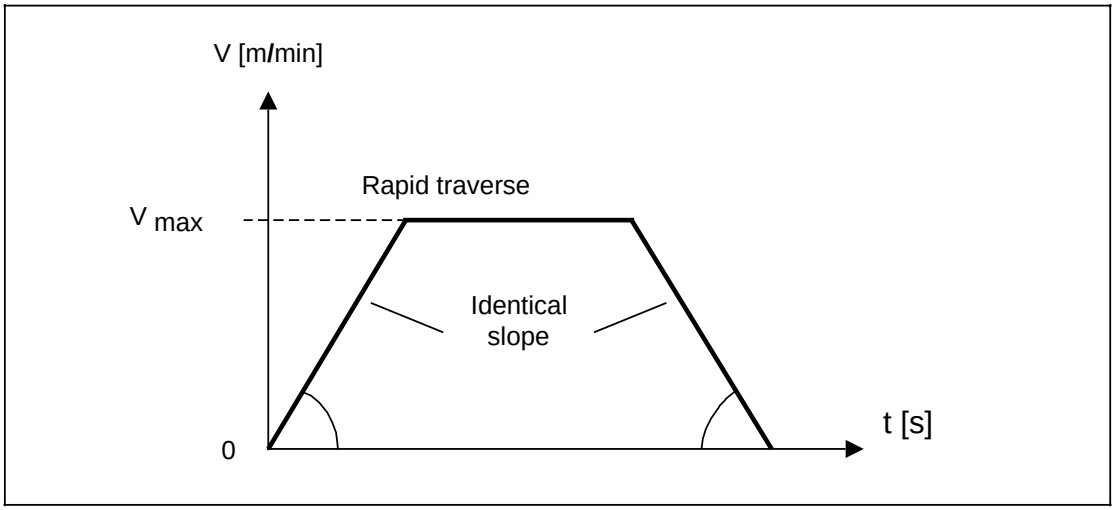
276*	Acceleration		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
50	**+0**	**16 000 (SW 3)** **9999 9999 (as from SW 4)** **99 000 000 (as from SW 4.4)**	**10 000** $\frac{\text{units}}{S^2}$



The acceleration values for the axes need not be identical. The control assumes the lowest acceleration value of the interpolating axes involved. These values also apply for deceleration (braking).

The value in NC MD 276* takes effect each time the axis is accelerated or decelerated (i.e. whenever there is a change in speed).

Exception

During reference point approach, the axis is decelerated as quickly as possible when the reference point is reached; the reference point cutoff speed (NC MD 284*) should therefore be as low as possible.

When an alarm is triggered, the relevant axis is decelerated as quickly as possible (also refer to the descriptions of the various alarms).

Note:

Values of approximately 50 to 150 (= 0.5 to 1.5 m/s2) are customary for standard machines. NC MD 276* must specify the angular acceleration in the case of rotary axes.

Calculation of the permissible acceleration G36, C axis mode.

The set acceleration must not exceed the available acceleration reserves of the drive in position control mode, otherwise deviations beyond the permissible limit occur during acceleration causing the drive to come to a standstill (with alarms 156*, 116*, 2014*).

When parameterizing the maximum acceleration please take note that the available driving torque decreases above the weak field limit.

ELG: With a following axis override, only 75% of the acceleration value are used for the following axis. The remaining 25% are reserved for possible actual value linkage.

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MD 276* is calculated as follows:

$$\text{MD 276*} = \frac{\text{Maximum speed [rev/min]} \cdot 360 \text{ degrees/input resolution}}{60 \text{ x run-up time [sec]} \cdot 10000}$$

Example:

Maximum speed: 1000 rev/min
Measured value: 200 msec
Reserve: 100 msec
C axis input resolution: 0.01 degrees

$$\text{MD 276*} = \frac{2000 \text{ rev.} \cdot 360 \text{ degrees} \cdot 100}{60 \text{ sec.} \cdot 0.3 \text{ sec} \cdot 100} = 400 \text{ [units IS} \cdot 10000 \text{ / s}^2 \text{]}$$

280*	**Maximum speed with G00**		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
10 000	**+0**	**99 999 999**	**1 000 units/min (IS)**

NC MD 280* is used to define the maximum speed to which the axis can accelerate (**rapid traverse limit**). If rapid traverse G00 has been programmed, the axis traverses at this speed.

All speeds programmed or input relate to this speed.

The maximum permissible speed depends on the position control resolution, the input resolution and the interpolation time (refer to Section entitled ”Axis (Analog) and Spindle Installation”).

284*	**Ref. point cutoff speed**		Active for all **channels of mode group in STOP**
Default value	Lower input limit	Upper input limit	Units
300	**+0**	**99 999 999**	**1 000 units/min (IS)**

MD 284* is accepted when all channels of the mode group are in STOP and applies from the next reference point approach.

During approach to the reference point, the cutoff speed takes effect as soon as the reducing cam is reached, i.e. the "Deceleration" signal is active (see NC MD 244*). In the case of distance coding, the whole referencing procedure is carried out with this speed. The feedrate override switch is not taken into account, except in the first position (0 %). The specified cutoff speed must not exceed the maximum speed (NC MD 280*). (For a detailed description of reference point approach see also Section entitled ”Axis (Analog) and Spindle Installation”). With reference point control with "distance coded reference marks", the reference point creep velocity must not exceed a maximum value. See Section entitled ”Axis (Analog) and Spindle Installation” for a calculation.

Recommended value:

A reasonable upper limiting value would be 1 m/min, but values between 100 and 500 mm/min, depending on the K_V factor, would be preferable.

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288*	Jog feedrate		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
2 000	**+0**	**99 999 000**	**1 000 units/min (IS)**

The specified value applies to travel in JOG mode with the feedrate override switch set to 100%.

The value in NC MD 288* must not exceed the maximum feedrate (NC MD 280*).

292*	Rapid traverse in jog mode		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
5 000	**+0**	**99 999 999**	**1 000 units/min (IS)**

The specified value applies to travel in JOG mode with the rapid traverse override key actuated and the rapid traverse override switch set to 100 %.

The value defined in NC MD 292* must not exceed the maximum speed (NC MD 280*).

The value in NC MD 292* is not used for programmed rapid traverse G00, which is defined by the maximum speed entered in NC MD 280*.

Recommended value

The selected value should be slightly lower than rapid traverse rate G00 to make allowance for the operator's response time.

296*	Ref. point approach speed		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
10 000	**+0**	**99 999 999**	**1 000 units/min (IS)**

If the Direction key leading to the reference point is depressed in "Reference point approach" mode, the axis accelerates to the reference point approach speed. (Exception: The axis is already at the deceleration cam or automatic reference point approach has been selected; also refer to NC MD 244*).

The direction of reference point approach is specified in NC MD 564*.

The value entered in NC MD 296* must not exceed the maximum speed (NC MD 280*).

Also refer to Section entitled ”Axis (Analog) and Spindle Installation” for details on reference point approach.

300*	Incremental speed		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
500	**+0**	**99 999 999**	**1 000 units/min (IS)**

The specified speed takes effect in incremental feed mode only (INC1 ... 10 000), and must not exceed the maximum speed (NC MD 280*).

When traversing with the handwheel in modes INC1 ... 10 000 or with the DRF function, the speed is determined exclusively by the handwheel.

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304*	Interpolation parameter name		Active in next block
Default value	Lower input limit	Upper input limit	Units
see table	**+0**	**3**	**–**

Default values		
	840C (T)	**840C (M)**
3040	1	1
3041	3	2
3042	0	3
3043 . . 3069	0 . . 0	0 . . 0

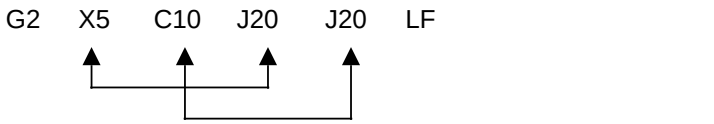
In the case of circular movements (G2/G3) and thread cutting (G33, G34, G35), the individual axes must be assigned an interpolation parameter:

0 = No interpolation parameter
1 = Interpolation parameter I
2 = Interpolation parameter J
3 = Interpolation parameter K

Standard MD: X axis I
Y axis ..... J
Z axis ..... K

Several axes may have the same interpolator name.

Programming when using identical parameter names



Assignment: 1st parameter for 1st programmed axis
2nd parameter for 2nd programmed axis

Axes without an interpolator name cannot execute circular or helical movements or perform thread cutting.

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308*	Limiting frequency C axis encoder		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
200	**0**	**16 000**	**kHz**

The limiting frequency of the C axis actual value encoder is entered in machine data 308*. The limiting frequency can be taken from the encoder manufacturer's specifications.

Pulses from the encoder may be lost when the limiting frequency is exceeded. Actual value acquisition will then not be correct and C axis operation is no longer possible. Alarm 1004* ”Feedrate too high” is triggered.

Note:

MD 308* is used only if a separate encoder is provided for C axis operation.
If not, the limiting frequency of the spindle encoder (MD 462*) is monitored also in C axis operation.

312*	Feedforward control factor		Active –
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**1 000**	**0.1 %**

Feedforward control is used to reduce the inaccuracy caused by the following error as much as possible.

For feedforward control, the set part position is multiplied by the feedforward factor and fed directly to the speed controller input. For static feedforward control, this value is fed directly to the position controller input while for dynamic feedforward control it is fed to the position controller input using a first order time-delay element after a delay specified in machine data 392*. No feedforward control is applied to the associated axis if feedforward factor 0 is entered in 312*.

Option (6FC5 150-0AS03-0AA0) must be set to activate feedforward control. [1)]

The feedforward factor can be adapted to suit the rigidity of the machine and the resulting acceleration**/**deceleration of the axes. By using feedforward control, the following error is reduced by the amount of the feedforward factor.

Assuming a feedforward factor of 1000 at zero speed, the following error will be approximately 0. However, it should be taken into account that this setting produces overshoots. To avoid this, use the setpoint smoothing factor (MD 1272*).

See Section entitled ”Functional Descriptions”.

Note:

As from SW 4, for 8 parameter sets

316*	Reference point pointer compensation +		Active on **Power On**
320*	**Reference point pointer compensation -**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**249**	**MD offset*)**

*) MD offset means 127 instead of 6127

1) The feedforward control can be switched off via PLC MD with SW 2 and higher.

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The NC activates leadscrew error compensation (SSFK) after reaching the reference point. The CNC must therefore be informed via MD 316* as to which of the 1000 possible compensation points represents the reference point for the axis in question.

Separate compensation curves for positive and negative traversing movements are available for direction dependent leadscrew error compensation, necessitating the use of two compensation pointers (MD 316* for " + " and MD 320* for " - "). The value refers to the compensation point which corresponds to the reference point (see Section entitled ”Functional Descriptions”).

324*	**Distance between 2 leadscrew error compensation values**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**32 000**	**units (MS)**

The distance between two compensation points depends on:

- the permissible tolerance band
- the maximum gradient of the sumcheck error characteristic of the spindle**/**measuring system
- the maximum number of compensation points

(See also Section entitled ”Functional Descriptions”).

328*	**Leadscrew error compensation value**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**100**	**units (MS)**

The compensation value depends on the permissible tolerance band for the axis position. The value for the tolerance band or a slightly lower value is entered in order to make use of the full bandwidth for each compensation procedure (also see Section entitled ”Functional Descriptions” for details on leadscrew error compensation).

The compensation value entered in NC MD 328* must be less than that entered in NC MD 324*. This MD applies both to rotary and linear axes.

332*	**Tolerance band for contour monitoring**		Active for all **channels of mode group in STOP**
Default value	Lower input limit	Upper input limit	Units
1 000	**+0**	**99 999 999**	**units (MS)**

The following error is proportional to the speed after acceleration or deceleration (i.e. in the steady state), so no fluctuations in the following error may develop during travel at constant speed, as this would result in contour deviations. Minor fluctuations in the following error which trigger control processes are, however, allowed.

The definition of a tolerance band is intended to prevent false tripping of the contour monitor due to slight fluctuations in speed caused by normal control processes.

For a detailed description, see Section entitled ”Axis (Analog) and Spindle Installation”.

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336*	Contour threshold speed		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
5	**+0**	**1 000 000**	**1 000 units/min (IS)**

NC MD 336* is used to define the speed at which the contour monitor is to be activated. At speeds below this axis-specific threshold speed, the contour monitor remains inactive. The zero speed monitor checks for illegal axis movements when the axes are at rest (alarm 112*). For details, refer to Section entitled ”Axis (Analog) and Spindle Installation”.

344*	Rotary axis modulo value for LEC		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
360 000	**±0**	**92 160 000**	**units (MS)**

NC MD 344* must define the compensation value for a rotary axis, which is normally 360 000 (corresponding to one revolution of the rotating table).

When specifying values > 360 000, care must be taken that a corresponding number of leadscrew error compensation points are provided (for details on leadscrew error compensation, see Section entitled ”Functional Descriptions”).

356*	IKA warning limit (as from SW 3)		Active **at once**
Default value	Lower input limit	Upper input limit	Units
	– 9999 9999	**+9999 9999**	**units (MS)**

If the set warning limit is exceeded, interface signal DB 32, DR K, bit 5 is set.

360*	Mode group		Active on **Power On**[1)]
Default value	Lower input limit	Upper input limit	Units
1	**+1**	**+1, 2 6 (as from SW 4)**	**–**

NC MD 360* is used to allocate the axes to the mode groups, i.e. to ensure that a channel will traverse only the axes in its mode group and not those of other mode groups. Within a mode group, several channels can process an axis successively, provided that axial synchronization of the "Block End Value" for that axis was carried out (NC STOP NC START) if the axis was previously traversed by another channel.

Mode groups without axes are possible.

---

1) The warm restart function enables the allocation of axes to another mode group without a hardware reset and without loss of the axes reference points (for a detailed description of the warm restart function, see Sect. 12)

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364*	u: Variable increment weighting pulses		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
1	**1**	**65 000 (SW 1)** **9999 9999 (as from SW 2)**	**–**

368*	v: Variable increment weighting traversing path		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
2	**1**	**65 000 (SW 1)** **9999 9999 (as from SW 2)**	**–**

The pulses coming from the digital measuring system and the position control resolution must be coordinated in order to produce a correctly closed position control loop.

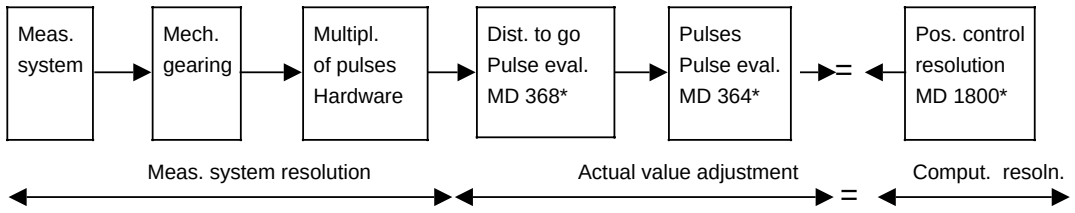
NC machine data 364* and 368* can be used for this purpose.

The number of pulses of the encoder and the appropriate distance to go on the machine must be known for determining machine data 364* and 368* .

The following formula represents the relation between these machine data:

Position control resolution × MD 368* = Measuring system resolution × MD 364*

Schematic block diagram of the position control parameters :



Note concerning upper input limits

MD 364* and MD 368* should always be reduced as much as possible (at least for values 100 000).

Note: as from SW 4

MD 3900* 3904* and 3908* in the MDD are used to automatically calculate MD 364*.

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The following parameters are used for adaption to the measuring system:

Parameter	Symbol	MD	Meaning
Position control resolution	b	1800* (Bit 0-3)	Internal computational resolution of the control
Multiplier for EXE	f		(signifies e.g. a five-fold EXE multiplication of the pulses coming from the scale with the factor 5)
Grid constant	g		Period interval on a linear scale
Spindle pitch	l		Leadscrew pitch
Measuring system resolution	m		Maximum resolution of the measuring system. The value serves as a basis for determining the actual value adjustment factors.
Pulses per revolution	p		Number of pulses per revolution of the ROD encoder [1)]
Transmission ratio of mechanical gearing	r		Transmission ratio of a mechanical gearing which may be present between motor and ROD encoder
Factor for position control pulses	u	364*	Evaluation of position control resolution
Factor for actual value pulses	v	368*	Evaluation of measuring system resolution

The relation may be formulated as follows (see above) :

$$\mathbf{m \times u = v \times b}$$

Determining the measuring system resolution and the variable increment weighting

- The ROD encoder is mounted directly onto the leadscrew:

  $m = \frac{l}{4p}$

  Example: l = 10 mm; p = 2500; b = 0.5×10^{-3} mm;

  $m = \frac{10}{4 \times 2500}$ mm = 0.001 mm

  $\frac{m}{b} = \frac{v}{u} = \frac{0.001\ mm}{0.5 \times 10^{-3}\ mm} = \frac{2}{1}$

  MD368* = 2; MD364* = 1;

1) *If a linear scale is used as the measuring system, this parameter must be set to 0.*

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- The ROD encoder is mounted onto the motor and the gearing is located between the motor and the leadscrew:

$$m = \frac{l}{4p} \times r$$

Example 1: l = 0.2 inch; p = 1000; b = 2×10^{-5} inch; r = 1:2 (i.e. 2 motor revolutions for 1 leadscrew revolution);

$$m = \frac{0.2 \times 2}{4 \times 1000}\ \text{inch} = 10^{-4}\ \text{inch}$$

$$\frac{m}{b} = \frac{v}{u} = \frac{10}{2} = \frac{10^{-4}\ \text{inch}}{2 \times 10^{-5}\ \text{inch}} = \frac{10}{2} = \frac{5}{1}$$

MD368* = 5; MD364* = 1;

Example 2: Same values as above, except b = 0.5×10^{-3} mm; K = 25.4 $\frac{\text{mm}}{\text{inch}}$ =^

Calculation factor inch mm

$$\frac{m}{b} = \frac{v}{u} = \frac{K \times 10^{-6}\ \text{inch}}{0.5 \times 10^{-3}\ \text{mm}} = \frac{5.08}{1}$$

MD368* =; MD364* =;

- A linear scale with EXE is used:

$$m = \frac{g}{4f}$$

Example: g = 0.02 mm; f = 10; b = 0.5×10^{-3} mm;

$$m = \frac{0.02\ \text{mm}}{40} = 0.0005\ \text{mm}$$

$$\frac{m}{b} = \frac{v}{u} = \frac{0.5 \times 10^{-3}\ \text{mm}}{0.5 \times 10^{-3}\ \text{mm}} = \frac{1}{1}$$

MD368* = 1; MD364* = 1;

- A rotary axis is used:

$$m = \frac{360\ \text{degrees}}{4pf}$$

Example: p = 18000; f = 5; b = 0.5×10^{-3} degrees;

$$m = \frac{360\ \text{degrees}}{18000 \times 5 \times 4} = 0.001\ \text{degrees}$$

$$\frac{m}{b} = \frac{v}{u} = \frac{1 \times 10^{-3}\ \text{degr.}}{0.5 \times 10^{-3}\ \text{degr.}} = \frac{2}{1}$$

Should either of the values be greater than 100 000, both values must be divided by the same divisor (e.g. one exponent of 10).

Recommendation: Reduce whenever possible

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- Linear axis with SIMODRIVE 611-D

b = 0.5×10^{-3} mm
l = 10 mm
p = 2048 pulses/rev (Motor measuring system)
v = 1 x 1
f = ? (SW EXE)
m = $0 \times 5 \times 10^{-3}$ mm (desired)

$$m = \frac{l}{4 \times p \times f}$$

$$f = \frac{l}{4 \times p \times m} = \frac{10\ mm}{4 \times 2048 \times 0.5 \times 10^{-3}\ mm} = 2.44$$

selected f = 4

$$m = \frac{10\ mm}{4 \times 2048 \times 4} = 0.3 \times 10^{-3}\ mm$$

$$\frac{u}{v} = \frac{4 \times p \times f}{\frac{l}{b}} = \frac{4 \times 2048 \times 4}{\frac{10}{0.5 \times 10^{-3}}} = \frac{16 \times 2048}{10 \times 2 \times 10^{-3}}$$

$$\frac{u}{v} = \frac{}{625}$$

MD 3640 = 1024
MD 3680 = 625
MD 11160 = 4

- Rotary axis with SIMODRIVE 611-D

b = 0.5×10^{-3} degrees
l = 360 degrees
p = 2048 pulses/rev (Motor measuring system)
v = 1 x 1
f = ? (SW EXE)
m = $0 \times 5 \times 10^{-3}$ degrees (desired)

$$m = \frac{l}{4 \times p \times f}$$

$$f = \frac{l}{4 \times p \times m} = \frac{360}{4 \times 2048 \times 0.5 \times 10^{-3}\ mm} = 87.89$$

selected f = 128

$$m = \frac{360}{4 \times 2048 \times 128} = 0.3 \times 10^{-3}\ degrees$$

$$\frac{u}{v} = \frac{4 \times p \times f}{\frac{l}{b}} = \frac{4 \times 2048 \times 128}{\frac{360}{0.5 \times 10^{-3}}} = \frac{512 \times 2048}{360 \times 2 \times 10^{-3}}$$

$$\frac{u}{v} = \frac{8192}{5625}$$

MD 3640 = 8192
MD 3680 = 5625
MD 11160 = 128

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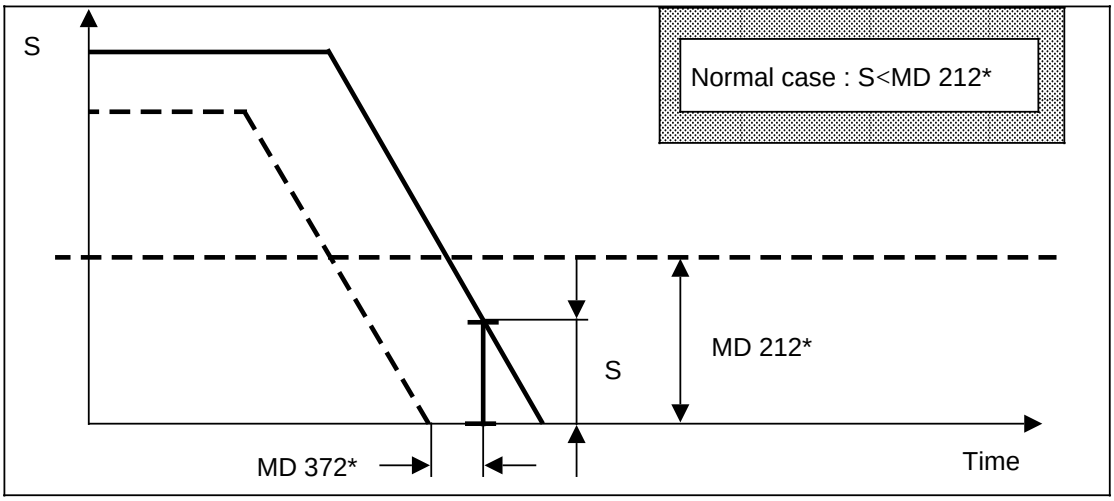
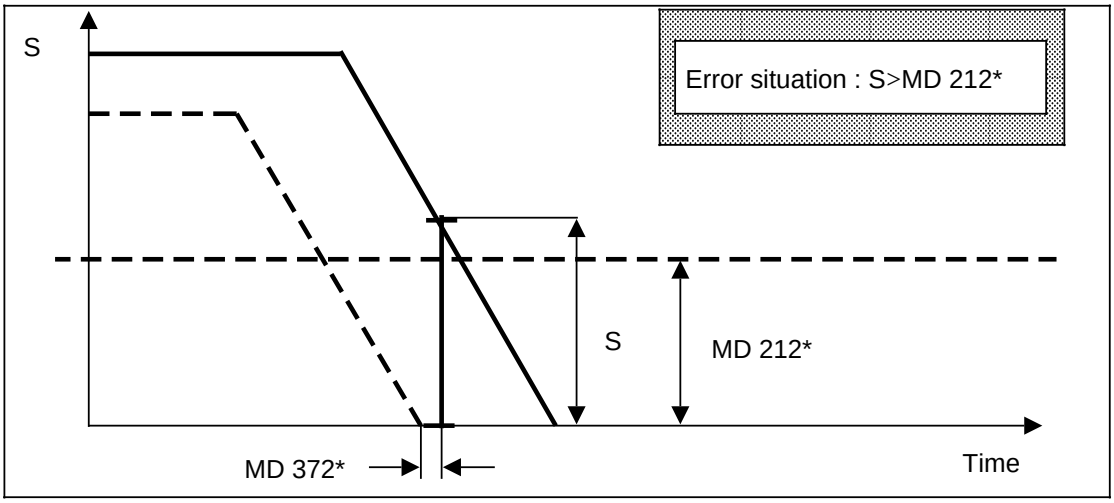
372*	Delay time zero speed monitoring		Active on **Reset**
Default value	Lower input limit	Upper input limit	Units
200	**0**	**1 000**	**ms**

NC MD 372* is used to specify the amount of time that is to elapse before zero speed monitoring (NC MD 212*) is to be activated during the approach to position (set speed=0). The time must be chosen so as to enable suppression of the largest possible following error. Failure to specify an appropriate delay time will trigger alarm 112*.

If NC MD 372* is 0, the value defined in NC MD 156 ("Servo enable cutoff delay") is taken as delay time for zero speed monitoring.





S....Following error (contouring error)

376*	Acceleration during emergency retraction guided by the control		Active on
Default value	Lower input limit	Upper input limit	Units
0	**0**	**99 000 000**	**10 000units/s²**

You can enter your own acceleration in this MD. An emergency retraction block an thus be made to respond more quickly.
If the value=0, the acceleration is taken from machine data 276* or from the parameter set for acceleration.

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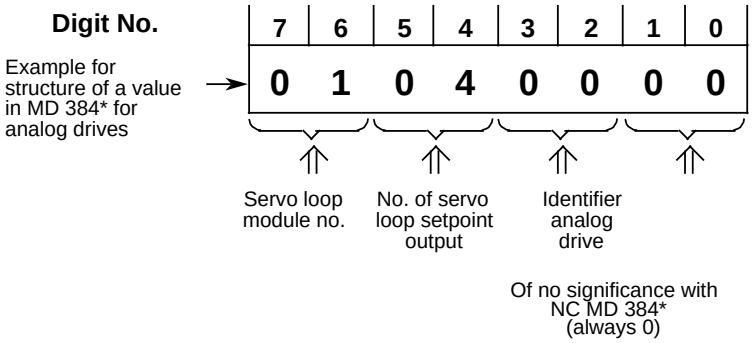
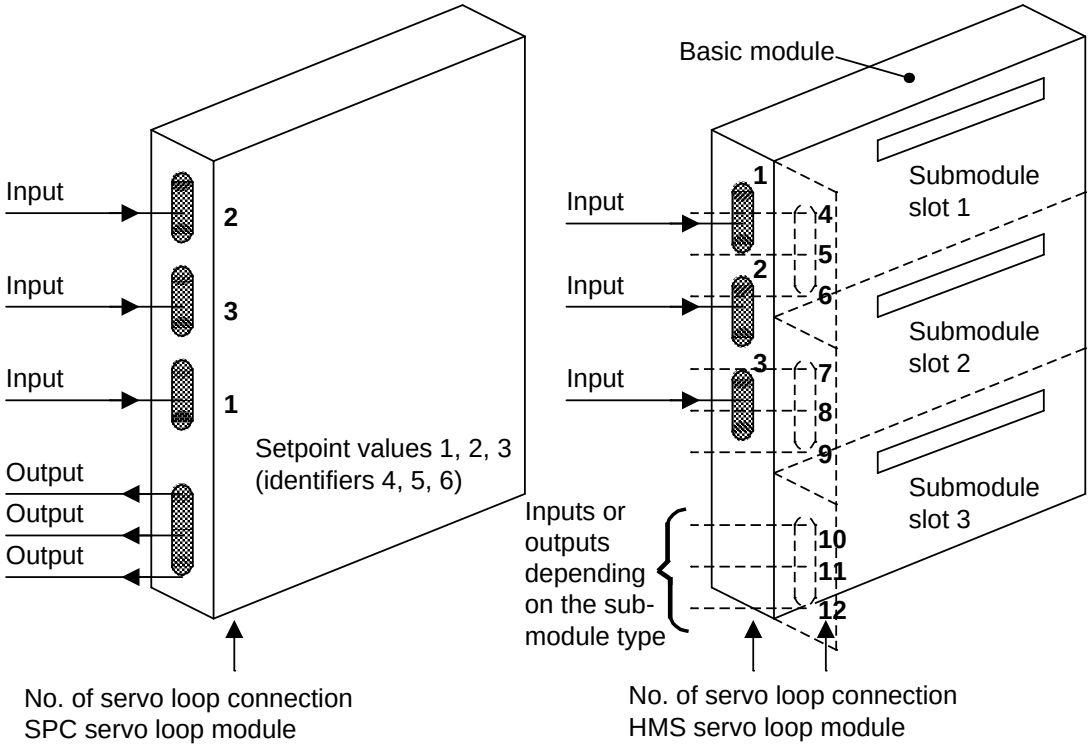
384*	Setpoint output (up to SW 2)		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**05120000**	**–**





MD 384* determines at which servo loop module or which output the axis setpoint values are output (see also NC MD 200*).

Note:

See Section 5, Machine Data Dialog, for the servo loop assignment.

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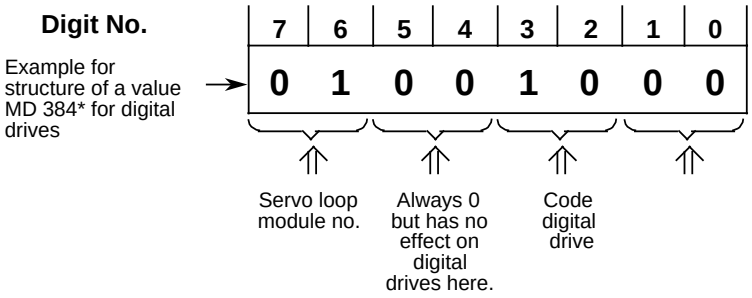
384*	Setpoint output (as from SW 3)		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**15001000 (up to SW 4) 30001000 (as from SW 5)**	**–**



Digit No. 3, 2: Code digital drive

Code 10(-15) assigns the address to 611-D (611-D servo loop or digital setpoint channel).

Codes 1-9, 11-15 are reserved for expansions in the future and are interpreted as for 00 or 10.

The code must be entered by the user.

Digit No. 7, 6: Logical drive number / Servo loop module number

The logical drive number is entered here for digital drives.

Input range (00..15): (up to SW 4)	00: No submodule available 01..15: Logical drive number corresponds to TEA30-MD 10000 ff.
Input range (00..30): (as from SW 5)	00: No submodule available 01..30: Logical drive number

Note:

See Section 5, Machine Data Dialog, for the servo loop assignment.

3840,2-3	Setpoint on digital drive		Active on
Default value	Lower input limit	Upper input limit	Units
0	**0**		

3840,4-5	SPC/HMS setpoint output		Active on
Default value	Lower input limit	Upper input limit	Units
0	**0**	**12**	

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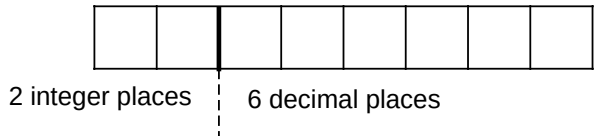
3840,6-7	Drive/servo loop module No.		Active on
Default value	Lower input limit	Upper input limit	Units
0	0	30	

388*	Weighting factor for path conversion		Active on All chan. of mode gr. in STOP
Default value	Lower input limit	Upper input limit	Units
0	+0	99 999 999	–

Hammering or kneading machines are used for manufacturing axially symmetrical parts using a forming process. The design of these machines sometimes necessitates traversing of an X' path although an X path was programmed.

The weighting factor is entered in NC MD 388* and can be anything within the range +0,00001 and+99,999999.

NC MD 388* is evaluated as follows:



(leading zeroes may be omitted)

The value zero is interpreted as weighting factor 1, so that the programmed path and the path to be traversed are identical. The weighting factor of the axis concerned is multiplied by the programmed path to produce the path to be traversed.

Conditions:

a) All other NC MD (in units [IS]) must be entered in the programmed system (X).

b) All other NC MD (in units [MS]) must be entered in the refined system (X').

c) The actual-value display (except in the Service displays), zero offsets, tool offset, PRESET offset, etc., relate to the programmed system.

d) The programmed F value relates to the programmed system.

e) If the programmed or specified speed exceeds the permissible axis speed in the refined system or cannot be converted into the internal computing format, alarm 2031 ("Weighting factor too high") is set and both machining and NC Start inhibited.

f) The weighting factor is effective in **all** modes.

g) The weighting factor is not effective in the case of rotary axes.

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392*	Time constant symmetrizing filter		Active –
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**1 000**	**0.1 ms**

In order to avoid axis overshooting when working with feedforward control, the set part position is fed to the position controller with a time delay. This delay is set with this machine data.

Input value:

= 0 Static feedforward control (e.g. for AC drives with a rise time < position control sampling interval)

0 Dynamic feedforward control (for axes with a rise time > position control sampling interval)

Note:

Normal: $^1/_2$ rise time of drive

As from SW 4, for 8 parameter sets

396*	Absolute offset		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**- 99 999 999**	**99 999 999**	**units (IS)**

Active after POWER ON

The offset is calculated automatically on reference point approach (SIPOS, ENDAT) or can be entered manually without a reference point approach (SIPOS, ENDAT, distance coding).

NC machine data bits 1808* bits 0 to 4 must be taken into consideration. On reference point approach with distance coded reference marks, the offset between the machine zero and the linear scale is entered as the offset. (See Section entitled ”Axis (Analog) and Spindle Installation” for calculation)

Note:

Observe MD 1808, bit 1 ”Value range extension of absolute offset” as from SW 5.

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6.5 Spindle-specific MD (spindle data)

400*	Measuring system connection		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**05031000 15021015 (up to SW 4) 30021015 (as from SW 5)**	**–**

The spindles available on the machine can be allocated to the measuring circuit modules in a flexible way. They are allocated separately according to actual value inputs (MD 400*) and setpoint outputs (MD 460*).

Simulation axes/spindles are defined if no measuring system is parameterized (measuring loop and encoder not entered in MD 200*, MD 400*).

The simulation axis**/**spindle generates partial actual values from the partial setpoints and therefore travels without following error. (For more detailed description see MD 200*).

Note:

See Section 5, Machine Data Dialog, for the servo loop assignment**.**

401*	Spindle drift compensation		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0 2) 0 3)	**–500 –500**	**500 500**	**VELO 2) 0.01% of max. motor speed 3)**

The input value must be modified in the appropriate direction until the spindle exhibits identical actual speeds in both directions of rotation. The value must be adjusted at low speeds, and can be checked by viewing the appropriate information in the Basic display in the service display for spindles (spindles with encoder), using a rev counter, or screening the Service data. In M 19 (spindle positioning), the spindle drift goes directly into the positioning error.

403*-410*	Maximum speed gear stages 1-8		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
see table	**+0**	**99 999**	**rev/min 1)**

Gear	1	2	3	4	5	6	7	8
NC MD	403*	404*	405*	406*	407*	408*	409*	410*
Default	500	1000	2000 4000 4)	4000	4000	4000	4000	4000

NC MD 403* - 410* specify the maximum spindle speed reached in the individual gears at a setpoint of 10 V. When no gear is available, the maximum permissible spindle speed is entered

---

1) The input resolution is 0.1 rev/min, if MD 520 bit 3=1.*

2) Up to SW 2

3) As from SW 3

4) As from SW 4

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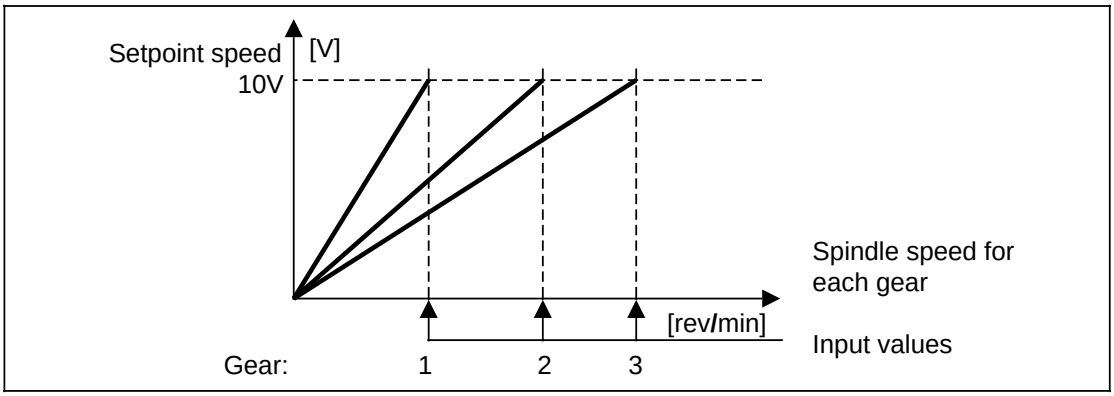
in NC MD 403* and 0 in NC MD 404* to 410*. In the case of gear units with fewer than eight gears, 0 should be entered for the non-existing gears (a value other than 0 for a non-existent gear will cause the spindle to come to standstill).

Gear input signals (see Interface Description Part 2).

Note:

Gear stages not used must be assigned the value zero.



403*-410*	Maximum spindle speed digital (as from SW 3)		Active **at once**
Default value	Lower input limit	Upper input limit	Units
500 - 4 000	**0**	**100 000**	**rev/min or 0.1 rev/min**

With these parameters it is then possible to achieve a very fine adjustment of the set speed ratio (e.g. to the speed ratios of belt drives which are not always precisely known).

411*-418*	Minimum speed gear stages 1-8		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
see table	**+0**	**99 999**	**rev/min 1)**

Assignment

Gear	1	2	3	4	5	6	7	8
NC MD	411*	412*	413*	414*	415*	416*	417*	418*
Default	50	500	1000	2000	2000	2000	2000	2000

By entering the minimum gear speeds, the gear-speed range is defined. On the basis of the programmed spindle speed, the NC can now transfer the required gear and a request signal for a gear change to the PLC. Should the speed ranges for the various gears overlap, the NC choses the appropriate gear on the basis of the fewest number of gear changes required to arrive at the required speed (selection by "Automatic gear selection").

_____

1) The input resolution is 0.1 rev/min, if MD 520 bit 3 = 1.*

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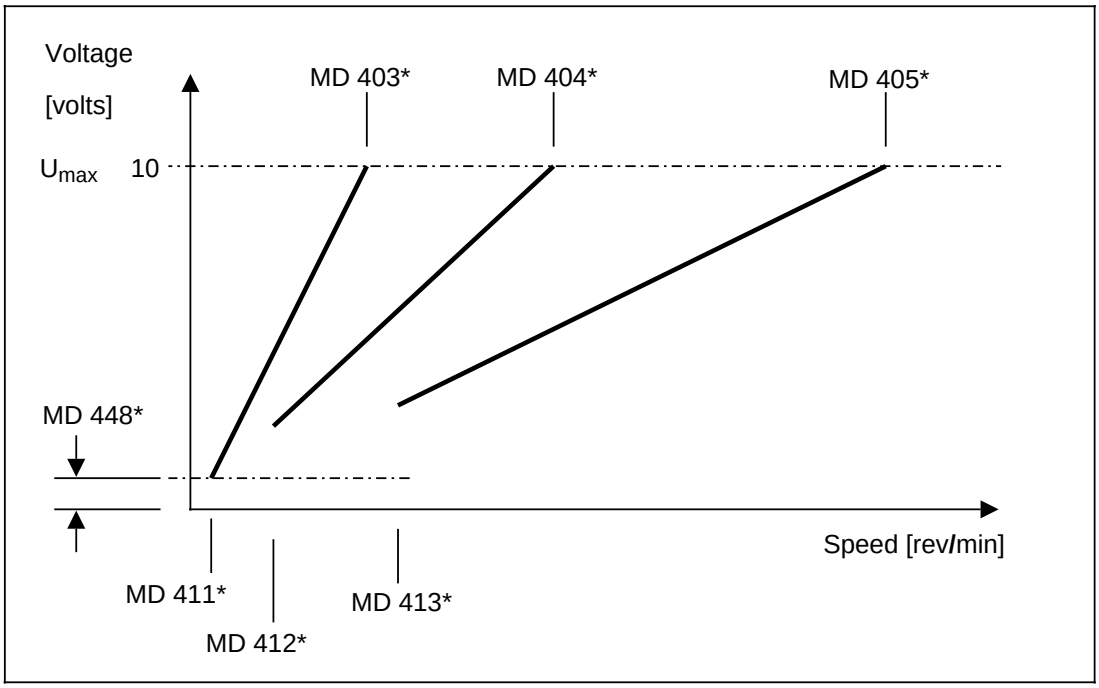

If 3rd gear has been engaged, the new S value must be lower than the contents of MD 413* in order for the NC to initiate a gear change.

U_{max}: maximum setpoint speed voltage (MD 468*)

419*-426*	**Acceleration time constant for eight gears**		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
800	**+0**	**50 000**	**1 ms**

Gear	1	2	3	4	5	6	7	8
NC MD	419*	420*	421*	422*	423*	424*	425*	426*

The control provides the setpoint for acceleration in the form of a ramp that is based on the contents of these MD. The MD thus act as variable ramp-function generators. They are set by measuring the interval from zero speed to maximum speed for each gear. NC MD 419*-426* can be set to zero when the drive actuator is equipped with an integrated ramp-function generator.

Notes:

- There are two acceleration time constants for every stage:
  – Acceleration time constant without position controller (MD 419* to 426*)
  – Acceleration time constant without position controller (MD 478* to 485*)
- In control mode the time constants are used without position control.
  In positioning mode the time constants are used with position control.

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- You can set MD 419* to 426* so that the motor is accelerated to the current limit for a certain time. If a ramp-up generator is built into the actuator, you can set MD 419* to 426* to 0. In this case, the setpoint changes in steps on acceleration and deceleration.
- You must set MD 478* to 485* so that the motor can always follow the setpoint without reaching the current limit. This is especially important in the field weakness area of the motor.
- When braking in M19 mode, the spindle is first decelerated with the acceleration constant in MD 419* to 426* to the creep speed set in MD 427* to 434* and then brought to rest in postion control mode with the acceleration time constant set in MD 478* to 485*.

427*-434*	**Creep speed for M19 gear stages 1-8**		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
100	**+0**	**1 500 16 000 (as from SW 4)**	**1 min[1)]**

Specifies the speed to which the spindle is to be reduced on an oriented spindle stop (M19) and at which travel is to continue until positioning on the basis of the specified position control characteristic (gain factor and acceleration time constant) has been completed (see also Section Axis (Analog) and Spindle Installation).

Assignments

Gear	1	2	3	4	5	6	7	8
NC MD	427*	428*	429*	430*	431*	432*	433*	434*

The creep speed is the limit beyond which no acceleration takes place:

- When positioning from zero speed, acceleration takes place up to or below the creep speed.
- When the spindle is running, the position controller becomes active when the creep speed is reached. The following applies regarding speed control:
  - If the momentary speed is less than creep speed, acceleration takes place up to creep speed. If you do not want this, program S0 before M19.
  - If the momentary speed is greater than the creep speed, the spindle speed is reduced to the creep speed and only then is the position controller activated.

435*-442*	**Gain factor for M19 for eight gears**		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
1 666	**166**	**10 000 80 000 (as from SW 5)**	**0.01 s^{-1}**

Assignments

Gear	1	2	3	4	5	6	7	8
NC MD	435*	436*	437*	438*	439*	440*	441*	442*

1) The input resolution is 0.1 rev/min, if MD 520 bit 3=1.*

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On an oriented spindle stop (M19), the spindle is included in the position control loop. The gain factor is defined by the steepness of the approach to the cutoff position.

If "0" is entered, the position controller loop is broken.

Notes:

The ”actual” gain factor of the gear obtained on the machine depends on several factors :

- Gain factor set for the gear
- Maximum rev**/**min for the gear speed
- Multgain factor (MD 468*)
- Setting of speed controller and drive

443*	**Positional tolerance for M19**		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
2 000	**+0**	**720 000**	**units (MS)**

On an oriented spindle stop (M19), the "SPINDLE POSITION REACHED" signal is output to the PLC over the interface (DB31 DLk bit 4) as soon as the positional deviation is within this tolerance. The positional tolerance is given in terms of position control resolution.

MD 443* has no effect on the positioning accuracy, because the control, in spite of the "Spindle position reached" signal, attempts to approach the specified position with the highest possible accuracy, unless the PLC or the NC aborts the positioning operation prematurely.

The position control for the spindle remains active until the "Acknowledge M19" signal (DB31 DRK+2) has been generated or the "Spindle controller enable" signal is revoked. For position control cancellation, see also NC MD 520* bits 5 and 6. Position control is not cancelled by setting the "Spindle stop" signal (see also Section entitled ”Axis (Analog) and Spindle Installation”).

Note:

As from SW 4, for 8 gear stages

444*	**Spindle speed tolerance**		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
10	**+0**	**100**	**%**

In systems with analog spindle speed and spindle encoder, the difference between actual speed and set speed is determined.

The actual speed is measured by means of the spindle encoders. The PLC is informed over the interface (DB31) of deviations exceeding the tolerance limit of the programmed spindle speed by removal of the "Spindle in set range" signal (DB31 DLk bit 5). This monitoring of the tolerance limit is always in force when a specified setpoint speed causes the spindle to start rotating, i.e. the tolerance is monitored and reported to the PLC even during the acceleration and deceleration phases.

The tolerance (rev**/**min) results from the tolerance (%) entered for the setpoint speed.

(Setpoint speed - tolerance) < actual speed < (setpoint speed + tolerance)
Monitoring is discontinued at 100 %.

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Example

- S value: 1000 rev/min
- Tolerance in MD: 3%

The permissible actual speed range is from 970 rev/min to 1030 rev/min.

445*	Maximum spindle speed tolerance		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
10	**+0**	**100** **10 000 (as from SW 4)**	**%**

In systems with analog spindle speed and spindle encoder, a deviation which extends beyond the maximum speed plus tolerance limit results in generation of the "Speed limit exceeded" signal (DB31 DLk bit 0) and issuance of alarm 2014*. The NC then shuts down spindle and feed for this mode group. The lowest of the maximum spindle speed limits listed below becomes active:

- Maximum gear speed (NC MD 403* - 410*)
- Maximum spindle speed (NC MD 451*)
- For G96: Value in setting data (G92 S...)
- Setting data item for spindle speed limit (G26 S...)

Monitoring is discontinued at 100 %.

446*	Zero speed tolerance		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
100	**+0**	**16 000** **10 000 (as from SW 4)**	**0.01 %**

Unit: 0.01 % of the maximum gear speed

The actual speed is measured in systems with analog spindle speed and spindle encoder. A "Spindle stationary" signal (DB31 DLk bit 3) informs the PLC when the actual speed falls below the zero speed.

Monitoring is discontinued at 100 % (entry in MD 446* ... 10000).

447*	Servo enable cutoff delay		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
1 000	**+0**	**16 000**	**ms**

The enable signal for the speed controller (servo enable) on the measuring circuit is removed when the specified delay time has elapsed. The delay takes effect in the following situations:

- Removal of the "Servo enable" signal
- "EMERGENCY STOP"
- "Response from the measuring-circuit monitor"
- Removal of the "Mode group ready" signal

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448*	Minimum motor setpoint speed		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
3	+0	16 000	rev/min[1)]

NC MD 448* defines the minimum spindle speed. The motor does not fall below this speed, for example, even when the cutting speed is constant and the turning diameter increases. In other words, when the motor reaches the minimum speed defined here, the cutting speed is no longer constant but increases with the turning diameter. Concentric running of the spindle is possible up to this minimum speed.

449*	Basic speed		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
50	+0	99 999	rev/min [1)]

If the PLC activates the "Basic speed" signal (DB31 DRk + 2, bit 5) and switches over to PLC spindle control, a spindle setpoint corresponding to this spindle speed is output, taking into account the gear just selected. Spindle override is active.

450*	Set oscillation speed		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
50	+0	1 000 [2)] 10 000 [3)]	0.01 %

So that you can set the oscillation speed as finely as possible, you enter it in 0.01% of the maximum motor speed, i.e. 10000 (previously 8192) is oscillation at maximum motor speed.

Note

The selection of an oscillating speed does not in itself result in oscillation. This must be brought about with "Set direction of rotation clockwise/counter-clockwise" (DB31 DRk + 2, bit 7).

451*	Maximum spindle speed		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
4 000	+0	99 999	rev/min [1)]

The "Speed limit exceeded" signal and alarm 225* are generated when the maximum spindle speed defined here is exceeded by more than the tolerance limit specified in NC MD 445*.

---

1) The input resolution is 0.1 rev/min, if MD 520 bit 3=1.*
2) Up to SW 2
3) As from SW 3

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452*	Spindle position for external M19		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**35 999**	**0.01°**

If M19 is started by the PLC via the "Position spindle" and "PLC spindle control" signals, the NC positions the spindle to the angle specified in NC MD 452*.

453*	Mode group		Active on **Power On**[1)]
Default value	Lower input limit	Upper input limit	Units
1	**+1**	**+1, 2 6 (as from SW 4)**	**–**

NC MD 453* defines the mode group to which the spindle is to belong.

Mode groups without spindles are permitted.

Note:

Spindles generally only react to the mode group RESET assigned to this MD. The spindle does not stop when a program is aborted with channel reset.

455*	u: Pulses variable increment weighting [2)]		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
32	**0**	**65 000 9999 9999 (as from SW 2)**	**–**

456*	v: Traversing path variable increment weighting [2)]		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
5 625	**0**	**65 000 9999 9999 (as from SW 2)**	**–**

The internal calculations for the spindle are made in the resolution provided by the measuring system (measuring system resolution). In order to be able to carry out the internal conversions to the measuring system resolution, the latter must be entered in MD 456*. As for axes, input is not made via the encoder graduation and pulse multiplication but via variable increment weighting. This makes it possible to use spindle encoders with an arbitrary number of pulses and measuring gear.

Note: as from SW 4

MD 2420* 2421* and 2422* in the MDD are used to automatically calculate MD 455* and 456*.

---

1) Spindles can be allocated to another mode group via the warm restart function without having to execute a hardware reset (for a detailed description of the warm restart function, see Section entitled "Functional Descriptions").

2) MD 455 and 456* are invalid and are not evaluated, if the same measuring system is used for the spindle and C axis. MD 364* and 368* are valid instead.*

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The parameters for defining MD 455* and 456* can be taken from the table below.

Parameter	Symbol	Meaning
Position control resolution	b	Reference unit for traversing path
Pulses per resolution	p	Number of encoder pulses per resolution
Pulse multiplication	f	Pulse multiplication for HMS measuring circuit module; MD 458*
Measuring gear	r1/r2	Gear transmission ratio between spindle and encoder

Parameters for defining MD 455 and 456**

MD 455* = $4 \cdot p \cdot f \cdot r2$ Number of measuring system pulses per encoder revolution including hardware multiplication; multiplied by r2

MD 456* = $\frac{360 \cdot r1}{b}$ Number of internally computed increments per encoder revolution; multiplied by r1

If the values thus calculated are greater than the input limits, common factors **must** be reduced.

Recommendation: Always reduce when possible, at least for values 100 000

Notes

- The position control resolution has been set to 0.5 x 10^{-3} degrees for the spindle.
- If the spindle is allocated to a C axis (MD 461*), the C axis resolution is used for the calculations (MD 1800*, 364*, 368*).
- The default values apply to the use of an SPC servo loop module and an encoder with 1024 pulses per revolution (see Example).

Examples

- Encoder mounted directly on the spindle; square pulse encoder and SPC servo loop module

  b = $0.5 \cdot 10^{-3}$ degrees
  p = 1024 pulses per revolution
  f = 1 no pulse multiplication
  r1 = 1 no measuring gear
  r2 = 1

  If the spindle performs one full revolution, the encoder generates 4 x 1024=4096 pulses.

  If these factors are introduced into the formula:

  MD 4550 = 4 096
  MD 4560 = 720 000

  Reduction by the common factor 128 yields:

  MD 4550 = 32
  MD 4560 = 5625

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- Encoder mounted to the spindle via the measuring gear; SIPOS unconditioned signal encoder and HMS servo loop module
  b = $0.5 \cdot 10^{-3}$ degrees
  p = 2500 pulses per revolution
  f = 8 HMS pulse multiplication
  r1 = 2 2 spindle revolutions correspond to
  r2 = 3 3 encoder revolutions

  If these factors are introduced into the formula then:

  MD 4550 = 240 000
  MD 4560 = 1 444 000

  Reduction by the common factor 240 000 yields:

  MD 4550 = 1
  MD 4560 = 6

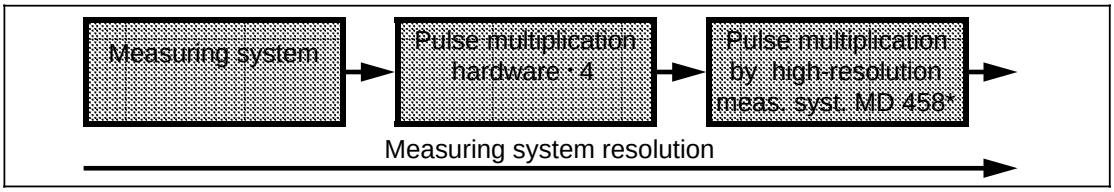
Example

Motor measuring systems as encoder with SIMODRIVE 611-D
G = $0.5 \cdot 10^{-3}$ degrees
p = 2048 pulses per revolution
f = 128 pulse multiplication
r = 1

MD 4550 = 8192
MD 4560 = 5625
MD 458* = 128

458*	**f: Pulse multiplication for EXE/611D/HMS**		Active on **Power On**
Default values	Lower input limit	Upper input limit	Units
1	**0**	**128** **512 (as from SW 3)**	**–**

The measuring system resolution can be adapted to any application using the HMS servo loop module. The pulses arriving from the encoder are multiplied in two steps:



Pulse multiplication for HMS

The following values are permissible for MD 458* when using a HMS servo loop module or 611D:

HMS: 1, 2, 4, 8, 16, 32, 64, 128
611D/PCU: 1, 2, 4, 8, 16, 32, 64, 128, 256, 512

Hence, the attainable maximum is a pulse multiplication by the factor 512.

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Notes

- Machine data 458* is taken into account only when a HMS servo loop module is used.

This MD also has an effect when the measuring system of the digital drive (611-D) is used.

- The multiplication factor must be taken into account for variable increment weighting (MD 455*, 456*).

459*	Zero mark offset		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**-99 999 999 -18 000 2)**	**99 999 999 18 000 2)**	**0.01°**

Using zero mark offset, the spindle angle zero position (e.g. after M19 S0) can be made to differ from the encoder zero mark. The spindle zero position can thus be defined arbitrarily.

In other words, the reference system for the spindle control is offset in relation to the encoder reference system.

Note

- Changes to MD 459* do not take effect until the spindle is resynchronized with the encoder.
- When specifying a positive value in MD 459*, the spindle angle zero position is offset in the direction which corresponds to clockwise rotation (M03).
- If a C axis is assigned to the spindle, axis MD 244* takes effect in C axis mode as soon as the C axis has been referenced.[1)]

Example

MD 4590 = 9 000	Zero mark offset by 90 degrees
`M19 S270 LF`	The spindle is positioned to 270° in the control reference system. As this reference system is offset from the encoder zero mark by 90 degrees, the spindle will thus be on the encoder zero mark.

(see MD 463* for further examples)

460*	Setpoint output (analog)		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**See permissible values**	**–**

MD 460* defines the assignment of the analog setpoint speed to a servo loop module and an output.

---

1) See also Section C axis mode

2) As from SW 4

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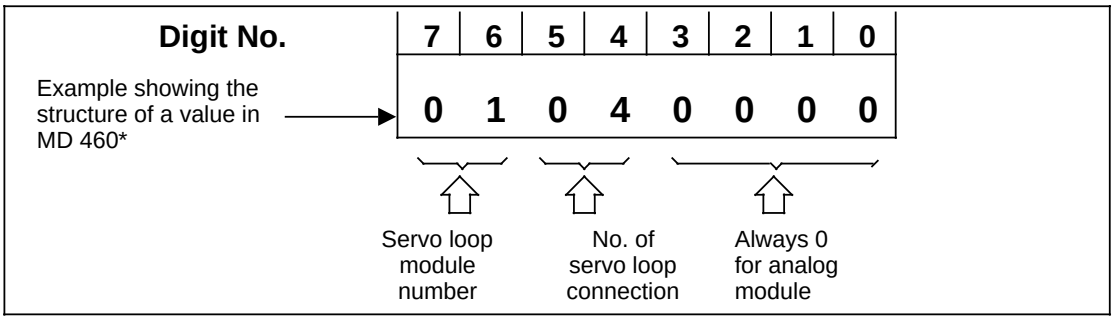

*Structure of MD 460**

Meaning of the individual terms

Digit No. 7, 6 The **servo loop module number** is the number of the module on the servo local bus. The modules are numbered from left to right in ascending order. The far left module has the number 1.

Permissible values: 00 to 5

Digit No. 5, 4 The **number of the servo loop connection** determines the number of the output on the selected HMS or SPC module.

Permissible values: 04 to 06 for SPC servo loop modules
04 to 12 for HMS servo loop modules

Note

- The value ”00 00 00 00” for MD 460* is permissible only if the spindle does not exist for the control (MD 521*, bit 7=0).

460*	**Setpoint output (digital) (as from SW 3)**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**15001000 (up to SW 4)** **30001000 (as from SW 5)**	**–**

Exact description see MD 384*.

Note

See Section 5, Machine Data Dialog, for the servo loop assignment.

4600,2-3	**Setpoint to digital drive**		Active
Default value	Lower input limit	Upper input limit	Units
0			

4600,4-5	**SP/HMS setpoint output No.**		Active
Default value	Lower input limit	Upper input limit	Units
0	**0**	**12**	

4600,6-7	**Drive/servo loop module No.**		Active
Default value	Lower input limit	Upper input limit	Units
0	**0**	**30**	

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461*	Allocated C axis		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0	0	30	–

MD 461* defines which global axis number is used to operate the spindle when it works as C axis. This determines, for instance, which axis-specific machine data block is used.

If the value 0 is entered in MD 461, the spindle cannot be used as a C axis.

Notes

- Any change in MD 461* does not take effect until Power On.
- If a C axis is assigned to a spindle (MD 461* not equal to 0), the internal calculations are also performed for this spindle in the measuring system resolution of the C axis. In the event of an identical measuring system, the variable increment rating of the axis must therefore be entered (MD 364*, 368*, 1800*).

462*	Spindle encoder cutoff frequency		Active on Power On
Default value	Lower input limit	Upper input limit	Units
200	0	16 000	kHz

The cutoff frequency of the spindles's actual value encoder is entered in MD 462*. The cutoff frequency can be taken from the encoder manufacturer's specifications.

Incoming pulses from the encoder may be lost when the cutoff frequency is exceeded. In this case actual value acquisition will not be correct. The signal ”SPINDLE STOPPED” must be evaluated by the drive. The SPINDLE SYNCHRONIZED interface signal is cancelled.

In the case of a repeated drop below the critical frequency, the spindle is automatically resynchronized with the encoder (hysteresis characteristic).

Note

If a separate encoder is not proivided for C axis operation, the limiting frequency of the spindle encoder is again monitored in this operating mode.

463*	Synchronous position offset		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0	-179.99	180.00	0.01°

465*	Feedforward control factor		Active –
Default value	Lower input limit	Upper input limit	Units
0	0	1 000	0.1 %

Active: During position controlled operation (M19)

The feedforward control is used to reduce the following error.

In feedforward control the partial setpoint is multiplied by the feedforward control factor and switched directly to the spindle speed control input. The time constant entered in MD 467* is switched to the input of the position controller directly, if it is static feedforward control, and delayed by a PT 1 element, if it is dynamic feedforward control.

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To activate feedforward control set option (6FC5 150-0AS02-0AA0). [1)]

The feedforward control factor is adapted to the machine stability and the resulting acceleration**/**deceleration of the spindle. The degree to which the following error is reduced depends on the feedforward factor.

A factor of 1000 reduces the following error almost to zero in the stationary state. However, this setting will cause overshooting. If this is a problem you can enter a lower value and enter the time constant in MD 467*.

See Section entitled ”Functional Descriptions”.

Note:

As from SW 4, for 8 gear stages

466*	**Position controller clock pulse spindle**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
1	**1**	**64**	**Multiple of position controller basic clock pulse**

Active: During position controlled operation (M19)

The number of axes and spindles can be increased by increasing the position control sampling interval. Such increase will, however, impair the results produced by the controller. See ”Axes” for advantage.

The spindle-specific position controller sampling interval T_{LS} is

T_{LS}=MD 155 · MD 168 · MD 466*

Notes

- The position control sampling interval must be in an integer ratio to the selected interpolation clock pulse (MD 155).
- If a C axis is assigned to the spindle via MD 461*, the position controller clock pulses of spindle and C axis must coincide. The position controller clock pulse for the C axis is set in MD 155, MD 160, MD 168, MD 1396*.

Permissible values:

1, 2, 4, 8, 16, 32, 64

467*	**Time constant feedforward control**		Active **–**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**9 999** **1 000 (as from SW 4)**	**0.1 ms**

Active: During position controlled operation (M19)

To avoid overshooting on spindles with feedforward control, insert a delay between the partial setpoint and the position controller. This delay is set with this machine data.

---

1) The feed forward control can be switched off via PLC MD as from SW 2.

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Input value:

=0 static feedforward control (e.g. for AC drives with rise time<position control scan time)

0 dynamic feedforward control (for spindles with rise time>position control scan time)
The time constant for setpoint smoothing is only injected into the setpoint branch when feedforward control (option) is active.

Note

Normal: $^1I_2$ rise time of the drive
As from SW 4, for 8 gear stages

468*	**Scaling factor max. speed setpoint**		Active in **all channels of the mode group in STOP**
Default value	Lower input limit	Upper input limit	Units
10 000 1) **10 000 2)** **9 000 3)**	**0** **0**	**32 000 1)** **20 000 2)** **32 000 3)**	**mV 1)** **0.1 % of max. setpoint 2)**

Like the axis-specific scaling factor of the maximum speed setpoint value (MD 260*), the spindle-specific scaling factor is used for the digital tachogenerator matching.

If U_{max} is the speed setpoint voltage at maximum motor speed, then:

Speed setpoint= Umax v [V]

Example: U_{max}= 8.345 V
Speed setpoint= 8 345

469*	**Factor for gain switchover**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**1**	**16 000**	**%**

In positioning mode, the spindle must be under position control in its target position. In order to ensure steady rest of the spindle even in the case of drift, extremely low setpoint speeds with a very high resolution must be fed to the drive actuator via the analog interface.

With some drive actuators it is therefore possible to choose a different scaling of the setpoint speeds by applying a configurable terminal signal.

Allowance must be made in the control for this change of scaling in the drive actuator so that the overall effective gain factor remains unchanged. To achieve this, the amplification factor (gear independent, MD 435* to 442*) must be matched to the new scaling.

The factor for gain switchover is

MD 469* = $\frac{1}{N}$ N being the scaling factor in the drive actuator

Notes

- Switchover of the gain factor is activated by setting the SWITCHOVER GAIN FACTOR interface signal. This signal must always be set together with the terminal signal.
- Entering the value 0 in MD 469* is equivalent to inputting the value 100. In neither of the two cases is the gain factor specified in MD 435* to 442* changed.

1) Up to SW 2
2) As from SW 3
2) As from SW 4

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478*-485*	Acceleration time constant with position controller gears 1-8		Active on **Power On**
Default value	Lower input limit	Upper input limit	
2 000	**0**	**50 000**	**1 ms**

Assignments

Gear	1	2	3	4	5	6	7	8
NC MD	478*	479*	480*	481*	482*	483*	484*	485*

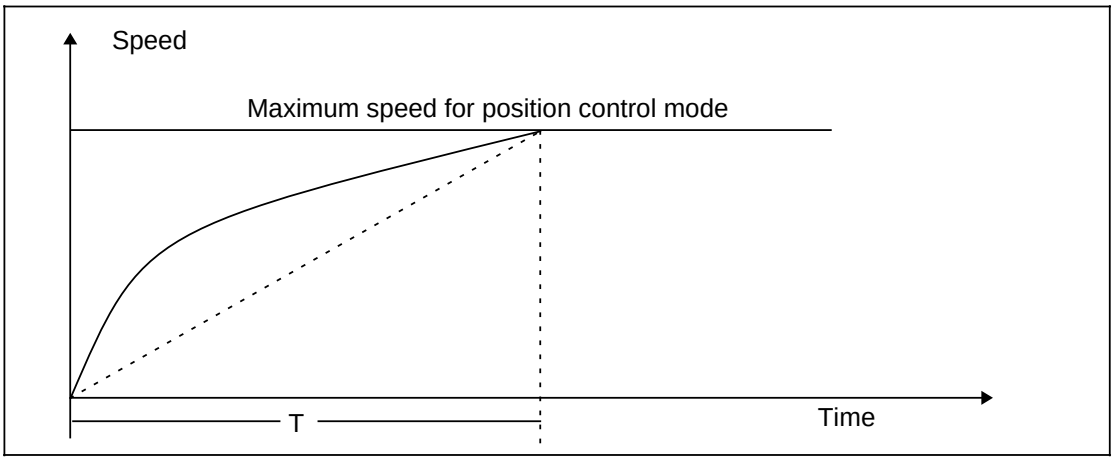
The control issues the ramp-form setpoints for acceleration and braking operations (ramp function generator). The gradient of this ramp is determined by the acceleration time constant.

Notes

- Two acceleration time constants are provided for each gear ratio:
  – Acceleration time constant without position controller (MD 419* to 426*)
  – Acceleration time constant with position controller (MD 478* to 485*)

  The time constants without position controller are used for the open-loop control mode, the time constants with position controller for the position mode.
- MD 478* to 485* must be set such that the motor can follow the specified setpoints at any one time without reaching the current limit. Particular care should be taken be taken that this is also the case in the field weakening range.
- The data in 478* to 485* should always be greater than the data in 419* to 426*.
- You can set MD 419* to 426* so that the motor is accelerated to the current limit for a certain time. If a ramp-up generator is built into the actuator, you can set MD 419* to 426* to 0. In this case, the setpoint changes in steps on acceleration and deceleration.

Calculation of the permissible acceleration in position controlled spindle operation.



Development of spindle speed in controlled mode at the acceleration limit (M3/M4)

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The set acceleration must not exceed the available acceleration reserves of the drive in position control mode as this will result in large system deviations which are too high and which will cause the drive to come to a standstill (with alarms 156*, 116*, 2014*).

In the parameterization of the maximum acceleration MD 478* of asynchronous main spindle drive, please make sure that the available driving torque is reduced above the field weakening range.

The run-up time of the drive must be measured against the set spindle maximum speed to work out the possible setting values.

MD 478* is calculated from the measured run-up time according to the following example:

- Measure the minimum possible run-up time against the maximum spindle speed:
  Select spindle mode, switch over gears if necessary
  Set MD 419* for the gear state to 0 or to the minimum permissible value
  M3**/**4 to the set maximum speed Nmax, e.g. 2000 rev**/**min
  Measure the run-up time T according to the diagram
- The measured time can be entered directly into MD 478* and following. In so doing, a certain reserve (10-50%) should be added to the measured value according to the expected load.

486*	**Time constant setpoint filter (as from SW 2)**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
55	**0**	**1 000** **16 000 (as from SW 4)**	**0.1 ms**

Active: Immediately

The feed forward control parameter ”Time constant setpoint filter” is necessary in order to also enable all the functions of dynamic feed forward control for the spindles.

The time constant is used to match the behaviour against time of the defined setpoint to the dynamics of the drive.

When axes and spindles are linked, e.g., with ELG or synchronous spindle mode, the drives involved must be set to the same dynamic response. The machine data in this case can be altered to any values up to 0. The optimum setting for normal spindle modes is the standard setting in the table above.

Note: As from SW 4, for 8 gear stages

487*	**P component compensatory controller 1)**		Active on **Reset**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**16 000**	**1**

Note: As from SW 4, for 8 gear stages

488*	**I component compensatory controller 1)**		Active on **Reset**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**16 000**	**1**

Note: As from SW 4, for 8 gear stages

1) As from SW 3

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489*	D component compensatory controller 1)		Active on Reset
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	1

These machine data are only used for the functionality "Electronic gearbox".

Together with the built-in test function (activated with NC MD 525*, bit 5), these machine data can be used to set the control response of the PID compensatory controller.

A more detailed description of this function is to be found in the functional description for the electronic gearbox.

Note: As from SW 4, for 8 gear stages

490*	Time constant parallel model 1)		Active on Reset
Default value	Lower input limit	Upper input limit	Units
6 000	0	16 000	0.01 ms

This machine data is only used for the functionality "Electronic gearbox".

The parallel model must be set to the time constant of the position control loop of the following spindle (time constant T = 1/servo gain).

If the value 16000 is entered in the machine data, the system automatically calculates the actual servo gain factor and the time constant of the following spindle. However, this actual servo gain factor is only stored internally, it cannot be looked at.

The value 16000 entered for the time constant is also automatically replaced by the value derived by the control.

Note: As from SW 4, for 8 gear stages

491*	Tolerance range synchronism fine 1)		Active on Reset
Default value	Lower input limit	Upper input limit	Units
40	0	16 000 99999999 (SW5.4 and higher)	1 unit (MS)

Same description as for MD 492*
Note: As from SW 4, for 8 gear stages

492*	Tolerance range synchronism coarse 1)		Active on Reset
Default value	Lower input limit	Upper input limit	Units
100	0	16 000 99999999 (SW5.4 and higher)	1 unit (MS)

This machine data is only used for the functionality "Electronic gearbox".

During LINK ACTIVE, the positional difference of the following spindle compared with the leading axes/spindles is monitored by the tolerance range "Synchronism fine" and "Synchronism coarse". If the positional difference is greater than the tolerance range, then the corresponding PLC interface signal SYNCHRONISM FINE OR SYNCHRONISM COARSE is set to 0 signal. With this interface signal it is therefore possible to determine the positional synchronism of the following spindle.

More detailed information is given in the functional description for the electronic gearbox.

Note: As from SW 4, for 8 gear stages

---

1) As from SW 3

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493*	Emergency retraction threshold 1)		Active on Reset
Default value	Lower input limit	Upper input limit	Units
400	0	16 000 99999999 (SW5.4 and higher)	1 unit (MS)

This machine data is only used for the functionality "Electronic gearbox".

With LINK ACTIVE, the positional difference between the following spindle and the leading axes/spindles can be monitored with the machine data value "Emergency retraction threshold". The emergency retraction monitoring must be enabled by setting an interface signal.

If the positional difference exceeds this threshold value, it can be output very quickly via a digital hardware signal. An NC alarm ("Following axis emergency retraction") and the PLC interface signal EMERGENCY RETRACTION ACTIVE are also set.

The MIXED I/O module must be in use in the servo area to achieve a very fast signal "Emergency retraction" (in the positional control cycle).

More detailed information is given in the functional description for the electronic gearbox.

Note:

As from SW 4, for 8 gear stages

494*	Warning threshold n_{max} and a_{max} 1)		Active on Reset
Default value	Lower input limit	Upper input limit	Units
90	0	100	%

Every spindle is limited to a maximum acceleration and a maximum speed (NC MD 478* - 485*).

In addition, in both cases the following spindle is checked against a warning threshold. The warning threshold is defined in this machine data and applies to both the speed threshold and the acceleration threshold. The warning threshold is entered as a percentage of the maximum value in question.

If the calculated setpoint speed/setpoint acceleration of the following spindle is greater than the defined values, the corresponding interface signals are set at the PLC interface.

More detailed information is given in the functional descriptions for the electronic gearbox.

495*	Delay controlled follow-up 1)		Active on Reset
Default value	Lower input limit	Upper input limit	Units
16000	0	16000	1 (ms)

If a fault occurs with the leading axes/spindles, the following spindle goes into follow-up mode, i.e. traverses with actual values as the control value (see the functional description for the electronic gearbox, "Maintenance of link during faults"). After the delay shown above, the following spindle switches from "controlled follow-up" to "normal follow-up" (follow-up mode).

1) As from SW 3

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Effect of the input values (different cases):

0:	No controlled follow-up; immediate normal follow-up
1...15000:	Initial controlled follow-up; switchover to normal follow-up after the delay
15001 and higher:	Always controlled follow-up; no switchover to normal follow-up

496*	**Default setting link type 1)**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**1**	**3 1) 4 2)**	**–**

This machine data only applies to leading spindles.

Type of coupling:

0 No default
1 Setpoint position coupling with compensatory controller
2 Actual position coupling with compensatory controller; actual values of leading axis**/**leading spindle are used for the compensatory control and monitoring.
3 Setpoint position coupling with simulated actual values of the leading axis/leading spindle; the compensatory controller only reacts to following spindle or other leading axis/leading spindle faults.
4 Actual position coupling**/**setpoint speed coupling 2)

The machine data is used for two applications.

Application:
A gearbox grouping can be configured with the G401 command. If the type of coupling has not been defined in the G401 command, the default value from MD 496* is taken.

Example:

G401 S1 S2 S1: Leading spindle, S2: Following spindle, no coupling type.

If "No default" (MD 496* = 0) has been entered and no coupling type has been entered in G401, reset alarm "GI CONFIGURATION illegal" is triggered.

1) As from SW 3
2) As from SW 4

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6.6 Machine data bits

6.6.1 General MD bits (general bits)

NC MD	Bit No. 7	6	5	4	3	2	1	0
5000					Name of radius and chamfer			
5001					Name of the angle			

Default value		
MD	**840C (T)**	**840C (M)**
5000	0000 0100	0000 0110
5001	0000 0011	0000 0011

Name of **radius** and **chamfer** for:

- Contour definition
- Circular-path programming
- Polar coordinates
- Name for approach path with soft approach and exit contour (G147, G247, G347, G48, G148, G248, G348)

Name of angle for:

- Contour definition
- Polar coordinates

3	2	1	0

Bit-No.

Address name

Code:

X = 0000
Y = 0001
Z = 0010
A = 0011
B = 0100
C = 0101
U = 0110
V = 0111
W = 1000
Q = 1001
E = 1010

Examples:
0100 = B
0110 = U

Valid names for axes, angles, chamfer and radius

A *Assignable address*	N Subordinate block
B *Assignable address*	O Danger of confusion with 0 (zero)
C *Assignable address*	P No. of subroutine passes
D Tool offset	***Q*** *Assignable address*
E *Assignable address*	R Arithmetic parameter
F Feed	S Spindle speed, S function
G G function	T Tool
H H function	***U*** *Assignable address*
I Interpolation parameter	***V*** *Assignable address*
J Interpolation parameter	***W*** *Assignable address*
K Interpolation parameter	***X*** *Assignable address*
L Subprogram (subroutine)	***Y*** *Assignable address*
M M function	***Z*** *Assignable address*

The names in MD 5000, MD 5001 and 568* must not overlap. An identical axis name with different extended address is not regarded as overlap.

Note:

If the value 0 (≙ address name X) is entered in MD 5000/5001, the programmed dwell time must not be programmed in G04 X... .
Remedy: Program dwell under G04 F... .

Active: In next block.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5002	Input resolution							

Possible combinations

See table for MD 18 000

Default value: 01000000

For combinations with display resolution (NC MD 1800*) and position control resolution (NC MD 1800*).

Active on: NCK Power On

The **input resolution** (IS) defines the incremental weighting for entering and displaying values.

At the same time the initial setting G70 (inches) or G71 (mm) is defined.

MD 5002, Input resolution

metric

Bit	7	6	5	4	mm/ degrees
	--	--	--	--	10^{-1}
	1	0	0	0	10^{-2}
	0	1	0	0	10^{-3}
	0	0	1	0	10^{-4}
	1	0	1	0	10^{-5}
	--	--	--	--	10^{-6}

Bit	7	6	5	4	inch/ degrees
	--	--	--	--	10^{-1}
	--	--	--	--	10^{-2}
	0	1	0	1	10^{-3}
	1	1	0	1	10^{-4}
	1	0	1	1	10^{-5}
	0	1	1	1	10^{-6}

All linear axes **and** rotary axes of the control can be defined with an axis-specific position control and display resolution. The input resolution and the resulting geometrical resolution (used for programming, TO, ZO, interpolation...) is defined once for the whole control (detail description see Section entitled ”Axis (Analog) and Spindle Installation”).

With these axis-specific resolutions (detailed description see Section entitled ”Axis (Analog) and Spindle Installation”) the demands of the machine regarding
- maximum velocity
- varying precision
- maximum traversing range

can be optimally met.

Input resolution NC MD 5002 bit 4 to 7
Axis-specific display resolution NC MD 1800* bit 4 to 7
Axis-specific position control resolution NC MD 1800* bit 0 to 3

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5003	No de-celeration at limit switch	Working area limitation in force in JOG mode	Interpol. params dependent on G91/G90	Polar coord. angle de-pendent on G91/G90	Do not clear PRESET OFFSET on POWER ON	Auxiliary function output before travel	Internal WAIT mark synchroni-zation (as from SW 5.6)	No NC STOP in dwell block G04S.../G1 4/G24 (as from SW 5.4)

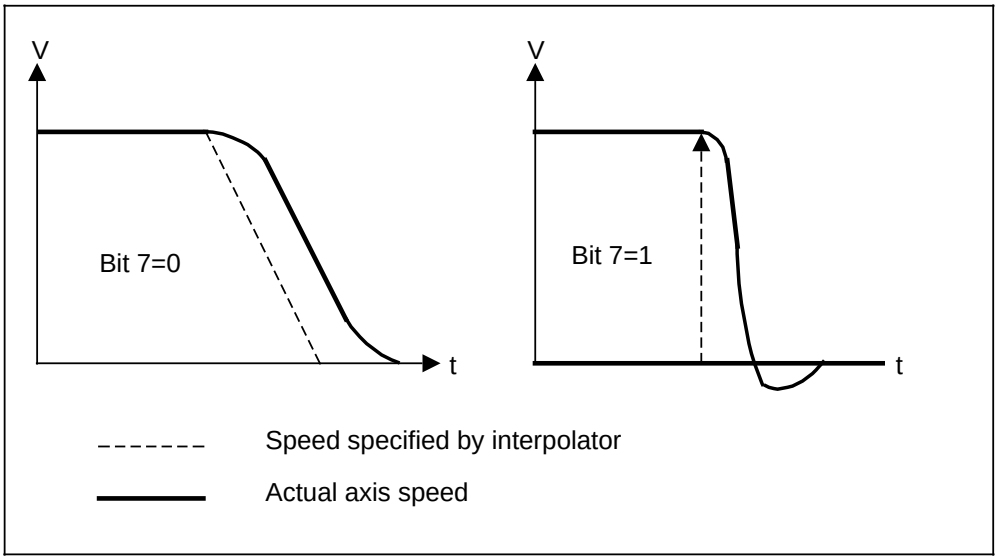
Default value: 0000 0100

Bit 7 No deceleration on reaching the software limit switch. When this bit is set, braking does not follow the acceleration/deceleration curve; only the following error is suppressed. The limit switch is not overrun to any great extent (also see NC MD 1100*).

Active: NC Stop

Note

In the case of interpolating axes, all axes are stopped when the range limit of an axis is reached. Stopping without a contour violation, however, is guaranteed only when bit 7 of MD 5003 is not set (no deceleration at limit switch), i.e. deceleration takes place over the acceleration ramp.



Bit 6 The working area limitation is also effective in JOG mode. In addition to the software limit switches, the working area can therefore be limited in JOG mode, thereby better safeguarding the machine against unintentional travel. However, since a working area limitation is a software limitation, proper operation can only be ensured following reference point approach.

Active: NC Stop

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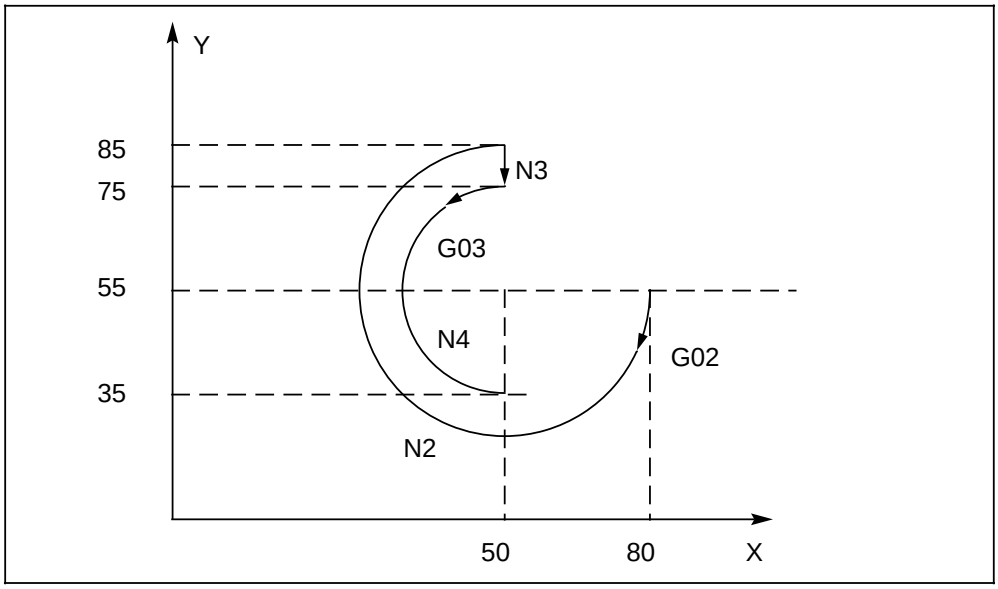
Bit 5 When bit 5 is set, the interpolation parameters (I, J, K) can be programmed either as absolutes (G90) or as increments (G91) in the block (also see NC MD 5007, bit 5). The interpolation parameters for contour definitions (blueprint programming) must always be specified incrementally (G91), regardless of whether bit 5 is set or not.

Active: In the next block

Example:

```
N1  G0  G90  X80  Y55  F500  LF
N2  G02  X50  Y85  I50  J55  F500  LF
N3  G01  X50  Y75  LF
N4  G03  X50  Y35  I50  J55  LF
N5  M30  LF
```

When the interpolation parameters are specified as absolutes, the centre point of the circle refers to the centre point of the workpiece and not the starting point of the circular path of the circle.



If an interpolation parameter was not programmed because it was "0", the G function, which also precedes the programmed interpolation parameter, also refers to the interpolation parameter that was not programmed.

Example:

`G02  X50  Y60  G91  I..`	J = 0 need not be programmed. G91 refers to both I and to the non-programmed J.
`G02  X50  Y60  G90  I..`	J = 0 need not be programmed. In this case, G90 lies in the workpiece centre point. Circle end position error is displayed (alarm 2048).

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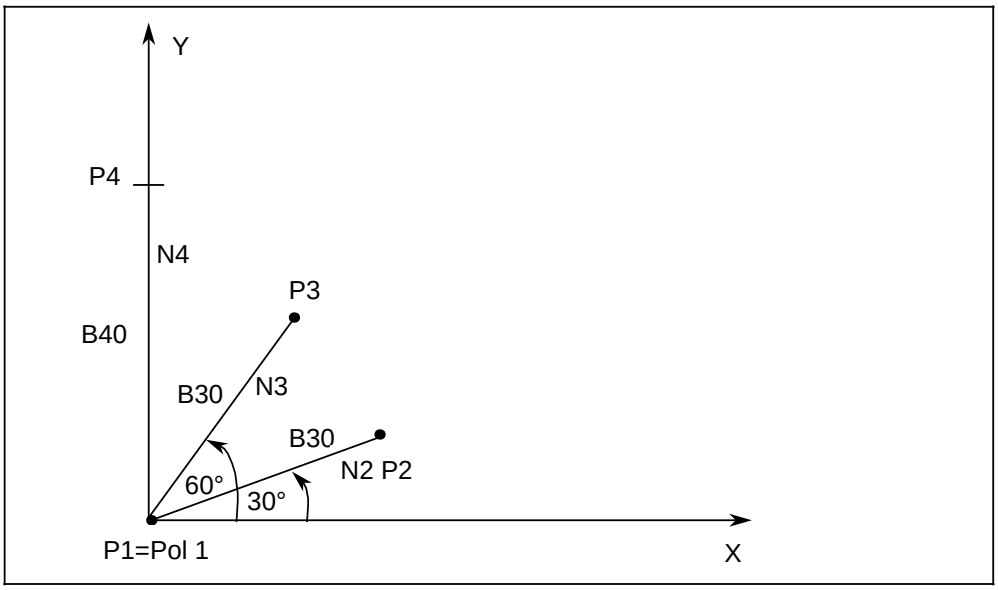
Bit 4 When bit 4 is set, the polar coordinate angles (G10, G11, G12, G13) can be programmed as either absolutes (G90) or increments (G91) in the block (also see NC MD 5007, bit 5).

Active: In the next block

Example:

```
N1  G0  G90  X0  Y0  LF                          (approach P1)
N2  G11  X0  Y0  A30  B30  F500  LF               (define Pol1 and traverse to P2)
N3  G91  A30  LF                                  (Pol1 is maintained, exit P2)
N4  A30  B40  LF                                  (Pol1 is maintained, traverse to P3)
N5  M30  LF                                       (traverse from P3 to P4)
```



Bit 3 **Bit 3 = 1:** The old "PRESET OFFSET" is automatically retained following Power On and reference point approach.

Active: NC Stop

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Bit 2 **Bit 2 = 0**, **Auxiliary function output during axis movement**

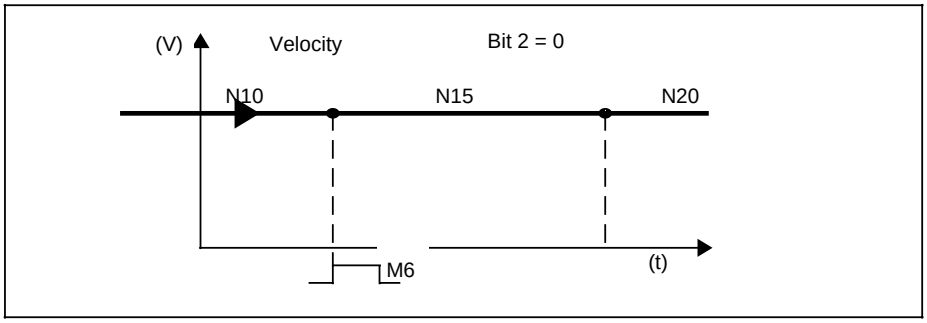
Bit 2 = 1, Auxiliary function output prior to travel

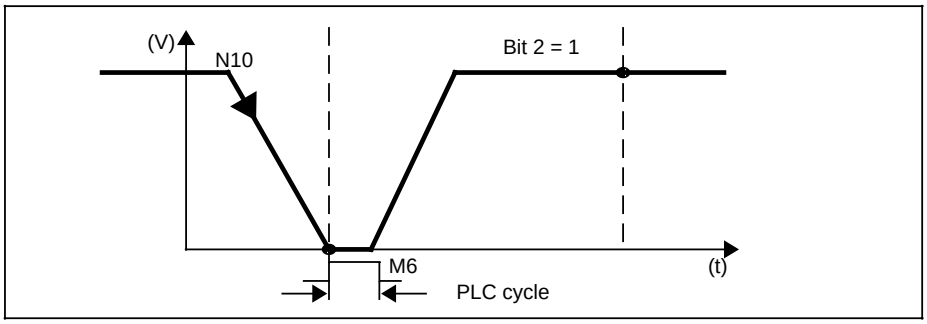
Active: NC Stop

If an auxiliary function (M, S, T, H, D) is also programmed in a traversing block, **bit 2** can bring about the following two states:

Example:

```
N10
N15  M6  X100  LF
N20
```





Bit 1=1 If the bit is set, the internal WAIT mark synchronization is active.

Bit 1=0 WAIT mark synchronization via PLC

Active: NC STOP

Note:

Observe the internal WAIT MARK SYNCHRONIZATION DB 10-15 DL 15.8 interface signal as from SW 6.3

Bit 0=1 No NC STOP in dwell block G04 S.../G14/G24. NC STOP is not active in these blocks, but only at the end of the block.

Bit 0=0 NC STOP is immediately active; the dwell time and thus the block are aborted completely. The next block is started with NC START.

Active: NC STOP

Note
A dwell time with G04 x..., G04 F... is always aborted by NC STOP.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5004	Var. increment for DRF (as from SW 6)	Mode group spec. single block, type B	Mode group spec. single block, type A	Own rapid traverse override	NC Start without ref.point all axes		2nd handwheel available	1st handwheel available

Default value: All 0

Bit 7 **Bit 7=0** (Default) The DRF increment is equal to 1.

Bit 7=1 This activates the function ”Variable increment for DRF offset”. The value in the ”INC variable” setting data is activated as the DRF increment.

Active: Immediately

Bit 6 The first channel to process a block sets the remaining channels in the same mode group to STOP. The axes that were halted are put into motion on the next Start. The channel that initiated the Stop begins with the next block. Type B single block.

Active: In the next block

Bit 5 The next NC Start is effective only when all channels in the same mode group have processed their blocks and the axes are at a standstill. Type A single block.

Active: In the next block

Bit 4 **Bit 4=0** Feed override effective for rapid

Bit 4=1 Own rapid override via DB 10-13 DR1 effective for rapid

Override is activated by selecting the appropriate softkey and FB 78 or DB 10 ... 13 DR 1 bit 5

Bit 3 The PLC signal "NC START" (DB 10-17 DR2 bit 0) initiates a program start, even if the reference points have not been approached, at least not for all axes, i.e. the feed axes have not been synchronized with the machine position. MD 560* bit 4 is irrelevant in this case. In order to ensure correct workpiece machining, synchronization must be carried out in another form, such as through use of the scratch method.

Active: NC Stop

Bit 1,0 The number of available handwheels is specified as follows:

Active: NC Stop

Bit	1	0
One handwheel	0	1
Two handwheels	1	1

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5005	Keyswitch group (configurable)			KEYSWITCH effective for: Position 1-3 ZO fine	ZO coarse R param. angle of rot.	TO wear	TO geometry	

Default value: All 0

Bit 7 to 5 Configured data blocks can be inhibited via keyswitch by setting these bits (see also WS 800A description).

Bit 4 to 1 The keyswitch can be used to prevent the entry or modification over the NC operator panel of the following data by setting the corresponding bit(s):

Bit 4 Zero offset (G54 - G57) fine
Bit 3 R parameters angle of rotation zero offset (G54 - G57) coarse
Bit 2 TO wear (parameters P5 to P7)
Bit 1 TO geometry

Bits 2 and 1 are effective only when the standard display for tool offsets (P0 ÷ 9) is not modified in any way. When configuring tool offsets, the keyswitch group (bits 5 to 7) for the data fields (P0 to Pxy) must also be configured via the NC workstation (WS 800A). Bits 1 and 2 can only be set together or not at all.

Active: At once

NC MD	Bit No. 7	6	5	4	3	2	1	0
5006		Axis/ spindle converter (as from SW 2)		KEYSWITCH effective for: ELG program-ming via [1] input display	PP manual input	Dry run feedrate	DRF	OVER-STORE

Default value: All 0
Active: Immediately

Bit 6 to 0 Entry or modification of the following data over the NC operator panel can be inhibited via the keylock switch by setting the corresponding NC MD bit(s).

Active: At once

Bit 6=0 Input not possible.

Bit 6=1 Input via keyswitch setting 1, 2 and 3 possible.

1) As from SW 3

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Bit 4 Keyswitch lock for input disable GI

Bit 4=1 Keyswitch setting=0: not possible to program gear interpolation (ELG) via input display.

Keyswitch setting 0: programming of gear interpolation (ELG) via input display possible.

Bit 4=0 Keyswitch locking not possible.

Active: immediately

Bit 3 Input of part programs over the operator panel (EDIT, INPUT, CANCEL)

Bit 2 To select dry run feedrate (DRY RUN)

Bit 1 When traversing via handwheel in Automatic mode (DRF function)

Bit 0 Entry of H, S, M, T and D functions in OVERSTORE submode

NC MD	Bit No. 7	6	5	4	3	2	1	0
5007	TO in diameter	Do not include tool wear	Mixed programming G90/91 in block		Tool basic dimension active	No output of M17	G53 as @706	Length compensation for non-programmed axes

Default value: 0000 0100
Active for all bits: In the next block

Bit 7 **Bit 7 = 0** The cutter (tool parameter P1 = 20) is defined as length (P2) and radius (P4). Consider also NC MD 5008, bit 4.

Bit 7 = 1 The cutter is defined as length and diameter. The cutter radius is always over radius.

Bit 6 This bit can be used to declare all tool wear data invalid. The tool wear data (P5 to P7) are thus available for user-specific purposes. A value can be added to or subtracted from the tool geometry data using the "EDIT" key.

Bit 5 In a part program, the manner in which programmed values are to be interpreted, i.e. whether they are to be regarded as absolute (G90) or incremental (G91) values, always relates to a whole block (up to LF). Setting bit 5 to 1 makes it possible to define how each separate programmed value of an axis is to be interpreted as absolute (G90) or increment (G91) (for further details on interpolation parameters and angles see NC MD 5003, bits 4 and 5).
Whether he programmed zero offsets G58/G59 are calculated absolutely or additively also depends on the setting of bit 5.

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Note:

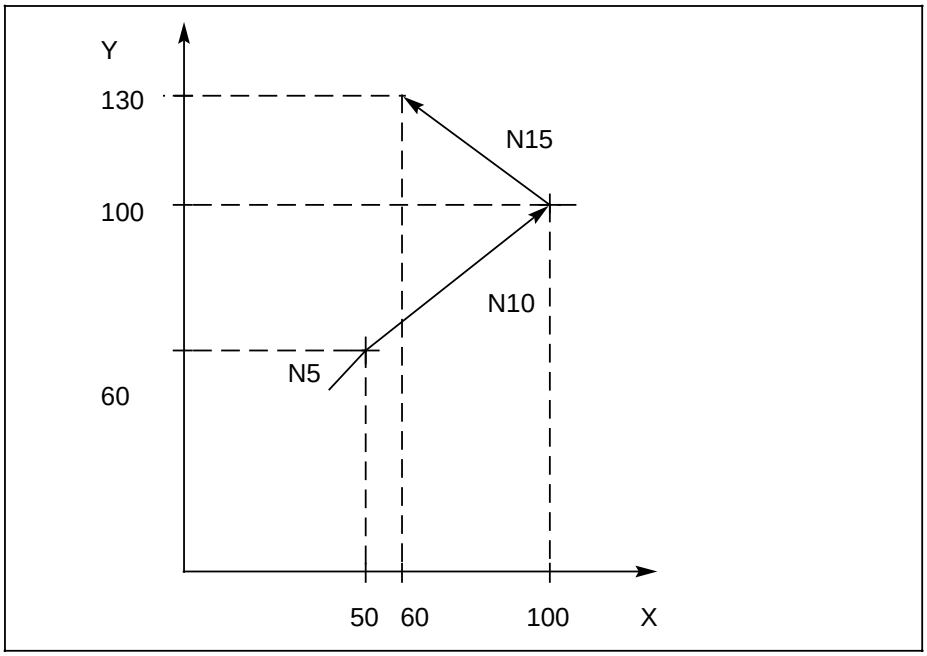
If the MD bit is not set, the last function to be programmed in the block is active.

Example:

G58 X... G91 X50... G90 Y100

added incrementally to previous G58 X... value	new absolute entry of Y value (Y = 100)

Example: Mixed programming G90/91 in one block




```
N5   G01  X50  Y60  F500  LF
N10  G91  X50  Y40  LF
N15  G90  X60  G91  Y30  LF
N20  M30  LF
```

Bit 3 The tool offset can be extended by 2 additional tool offset parameters (P8, P9) (see also Programming Guide).

Bit 2 **Bit 2 = 0** SUBROUTINE END (M17) is sent to the PLC as an M function.

Bit 2 = 1 SUBROUTINE END is only active NC internal (subroutine return jump fast).

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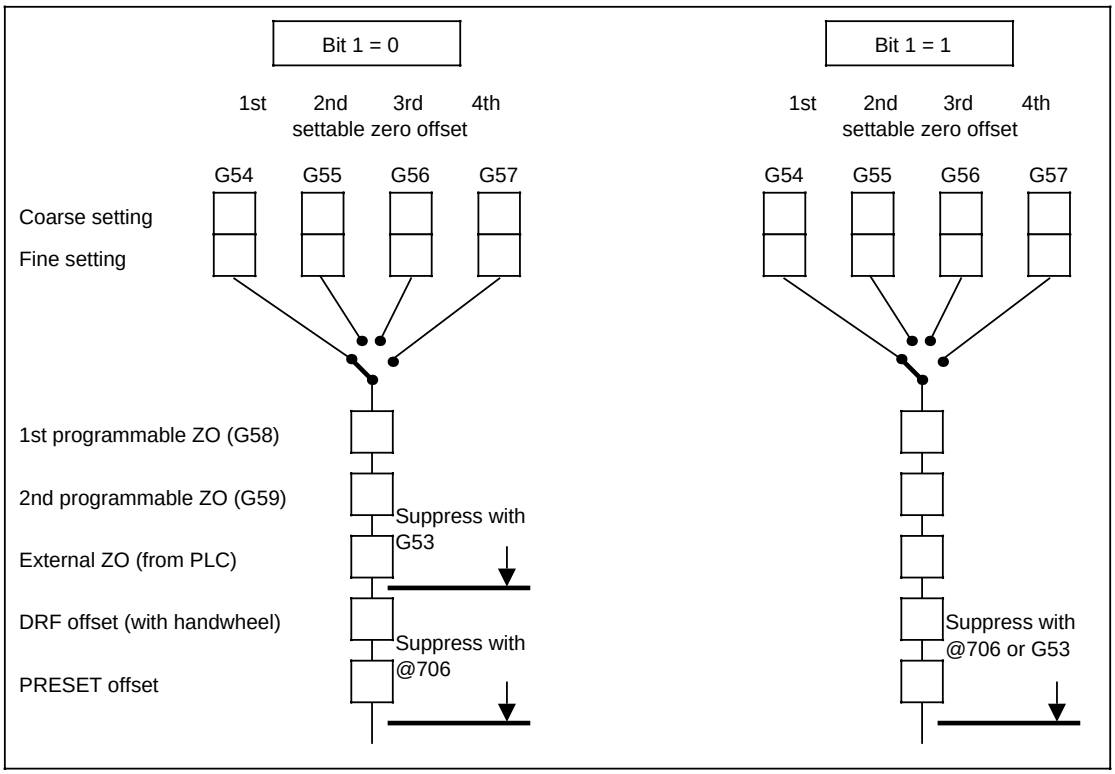
Bit 1 **Bit 1 = 0** All zero point offsets are deselected with G53 (G54-G59 + ext. ZO).

Bit 1 = 1 G53 has same effect as @706, all zero offsets (G54-G59 + ext. ZO), DRF and PRESET are deselected with G53 or with @706. Tool offset (TO) is not deselected.



Bit 0 Run the length compensation even for non-programmed axes (840C (T)): If a modification of the tool length compensation (e.g. deselection via D0) produces a traversing path in an axis that is not programmed in this block, traversing is carried out nonetheless. If this bit is not set, traversing is carried out only if the axis has been programmed.

Programming example for the 840C (T):

```
:
N5  G18  G0  X0  Z0  LF
N10  G01  F200  D3  X10  LF
N20  Z30  LF
:
```

D3 ....Type 3 (turning tool)
Length 1 30
Length 2 20

If the bit is set, the length compensations are run in block N10 already to position Z20.

If the bit is not set, the Z axis is not moved to position Z50 (Z30 + length compensation 2) until block N20 is processed.

This function is active only for 2 axes in the mode group.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5008	Path dimension from PLC without NC STOP	REPOS in JOG mode	INC and REF in JOG mode	TO type 0 identical with type 20	CC with mode group disable (as from SW 5)			Effect of CANCEL key channel-specific (as from SW 2)

Default value: 0100 0000
Bits 7-5 become active: At once

Bit 7 **Bit 7 = 0** Displacement path from PLC (via command channel) is started in AUTOM./MDA mode only when the preselected NC channel has an NC STOP status. The displacement path is **not** started if the NC channel is stopped with only a read-in disable at the end of the block.

Bit 7 = 1 Displacement path from PLC (via command channel) is started in AUTOM./MDA mode on a NC STOP or with a read-in disable at the end of the block. The occurrence of a situation in which displacement path from PLC was selected, the read-in disable was set, and the current part program block was prematurely aborted due to an NC STOP (tool breakage, "NC STOP" key, etc.) now becomes feasible, in which case the displacement path from PLC function would be started at once rather than at the end of the block. It is therefore recommended that bit 7 not be set.

Bit 6 **Bit 6 = 0** In the REPOS function (JOG mode), return to the contour is initiated by brief pressing of the relevant direction key. Axis movement can subsequently be halted only via either feed hold or feedrate override 0%.

Bit 6 = 1 Return to the contour is performed only as long as the relevant direction key is held down.

Bit 5 Same as bit 6 but for functions INC1 ... 10 000 and reference point approach (JOG mode).

Bit 4 **Bit 4 = 0** If no TO type is specified, alarm 2060 is issued when called in the NC program.

Bit 4 = 1 WZK-Typ wirkt wie Typ 20
If TO type 0 is specified, the tool is interpreted as type 20 and no alarm is issued. The TO type remains 0 in the tool offset memory. Radius and length compensation are assigned as for 20.

Bit 3 **Bit 3 = 1** Command channel error 200 with detailed error coding 14-18 is suppressed.

Bit 0 **Bit 0 = 1** Cancel key channel-specific
Bit 0 = 0 Cancel key NC-specific (standard)

Active: NC STOP**/**RESET

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Acknowledging the channel-specific cancel alarm via operator panel (BT)

Cancel alarms are acknowledged with the ⊖ key. With MD 5008 bit 0 you can set whether the ⊖ key affects **all** channel-specific alarms or only **those of the selected (actual channel)**. Other channel alarms are acknowledged NC-specifically.

Acknowledging channel-specific cancel alarms via the PLC

Channel-specific cancel alarms can be acknowledged via the PLC user interface signal ”CANCEL” (DB 10 - DB 13) in the same way as with the reset key.

NC MD	Bit No. 7	6	5	4	3	2	1	0
5010	5D Tool length compensa-tion	Tool offset for gear cutting tools				Type 5D tool length comp.		

Default value: All 0

Active: in next block

Bit 0 to 2	Bit 2	Bit 1	Bit 0
Gimbal head	0	0	1
Twist & nod head	0	1	0
Nutating head	1	0	0
Inclinable head (parallel Y)	1	0	1
Inclinable head (parallel Z)	1	1	0

Bit 7 **5 axis tool linear compensation**

The 5 axis tool linear compensation corrects the programmed block end points depending on the type of milling head used in short linear blocks with G01. If a tool breaks, the milling machine can carry on from the point of the breakage if a tool with the programmed radius but a different length is chucked. The difference in length is entered as the tool length compensation in tool offset type 40.

This is only possible if the programs have been written taking the tool length and cutter radius into consideration.

The 5 axis tool length compensation is called up with NC MD 5010 and tool type 40. The tool length (different in length as compared with the old tool) is stored in tool parameter P2. In the case of milling machines with a nutating head, the permanent nutating angle must also be entered in MD 20.

See also Programming Guide.

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Bit 6 **Bit 6=1** An extended tool parameter basic display with 12 parameters (P0 ...P11) is displayed.

MD 13, "Number of parameter values per D no.", is monitored for greater than, equal to 12 on Power On and Format tool offset memory.

Bit 6=0 The existing tool parameter basic display with 10 parameters (P0 ... P9) is displayed.

MD 134, "Number of parameter values per D no.", is monitored for greater than, equal to 10 on Power On and Format tool offset memory.

NC MD	Bit No. 7	6	5	4	3	2	1	0
	Diameter function for							
5011	@ read/load	Actual value display	G91pro-gramm.	G90 progr. TO wear	TO geometry (type 1-9)	Incr. dim., DRF	Zero offset	TO wear (as from SW 6)

Default value 840C (T): 0101 0000
Default value 840C (M): 0000 0000

All bits in NC MD 5011 affect the axes defined as transverse axes in NC MD 572*, bit 1. All bits in NC MD 5011 must be set to zero if no transverse axes were defined (i.e. if bit 1 in NC MD 572* is 0).

Active: At once

Bit 7 All axis-specific @ of axes defined as a transverse axis must be entered as diameter and are written as diameter (CL 800).

Bit 6 Machine-related actual value and workpiece-related actual value are displayed in diameter (also see NC SD 5001, bit 0). The actual values in the axis-specific Service displays are still shown as radii.

Bit 5 Diameter programming in G91.

Bit 4 Diameter programming in G90. The TO wear for tool types 1 to 9 is entered and displayed in diameter.

Bit 3 The tool length for tool types 1 to 9 is entered and displayed in diameter.

Bit 2 Pulse weighting is diametral for INC handwheel and DRF handwheel. The DRF offset is displayed in diameter.

Bit 1 Settable ZO and programmable ZO are entered, programmed and displayed in diameter.
External ZO, PRESET offset, distance to go and REPOS are displayed in diameter.

Bit 0 Tool wear for tool type 1-9 in diameter

Note:

This machine data applies to transverse axes only.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5012					Do not delete work-piece name with PLC program selection (as from SW 3)	Write MD disabled by @	Sign change handwheel 2 (as from SW 6.3)	Sign change handwheel 1 (as from SW 6.3)

Default value: All 0
Active: In the next block

Bit 3 If the bit is set, the workpiece name is not deleted with program selection via FB 62.

Bit 2 Bit 2 can be used to inhibit entry and modification of NC MD, PLC MD and cycles MD using @ commands @4.. (CL800 commands).

Bit 1 Bit 1=1 Leads to a sign change of handwheel 2

Bit 0 Bit 0=1 Leads to a sign change of handwheel 1

NC MD	Bit No. 7	6	5	4	3	2	1	0
5013	Circle program-ming	Polar coordinate program-ming		Feed not contour-related		M and S address extension for spindle to PLC	Tapping without encoder	G63 without feedrate reduction

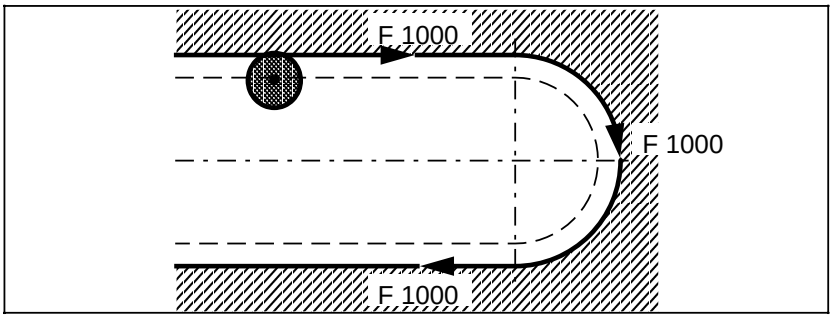
Default value: 1000 0000
Active: In the next block

Bit 7 Bit 7=1 When bit 7 is set, a circle can be programmed by specifying the radius and**/**or angle.

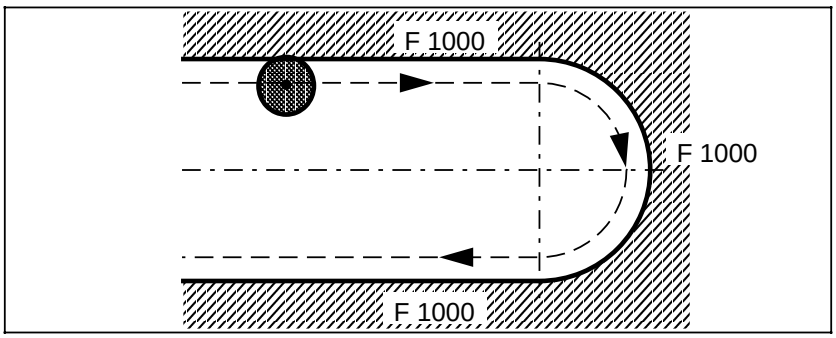
Bit 6 Bit 6=1 Positions related to a set mid-point can be defined by programming polar coordinates using details of radius and angles.

Example 840C (M):

Bit 4 Bit 4=0 The programmed feedrate refers to the contour.



Bit 4 Bit 4=1 The programmed feedrate of the milling tool refers to the tool center path.



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Bit 2 This bit indicates whether the programmed address extension or the M and S address extension automatically generated by the control is to be transferred to the PLC interface (in the control, the address extension is always in force, except for emergency retraction).
This bit can be set if the control has more than one spindle. (The extended M function must be decoded with DB80**/**DB30).

Bit 1 When using the Siemens tapping cycle L84 (G84) on the SINUMERIK 840M, it is necessary to indicate whether or not the spindle has an encoder.

Bit 1 = 0 The spindle has an encoder (512 or 1024 pulses). G33 (pitch in mm**/**rev) is therefore used in tapping cycle L84.

Bit 1 = 1 The spindle has no encoder or its encoder is not to be used for cycle L84.
G63 (F in mm**/**min) is therefore used in tapping cycle L84. The programmer must define feedrate and spindle speed so as to produce the correct pitch. Slight errors are taken up by the compensating chuck.

Bit 0 At block boundaries in G63 (tapping without encoder), the programmer can specify whether the new setpoint speed should be output with consideration given to the acceleration characteristic or abruptly.

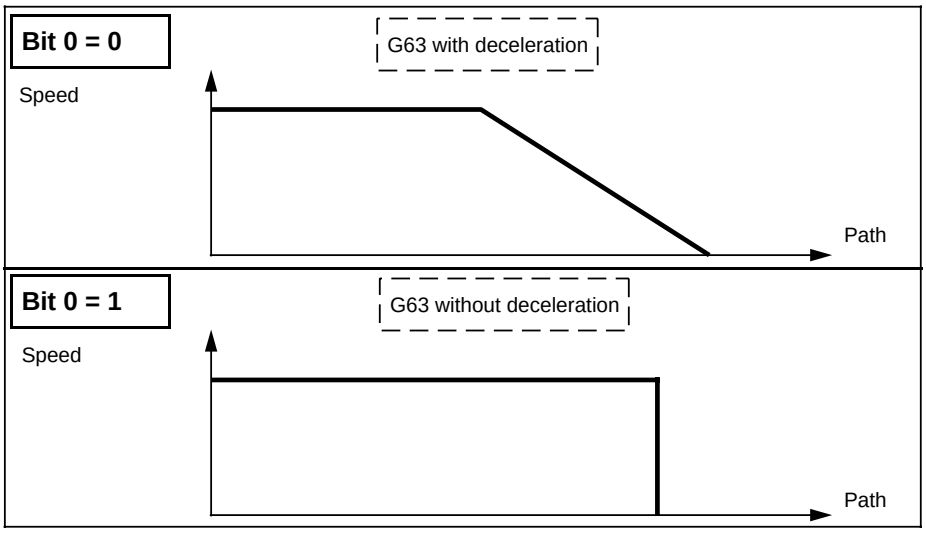
Bit 0 = 0 Acceleration characteristic
Bit 0 = 1 Abrupt setpoint speed

Note:

If the bit is set the exact stop limits are not taken into account on a block change. This means that the existing path velocity is output to the axes of the next block. If a servo enable has not been set for these axes, alarm 168* ”Servo enable for traversing axis” is output.

To avoid this

- Program G09 (exact stop) in the last G63 block
- Approach the same drilling axis position with G0 or G01 in the next block
- Program a dwell time in the next block.



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NC MD	Bit No. 7	6	5	4	3	2	1	0
5014	Tool radius compen-sation (TRC)	Blueprint program-ming	Cycles (ref. con-ditioning)		Extended contour def. progr.			Thread revolution feedrate G33/G95

Default value 840 C-T: 1010 0001
Default value 840 C-M: 1010 0000
Active: In the next block

Bit 7 TRC T: Activation of tool nose radius compensation
M: Activation of cutter radius compensation

Bit 6 Blueprint programming
This function can simplify NC programming. You can enter the words to describe lines and circles directly from the part drawing. See Programming Guide.

Bit 5 Cycles: This bit activates the reference conditioning (software module), which is essential for processing stock removal cycle L95.

Bit 3 Extended contour definition programming
This function can simplify NC programming. You can enter the words to describe lines and circles directly from the drawing into the control. See Programming Guide.

Bit 0 The spindle encoder is taken as a basic measurement for pitch.

NC MD	Bit No. 7	6	5	4	3	2	1	0
5015							External data input (as from SW 4)	3D inter-polation

Default value: 0000 0010

Bit 0 3D interpolation
Helical interpolation, helical interpolation 3 axes linear or 2 axes circular and 1 axis linear.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5016	Slave axis sorting [1)]							

Bit 7 **Bit 7=0** In slave axis cascading, the arithmetic sequence is selected in such a way that no dead times occur. A slave axis ring triggers alarm 3085 "NC CPU time monitoring"

Bit 7=1 If bit 7 is set to 1 in MD 5016, the slave axes are entered in an execution list in the same order as their global KOPEIN. This list is not sorted again so that dead times can occur with slave axis cascading. The desired sequence can be set using the global KOPEIN sequence.
A slave axis can be pushed to the end of the execution list by (online) a global KOPAUS and subsequent global KOPEIN. With SW 3 and higher it is only possible to resort in this way by exchanging the global axis numbers.

NC MD	Bit No. 7	6	5	4	3	2	1	0
5017	Transformation machine data changes are effective without warm restart (from SW 6.2 5.8)	Transformation machine data changes permissible during active transformation (from SW 6.2 5.8)						

Default value: Bit 7 and bit 6=0

Bit 7 **Bit 7=1** Activation of the function ”Transformation machine data changes effective without warm restart”. This means that a warm restart is no longer necessary after making changes to the transformation machine data (MD 730-MD 809).

Bit 7=0 The previous functionality (compatibility), i.e. the necessity of a warm restart after a machine data change, is active.

Bit 6 **Bit 6=1** Changes may also be made to the transformation machine data when that same data are active in a transformation.

Bit 6 **Bit 6=0** Transformation machine data changes may only be made when these machine data are not in an active transformation. In this case, a tolerance check will not be made.

1) SW 4.4 and higher

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5018	Second CP module	First CP module	Path dimension from PLC	Indexing division from PLC		File transfer		

Default value: All 0

Bit 5 Path dimension from PLC, F73
This function provides a way of traversing NC axes in incremental or absolute dimensions from the PLC. The data is transferred from the PLC to the NC via a rapid "command channel". Tool offsets and zero offsets are not taken into account. Application: positioning of auxiliary axes.

Bit 4 Indexing division from PLC
You must set this bit if indexing is to be used from the PLC.

NC MD	Bit No. 7	6	5	4	3	2	1	0
5019		Soft approach to and exit from contour	Scale factor		Axis coupling	High-resolution rotary axis	Memory expansion to 819 tools (up to SW2)	Memory expansion to 409 tools (up to SW2)

Default value: All 0

Bit 6 Soft approach to and exit from contour
A contour tangential is approached or exited to avoid cutting edge marks. See the Programming Guide.

Bit 5 Scale factor
You can simplify programming by entering a factor with which the coordinate values of a part program can be weighted. See the Programming Guide.

Bit 2 High-resolution rotary axis
This option increases the position control resolution of rotary axes from the 0.005° of the basic version to 0.000005°.

Bit 1 *1) ** Increase of tool offset memory from 408 to 819 tools
The tool offset memory is expanded from 16 KB to 32 KB. This is enough for 819 tools if each tool has 10 parameters. The bit becomes active when you press the softkey "Format tool data" and enter the initial clear mode.

Bit 0 *1) ** Increase of tool offset memory from 204 to 409 tools
The tool offset memory is expanded from 8 KB to 16 KB. This is enough for 409 tools if each tool has 10 parameters. The bit becomes active when you press the softkey "Format TO data" in initial clear mode.

---

1) With SW 3 and higher, these bits can no longer be altered. The tool offset memory is set to 32 KB on POWER ON RESET. Only these values are permissible if standard tool management is used.

** For SW 4 and higher see functional description "Flexible Memory Configuration".*

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5020						Emergency retraction off (as from SW4.7 SW 5.2)		

Default value: 0

Bit 2 **Bit 2 = 1** Emergency retraction off (G420) for all channels
Meaning:
Monitoring of the ER sources, specified via MD, OFF for:
- the channel where the part program is executed
- all axes of the mode group for ALL channels incl. PLC
- all spindles of the mode group for ALL channels incl. PLC

G420 X S1 =
Meaning:
Monitoring of the ER sources, specified via MD, OFF for:
- the X axis for ALL channels incl. PLC
- the spindle S1 for ALL channels incl. PLC

"G420/G421" from PLC:

Axis-specific:	DB29	DR K+ 2.5	DL K+ 2.5
Spindle-specific:	DB29	DR K+ 26.5	DL K+ 26.5

Monitoring for axes (FA/FS) can also be switched on/off from PLC. If monitoring is switched off from PLC, it is switched off for all channels.

Bit 2 = 0 Emergency retraction off (G420) in current channel

NC MD	Bit No. 7	6	5	4	3	2	1	0
5021			Neutral position of outputs for mode group 6 [1]	Neutral position of outputs for mode group 5 [1]	Neutral position of outputs for mode group 4 [1]	Neutral position of outputs for mode group 3 [1]	Neutral position of outputs for mode group 2 [1]	Neutral position of outputs for mode group 1 [1]

Neutral position of mixed I/O outputs bit 5 to 0

Bit 5-0=1 After Mode Group Reset the output byte of the mixed I/O module is at high level (24 V).

Bit 5-0=0 After Mode Group Reset the output byte of the mixed I/O module is at low level (0 V).

Active: On Power On

1) As from SW 4

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5022	Delay of the NC ready signal by 1 IPO cycle in case of PLC failure or 5 V under-voltage (as from SW 6.3)	Consider software limit switch emergency retraction (as from SW 6)	5 V under-voltage (as from SW 6.3)	Retraction in case of PLC failure (as from SW 6.3)			Extended stopping 1)	Stopping also on Emergency OFF 1)

Control bits to define stopping procedure.

Bit 7 **Bit 7=1** Delay of NC ready signal by 1 IPO cycle in case of PLC failure or 5 V under-voltage.

Bit 6 **Bit 6=1** The function ”Consider software limit switch with controlled emergency retraction” is activated.

Bit 5 **Bit 5=1** Enables release of the configured independent emergency retraction at 5 V undervoltage.

Bit 4 **Bit 4=1** Enables release of the configured independent emergency retraction in case of PLC failure.

Bit 1 **Bit 1=1** Stopping is extended by the phase T1 and T2, i.e. interpolator-controlled continuation and deceleration.

Bit 1=0 When stopping signal is recognized deceleration starts immediately with speed setpoint 0. The following axes go into controlled follow-up.

Bit 0 **Bit 0=1** Stopping is also performed with Emergency stop. The following axes subsequently go into controlled follow-up.

Bit 0=0 On Emergency stop deceleration with speed setpoint 0 is performed immediately. Following axes go into controlled follow-up.

NC MD	Bit No. 7	6	5	4	3	2	1	0
5024							Automat. block end value synchr. G105/G119 1)	Abort on contour violation TRC

Default value: 0000 0110

Bit 1 **Bit 1=1** In the case of G[..]105 and G[..]119, a G200 is generated by the NC for this axis. The same restrictions apply here as for programmng of a G200 axis.

Bit 1=0 Automatic synchronization of end-of-block value with G[..]105 and G[..]119. In the case of G[..]105 and G[..]119, **no** G200 is generated by the NC for this axis.

Bit 0 **Bit 0 = 1** If a contour violation occurs when tool radius compensation is active, alarm 2021 ”Contour violation with TRC” is signalled. Processing of the part program is interrupted, the alarm can be acknowledged with the reset key.

Bit 0 = 0 If a contour violation occurs when tool radius compensation is active, alarm 3021 ”Contour violation with TRC” is signalled. Processing of the part program is **not** interrupted, the alarm is deleted with the acknowledge key.

1) As from SW 4

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5025	Reload workpiece on power on (as from SW 2)	Endlessly turning rotary axis	Alarm "Axis not in C axis mode"		Travel thru transform. center (as from SW 5)	Extended threading package	Axis-specific G functions to PLC	

Bit 7 **Bit 7=1** The last active workpiece is reloaded channel-specifically in the NCK CPU on warm restart. This can only be done if a workpiece was already loaded or had been selected before switching off, i.e. the workpiece pointers are preassigned. The workpieces are loaded in order into channel 1 to channel n. The order in which the workpieces were loaded before the control was switched off no longer applies. Loading of workpiece STANDARD is always executed before the function "Reload workpiece ..." and cannot be disabled via machine data. Please note that the function can also alter data (TOA, ZOA, etc.) which might have been manipulated on the NCK before switching off the control if any of them are overwritten by the job concerned.

Note:

Workpiece loading can be disabled channel-specifically. See setting data 540*.

Bit 6 **Bit 6 =1** The function "Endlessly turning rotary axis" is activated (see Functional Description).

Bit 5 **Bit 5 =1** This bit is activated via the toggle field in the display NC machine data/Gen. data/Basic data under the intermediate heading "General basic data".

Bit 3 Change as from SW 5:

Independent of this bit

- it is possible to travel through the transformation center in JOG mode. Previously the alarm "Speed setpoint warning limit" was triggered in this case.
- the velocity of the rotary axis is always limited to the maximum possible value.
- see also Functional Description: Coordinate transformation in Section 12.

Bit 3=1 Activates the function "Travel through the transformation center". It is possible both to machine contours near the turning center faster than before and to travel through the transformation center. The permissible feedrate in the fictitious coordinate system is calculated as a function of the current distance from the center of turning and the MD "Maximum velocity rotary axis" so that the path feedrate changes continuously.

Bit 3=0 Activates the previous functionality: With the function Transmit, note that the rotary axis must rotate faster the nearer the contour is to the turning center. The maximum velocity of the rotary axis entered in MD 280* must not be exceeded.

This is achieved by traversing the entire contour of a part program with a lower speed in the fictitious coordinate system. This velocity is chosen such that at the point which is closest to the center of turning within the contour, the velocity of the rotary axis is not exceeded. This method has the disadvantage that the velocity is also lower in parts of the contour that are farther away from the turning center.

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Bit 2 The extended threading package contains the following functions:

a) Following error compensation
b) Multiple-turn thread
c) Thread recutting logic

a) Following error compensation
This function corrects the start angle of the spindle by the following error. This means that the same thread is cut at high speed as at low speed.

b) Multiple-turn thread
With this function, you can cut multiple-turn threads. The channel-specific start angle for each turn is programmed directly with G92 A.. The angle is displayed in the setting data display "spindle data" under the letter for the angle. You can also enter the angle in this display.

c) Thread recutting/set-up
With this function you can reclamp and recut a precut thread with a constant pitch. You cannot recut a thread with a variable pitch. You can select the appropriate display in the machine area display of the "JOG" mode by pressing softkey "Recut/set up thread".

d) Smoothing exponent G92 T
In addition to the above functions the function package level-up thread contains the function smoothing exponent which you can program with G92 T.. You can program the smoothing exponent for dynamic smoothing using the G92 function with the letter T. You must have set the value for T value in a setting data. The T value can also be changed in the setting data display.

Bit 1 **Bit 1=1** Axis-specific G commands to PLC
Bit 1=0 No axis-specific G commands to PLC.
Active: On POWER ON

NC MD	Bit No. 7	6	5	4	3	2	1	0
5026 (as from SW 6)						2nd MCS mirroring Z	2nd MCS mirroring Y	2nd MCS mirroring X

Mirroring of the axis in question of the 2nd machine coordinate system at the coordinate origin opposite the collision monitoring coordinate system.

Bit 0-2=1 Mirroring of the axis in question
Bit 0-2=0 No mirroring
Active: Power On

NC MD	Bit No. 7	6	5	4	3	2	1	0
5027 (as from SW 6)						3rd MCS mirroring Z	3rd MCS mirroring Y	3rd MCS mirroring X

Mirroring of the axis in question of the 3rd machine coordinate system at the coordinate origin opposite the collision monitoring coordinate system.

Bit 0-2=1 Mirroring of the axis in question
Bit 0-2=0 No mirroring
Active: Power On

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5028 (as from SW 6)						4th MCS mirroring Z	4th MCS mirroring Y	4th MCS mirroring X

Mirroring of the axis in question of the 4th machine coordinate system at the coordinate origin opposite the collision monitoring coordinate system.

Bit 0-2=1 Mirroring of the axis in question

Bit 0-2=0 No mirroring

Active: Power On

NC MD	Bit No. 7	6	5	4	3	2	1	0
5029								Dynamic software limit switch for following axes (as from SW 5)

Bit 0 The dynamic limit switch for ELG following axes can be operated without dead-time compensation in certain cases. Not the actual value but the precalculated ”actual value” is used for calculation. The function is activated via MD 5029.0 and axis-specifically via MD 584*.1.

NC MD	Bit No. 7	6	5	4	3	2	1	0
5030 as from SW 3	CSB input 7 signal from UPS: power failure	CSB input 6 signal from UPS: power failure	CSB input 5 signal from UPS: power failure	CSB input 4 signal from UPS: power failure	CSB input 3 signal from UPS: power failure	CSB input 2 signal from UPS: power failure	CSB input 1 signal from UPS: power failure	CSB input 0 signal from UPS: power failure

Bit 0-7=1 Definition of the CSB input used for the uninterruptible power supply (UPS) signal ”Power failure”

Bit 0-7=0 UPS signal not active in NCK

Active: immediately

Note:

See also Section 12.35 in the Functional Description.

NC MD	Bit No. 7	6	5	4	3	2	1	0
5038								Declaration of PLC
5039								PLC config. display

Default value: 0000 0001

Because a SINUMERIK 840C is always equipped with a PLC (135 WB), bit 0 of MD 5038 must always be set to 1 and bits 1 to 7 to 0. With 1 in bit 0 of MD 5039, the control indicates that the PLC has been recognized.

Active: On POWER ON

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5051								Cycle setting data

Default value: All 0

By setting the relevant NC MD bit, entries and modifications through the NC operator panel can be prevented with the keyswitch.

Bit 0 Cycles setting data
Active: At once

NC MD	Bit No. 7	6	5	4	3	2	1	0
5052	F62 programming (as from SW 6.3)	Prog. Predecod. with G171/G172					Cylindrical interpolation with 4 axes (as from SW 6)	No automat. gener. of G68 for rot. axes [1]

Bit 7 **Bit 7=0** F62 programming not active.

Bit 7=1 F62 programming active.

Default setting: 0

Active: MD immediately active

Bit 6 With this, the function "Progr. predecod. with G171/G172 is enabled (see Section Functional Description).

Bit 1 **Bit 1=0** Cylindrical interpolation with 2 axes

Bit 1=1 Cylindrical interpolation with 4 axes activated

Cylindrical interpolation can be activated for up to four axes, cylindrical interpolation remains active. One limitation of this function is that the cylindrical interpolation axis must be programmed as the 1st or 2nd axis in a block. The axes cannot therefore be programmed in any order, nor can a circle be programmed without including the cylindrical interpolation axis. If more than five axes are programmed in a block or if an axis other than the 1st or 2nd axis is programmed as the cylindrical interpolation axis, alarm 2059 is output.

Default value: 0 for T and M controls

Bit 0 **Bit 0=0** Automatic generation of G68 for initial programming of rotary axes.

Bit 0=1 No automatic generation of G68 for initial programming of rotary axes.

With this MD the user can define how the control is to behave on initial programming of the axis by programming G68, G90 or G91. On a block search, the automatic generation of G68 is retained because the user cannot influence by programming.

1) As from SW 5

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5053							Axis display for all mode groups (as from SW 6)	Channel-spec. axis and spindle display [1]

Default value: 0

Bit 0 Channel-specific axis and spindle display (as from SW 5)

Bit 0=1 Display of the axes according to the setting in MD 9000 ... 9099, display of the spindles according to setting of the MD 9100 ... 9139

Bit 0=0 Display of the axes and spindles as before (mode-group-specific)

Bit 1 **Bit 1=1** If this bit is active, all axes are displayed in the machine basic display, whatever mode group they are assigned to. Whether individual axes are displayed or not can be set in channel-specific bits 900*.

Note:

The machine data bit is independent of the option multichannel display. This means that the user can set precisely those axes and spindles he wishes to display even in single-channel display (no multichannel display option). No change to displays already created is required. It is only important to make sure that MD 9000 ... 9139 are set for channel-specific display of the axes and spindles because the standard setting is 0. This means no display.

1) As from SW 5

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Note on WS800A:

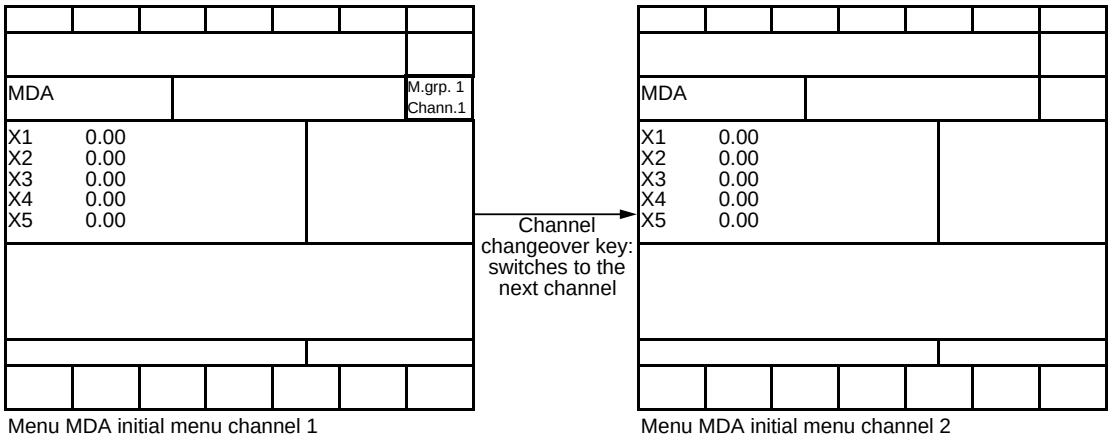
With the multichannel display option, the user can, of course, continue to configure channel-specific axis and spindle displays with the data groups and data types for multichannel display whatever the setting in the new machine data bit.

Example:

The following example (see figures below) shows examples of the effect of the machine data bit MD 5053 bit 0. The following MD presetting is assumed.

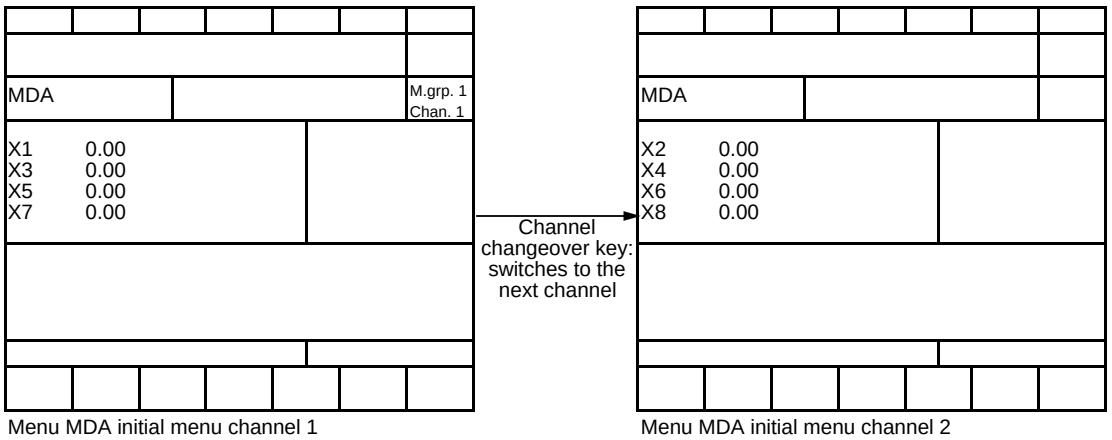
MD	Meaning	Value
1000	Channel 1 in mode group 1	
1001	Channel 2 in mode group 1	1
360*	Axis 1 to 8 in mode group 1	1
564*	Axis exists	Bit 7
568*	Axis name X1 to X8	xxxx0000
9000	Display axis 1 3 5 7 in channel 1	01010101
9001	Display axis 2 4 6 8 in channel 2	10101010
9100	Display 1st spindle in channel 1	00000001

Active: immediately



Menu MDA initial menu channel 1 Menu MDA initial menu channel 2

Mode-group-specific axis display (MD 5023 Bit 0=0)



Menu MDA initial menu channel 1 Menu MDA initial menu channel 2

Channel-specific axis display (MD 5053 Bit 0=1)

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5060	Transformation channel number (1st block)							
5061	G function for transformation selection (1st block)							
5062 to 5069	Axis name (1st block)							

Default values MD 5060, 5061: All bits default to 0
" MD 5062 to 5069: All bits default to 1

MD for 1st TRANSFORMATION BLOCK.
MD 5060 Channel numbers 1 to 4
Example for channel 3 0000 0011
MD 5061 G function for Transmit G131 0001 0001
G231 0010 0001
G331 0011 0001
MD 5062-5069 Axis name according to code table, see MD 568*

The default values must be retained if Transformation (option 6FC5 150-0AD04-0AA0) is not used. Illegal MD results in alarm 3087.

Active: All Transmit MDs become active on Power On or on a warm restart
For a detailed description, see Section 13.4.

NC MD	Bit No. 7	6	5	4	3	2	1	0
5070	Transformation channel number (2nd block)							
5071	G function for transformation selection (2nd block)							
5072 to 5079	Axis name (2nd block)							

See MD 5060
MD for 2nd TRANSFORMATION BLOCK.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5080	Transformation channel number (3rd block)							
5081	G function for transformation selection (3rd block)							
5082 to 5089	Axis name (3rd block)							

See MD 5060
MD for 3rd TRANSFORMATION BLOCK.

NC MD	Bit No. 7	6	5	4	3	2	1	0
5090 to 5139	These NC MDs are intended for future expansion only and cannot be used at the present time.							

Default values NC MD: All bits 0 for
5070, 5071, 5080, 5081, 5090, 5091,
5100, 5101, 5110, 5111, 5120, 5121, 5130, 5131

Default values NC MD: All bits 1 for
5072-5079, 5082-5089, 5092-5099,
5102-5109, 5112-5119, 5122-5129, 5132-5139

These NC MDs must not be changed during the transformation option. They are verified on Power On and alarm 3087 issued in the event of a verification error.

Active: On POWER ON or on a warm restart

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5141 to 5146		Ethernet address						

The Ethernet address is the address of the bus interface module within the network.

Active: On POWER ON

NC MD	Ethernet address (Binary)	Byte	Decimal	Default value
5141	0 0 0 0 1 0 0 0	Byte 1	08	0 0 0 0 1 0 0 0
5142	0 0 0 0 0 0 0 0	Byte 2	00	0 0 0 0 0 0 0 0
5143	0 0 0 0 0 1 1 0	Byte 3	06	0 0 0 0 0 1 1 0
5144	0 0 0 0 0 0 0 1	Byte 4	01	0 0 0 0 0 0 0 1
5145	User assignable	Byte 5	User assignable	0 0 0 0 0 0 0 0
5146	User assignable	Byte 6	User assignable	0 0 0 0 0 0 0 0

The last four bits in the Ethernet address are for the bus interface module.
(See Computer Link).

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5147					Protect EPROM cycles from overwrit. (as from SW 4)	File transfer: Do not delete read only programs	File transfer: Acknowl-edge message at once	File transfer: Pos. acknow. of end messages

Default value: All bits 0
Active: On POWER ON

Bit 3 **Bit 3=1** The program to be read in is not read in, the cycle is still available for processing. The cancel alarm 3240 ”Subroutine not read in” is output. The program number concerned is output in the block number of the alarm. Reading in via RS 232 C/file transfer is continued.

Bit 3=0 The program to be read in is read in and is available for processing. Cancel alarm 3239 ”Cycle overwritten by subroutine” is output. The program number concerned is output in the block number of the alarm.

Caution:
The alarm is not returned via the file transfer message sequence.

Bit 2 Do not delete read only programs. Is used in computer links.

Bit 2=0 A program is not deleted until it is released (end-of-program and Reset). File transfer is suspended in the interim.

Bit 2=1 A read only program is not deleted.

Bit 1 Acknowledge message at once.
Is used in computer links. When this bit is set, the NC forwards a request to the host computer before entering data in NC memory.

Bit 0 Positive acknowledgement of end message.
Is used in computer links.
When this bit is set, the NC responds to an incorrect message from the host computer by sending a positive acknowledgement. When the NC transmits an end message, it also expects a positive acknowledgement from the host.

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Execution from external

NC MD	Bit No. 7	6	5	4	3	2	1	0
5148	0	1	0	0	0	1	1	0

NC MD	Bit No. 7	6	5	4	3	2	1	0
5149	0	1	0	0	1	1	0	0

NC MD	Bit No. 7	6	5	4	3	2	1	0
5150	0	1	0	1	0	0	1	0

NC MD	Bit No. 7	6	5	4	3	2	1	0
5151	0	1	0	1	1	1	1	1

These machine data are valid only for ”Execution from external”via the computer link interface.

In the 4 bytes, the ”Logical partner receiver” is entered to which the request message is forwarded when starting the ”Execution from external” function.

These values are entered as ASCII values

The default setting is as described above and is referred to in ASCII as ”FLR_”.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5152	0	0	0	1	0	0	0	1

This machine data is valid only for ”Execution from external” via the computer link interface.

In this byte, the ”Location receiver” is entered.

The specification ”Location receiver” defines the interface module via which the ”Logical partner receiver”can be reached.

The following applies: 11H (00010001) equivalent to the 1st interface module
12H (00010010) equivalent to the 2nd interface module

The default setting is the one entered above (11H).

Additional MDs (MD 30, MD 130*, MD 5148-5151) and the ”Execution from external” option.

NC MD	Bit No. 7	6	5	4	3	2	1	0
5153	ZO and D No. indep of prog. move. travel [1)]						Init. setting after NC start active	

Active: NC Start

After NC Start, the initial setting becomes active for the 6th G group for each channel as set in MD 112*. A permanently defined value D0 is selected for the TO as standard. If NC MD 5153.1 = 1 is set, the last zero offsets, tool offsets and plane to be selected can also remain active.

Bit 7
Bit 7=0 No function
Bit 7=1 The actual zero offsets (ZO) and the active D number (TO) are calculated independently of the programmed traversing movement. Workpiece related axis actual values can be read channel-specifically with FB 61 (read data).

Bit 1
Bit 1=0 Initial setting (MD 112* and TO = D0) active after NC Start
Bit 1=1 No initial setting (selected ZO, TO and plane also remain active after NC Start)

Note:
Please refer to the Programming Guide in the Section entitled ”Workpiece name and actual value system”.

1) SW 3 and higher

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5156 to 5182		Coupled motion combination						

Default value: All bits 0

The definition of this coupled axis combination defines which coupled axis pairings form a coupled axis combination and how the coupled motion is performed (coupled motion in the same direction or opposite directions).

The 9 possible coupled axis combinations are programmed with G151 to G159. Each coupled axis combination is defined with 3 NC MDs corresponding to the 9 coupled axis pairings (12 times 2 bits).

Active: RESET

See also NC MD 876 - 899 and the Programming Guide.

	Programming	NC MD
1st coupled axis combination	G151	5156 to 5158
2nd coupled axis combination	G152	5159 to 5161
3rd coupled axis combination	G153	5162 to 5164
4th coupled axis combination	G154	5165 to 5167
5th coupled axis combination	G155	5168 to 5170
6th coupled axis combination	G156	5171 to 5173
7th coupled axis combination	G157	5174 to 5176
8th coupled axis combination	G158	5177 to 5179
9th coupled axis combination	G159	5180 to 5182

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Two bits are assigned to every coupled axis pairing in every coupled axis combination.

Leading axis	898	896	894	892	890	888	886	884	882	880	878	876	**NC MD**
Coupl. mot. axis	899	897	895	893	891	889	887	885	883	881	879	877	**NC MD**

Definition of the coupled axis pairing

Bit				Bit				Bit			
7 a. 6	5 a. 4	3 a. 2	1 a. 0	7 a. 6	5 a. 4	3 a. 2	1 a. 0	7 a. 6	5 a. 4	3 a. 2	1 a. 0

Programming function

G	151	5158	5157	5156	
G	152	5161	5160	5159	
G	153	5164	5163	5162	
G	154	5167	5166	5165	**NC MD**
G	155	5170	5169	5168	
G	156	5173	5172	5171	
G	157	5176	5175	5174	
G	158	5179	5178	5177	
G	159	5182	5181	5180	

With these 2 bits you determine how coupled motion is to be performed.

00 ... no coupled motion

10 ... coupled motion in opposite directions

11 ... coupled motion in the same direction

01 ... not defined (Alarm 85)

The definition of the coupled motion combination can be changed on a warm restart without POWER ON (for warm restart see also Section entitled ”Functional Descriptions”).

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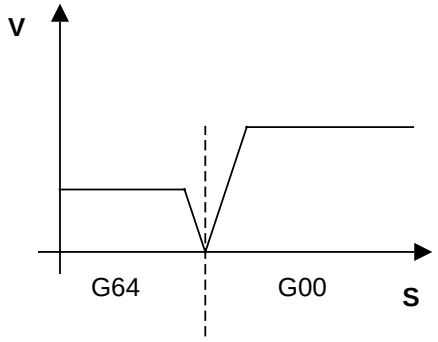
NC MD	Bit No. 7	6	5	4	3	2	1	0
5185	Angle offset for thread cutting negative | positive (as from SW 5.7)							Exact stop on change from G64 to G00

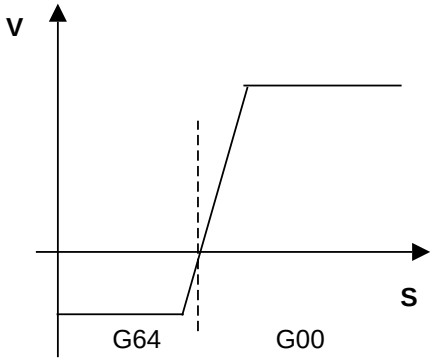
Default value: 0
Active: NC Stop

Bit 0

Bit 0 = 1 If a path is traversed in an NC block with G64 and traversing continued in the next block with G00, the NC generates feedrate reduction with coarse exact stop at the end of the block.

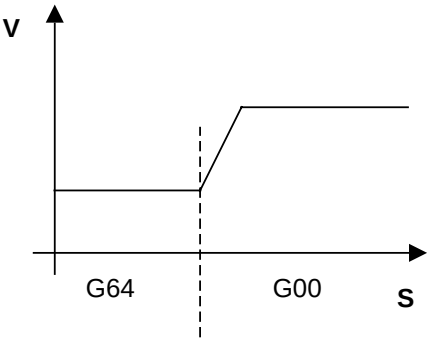


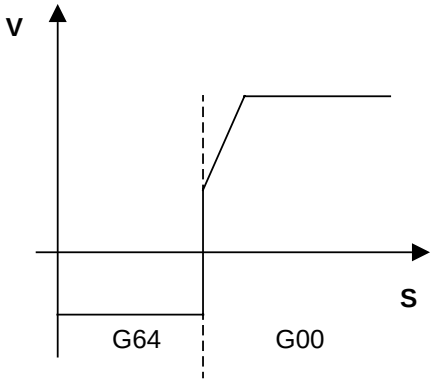
NC generates "coarse" exact stop



NC generates "coarse" exact stop

Bit 0 = 0





Bit 6 and 7 (should only be used for very slow spindle speeds)

The G92 angle is always calculated in one direction, irrespective of the direction of rotation. This direction can be set via machine data:

Bit 6=1 Angle G92 A.. always calculated in the positive spindle direction

Bit 7=1 Angle G92 A.. always calculated in the negative spindle direction

Note:

Only one direction can be selected.

Default value: Both bits=0 Angle is calculated in the actual direction of rotation.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5186				Fast block change (up to SW 2)	G176 active (up to SW 3)	Axis conv. spindle conv. active (as from SW 2)	Several block skip levels (as from SW 2)	Program coordination (as from SW 2)

Default value: 0

Active: In the block prior to decoding

Bit 4 **Bit 4=1** FIFO active (see Section entitled ”Functional Descriptions”)

Bit 3 **Bit 3=0** Programming function G176 cannot be used.

Bit 3=1 Programming function G176 is used to 'freeze' the zero offsets for the angles of rotation and the tool length compensations, i.e. these values are not updated in every block. This reduces the amount of time required for block changes. G176 can be revoked with G175 (initial setting).

Bit 2 **Bit 2=1** The ”Axis converter**/**Spindle converter” function is active (see Section entitled ”Functional Descriptions”).

Bit 1 **Bit 1=1** Function BLOCK SKIP LEVELS is active (refer also to SINUMERIK 840C Programming Guide).

Active: immediately

Bit 0 **Bit 0=1** Program coordination permits the user to program coordination commands in plaintext in the part program. The coordination commands are transferred to the NC PLC interface. The PLC performs the coordination itself (see also SINUMERIK 840C Programming Guide).

Active: On POWER ON

NC MD	Bit No. 7	6	5	4	3	2	1	0
5188								Double channel displ. (as from SW 2)

Bit 0 MCD (Multi-channel display)
Several channels can be displayed at any one time on the screen for operator support when multiple machine tools are used. The operator can then check the allocation of programs that run simultaneously and test the synchronization marks in test mode.

Active: POWER ON

NC MD	Bit No. 7	6	5	4	3	2	1	0
5189	MD 161 enabled (from SW 6.4)	Extended program view (from SW 6.3)	Suppression of alarm 3265 (from SW 6.03.57)		Name of default workpiece (from SW 5)			

Default value: 0

Bit 5 **Bit 5=1** Alarm 3265 is suppressed

Bit 5 **Bit 5=0** Alarm 3265 is active

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The function ”Automatic saving of part programs on hard disk” can be activated with no**/**yes in the machine area ”Automatic” via program modification and toggle field ”Automatic save”. Activation of the function ”Automatic saving of part programs on hard disk” is indicated by displaying of the text ”SAV” in the editor status line of the NCK editor.

When the ”Automatic saving of part programs on hard disk” function is activated, ”SAV” is added to the editor displays in the editor status line.

The entry ”SAV” is displayed as variable text in the editor status line. The display cannot be configured.

The part program is saved either in the original workpiece or the workpiece ”STANDARD” of ”NCKTMP” according to the machine data 5189 bit 3.

Bit 2 **Bit 2=1** Jerk-controlled interpolator active

Bit 2=0 Standard interpolator active (default setting)

Bit 6 **Bit 6=0** Extended program view: Display of the active part program in the current program level

Bit 6=1 Default program view: Display of the active part program in program level 0.

Bit 7 **Bit 7=1** MD 161 (number of IKA configurations via PLC**/**DB48) is active.

Bit 7=0 MD 161 is disabled. Thus, all (32) IKA configurations via PLC**/**DB48 are active.

Default value: Bit 6=0

Bit 3 **Bit 3=0** The part program is saved in the workpiece STANDARD.

Bit 3=1 The part program is saved in the workpiece NCKTMP.

NC MD	Bit No. 7	6	5	4	3	2	1	0
5197							Modif. of the interf. signal FB24.5 (from SW 6.4)	Display T**/**M active

Bit 0 **Bit 0=0** 840C (T) active

Bit 0=1 840C (M) active

Activation in OVERALL RESET mode

The function of the interface signal (flag byte) FB24.5 (NC alarm with machining standstill) can be changed via the machine data bit 5197.1:

Definition of MD bit 5197.1:

MD 5197.1=0:
For reasons of compatibility, the functionality is the same as of the preceeding software versions, i.e the number of alarms influencing the interface signal MB 24.5 is decreased by the following alarms:
148*,152*, 2065, 2068, 1316*

The machine data 5197 bit 1 can be modified in the user data lists. For this, proceed as follows:
Softkey: "Diagnostics**/**Start-up**/**Machine data**/**User data**/**NC data".
Enter MD 5197.1 in the Editing list and save the data. Then press the softkey "Recall". The machine data can now be modified.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
5198	Compensation beyond working area (from SW 5.03.57)			Block definition from PLC (as from SW 4)	Extended overstore (as from SW 4)	Jerk IPO		Ref. point synch. via G74

Default value: 0

Bit 7 **Bit 7=1** Enables compensation beyond working area

Bit 7=0 Compensation beyond working area disabled

Bit 4 **Bit 4=1** Enables block definition from PLC.

Bit 4=0 Block definition from PLC disabled.

Bit 3 **Bit 3=1** Extended overstore enabled. Only checked if extended overstore is selected.

Bit 2 **Bit 2=1** Jerk-controlled interpolator active

Bit 2=0 Standard interpolator active (default setting)

Bit 0 **Bit 0=1** Reference point synchronization

By selecting the function G74 you can approach the reference point in a programmed axis in a program. The function works in a similar way to the reference point approach in the reference point mode. You can only select this function in AUTOMATIC and MDA modes for one axis at a time.

NC MD	Bit No. 7	6	5	4	3	2	1	0
5199				Display PLC message texts (up to SW 2)	R parameter extension (up to SW 2)			

Default value: 0
Active: On POWER ON

Bit 4 **Bit 4=1** Storing PLC alarm texts (PCF) in the NC part program memory

The alarm texts are stored in the NC part program memory in the same way as in an ASCII file. The block numbers in this alarm text program correspond to the alarm number to which the text is allocated. This file can be read in and out via the MMC/computer link and can be edited, deleted, renamed and copied within the possibilities offered by part program processing with certain restrictions regarding start-up and password.

If available, the alarm texts are taken from the program, otherwise the display submodules search for the alarm text in the UMS.

Bit 3 **Bit 3=1** R parameter extension
This function gives you more R parameters.

R parameters	Basic version	Expansion
Channel-specific	R00 - R599	R600 - R699
Central	R700 - R899	R1000 - R1299

This bit is activated when the softkey "Format R parameters" is pressed in initial clear mode.

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6.6.2 Spindle-specific MD bits (spindle bits)

NC MD	Bit No. 7	6	5	4	3	2	1	0
520*	Spindle override active for thread cutting	No M19 abort on RESET	M19 with axis movement	M19 oriented spindle stop	Speed in 0.1 rev/ min units	Encoder available	Actual value sign change	

Default value		
MD	**840C (T)**	**840C (M)**
5200	0000 0100	0000 0000
5201 - 5205	0000 0000	0000 0000

Active: On NC STOP

Bit 7 **Bit 7=1** When this bit is set, a change in the following error (due to a change in the spindle speed) results in a thread fault!

Note:

Only the leading spindle of the channel may be programmed before first programming and during activated G33, G96 and G97.

Bit 6 **Bit 6=1** M19 is active until the "Acknowledge M19" interface signal is generated, without regard to RESET (or to M02**/**M30 etc.).
(Refer also to the Section entitled ”Axis (Analog) and Spindle Installation”.)

Bit 5 **Bit 5=1** No waiting for positioning of the main spindle; instead, the next program block (which might include axis movement) is executed when M19 is output to the PLC. Positioning (M19) is also terminated with an M3 or M4 in the part program.

Bit 5=0 No acknowledgement with M3 or M4 (block search)

Bit 4 **Bit 4=1** Oriented spindle stop
When this bit is set, the NC can stop the spindle at specific positions. S analog and encoder are required. See Section 6.

Bit 3 **Bit 3=1** The programmed S word is given the dimension 0.1 rev/min, i.e. the speed range lies between 0.1 rev**/**min and 1600 rev**/**min. This bit is required for actual speed monitoring only; the spindle setpoint (speed) is specified in NC MD 403* to 410*. The actual value is always displayed in whole revolutions. For the actual spindle speed monitor, the minimum speed is always approximately 2 rev**/**min for the 0.1 rev**/**min and 1 rev**/**min settings.

Note:

When using this bit it should be noted that a value is entered in MD 403* that is 10 times greater.

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Bit 2 **Bit 2=1** Must be set when a function calling for a spindle encoder is required, e.g.

- G33/34/35 (Thread cutting)
- G 95 (Feedrate per revolution)
- G 96 (Constant cutting speed)
- G 97 (Freeze spindle speed)
- M 19 (Oriented spindle stop)

The encoder is allocated in MD 400*, which also activates the hardware monitor for the measuring circuits. If the M19 option is invoked, bit 2 must be set to 1 (also see Section entitled ”Axis (Analog) and Spindle Installation”).

Bit 1 **Bit 1=1** The sign of the spindle encoder pulses is inverted every time this bit changes its status.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
521*	Spindle available	No spindle zero speed with M03 and Reset	New S value after gear acknow.	Switch off C axis mode on RESET (as from SW 2)	No measuring circuit monitoring	Ramp-up as C axis (as from SW 4)	Setpoint sign change	Automatic drift compen-sation on M19 (as from SW 2)

Default value		
MD	**840C (T)**	**840C (M)**
5210	1000 0000	0000 0000
5211 - 5215	0000 0000	0000 0000

Bit 7 A SINUMERIK 840C system can include up to 6 spindles.

Active: POWER ON

Bit 6 Instead of being decelerated to zero speed on a key-initiated reset, mode change or M2 **/** M30, the spindle continues to rotate at the spindle speed last programmed (spindle override active). In this case, the spindle can be decelerated with the interface signal "Spindle RESET" (DB 31 DR_{k+1}, bit 5).

EMERGENCY STOP (alarm 2000) and all alarms that result in removal of the "Mode group ready" interface signal decelerate the spindle to zero speed in all cases (mode group-specific).

The "Spindle RESET" signal is effective only when the channel to which the spindle is currently allocated (DB 31 DLK_{+1}, bits 0 to 4) is in the RESET state.

This bit has no effect on the M19 function (spindle positioning); only NC MD 520*, bit 6, is relevant.

Active: In next block

Bit 5 Up to SW 4
A newly programmed spindle speed, which requires a gear change (automatic gear selection in the NC), is not accepted until the gear change has been acknowledged over the interface (DB31, DRk, bit 7), thus preventing an unintentional speed increase in the old gear prior to a gear change.

Active: NC STOP

Bit 5 As from SW 5

Bit 5=0 The new speed setpoint is output immediately on a gear stage change.

Bit 5=1 Spindle speed not accepted until acknowledged by PLC.
The new speed setpoint is not output until interface signal ”Switch over gear” has been acknowledged by the PLC user program.

Bit 4 Whether C axis mode is maintained on RESET depends on how bit 4 is set.

Bit 4=0 C axis mode is maintained

Bit 4=1 C axis mode is switched off on RESET

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Bit 3 If the bit is **set**, no measuring circuit monitoring is performed.
Examples for measuring circuit monitoring:

- Check for encoder line breakage
- Check for contamination, if the encoder has a signal for contamination or if the amplitude can be monitored (with unconditioned signal encoders).

Active: Immediately

Bit 2 **Bit 2=1** The spindle is switched to C axis mode on Power On.

Bit 2=0 The spindle is (remains) in spindle mode after Power On.

Bit 1 Is used to match the programmed direction of rotation (M03 and M04) to the main spindle's direction of rotation. When bit 1 = 0, a positive setpoint speed is output for M03. The spindle's direction of rotation can be reversed over the PLC with interface signal "Invert M3/M4" (DB31 DRK + 1).

Active: NC STOP

Bit 0 Automatic drift compensation with M19

The function ”Automatic drift compensation wth M19” has the same effect on spindles as ”Semi-automatic drift compensation” for axes. The function is activated with every M19 command (even if M19 is sent from the command channel), if the function is selected via MD 521*, bit 0, and the end position is approached in M19 operation.

With this function a drift compensation is performed for the spindle when the setpoint position is reached in M19 mode (speed 0 crossing of actual speed) so that the following error of the position control is reduced.

The compensation value is derived from the sum of the NC spindle drift (MD 401*) and the speed setpoint at zero speed. The result is smooth with a filter and stored internally.

The speed setpoint which is sent to the DAC, is derived from the sum of the smoothed internal drift value, the NC spindle drift machine data and the speed setpoint.

The function is deactived by

- Deleting the maching data bit (the internal compensation value is deleted, only NC MD 401* has an effect).

or

- Deleting the alarm ”Speed setpoint warning limit” (control direction monitoring with M19) (the compensation value calculated internally is deleted, only NC MD 401* remains active).

The compensation value is deleted on POWER ON.

Effects on other functions

- **Tacho compensation**

  Tacho compensation is only active during constant movement.

  The new function is only executed after M19 with an actual speed of = 0
  no reciprocal effect.

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- **Control mode**

  The last drift compensation value to be derived is also maintained in control mode (M3**/**M4**/**M5).

- **C axis mode**

  The NC axis drift machine data MD 272* applies here; the compensation calculated by the function ”Automatic drift compensation with M19” has no effect here.

Note:

- If the M19 area is deselected the derived compensation value remains active.

  If the NC spindle drift machine data (NC MD 401*) is altered, the internal compensation value is not deleted, i.e. M19 has to be executed again to adjust the compensation value to the new machine data.
- The internal compensation value is maintained on warm restart.

NC MD	Bit No. 7	6	5	4	3	2	1	0
522*				Switch over parameter groups separately	Switching off with braking ramp	Multiple assignment setpoints	Number of encoder pulses (611D) multiple of	Measuring system with ext. zero mark

Bit 4 **Bit 4=0** Active for digital and analog drives

The parameter set of digital spindles is switched over by presetting the actual gear stage in DB 31, DR K + 1, Bit 0...2. The control signals in DB 31, DR K + 74, bit 0...2 ("Parameter set number") have no effect.

Bit 4=1 The parameter set number of the digital spindle is switched over via PLC control signals DB 31, DR K + 74, bit 0...2 irrespective of the actual NC gear stage.

Bit 3 **Bit 3=0** No braking ramp when switching off the rpm servo control.

The speed setpoint immediately drops to 0 when the rpm servo control is switched off. PLC control signal DB 31, DL K + 74, bit 9 ”Ramp-function generator rapid stop”, has no effect on the setpoint assignment. (No setpoint is output with bit 9 of DB 31 DW 74).

Bit 3=1 Deceleration with braking ramp for mode group stop
If PLC control bit DB 31, DL K + 74, bit 9 = 0, the setpoint is ramped down to zero. Otherwise it is brought abruptly to zero as described above.
This bit is also effective in C axis mode. Braking is then executed with the acceleration from MD 276*. Only SW 4, uses the acceleration from MD 1768* (set of parameters); however, a value greater by the ratio of Ipo to position control cycle must then be entered.

Bit 2 **Bit 2=0** No multiple assignment of setpoint.

The control recognizes if several spindles have been assigned to the same digital setpoint output on runup, which triggers the alarm "Parameterization error NC MD" with service number 329.

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Bit 2=1 The control ignores multiple assignment of different spindles to the same digital setpoint output on runup. The control checks cyclically that the spindles do not access the setpoint output at the same time. If they do, reset alarm 2016, "Multiple assignment of connection" is triggered. This alarm cannot be acknowledged until the rpm servo control has been removed of at least one of the involved spindles by cancellation of the servo enable.

Note:

Multiple assignment of setpoints is only possible with digital setpoint values, the encoders must not be SPC encoders.

Bit 1 (digital drives only)

Bit 1=0 Number of encoder periods between two reference marks is a multiple of 16.

Bit 1=1 Number of encoder periods between two reference marks is a multiple of 10.

Bit 0 **Bit 0=0** The spindle actual value system is updated to the encoder zero marker signal.

Bit 0=1 (digital drives only)
The spindle actual value system is updated when the external zero marker signal is received.

The external zero marker system (BERO proximity switch) must be connected to the drive module.

Note:

The bits have an extended function in SW 4 and higher.

Bit 4 **Bit 4=0** All parameter groups are switched over with the gear stage (active immediately).

Bit 4=1 All parameter groups are switched over separately
Drive (DB 31, DR K+74, bit 0-2)
Position control (DB 31, DR K+xx, bit 0-2)
Transmission (DB 31, DR K+yy, bit 3-5)

Bit 0 With digital and analog drive:

Bit 0=0 Spindle measuring system without external zero marker (BERO) (active immediately).

Bit 0=1 Spindle measuring system with external zero marker (BERO) (active immediately).

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NC MD	Bit No. 7	6	5	4	3	2	1	0
523*	Sign inversion setpoint master/ slave (as from SW 4.4)	Controller output controls master (as from SW 4.4)	Controller output controls slave (as from SW 4.4)	Master-slave oper-ation after Power On (as from SW 4.4)	Position-controlled follow-up if error occurs (as from SW 5)			Extended para. set switchover (as from SW 4)

Active: On Power On

Bit 7 With bit 7 it is possible to take account of different ways in which the master and slave drives might be connected to the common output without having to change the polarity of the control and the direction of travel of the individual drives (MD 5210 bit 1 and MD 5200 bit 1). This bit only has to be set if, given a positive setpoint, the axes**/**spindles would rotate in opposite directions at the mechanical coupling.

Bits 5 and 6 The output of the torque compensation controller is connected with bits 5 and 6. It can either affect the speed setpoint of the slave (bit 5 = 1 only), the master (bit 6 = 1 only) or the master and slave (bits 5 and 6 = 1)

Bit 4 Bit 4=1 If bit 4 = 1, this axis is switched to slave operation immediately after Power On (see Function description Master**/**Slave). This bit is therefore only active after Power On. It is not longer possible to disable this function with a PLC signal.

Bit 3 If bit 3 is set, a master or slave spindle which is also a following spindle is switched over to position-controlled follow-up mode if errors occur in the master**/**slave grouping (multidrive, gearbox interpolation). If no "Extended stopping and retract" is active, switchover is also performed if errors occur in the same mode group.

Note:

This function must not be used if the master spindle is simultaneously the leading spindle for the slave (synchronous spindle), as then an unstable control loop results.

Bit 0 Bit 0=1 Extended parameter switchover

Bit 0=0 Gear stage**/**parameter set change as for Software Versions 1 - 3.

This parameter switchover is only possible with the option bit.

NC MD	Bit No. 7	6	5	4	3	2	1	0
524*					Position control resolution			

Active: On POWER ON

Bits 0 to 3 Position control resolution for spindle

The measuring system resolution chosen is matched to the rotary encoder using the NC machine data MD 455* and 456*.

The coding of the possible measuring system resolutions can be taken from the table giving the position control resolution of the rotary axes (see MD 1800* bit 0 to 3).

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Following spindle-specific machine data bits

NC MD	Bit No. 7	6	5	4	3	2	1	0
525*			Test bit compensa-tory controller		Position overwrite permissible	Coupling factor switchover permissible	Reconfig. permissible	Spindle can be FS

The following bits only apply to following spindles and are active after Power on.

Bit 5 Test bit compensatory controller

Bit 5=1 Compensatory controller test mode switched on

Bit 5=0 Compensatory controller test mode not switched on.

Bit 3 Position overwrite permissible

Bit 3=1 Overwriting positions enabled

Bit 3=0 The synchronous positions (or switching positions) entered for the leading axes**/**spindles must not be overwritten. I.e., synchronization must always start with the same positions.

Bit 2 Coupling factor switchover permissible

Bit 2=1 Switching over the coupling factor is permitted (with G402, G403 commands or via input display)

Bit 2=0 Switchover not permitted.

Bit 1 Reconfiguration permissible

Bit 1=1 Reconfiguration is permissible (with G401 command or via input display)

Bit 1=0 Reconfiguration not permissible

Bit 0 Spindle can be following spindle

Bit 0=1 Spindle can be following spindle

Bit 0=0 Spindle **must not** be a following spindle

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NC MD	Bit No. 7	6	5	4	3	2	1	0
526*	Synchroni-zation of tooth pitch (as from SW 6)		Block change when syn-chronization achieved		Suppres-sion of accel. limit.	Block change with synchro-nism fine	Reserved	Reserved

Bit 7=1 The synchronization path of following spindles is limited to 1 revolution**/**denominator of the GI link ratio to the leading spindle. The synchronous position is then determined by the setting in MD 531*, bit 4 or reached by deceleration.

Bit 7=0 The synchronous position of following spindles is limited to 1 revolution. Above half the maximum speed, the synchronous position is reached by deceleration, below half the maximum speed along the shortest path.

Note:

If bit 4 has been set, synchronization must never be performed while the tool and wheel are in use.

Bit 5 Block change after synchronization (with on-the-fly synchronization)

Bit 5=1 On-the-fly synchronization with G403: Block change after the synchronous position has been reached (see also PLC signal, "Synchronous position reached").

Bit 5=0 Block change immediately, i.e., as soon as synchronization is triggered. Synchronization does not start if PLC signal "Disable LINK ON" is active.

Bit 3 "Suppression of acceleration limitation"

Bit 3=1 "Acceleration limitation not active"
With LINK ACTIVE, the acceleration of the following spindle is not limited by the control but is output directly, as determined by leading spindle. If MD value 2522*-2529* is exceeded, no alarm is triggered.

Bit 3=0 "Acceleration limitation active"
With LINK ACTIVE, the acceleration of the following spindle is limited to the acceleration value set in the machine data (MD 2522*-2529*).

Note:

The limitation remains active until the synchronous speed or zero speed is reached:

- On runup after switching on the link
- When switching from speed ratio
- When stopping the spindle by switching off the link

Bit 2 ”Block change with synchronism fine”

Bit 2=1 After an overlaid movement, block change is triggered in the NC. As soon as the following spindle has reached "Synchronism fine" and all the partial setpoints of the block have been output.

Bit 2=0 Block change is triggered when the synchronism speed has been reached and all the partial setpoints of the block have been output.

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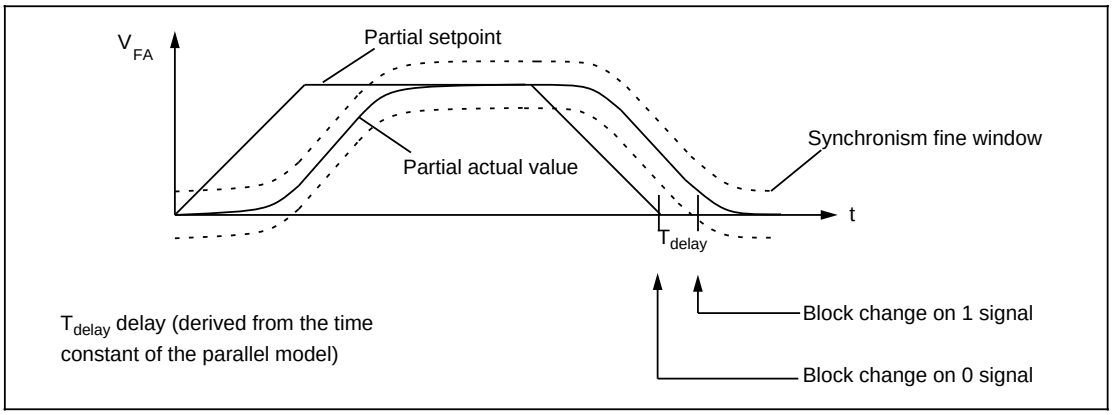

NC MD	Bit No. 7	6	5	4	3	2	1	0
527*			Include tool length compen-sation	Include program-med ZO G58...G59	Include external ZO	Include settable ZO G54...G57	Include DRF and preset	Ref. system GI positions

Active: Immediately

The bits below are defined for the following spindles. They do not affect the following spindles, only the active leading axes which belong the to GI grouping defined by the following spindle. The above values are included when calculating the synchronous position (G403).

Bit 5 **Bit 5=1** Include tool length compensations for GI position calculation
Bit 5=0 Do not include tool length compensations
Circle radius compensations are never included in calculations.

Bit 4 **Bit 4=1** Include programmable ZO offset (G58...G59) for GI position calculations
Bit 4=0 Do not include programmable ZO offset

Bit 3 **Bit 3=1** Include external ZO for GI position calculations
Bit 3=0 Do not include external ZO

Bit 2 **Bit 2=1** Include ZO (G54...G57) for GI position calculations
Bit 2=0 Do not include ZO (G54...G57)

Bit 1 **Bit 1=1** Include DRF and preset for GI position calculations
Bit 1=0 Do not include DRF and preset

Bit 0 Reference system GI positions

Bit 0=1 The positions have been entered in the workpiece system; include offsets as for bits 2..5 in calculation
Bit 0=0 Positions have been entered in machine system; do not include any offsets in calculation

Following axis/following spindle-specific machine data bits

NC MD	Bit No. 7	6	5	4	3	2	1	0
528*	Switch over output bit 7 on emergency retraction	Switch over output bit 6 on emergency retraction	Switch over output bit 5 on emergency retraction	Switch over output bit 4 on emergency retraction	Switch over output bit 3 on emergency retraction	Switch over output bit 2 on emergency retraction	Switch over output bit 1 on emergency retraction	Switch over output bit 0 on emergency retraction

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These bits only affect following spindles and are active immediately

Bit 0-7 Switchover bit for emergency retraction

Bit 0-7=1 The corresponding bit in the output byte of the mixed I/O module is switched from the normal state to the inverted state when an emergency retraction has been triggered by this axis/spindle.

Bit 0-7=0 The corresponding bit in the output byte of the mixed I/O module remains unchanged with an emergency retraction.

Comments:

The normal state is 1 (i.e. the condition after Power on, Reset) for all the bits of the mixed I/O module.

If an axis/spindle triggers an emergency retraction, the bits defined in MD 528* change from 1 to 0.

Even if several axes/spindles trigger an emergency retraction simultaneously or in quick succession and the same bit is marked for all of them, it only changes from the normal state to error once. This is then maintained until the next Reset.

Example:

12 is set in MD 312
This means that the 2nd byte of the 1st mixed I/O module for the first mode group is used for the emergency stop. After Reset all outputs of this byte are set to 1.

S1 (1st spindle) and S2 (2nd spindle) are defined as following spindles.
0001 0001 is set in MD 5280 and 001 0010 is set in MD 5281.
If spindle S1 detects that the emergency retraction threshold has been exceeded in follow-up mode and emergency retraction has been enabled via PLC interface signal, bit 0 and bit 4 in the mixed I/O module change from 1 to 0.
If spindle S2 then detects an emergency retraction, bit 1 additionally changes to 0. Bit 4 is already at 0 and remains so.
With these switchover bits it is possible to output common signals for several spindles of one mode group as well as spindle-specific signals.

NC MD	Bit No. 7	6	5	4	3	2	1	0
529*						Drive-autonomous ext. stop and retract. 1)	Controlled ext. stop and retract. 1)	Trigger alarm + mode group stop on error 1)

Determining spindle-specific responses (spindle was the source of the response). Internal spindle-specific responses

Bit 2 **Bit 2=1** Drive-autonomous extended stopping and retraction enabled.

Bit 2=0 Drive-autonomous extended stopping and retraction disabled.

Bit 1 **Bit 1=1** NC-controlled extended stopping and retraction enabled.

Bit 1=0 NC-controlled extended stopping and retraction disabled.

Bit 0 **Bit 0=1** When a fault is detected an alarm and Mode Group Stop is triggered and, with it, stopping as well as retraction is requested.

Bit 0=0 No alarm or Mode Group Stop is triggered if a fault is detected.

Active: At once

Note:

See functional description of ESR

1) As from SW 4

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NC MD	Bit No. 7	6	5	4	3	2	1	0
530*						EMERG. retraction when generator speed threshold no met 1)	EMERG. retraction when DC link voltage warning threshold not met 1)	EMERG. retraction threshold FA/FS 1)

Spindle-specific sources for retraction.

Bit 2 **Bit 2=1** A retraction movement is triggered if the generator speed of an axis**/**spindle falls below the minimum.

Bit 2=0 A retraction movement is not triggered if the generator speed of an axis**/**spindle falls below the minimum.

Bit 1 **Bit 1=1** A retraction movement is triggered if the DC link undervoltage of an axis**/**spindle falls below the minimum.

Bit 1=0 A retraction movement is not triggered if the DC link undervoltage of an axis**/**spindle falls below the minimum.

Bit 0 **Bit 0=1** A retraction movement is triggered if the retraction threshold of an FA is exceeded.

Bit 0=0 A retraction movement is not triggered if the retraction threshold of an FA is exceeded.

Active: At once

NC MD	Bit No. 7	6	5	4	3	2	1	0
531*				Time-optimized synchroniz-ation (as from SW 6)				

Time-optimized tooth pitch synchronization can be set via bit 4. This means that the synchronized position is approached by deceleration when the following spindle speed is above half the maximum speed. Below this speed the synchronous position is approached along the shortest path.

Note:

- This bit is only active when MD 526*, bit 7,”Synchronization of tooth pitch” is also active.
- Gear wheels must not be in motion when this function is active.

Bit 4 **Bit 4=1** The synchronization path of following axes is limited to 1 revolution**/**denominator of the GI link ratio to the leading spindle. Above half the maximum speed, the synchronous position is reached by deceleration, below half the maximum speed along the shortest path.

Bit 4=0 The synchronization path of following axes is limited to 1 revolution**/**denominator of the GI link ratio of the leading spindle. The synchronization position is then always approached along the shortest path.

1) As from SW 4

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6.6.3 Channel-specific MD bits 1 (channel bits)

NC MD	Bit No. 7	6	5	4	3	2	1	0
540*	No transform-ation deselect on RESET	F value in m/min				Spindle setpoint output (S analog)	G functions to PLC	Aux. functions to PLC

Default value		
MD	**840C (T)**	**840C (M)**
5400	0000 0101	0000 0001
5401	0000 0001	0000 0001
5402	0000 0001	0000 0001
5403	0000 0001	0000 0001
5404	0000 0001	0000 0001
5405	0000 0001	0000 0001

Bit 7 A key-initiated Reset, mode change or M2/M30 does not deselect transformation (TRANSMIT).
Active: RESET

Note:

For as from SW 6, transformation is always deselected on warm restart irrespective of the setting of MD bit ”No transformation deselection on RESET”.

Transformation is always deselected in 'Reference point approach' mode.

Bit 6 Causes the F value to be programmed in m**/**min.
This MD affects all metric input systems. The maximum axial speeds specified in the machine data are not affected (input unit is still 'units').

Programming of F10 Speed 10 m**/**min

The feedrate display depends on the status of this bit. The feedrate for F external and dry run is not converted into m/min. This MD has no effect on "inch" systems, i.e. the feedrate is always defined in inches**/**min.
Active: In the next block

Bit 2 S analog
If this bit is set, it is possible to output analog spindle setpoints.

Bit 1 **Bit 1 = 0** Inhibits G function output to the PLC

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Bit 0 **Bit 0 = 0** Inhibits auxiliary function output to the PLC
Auxiliary functions are: M, S, T, H, D. Use is recommended for computational channels.

For output of the programmed F value to the PLC, see NC MD 544*, bit 0.

Note:

In machining channels bit 0 must always be "1".

Active: In the next block

NC MD	Bit No. 7	6	5	4	3	2	1	0
542*	Fast auxiliary function output to the PLC				T	S	F	D

All auxiliary functions M, S, T, D, H and F are always output to the PLC under acknowledgement control.

For slow auxiliary function output (bits 0 to 3 = 0), the auxiliary function is not acknowledged by the PLC until the cyclic user program (UB1) has been run once.

For fast auxiliary function output (bits 0 to 3 = 1), the auxiliary function is acknowledged by the PLC already after the basic program has been run once. The auxiliary function can be safely recognized in the PLC user program, but read-in disable, feed hold, etc. **cannot** take effect in the same NC block.

Bit 0 to 3=1 Fast auxiliary function output to the PLC
Bit 0 to 3=0 Slow auxiliary function output to the PLC (default setting).
Active: Immediately

Notes:

- The auxiliary functions M and H can be declared as fast auxiliary functions by programming ”–” (e.g. M-03) (see Programming Guide).
- If several auxiliary functions are programmed in one block, all auxiliary functions must be parameterized as fast auxiliary functions so that output to the PLC is "fast". This also applies to the F word even if it is not transferred to the PLC (see MD 544*, bit 0).

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NC MD	Bit No. 7	6	5	4	3	2	1	0
544*	Output of auxiliary functions in BCD: F	H	D	T	S	M		No F value output to PLC

Default value: All 0
Active: In the next block

Bit 7-2 **Bit 7-2=1** The auxiliary function is output to the PLC in BCD. Bit 2 may not be set to 1 because of the basic PLC program.

Bit 7-2=0 If the basic program M functions are to be decoded.
The auxiliary function is output to the PLC in hexadecimal (binary).

Bit 0 F value output to the PLC is deselected via machine data. This makes it possible to improve the time required for block changes involving travel blocks with F values, as it is not necessary to wait for an acknowledgement from the PLC (e.g. 5D machining).

NC MD	Bit No. 7	6	5	4	3	2	1	0
546*	Aux. functions that are output immediately instead of being collected during block search with calculation: F	H	D	T	S	M		No aux. function on block search

Default value: All 0
Active: At once

Bit 7, 6, 5, 4, 3, 2
The auxiliary function types defined by these bits are not collected during a block search with calculation, but are output immediately (may result in PLC based triggering of several switching functions in succession).

Bit 0 When this bit is set, all auxiliary functions (M, S, T, D, H and F) encountered during a block search with calculation are skipped and ignored (no output to PLC and no internal reaction).

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	Bit patterns for bits...							Description
	7	**6**	**5**	**4**	**3**	**2**	**0**	
Example a		Irrelevant						No output of auxiliary functions
Example b	0	0	0	0	0	0	0	All auxiliary functions are collected and the last is output following NC START
Example c	1	1	1	1	1	1	0	All auxiliary functions are output during block search with calculation
Example d	0	0	0	0	0	1	0	M functions are output during block search with calculation; F, H, D, T and S functions are collected and the last function output following NC START.

All auxiliary functions that were collected during block search are activated with NC START at the end of the block search and output to the PLC. The 'collection' procedure ensures that only the last F, H, D, T, S and M function becomes active.

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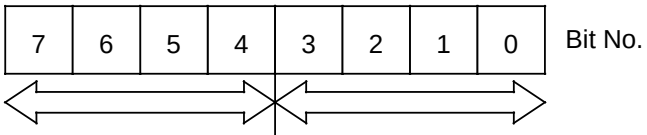
NC MD	Bit No. 7	6	5	4	3	2	1	0
548*	Name of the abscissa (horizontal axis) (same code as for axis definition)							
550*	Name of the ordinate (perpendicular axis) (same code as for axis definition)							
552*	Name of the applicate (vertical axis) (same code as for axis definition)							



Extended address (Address number)

Code:
blank = 0000
1 = 0001
2 = 0010
3 = 0011
4 = 0100
5 = 0101
6 = 0110
7 = 0111
8 = 1000
9 = 1001
10 = 1010
11 = 1011
12 = 1100
13 = 1101
14 = 1110
15 = 1111

Address name

Code:
X = 0000
Y = 0001
Z = 0010
A = 0011
B = 0100
C = 0101
U = 0110
V = 0111
W = 1000
Q = 1001
E = 1010

Permissible names for axes, angle, chamfer and radius

A	*Assignable address*	N	Subordinate block
B	*Assignable address*	O	Danger of confusion with 0 (zero)
C	*Assignable address*	P	Number of subroutine passes
D	Tool offset number	***Q***	*Assignable address*
E	*Assignable address*	R	Arithmetic parameter
F	Feed	S	Spindle speed, S function
G	G function	T	Tool
H	H function	***U***	*Assignable address*
I	Interpolation parameter	***V***	*Assignable address*
J	Interpolation parameter	***W***	*Assignable address*
K	Interpolation parameter	***X***	*Assignable address*
L	Subroutine	***Y***	*Assignable address*
M	M function	***Z***	*Assignable address*

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With SINUMERIK 840C, the initial plane is defined in NC MD 110*. In NC MDs 548*, 550* and 552* you define to which axes the radius compensation and/or length compensation is to apply when the NC is switched on. In NC MD 548* and 550* you define the axes to which the radius compensation is to apply in the default setting, i.e. when the NC is switched on. In NC MD 552* you define the axis to which the length compensation 1 (tool parameter P2) is to apply (for cutters only). The axis to which the second length compensation (tool parameter P3) is to apply depends on the order of the programmed axes and the tool type.

Example:

NC MD 548* = 0000 0000 X axis
NC MD 550* = 0000 0001 Y axis
NC MD 552* = 0000 0010 Z axis

- Program

N10 G0 G41 D1 X0 Y0 Z0 (D1 = tool type 20 cutter)
Radius is calculated in X-Y
L1 is calculated in Z
L2 is not calculated

- Program

N10 G16 X Y Y Z (plane selection)
N20 G0 G41 D1 X ... Y ... Z ... (D1 = tool type 30 angle-headed cutter)

Radius is calculated in X-Y
L1 is calculated in Y
L2 is calculated in Z

- Program

N10 G16 Z X Z (plane selection)
N20 G0 D1 Z ..... (D1 = tool type 10 drill)

No radius is calculated
L1 is calculated in Z

Z-X (G18) is to be selected as the initial plane on a lathe with an X and Z axis. The NC MD must be set as follows:

NC MD 548* = 0000 0000
NC MD 550* = 0000 0010
NC MD 552* = 0000 0010

Plane Z-X is defined with NC MD 548* and 552*. The axis to which the L1 geometry is to apply is set in NC MD 550* if a drill or a cutter is used.

Applies up to tool type 9:	Length 1 (tool parameter P2) always refers to the second axis name behind G16<
	Length 2 (tool parameter P3) always refers to first axis name behind G16
	Length 1 (tool parameter P2) always refers to the transverse axis.

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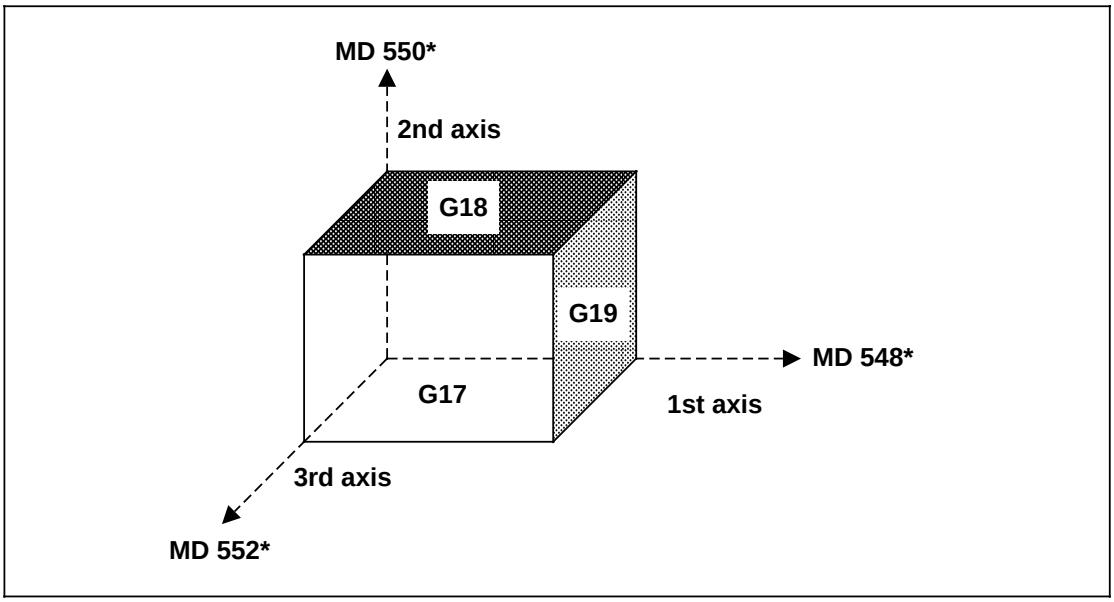

PLANE	G17	G18	G19
Axis No.	1	3	2
	2	1	3
	3	2	1

NC MD	Bit No. 7	6	5	4	3	2	1	0
554*	Axis with constant cutting speed G96							

Default value: All 0
Active: When the function is reprogrammed

The **number** of the axis with which the constant cutting speed (G96) is to be attained must be specified (normally the transverse axis).
The axis number must be specified as follows:

1st axis ... 0000 0000
2nd axis ... 0000 0001
3rd axis ... 0000 0010
4th axis ... 0000 0011
.
.
.
8th axis ... 0000 1000

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NC MD	Bit No. 7	6	5	4	3	2	1	0
558*					Autom. refresh when changing the param. block of a mode group axis (from SW 6.1)			Supplement axis after block search

Default value: 0

Bit 0 **Bit 0 = 1** The "3D interpolation" option must be programmed. Following the block search with calculation, not only the axes programmed in the destination block are traversed, but also as many as 5 additional axes, as long as these axes were previously programmed.

If more than 5 axes were programmed, the first 5 must be traversed in REPOS mode. Tool offset, current D no. or zero offset must not be modified prior to NC START.

Bit 0 = 0 Following the block search with calculation, only the axes programmed in the destination block are traversed. It is thus possible to modify the TO and the ZO prior to NC START.

Active: In the next block

Bit 3 **Bit 3=1** If the parameter set "Position control" is switched over for an axis of the mode group, a "Refresh" is carried out with the next block change with exact stop (i.e. not with G62**/**G64 enabled). The parameter set-dependent data for velocity, acceleration and jerk are therefore effective in the pre-calculated blocks. This function should only be used if there are axes in a channel that use the parameter block change for velocity, acceleration or jerk.

Bit 3=0 If the parameter set "Position control" is switched over, the new machine data values for velocity, acceleration and jerk are only effective with time delay (after the pre-calculated blocks have been processed). In order to avoid this, a @714 must be programmed in the part program or a NC Stop**/**NC Start must be preset for the current channel.

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6.6.4 Axis-specific MD bits 1 (axial bits 1)

NC MD	Bit No. 7	6	5	4	3	2	1	0
560*	Act.-value display modulo 360 deg.	Automatic direction recog. on referencing	Software limit switches active	NC start although ref. pt. not reached	Rounding for rotary axes	Rounding to whole/half degrees	Dyn. SW limit switch for following axes	Servo loop monitor not active

Default value: MD 5600-5629 0010 0000

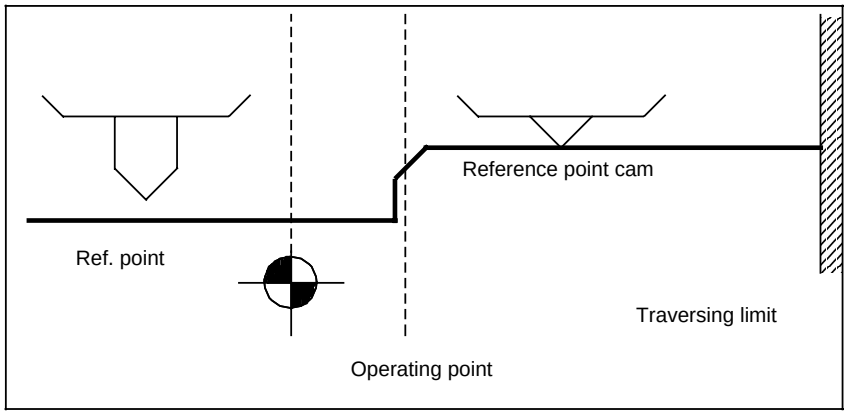
Bit 7 For rotary axes (NC MD 564*, bits 5-1)! Acts on linear axes as well.

The actual-value display jumps from 359.999 to 0 degrees after one revolution of the rotary axis.
Rotary axes, see also Section Functional Descriptions.

Active On: RESET

Bit 6 **Bit 6 =1** The NC can detect precisely the direction in which the reference point lies from the "Deceleration" interface signal, as the reference point extends up to the traversing limit (also see Section Axis (Analog) and Spindle Installation).

Active On: NC STOP



Bit 6 = 0 If the axis is between the reference point cam and EMERGENCY STOP when the control is powered up, the axis moves to EMERGENCY STOP during reference point approach, as the control cannot detect from the "Deceleration" interface signal whether the axis is ahead of or behind the reference point cam (also see Section Axis (Analog) and Spindle Installation).

Bit 5 **Bit 5 = 0** The software limit switches defined in NC MD 224* to 236* are overrun without a reaction of any kind. The working field limitation (setting data) is not in force.
Active On: RESET

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Bit 4 The program can be started with NC START without approach to the reference point of this axis.
Bit 3 of NC MD 5004 can be used to indicate whether reference point approach is required prior to program start; this bit applies to all axes and channels.

Active On: NC STOP

Bit 3, 2 May be set for rotary axes only! In JOG mode, bit 2 is used to choose between rounding (positioning) to whole or to half degrees. Bit 2 = 1 means rounding to whole degrees.
In AUTOMATIC or MDA mode, alarm 2064 is displayed for programmed positions which do not represent a movement of 0.5 or 1 degree (rounding for rotary axis incorrectly programmed). The occurrence of axis-specific, spindle-specific or channel-specific alarms which result in opening of the closed position control loop (removal of MODE GROUP READY), on RESET and on EMERGENCY STOP, the control is no longer able to position the rotary axis to a half or a whole degree. In this case, the rotary axis must not be lowered into the serration.

Active On: NC STOP

Bit 1 Bit 1 = 1 This bit activates the function ”Dyn. SW limit switch for following axes”.

Active On: Power On

Bit 0 Alarm 132* is disabled. The cables to the encoder are no longer monitored for cable breaks. An encoder failure or cable break is therefore not immediately flagged, but rather with a greater delay in form of alarm 104*, 112* or 116*. Nor does the measuring circuit monitoring switch off the zero and pulse code monitoring.

Active On: NC STOP

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NC MD	Bit No. 7	6	5	4	3	2	1	0
564*	Axis exists	Axis type	Rotary axis	Division axis	Actual values division-related	Actual value sign change	Setpoint sign change	Ref. point appr. in neg. direction

Default value		
MD	**T**	**M**
5640	1000 0010	1000 0010
5641	1000 0010	1000 0010
5642	0	1000 0010
5643	0	0
5644 . . . 5669	0 . . . 0	0 . . . 0

840T: Bit 7 in MD 5640 and 5641 must be "1".
840M: Bit 7 in MD 5640, 5641 and 5642 must be "1".

Bit 7 When this bit is set, the axis is displayed on the monitor screen and the position controller and measuring circuit monitor are activated. PLC MD 6016 and 6017 must be observed as regards the interface.
If this bit is set the axis can be used as an auxiliary axis. Interpolation is then not permissible.
Active On: POWER ON

Bit 6 Fictitious axes are required for coordinate transformation (see NC MD 5060 to 5069). Fictitious axes have no position controller (NC MD 200* irrelevant) and require no measuring circuit. Fictitious axes must be linear axes.
Active On: POWER ON

Note:
SW4: With a fictitious axis, only 14 real axes are possible. With reference to MD 2000.

Bit 5 The axis is declared as rotary axis. Position control thus begins in degrees, and G70/G71 is disabled for rotary axis programming. For further details on rotary axes, also see Section entitled ”Functional Descriptions”.
Active On: NC STOP

Bit 4 Bit 4 ("Division axis") declares a linear or rotary axis to be a division axis, and thus activates NC MD 1104*, 1108*, 1112* and 564* bit 3. See Section entitled ”Functional Descriptions”.
Active: At once

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Bit 3 The actual value (actual position display) is converted into division positions. A division position < 1 is not possible (applies to both rotary and linear axes). The actual value display in the Service data is not converted into division positions.

If bit 3 is not set for a division axis, the position is assigned (over command channel) in division positions but the actual value is displayed in mm or inches. Also see Section entitled ”Functional Descriptions”.

Active: At once

Bit 2 The signs of the measuring-system pulses can be inverted by changing the state of this bit (this is necessary when the axis traverses uncontrollably due to an incorrect position control direction). This bit has no effect, if the spindle and the C axis have the same actual value. In this case the spindle bit is active instead.

Active On: NC STOP

Bit 1 A change in the state of the bit changes the polarity of the speed controller's setpoint voltage (necessary when the axis moves in a direction which is 'mechanically' incorrect).
Active On: RESET

Bit 0 **Bit 0 = 1** Start reference point approach with " **-** " key

Bit 0 = 0 Start reference point approach with " + " key

Active On: RESET

NC MD	Bit No. 7	6	5	4	3	2	1	0
568*	AXIS NAME							

Default value		
MD	**T**	**M**
5680	0000 0000	0000 0000
5681	0000 0010	0000 0001
5682	0	0000 0010
5683 . . . 5709	0 . . . 0	0 . . . 0

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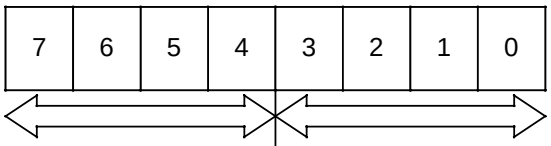
The axis name must be defined according to the table.



Extended address (address number)	Address name
Code:	Code:
blank = 0000	X = 0000
1 = 0001	Y = 0001
2 = 0010	Z = 0010
3 = 0011	A = 0011
4 = 0100	B = 0100
5 = 0101	C = 0101
6 = 0110	U = 0110
7 = 0111	V = 0111
8 = 1000	W = 1000
9 = 1001	Q = 1001
10 = 1010	E = 1010
11 = 1011	
12 = 1100	
13 = 1101	
14 = 1110	
15 = 1111	

Example: 0000 0010=Z
0001 1001=Q1

The names in MD 5000, MD 5001 and 568* must not overlap. Identical address names with different address extensions are not regarded as overlaps.
For a list of permissible names, see NC MD 5000
Active: In the next block

Permissible names for axes, angle, chamfer and radius

A	*Assignable address*	N	Subordinate block
B	*Assignable address*	O	Danger of confusion with 0 (zero)
C	*Assignable address*	P	Number of subroutine passes
D	Tool offset number	***Q***	*Assignable address*
E	*Assignable address*	R	Arithmetic parameter
F	Feed	S	Spindle speed, S function
G	G function	T	Tool
H	H function	***U***	*Assignable address*
I	Interpolation parameter	***V***	*Assignable address*
J	Interpolation parameter	***W***	*Assignable address*
K	Interpolation parameter	***X***	*Assignable address*
L	Subroutine	***Y***	*Assignable address*
M	M function	***Z***	*Assignable address*

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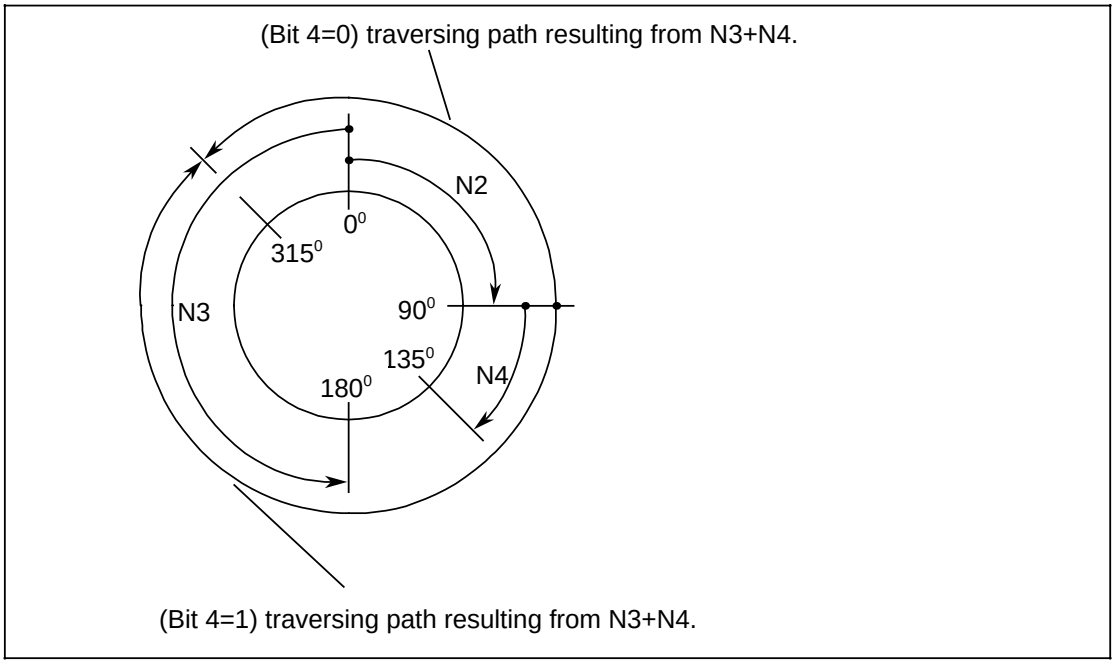
NC MD	Bit No. 7	6	5	4	3	2	1	0
572*				Traverse rotary axis modulo 360 deg.	TO mirroring for transverse axis	Modulo 360° prog. of rotary axis	Transverse axis	Axes without TO on PRESET

Default value: MD 572 = 0000 1010 only on the 840C; otherwise, all bits are 0.
For 840C (M), all are 0.
Active: In the next block

Bit 4 **Bit 4 = 0** When G90 and/or G68 are programmed with rotary axes, traversing paths of > 360 degrees or > 180 degrees can result, and the established direction of movement can change if zero offsets, tool offsets etc. are set up for the first time or if ZO, TO etc. are altered in the program.

Example:

N1 G90 C0 LF (C ... rotary axis)
N2 C90 LF
N3 G58 C-180 LF
N4 G90 C+135 LF



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Bit 4 **Bit 4=1** To set a traversing path and direction with G90 programming which corresponds to the program. The control behaves according to the G function programmed:

G91: No modulo 360° calculation. The current ZO and TO are added to the programmed position (more than 360° also possible) which results in a new position and a new direction of movement.

G90: The current ZO and TO are added to the programmed position (± 359.999 degrees), a modulo 360° calculation is carried out and the determined traversing path is traversed with the programmed direction of travel (+ ... clockwise movement, – ... counter-clockwise direction) (see example above).

G68: The current ZO and TO are added to the programmed position (0 to 359.999 degrees), a modulo 360° calculation is performed and the midpoint is determined (± 180 degrees). The control can then determine the shortest direction of movement.

Bit 3 The tool length compensations and the position of the tool nose are mirrored for tool types 1 to 9 (lathe tools) depending on the axis-specific bit.

Bit 2 **Bit 2=1** The rotary axis can be programmed to an absolute (G90) value of max. ± 359.999 degrees. The sign programmed determines the direction of movement.

(See Programming Guide for programming rotary axes).
A rotary axis can also be programmed with G68 where positioning is along the shortest path (max. ± 180 degrees).

If a rotary axis is programmed for the **first** time is a part program, the control always selects G68, irrespective of the G function program (G68, G90, G91). Automatic selection of G68 can only be deselected with G91 C0 (C ... rotary axis). Automatic selection of G68 is also performed after a block search and can in this case only be deselected by traversing the axis in REPOS. If a ”Modulo” rotary axis is switched to follow-up mode, G68 automatically becomes active with NC start for the next traversing block of this rotary axis.

If mixed programming of G90/G91 has been selected in the block (NC MD 5007 bit 5), it is always the last programmed G90/G91 function which affects the programmed rotary axis position.
See Section Functional Descriptions for rotary axes.

Bit 2=0 The path programming and rotary axis traversing is the same as for linear axes.

Bit 1 In the 840C, the X axis is a transverse axis with diameter programming as standard. This bit activates the bits set in NC MD 5011.

Bit 0 No TO are calculated in this axis on PRESET.

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NC-MD	Bit No. 7	6	5	4	3	2	1	0
576*			6 [1]	5 [1]	Axis disabled for channel 4	3	2	1

Default: All 0

Bit 3, 2, 1, 0 The channel for which a bit is set cannot traverse the axis. Alarm 3014 (”Axis disabled in channel”) is displayed in the event of an error. The disable is effective in AUTOMATIC and MDI AUTOMATIC mode only (not with command channel and absolute/incremental dimension from PLC function).

Active: Block before decoding

NC-MD	Bit No. 7	6	5	4	3	2	1	0
584*							Dynamic software limit switch for following axis (as from SW 6)	Initial setting of simulta-neous axis [1]

Bit 0 **Bit 0=1** The initial setting for simultaneous axis mode is G98.

Bit 0=0 The initial setting for simultaneous axis mode is G94.

Bit 1 The dynamic limit switch for ELG following axes can be operated without dead-time compensation in certain circumstances. Not the actual value, but a precalculated ”actual value” is used in the calculation. The function is activated via MD 5029.0 and axis-specifically via MD 584*.1.

1) As from SW 4

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NC MD	Bit No. 7	6	5	4	3	2	1	0
588*	Switch over output bit 7 on emergency retraction	Switch over output bit 6 on emergency retraction	Switch over output bit 5 on emergency retraction	Switch over output bit 4 on emergency retraction	Switch over output bit 3 on emergency retraction	Switch over output bit 2 on emergency retraction	Switch over output bit 1 on emergency retraction	Switch over output bit 0 on emergency retraction

These bits only affect following axes and are active immediately

Bit 0-7 Switchover bit for emergency retraction

Bit 0-7 = 1 The corresponding bit in the output byte of the mixed I/O module only switches from rest to the inverse condition when an emergency retraction has been triggered by this axis.

Bit 0-7 = 0 The corresponding bit in the output byte of the mixed I/O module remains unchanged with an emergency retraction.

Active: At once

Comments:

The state of rest (i.e. the condition after Power on, Reset) is 1 for all the bits of mixed I/O module.
If an axis/spindle triggers an emergency retraction, the bits defined in MD 588*, 528* change from 1 to 0.
Even if several axes trigger an emergency retraction simultaneously or in quick succession and the same bit is marked for all of them, it only changes from rest to error condition once. This is then maintained until the next Reset.

Example:

12 is set in MD 312
This means that for the first mode group the 2nd byte of the 1st mixed I/O module is used for the emergency stop. After Reset all outputs of this byte are set to 1.

X (1st axis) and Y (2nd axis) are defined as following axes.
0001 0001 is set in MD 5880 and 001 0010 is set in MD 5881.
If the X axis detects that the emergency retraction threshold has been exceeded in follow-up mode and emergency retraction has been enabled via PLC interface signal, bit 0 and bit 4 in the mixed I/O module change from 1 to 0.
If the Y axis then detects an emergency retraction, bit 1 additionally toggles to 0. Bit 4 is already at 0 and remains so.
With these switchover bits it is possible to output common signals for several axes of one mode group as well as axis-specific signals.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
592*						ESR drive-autonomous 1)	ESR controlled by the NC 1)	Trigger alarm + mode group stop on error 1)

Determining axis-specific responses (axis was the source of the response). Internal axis-specific responses

Bit 2 **Bit 2=1** Drive-autonomous extended stop and retract enabled.

Bit 2=0 Drive-autonomous extended stop and retract disabled.

Bit 1 **Bit 1=1** NC-controlled extended stop and retract enabled.

Bit 1=0 NC-controlled extended stop and retract disabled.

Bit 0 **Bit 0=1** When a fault is detected an alarm and Mode Group Stop is triggered and, with it, stop as well as retract is requested.

Bit 0=0 No alarm or Mode Group Stop is triggered if a fault is detected.

Active: At once

Note:

See functional description of ESR

NC MD	Bit No. 7	6	5	4	3	2	1	0
596*						Generator speed below threshold 1)	Retract if DC link warn. threshold not met 1)	Retraction threshold FA/FS 1)

Axis-specific sources for retraction.

Bit 2 Relevant for 611D only.

Bit 2=1 A retraction movement is triggered if the generator speed of an axis/spindle falls below the threshold value.

Bit 2=0 A retraction movement is not triggered if the generator speed of an axis/spindle falls below the threshold value.

Bit 1 Relevant for 611D only.

Bit 1=1 A retraction movement is triggered if the DC link voltage of an axis/spindle falls below the threshold value.

Bit 1=0 A retraction movement is not triggered if the DC link voltage of an axis/spindle falls below the threshold value.

Bit 0 **Bit 0=1** A retraction movement is triggered if the retraction threshold of an FA is exceeded.

Bit 0=0 A retraction movement is not triggered if the retraction threshold of an FA is exceeded.

Active: at once

1) As from SW 4

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6.6.5 Leadscrew error compensation bits (compensation flags)

MD No.	Bit No. 7	6	5	4	3	2	1	0
6000	C point 4 yes/no	+/–	C point 3 yes/no	+/–	C point 2 yes/no	+/–	C point 1 yes/no	+/–
6001	C point 8 yes/no	+/–	C point 7 yes/no	+/–	C point 6 yes/no	+/–	C point 5 yes/no	+/–
6002	C point 12 yes/no	+/–	C point 11 yes/no	+/–	C point 10 yes/no	+/–	C point 9 yes/no	+/–
-//-								
-//-								
-//-								
-//-								
-//-								
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-//-								
-//-								
6248	C point 996 yes/no	+/–	C point 995 yes/no	+/–	C point 994 yes/no	+/–	C point 993 yes/no	+/–
6249	C point 1000 yes/no	+/–	C point 999 yes/no	+/–	C point 998 yes/no	+/–	C point 997 yes/no	+/–

-	Bit = 0	Negative compensation
+	Bit = 1	Positive compensation
no	Bit = 0	No compensation
yes	Bit = 1	No compensation

All MD for leadscrew error compensation become effective on Power On and following completion of reference point approach. See Section entitled ”Functional Descriptions”.
Default value: All 0

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6.6.6 Channel-specific MD bits 2

NC MD	Bit No. 7	6	5	4	3	2	1	0
9000 to 9005	Channel-specific axis allocation for multi-channel display (channels 1 to 6)							
	Axis 8	Axis 7	Axis 6	Axis 5	Axis 4	Axis 3	Axis 2	Axis 1
9020 to 9025	Channel-specific axis allocation for multi-channel display (channels 1 to 6)							
	Axis 16	Axis 15	Axis 14	Axis 13	Axis 12	Axis 11	Axis 10	Axis 9
9040 to 9045	Channel-specific axis allocation for multi-channel display (channels 1 to 6)							
	Axis 24	Axis 23	Axis 22	Axis 21	Axis 20	Axis 19	Axis 18	Axis 17
9060 to 9065	Channel-specific axis allocation for multi-channel display (channels 1 to 6)							
			Axis 30	Axis 29	Axis 28	Axis 27	Axis 26	Axis 25

Default value: 0

Channel 5 and 6 as from SW 4

Note:

Valid if option "Multi-channel display" is set.
As from SW 5 also valid with single-channel display if NC MD 5053, bit 0=1

Note:

See also description of NC MD 5053, bit 0, channel-specific axis and spindle display.

Channel-specific spindle assignment with multiple-channel display (up to SW 4)
Channel-specific spindle assignment with single and multiple channel display (as from SW 5)

NC MD	Bit No. 7	6	5	4	3	2	1	0
9100 to 9105	Channel-specific spindle allocation for multi-channel display (channels 1 to 6)							
			Spindle 6	Spindle 5	Spindle 4	Spindle 3	Spindle 2	Spindle 1

Default value: 0

Channel 5 and 6 as from SW 4

Note:

Valid if option "Multi-channel display" is set.
As from SW 5 also valid with single-channel display if NC MD 5053, bit 0=1

Note:

See also description of NC MD 5053, bit 0, channel-specific axis and spindle display.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
914*								Channel with FIFO (up to SW2)

Default value: all bits default to 0

Bit 0 **Bit 0=0** Channel without FIFO

Bit 0=1 Channel with FIFO

Active: On warm restart**/**Power On

If FIFO is selected for the four MDs only once, the entire storage space (30 Kbytes) is allocated to the respective channel.

If two FIFO channels are selected, these two channels share the available storage space (15 Kbytes per channel).

If more than two channels are defined, an error message (”Too many FIFO channels defined” alarm) is issued.

NC MD	Bit No. 7	6	5	4	3	2	1	0
916*	Toggle output bit 7 on emer-gency retraction 1)	Toggle output bit 6 on emer-gency retraction 1)	Toggle output bit 5 on emer-gency retraction 1)	Toggle output bit 4 on emer-gency retraction 1)	Toggle output bit 3 on emer-gency retraction 1)	Toggle output bit 2 on emer-gency retraction 1)	Toggle output bit 1 on emer-gency retraction 1)	Toggle output bit 0 on emer-gency retraction 1)

Toggle of outputs for retraction enabled: Bits 7 to 0

Bit 0-7 **Bit 0-7=1** The corresponding bit in the output byte of the mixed I/O module is inverted when a retraction is triggered by this channel.

Bit 0-7=0 The corresponding bit in the output byte of the mixed I/O module remains unaltered on retraction.

Active: at once

NC MD	Bit No. 7	6	5	4	3	2	1	0
918*							NC-controlled ext. stop. and retract. 1)	Trigger alarm + mode group stop on error 1)

Bit 1 **Bit 1=1** NC-controlled extended stopping and retraction enabled.

Bit 1=0 NC-controlled extended stopping and retraction disabled.

Bit 0 **Bit 0=1** When a fault is detected an alarm and Mode Group Stop is triggered and, with it, stopping as well as retraction is requested.

Bit 0=0 No alarm or Mode Group Stop is triggered if a fault is detected.

1) As from SW 4

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NC MD	Bit No. 7	6	5	4	3	2	1	0
920*							Emergency Stop triggers retraction 1)	Mode Group Stop triggers retraction 1)

Bit 1 **Bit 1=1** Emergency Stop triggers a retraction.

Bit 1=0 Emergency Stop does not trigger a retraction.

Bit 0 **Bit 0=1** Mode Group Stop triggers a retraction.

Bit 0=0 Mode Group Stop does not trigger a retraction.

Active: at once

NC MD	Bit No. 7	6	5	4	3	2	1	0
922*	Input bit 7 triggers retraction 1)	Input bit 6 triggers retraction 1)	Input bit 5 triggers retraction 1)	Input bit 4 triggers retraction 1)	Input bit 3 triggers retraction 1)	Input bit 2 triggers retraction 1)	Input bit 1 triggers retraction 1)	Input bit 0 triggers retraction 1)

Effect of mixed I/O or CSB inputs bit 7 to 0

Bit 7-0 **Bit 7-0=1** If a 0 V signal is applied at the corresponding input of the mixed I/O module or CSB, a retraction is triggered.

Bit 7-0=0 The level of the input does not trigger a retraction in any position.

Active: at once

Note:

The 6 CSB inputs correspond to bits 2 - 7, bit 0 corresponds measurement input 1, bit 1 corresponds to measurement input 2.

1) As from SW 4

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6.7 Axis-specific MD 2 (axial data 2)

1100*	SW prelimit switch		Active at once
Default value	Lower input limit	Upper input limit	Units
20 000	**- 99 999 999**	**99 999 999**	**units (MS)**

Defines the distance at which the braking operation is to be prematurely begun if the current speed exceeds the speed in NC MD 1, thus ensuring that the position of the software limit switch will be overrun only to a negligible degree during circular interpolation.

Overshooting of the pre-limit switch triggers alarm 3091 except in the case of rapid traverse.

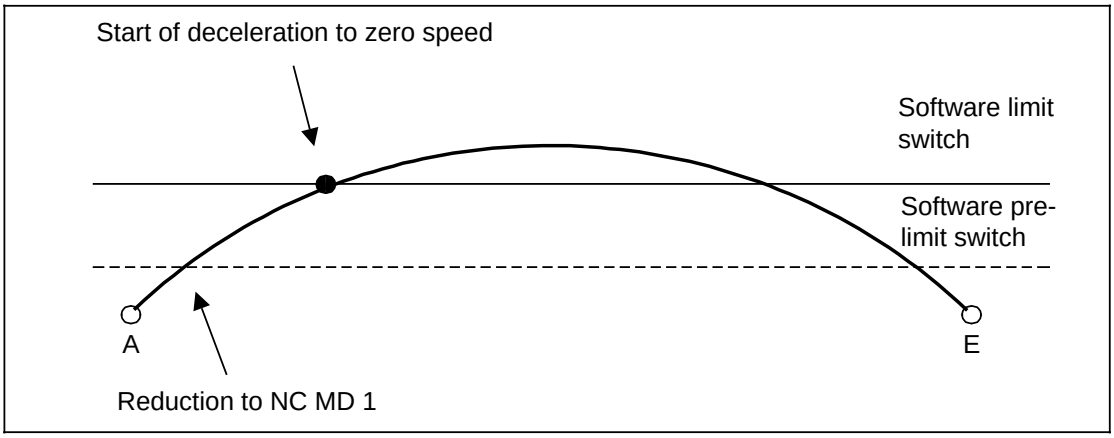
Recommendation

The value entered should be slightly higher than the value which would correspond to the braking distance from rapid traverse to NC MD 1.

In program mode, travel movements which would result in overshooting of the software limit switch position are simply not started (alarm 2065 is triggered).

Exception!

Circular interpolation, helical interpolation



Machine data for the ”Setup mode division-related” function.

1104*	Number of divisions		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**999**	**–**

Input limits: The value 0 is allowed only if the axis involved is **not** an indexing axis (NC MD 564* bit 4 = 0).

The number of divisions gives the divisions per division reference dimension (NC MD 1108*).

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1108*	Division reference dimension		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**99 999 999**	**units (MS)**

Note:

The rotary axis has a defaulted internal reference dimension of 360 degrees in accordance with the input resolution. No input is necessary.

When using the function in conjuction with chain-type magazines it may be necessary for the rotary axis to perform several revolutions to arrive at one magazine revolution.

The division reference in this case will still be 360°. Adjustment of either the rotary axis or the chain-type magazine can be carried out by variable increment weighting.

1112*	Division dimension offset		Activ **see below**
Default value	Lower input limit	Upper input limit	Units
0	**- 999 9999**	**99 999 99**	**units (IS)**

Remarks regarding the action of machine data:

If the use of the function is dependent on the workpiece, the machine data are changed while the workpiece is being machined and in setup mode. This can be done by:

- MD modification from the PLC
- MD modification via configuration
- MD modification via CL 800

The machine data can be configured in such a way that they can be changed without start up mode. They take effect immediately after change without, for instance, Warm restart or Reset having to be performed.

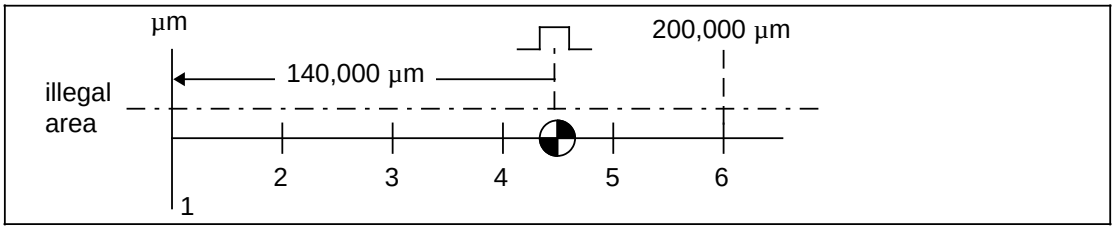
If, for instance, the division machine data are changed while a division processing operation is in progress, they will take effect after about only 100 ms.

Traversing an indexing axis to the reference point

If the function is used on a machine-specific basis, the indexing axis can be traversed to a division-specific reference point. The MD ”Reference point offset” can be used to specify the distance of the zero mark to an indexing position. The indexing axis need not be traversed to an indexing position using the reference point. The next traverse of the axis after reference point approach is automatically a movement to an indexing position.

Example:

Linear axis: Number of divisions = 5
Division reference dimension = 200,000 µm
Reference point = 140,000 µm;
Reference point offset = 0;



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1116*	f: Pulse multiplication EXE/611D/HMS 1st measuring system		Active on **Power On Warm restart**
Default value	Lower input limit	Upper input limit	Units
1	**1**	**128** [1] **512** [2]	**–**

MD 1116* is used to set the multiplication factor for the actual position pulses when using the 6FX 1145-6B... HMS measuring-circuit module. On Power On, the NC software checks to see whether an HMS measuring-circuit module has been inserted; only when this is the case does MD 1116* take effect.

The following multiplication factors can be specified:

HMS: 1, 2, 4, 8, 16, 32, 64, 128

611D/PCU: 1, 2, 4, 8, 16, 32, 64, 128, 256, 512

Measuring system resolution = measuring system x 4 x MD 1116*

Note

This MD also has an effect when the measuring system of the digital drive (611-D) is used.

1124*	D component feedforward control		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1 000**	**0.1 %**

Active: When activating feedforward control

MD 1124* is used to modify the setpoint speed in proportion to acceleration. Where position control cycles are < 1 ms, the rise process can be accelerated even more by the D component. It should not be used with larger sampling intervals.

Note:

As from SW 4, for 8 parameter blocks

1140 *	Feedforward control factor 3rd parameter set [3]		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**1 000**	**0.1%**

This MD has the same meaning as MD 312*, see also functional description of parameter set switchover.

1) *As from SW 2*
2) *As from SW 3*
3) *As from SW 4*

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1144*	Switch over current setpoint 1)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
60	60 1 2)	999	0.1 % of max. current setpoint

Move against fixed stop

Current setpoint which is to take effect as soon as speed control mode switches to current control mode. The percentage that has to be entered refers to the max. motor current (drive machine data MD 1104) and the possible reduction of the max. motor current (drive machine data MD 1105). The holding torque can be matched still further in setting data SD 320*. See functional description for ”Travel to fixed stop”

1148*	IKA/TK speed 1)		Active on at once
Default value	Lower input limit	Upper input limit	Units
500	0	4 900 000	1000 units (IS) / min

If the max. speed as IKA partial setpoint is exceeded, interface signal "IKA/TKH SPEED" is set in DB 32.

1152*	Speed tolerance endlessly turning rotary axis (as from SW 4)		Active on see below
Default value	Lower input limit	Upper input limit	Units
10	+0	+100	%

If the actual speed of the "endlessly turning rotary axis" remains within the setpoint speed tolerance defined in this machine data, interface bit "Axis in setpoint range" is set.

The tolerance monitoring is activated by switching on "Endlessly turning rotary axis" with G[..]103 and G[..]104 and defining a new speed.

If movement is aborted in the mode group (Mode Group Ready = 0), an ERA does not have to be explicitly reset with axis reset. ERA is reset with a mode group reset.

1156*-1180*	D component feedforward control 2nd - 8th parameter set 2)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	+0	1 000	0.1%

This MD has the same meaning as MD 1124*, see also functional description of parameter set switchover.

1) *As from SW 3*
2) *As from SW 4*

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1184*-1196*	Feedforward control factor 4th - 7th parameter set 3)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	+0	1 000	0.1%

This MD has the same meaning as MD 312*, see also functional description of parameter set switchover.

1200*	Delay for contour monitoring		Active in all channels of mode group in STOP
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	ms

With this MD, it is possible to set a time where the contour deviation may exceed that of MD 332* without an alarm message ”Contour monitoring” being output.

1204*	f: Pulse multiplication EXE/611D/HMS 2nd measuring system 1)		Active on Power On
Default value	Lower input limit	Upper input limit	Units
1	1	128 1) 512 2)	–

Active: After POWER ON

The matching of the internal computing precision and the precision of the second measuring system is carried out in the same way as the settings for the first measuring system (MD 364*/368*/1116*).

1) *As from SW 2*
2) *As from SW 3*
3) *As from SW 4*

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1208*	u: Impulses variable incremental weighting 2nd measuring system 1)		Active on Power On
Default value	Lower input limit	Upper input limit	Units
1	0	65000 1) 9999 9999 2)	–

Active: After Power On

Applies to feed axes only.

See MD 364*, 368*.

1212*	v: Traversing path variable incremental weighting 2nd measuring system 1)		Active on Power On
Default value	Lower input limit	Upper input limit	Units
1	0	65 000 1) 9999 9999 2)	units (MS)

Active: After POWER ON

Applies to feed axes only.

See MD 364*, 368*.

1216*	Switchover tolerance 1st/2nd measuring system		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0 1000 3)	0	16 000	units (MS)

Active: After Power On

Applies only to feed axes (not to C axes for spindles).

This machine data defines the maximum tolerance between the actual value of the first measuring system and the actual value of the second measuring system which must not be exceeded at the time of switching from one measuring system to another. Otherwise a setpoint value jump occurs because the position controller tries to compensate for the change in the actual value. To prevent this it is not possible to switch from one measuring system to another when the tolerance is not maintained and the alarm 1016* ”Measuring system switchover not possible” is output.

1220*	Servo gain (Kv) factor 3rd parameter set		Active on Power On
Default value	Lower input limit	Upper input limit	Units
1 666	0	10 000 80 000 (as from SW 5)	0.01s^{-1}

This MD has the same meaning as MD 252*, see also functional description of parameter set switchover.

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1) As from SW 2
2) As from SW 3
3) As from SW 4

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1224*	Servo enable switch-off delay		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
200	0	1 000	ms

The speed enable (servo enable) on the servo loop is revoked after the set delay time has elapsed. The servo enable is available on the servo loop once per axis/spindle and is allocated by the control on a mode group specific basis.

Action of the time delay entered:

1. After the interpolater has reached the programmed position, the clamping tolerance (MD 212*) is activated after the set time delay has elapsed. At this instant, the following error must therefore be less than the clamping tolerance. The time must be set to be long enough for the maximum following error (rapid traverse) to be removed. Failure to do this causes the servo enable on the servo loop to be revoked and alarm 112* (zero speed control) is issued.

   This applies only if NC MD 372* (zero speed control delay) is set to 0.

2. Time delay for removing the servo enable on the servo loop after ”EMERGENCY STOP” and other errors leading to immediate stoppage of the axes (e.g. contour monitoring).

3. Time delay for removal of servo enable on the servo loop when the servo enable of an axis has be revoked by the PLC.

   Modification of MD 1224* does not take effect until ”POWER ON” and replaces the axis-independent MD 156.

1228*	Backlash compensation 2nd measuring system 1)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	- 16 000	16 000	units (MS)

Active: At once

MD 1228* has the same significance/unit as MD 220* (backlash compensation first measuring system).

A different backlash occurs in this system if the second measuring system is connected in a different way. When the measuring system is switched over, the associated compensation value is always activated:

Measuring system 1 active: MD 220* active
Measuring system 2 active: MD 1228* active

1232*	Compensation value 1)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	0.01 %2) 0.1 (mV)

1) *As from SW 2*
2) *As from SW 3*

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1236*	Compensation time constant quadrant error compensation (SW 2 and SW 3)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	0.1 ms

1236*	1st compensation time constant 3)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
150	0	16 000 99 999 999 (as from SW 4.4)	0.1 ms

MD 1236* defines the recovery time for the compensation setpoint pulse when operation is without its adaptation. MD 1236* applies to neural and conventional quadrant error compensation. If the adaptation of the recovery time constant (neural QEC only) is selected (MD 1812*, bit 2 = 1), MD 1236* defines the filter time constant in the middle of the working range, MD 1364* defines the value for acceleration 0.

1240*	Minimum compensation (as from SW 1)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	0.01 %2) 0.1 (mV)

See Section Functional Descriptions for installation of the friction feedforward control function.

1244*	Range limit 1		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	100 (units MS/s^2)

1248*	Range limit 2		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	100 (units MS/s^2)

1252*	Range limit 3		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	10000 (units MS/s^2)

1256*	Smoothing time constant (SW 2 and higher)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0 60 3)	0	16 000 99 999 999 3)	MS

See Section entitled ”Functional Descriptions” for installation of the quadrant error compensation function.

1) As from SW 2
2) As from SW 3
3) As from SW 4

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1256*	Filter time constant acceleration determination for quadrant error compensation (as from SW 4)		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
60	**0**	**16 000**	**1 ms**

This value is usually not altered by the user. The value should only be increased if the compensation in the smallest speed range is insufficient.

1260*	Feedfwd control factor for rigid tapping (as from SW 2)		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1 000**	**0.1 %**

A P feedforward control factor can be entered for the axes involved in the function ”Rigid tapping”. This machine data has the same meaning as that of NC MD 312*. NC MD 1260* is only used if NC MD 1320* is not 0.

1264*	Grid spacing / ENDAT measuring step (as from SW 5.4)		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**16 000**	**-**

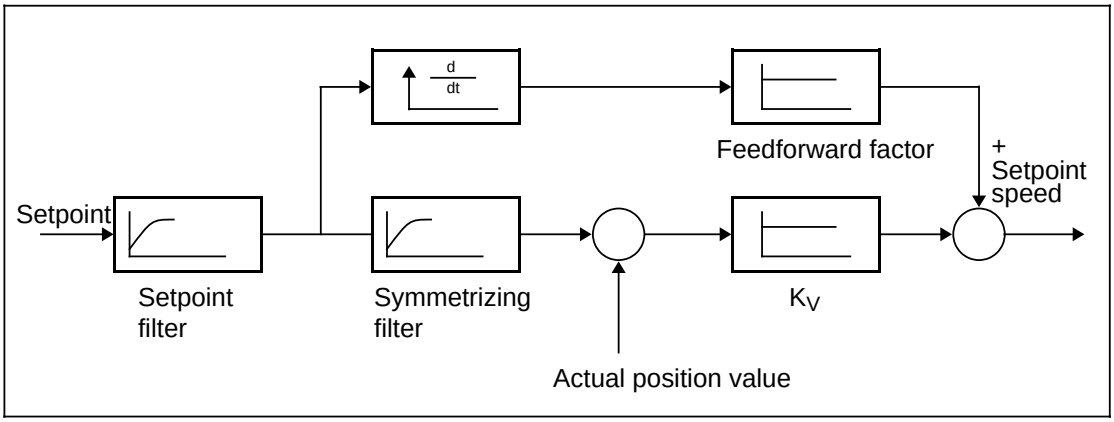
The SINUMERIK 840C supports ENDAT absolute encoders where the ratio of grating pitch**/**ENDAT measuring step as an integer can be divided by 4. If you enter an incorrect value, this leads to measuring errors. The input values 0 to 7 are internally processed as the value 4 (default value for rot. EQN 1325). The grid spacing and the ENDAT measuring step must be taken from the data sheet of the ENDAT absolute encoder.

1272*	Setpoint filter time constant		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1 000**	**0.1 ms**

The setpoint filter prevents overshooting of positions in the case of a dynamic speed feedforward control of 100 %.

Note:

As from SW 4, for 8 parameter blocks



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1280*	Following error threshold for detecting the fixed stop (as from SW 3)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
1 000	0	16 000	units (MS)
1 000	0	99 999 999 (as from SW 4.4)	units (MS)

Following error increase threshold for detecting the fixed stop.

This machine data is only active when MD 1804* bit 4 = 0. The signal ”Fixed stop reached” is set when the following error has been exceeded by the value defined in MD 1280*.

Example:

MD 1280* = 500 = 0.5 mm
Traversing velocity 1000 mm/min
Servo gain factor = 1 following error 1 mm

The triggering threshold for the fixed stop reached in this example is:
1 mm + 0.5 mm = 1.5 mm

1284*	Clamping tolerance		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
100	0	16 000	units (MS)
100	0	99 999 999 (as from SW 4.4)	units (MS)

Zero speed control window in fixed stop.

This data only takes effect when MD 1804*, bit 3 = 1.

If the position at which the fixed stop was triggered is exceeded by more than the tolerance defined in MD 1284*, travel to fixed stop is aborted with an error message.

1288*	Torque compensation controller integral action time		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	1 000 000 99 999 999 (as from SW 4.4)	ms

The integral action of the torque compensation controller is parameterized in the integral action time. The integral action is deactivated if set to the default value 0 because the proportional action (MD 1384*) already ensures an adequate static distribution of torque.

The additional integral action can produce a better distribution in multi-slave operation. Practical values are in the region of seconds. See also MD 1812*.

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1292*	Motor current on equilibration (as from SW 3)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	-70 -700 (as from SW 4)	70 700 (as from SW 4)	0.1 % of the power section current

MD 1292* is used to define the value of an additional torque of a motor used to compensate for stationary loads (e.g. pull of gravity on hanging axes) (this MD is only active for digital feed spindle drives).

Note: As from SW 4, for 8 parameter sets

1296*	Period of the learning signal (as from SW 4.4)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	ms

The learning signal period of neural quadrant error compensation can be changed with this data. This also alters the **required traversing range** and the learning time.

Note:

With default value 0 and values under 500 ms are used a permanently set period length of 2 s is used. Up to SW 4.3 this time cannot be parameterized and is permanently set to 1 s.

1300*	Basic distance for distance coding		Active on Power On
Default value	Lower input limit	Upper input limit	Units
1 000	0	16 000	–

Active: After POWER ON

The basic distance between the reference marks for distance coded linear scales entered in multiples of the grating pitch (division period).

1304*	External pulse multiplication		Active on Power On
Default value	Lower input limit	Upper input limit	Units
1	1	100	–

Active: After Power On

External pulse multiplication factor (e.g. external EXE error) for linear measuring systems with distance coded reference points.

The number of signal periods (grid lines) that are generated from **one** division period of the of the linear scale (grating pitch) by external interpolation digital electronics.

1308*	Servo gain factor 4th parameter set (as from SW 4)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
1 666	0	10 000 80 000 (as from SW 5)	$0.01s^{-1}$

These MD have the same meaning as MD 252*, see also ”Functional Descriptions: Parameter set switchover”.

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1312*	Servo gain factor 5th parameter set (as from SW 4)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
1 666	0	10 000 80 000 (as from SW 5)	0.01s^{-1}

These MD have the same meaning as MD 252*, see also ”Functional Descriptions: Parameter set switchover”.

1316*	Servo gain factor 6th parameter set (as from SW 4)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
1 666	0	10 000 80 000 (as from SW 5)	0.01s^{-1}

These MD have the same meaning as MD 252*, see also ”Functional Descriptions: Parameter set switchover”.

1320*	Servo gain factor 2nd parameter set for thread cutting (G33, G36, G63)		Active in BAG in Stop
Default value	Lower input limit	Upper input limit	Units
0	166 0 (as from SW 4.4)	10 000 80 000 (as from SW 5)	0.01 s^{-1}

Active: All channels of the mode group in STOP

This NC MD is similar to NC MD 252*. However, it only applies to axes involved in the function ”Thread” (G33 to G36, G63) (see Section entitled ”Functional Descriptions”).

As the rotary axis and the infeed axes interpolate for tapping, both of these axes must be set with the active servo gain factor.

The time constants for the dynamic feedforward control (see NC MD 1324*) and the feed-forward control factor (NC MD 1260*) can also be used to reduce the following error.

Input value ”0” means that instead of 1320* the value from 252*, instead of 1324* the value from 392* and instead of 1260* the value from 312* are used.

Note:

SW 4 and higher: see the section entitled ”Functional Descriptions: Parameter set switchover”.

1324*	Time constant symmetrizing filter rigid tapping		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	1 000	0.1 ms

Active: In the next block

A time constant of the dynamic feedforward control can be entered for the axes involved in the function ”Thread” (G33 to G36, G63).

This machine data has the same effect as NC MD 392*.

NC MD 1324* is only used when NC MD 1320* is not equal to 0.

Note:

As from SW 4, for 8 parameter sets see the section entitled ”Functional Descriptions: Parameter set switchover”.

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1328*	Servo gain factor 7th parameter set (as from SW 4)		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
1 666	**0**	**10 000 80 000 (as from SW 5)**	**$0.01s^{-1}$**

These MD have the same meaning as MD 252*, see also ”Functional Descriptions: Parameter set switchover”.

1332*	Servo gain factor 8th parameter set (as from SW 4)		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
1 666	**0**	**10 000 80 000 (as from SW 5)**	**$0.01s^{-1}$**

These MD have the same meaning as MD 252*, see also ”Functional Descriptions: Parameter set switchover”.

1336*	Master for speed setpoint coupling (as from SW 4.4)			Active on **Power On**
Default value	Lower input limit	Upper input limit	Units	
0	**0**	**50**	**-**	

Machine data 1336* assigns the master to a slave for speed setpoint coupling. The speed setpoint is taken from the axis entered here and output as the speed setpoint while ignoring its own position control. The assignment is made with the axis**/**spindle number.

Value	0	1 - 30	41 - 46
Meaning	No axis**/**spindle	Axis 1 - 30	Spindle 1 - 6

1340*	Master for torque compensation control (as from SW 4.4)			Active on **Power On**
Default value	Lower input limit	Upper input limit	Units	
0	**0**	**50**	**-**	

Machine data 1340* assigns the master axis to a slave. The torque setpoint is taken from the axis entered here and compared with the torque setpoint of its own drive. The difference is the input variable for the torque compensation controller.

The assignment is made via the axis**/**spindle number.

If the default value 0 is entered, the master of the speed setpoint coupling (MD 1336*) is also used for the torque compensation control.

Value	0	1 - 30	41 - 46
Meaning	No axis**/**spindle	Axis 1 - 30	Spindle 1 - 6

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1344*	Torque distribution torque compensation controller (SW 4.4 and higher)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
500	**0**	**984**	**‰**

With MD 1344*, the input variables of the torque compensation controller are weighted to permit a parameterizable torque distribution over both drives according to the respective moments of inertia.

The standard parameterization of 500 _ produces a distribution according to the values in **drive machine data** 1725 (normalization torque setpoint interface) for both axes. If a different distribution is to be used, MD 1344* must be calculated according to the following formula:

$$\text{MD 1344*} = \frac{M_{desired_{slave}}}{M_{desired_{slave}} + M_{desired_{master}} * \frac{\text{MD 1725}_{slave}}{\text{MD 1725}_{master}}} \cdot 1000\ ‰.$$

$M_{desired}$ is the desired torque distribution between master and slave.

1364*	2nd compensation time constant (as from SW 4)		Active on NC Stop
150	**0**	**9999 9999**	**0.1 ms**

MD 1236* defines the recovery time for the compensation setpoint pulse when operation is without its adaptation. MD 1236* applies to neural and conventional quadrant error compensation. If the adaptation of the recovery time constant (neural QEC only) is selected (MD 1812*, bit 2 = 1), MD 1236* defines the filter time constant in the middle of the working range, MD 1364* defines the value for acceleration 0.

1368*	Learning rate (as from SW 4)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
100	**1**	**500**	**%**

The learning rate for neural quadrant error compensation defines how quickly the neural network learns the optimum characteristic during the neural quadrant error compensation (MD 1812*, bit 0 and 1 set) active learning phase. A high learning rate means a short learning phase, which in the worst situation can cause instability. A low learning rate is recommended for learning processes during normal operation as otherwise the characteristic will be changed if even the smallest disturbance occurs when the speed goes through zero. Reproducibility is then no longer possible.

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1372*	Measuring time 1 (neural QEC only) (as from SW 4)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
600	1	9999 9999	% of MD 1236*

1376*	Measuring time 2 (neural QEC only) (as from SW 4)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
300	1	9999 9999	% of MD 1236*

1380*	Measuring time 3 (neural QEC only) (as from SW 4)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
300	1	9999 9999	% of MD 1236*

Measuring times MD 1372* - 1380* are used to set the adaptation of the measuring duration to determine the fault criteria during the neural quadrant error compensation learning phase (MD 1812*, bit 0 and 1).

If this measuring duration is to remain constant, all 3 machine data must be parameterized to the same value. Reparameterization of the standard value is usually not necessary because a percentage is entered in MD 1236*.

The middle measuring duration (MD 1376*) is also used for conventional quadrant error compensation if the service QEC display is used to make the settings.

Special features:

If the value 0 is entered in MD 1236*, 100% = 10 ms, as otherwise it is not possible to parameterize error measuring times > 0.

1384*	Torque compensation controller P component (as from SW 4.4)		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
100	0	1 000 000	0.0001%

The P gain of the torque compensation controller is parameterized in % of the ratio drive maximum speed to nominal torque of the slave drive. The input variable of the torque compensation controller is the difference in torque between master and slave, the output variable is a speed setpoint. See also MD 1812* and 523*.

Formula:

Output variable = P gain * control difference

Example:

A torque difference of 10 % of the slave nominal torque and standard parameterization 100 (= 0.01%) produces an output variable of the controller of 0.001 % of the maximum speed of the slave drive (0.01 % * 10 % = 0.001 %).

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1388*	Measuring circuit assignment 2nd measuring system (as from SW 2)		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**5030000 analog (as from SW 2) 15021000 (as from SW 3) 30021000 (as from SW 5)**	**–**

Active: After POWER ON.

Only applies to feed axes.

The second measuring system is defined in the same way as the first measuring system with MD 200*.

1392*	Feedforward control factor 8th parameter set (as from SW 4)		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**1 000**	**0.1 %**

This MD has the same meaning as MD 312*, see also functional description of parameter set switchover.

1396*	Position control cycle		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
1	**1**	**64**	**–**

NC MD 1396* modifies NC MD 155 ”Position controller sampling time”, i. e. the controller can be slowed down by a factor of 2 to 64.

Permissible values:

1, 2, 4, 8, 16, 32, 64

The following applies:

Position control cycle time = Position control basic cycle x MD 1396*

Conditions: $\frac{\text{Interpolation cycle}}{\text{Axial pos. control cycle}}$ >1 (integer)

See also MD 466*

1420*	P component compensatory controller		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**16 000**	**1**

Note: As from SW 4, for 8 parameter sets

1424*	I component compensatory controller		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**16 000**	**1**

Note: As from SW 4, for 8 parameter sets

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1428*	D component compensatory controller		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	**0**	**16 000**	**1**

These machine data are only used for the functionality "Electronic gearbox".

Together with the installed test function (activated with NC MD 1844* bit 5), these machine data are used to set the control behaviour of the PID compensatory controller.

For additional information see the functional description of the electronic gearbox.

Note:

As from SW 4, for 8 parameter sets

1432*	Time constant parallel model		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
6 000	**0**	**16 000**	**0.01 ms**

This machine data is only used for the functionality "Electronic gearbox".

The parallel model must be set to the time constant of the position control loop of the following axis (time constant T=1/servo gain).
If the value 16000 is entered in the machine data, the system automatically calculates the actual servo gain factor and the time constant of the following axis. However, this actual servo gain factor is only stored internally, it cannot be looked at.

The value 16000 entered for the time constant is also automatically replaced by the value derived by the control.

Note:

As from SW 4, for 8 parameter sets

1436*	Tolerance range synchronism fine		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
40	**0**	**16 000 99999999 (SW5.4 and higher)**	**1 unit (MS)**

Note:

As from SW 4, for 8 parameter sets

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1440*	Tolerance range synchronism coarse		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
100	**0**	**16 000 99999999 (SW 5.4 and higher)**	**1 unit (MS)**

This machine data is only used for the functionality "Electronic gearbox".

During LINK ACTIVE, the positional difference of the following axis compared with the leading axes/spindles is monitored by the tolerance range "Synchronism fine" and "Synchronism coarse". If the positional difference is greater than the tolerance range, then the corresponding PLC interface signal SYNCHRONISM FINE OR SYNCHRONISM COARSE is set to 0 signal. With these interface signals it is therefore possible to determine the positional synchronism of the following axis.

More detailed information is given in the functional description of the electronic gearbox.

Note:

As from SW 4, for 8 parameter sets

1444*	Emergency retraction threshold		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
400	**0**	**16 000 99999999 (SW 5.4 and higher)**	**1 unit (MS)**

This machine data is only used for the functionality "Electronic gearbox".

With LINK ACTIVE, the positional difference between the following axis and the leading axes can be monitored with the machine data value ”Emergency retraction threshold”. The emergency retraction monitoring must be enabled by setting an interface signal.

If the positional difference exceeds this threshold value, it can be output very quickly via a digital hardware signal. An NC alarm ("Following axis emergency retraction") and the PLC interface signal EMERGENCY RETRACTION ACTIVE are also set.

The MIXED I/O module must be in use in the servo area to achieve a very fast signal "Emergency retraction" (in the positional control cycle).

More detailed information is given in the functional description of the electronic gearbox.

Note:

As from SW 4, for 8 parameter sets

1448*	Warning threshold n_{max} and a_{max}		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
90	**0**	**100**	**%**

Every axis is limited to a maximum acceleration and a maximum speed (NC MD 276*, 280*).

In addition, the following axis is in both cases checked against a warning threshold. The warning threshold is defined in this machine data and applies to both the speed threshold and the acceleration threshold. The warning threshold is entered as a percentage of the maximum value in question.

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If the calculated setpoint speed/setpoint acceleration of the following axis is greater than the defined values, the corresponding interface signals are set at the PLC interface.

If, for example, 50 is entered in MD 276* as the acceleration value, interface signal "ACCELERATION WARNING THRESHOLD REACHED" is set if 45 is exceeded in the standard setting.

More detailed information is given in the functional description of the electronic gearbox.

1452*	**Delay controlled follow-up**		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
16 000	**0**	**16 000**	**1 (ms)**

If a fault occurs with the leading axes, the following axis goes into follow-up mode, i.e. traverses with actual values as the control value (see the functional description of the electronic gearbox, "Maintenance of link during faults"). After the delay shown above, the following spindle switches from "controlled follow-up" to "normal follow-up" (follow-up mode).

Effect of the input values (different cases):

0:	No controlled follow-up; immediate normal follow-up
1...15000:	Initial controlled follow-up; switchover to normal follow-up after the delay
15001 and higher:	Always controlled follow-up; no switchover to normal follow-up

1456*	**Default setting link type**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**–**	**3 4** [1)]	**–**

This machine data only applies to leading axes.

Type of link:

0 No default
1 Setpoint position link
2 Actual position link
3 Setpoint position link (with simulated actual values of the leading drives; the compensatory controller only reacts to following axis faults.
4 Actual position link**/**setpoint speed link [1)]

The compensatory controller can be activated**/**deactivated via the PLC signals "Compensatory controller ON**/**OFF".

The machine data is used for two applications.

1) As from SW 4

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Application:
A gearbox grouping can be configured with the G401 command. If the type of link has not been defined in the G401 command, the default value from MD 1456* is taken.

Example:

`G401 X Y Z` X, Y: leading axes, Z: following axis, no link type.

If "No default" (MD 1456* = 0) has been entered and no link type has been entered in G401, reset alarm "GI CONFIGURATION illegal" is triggered.

1460*-1480*	**Time constant symmetrizing filter 3rd - 8th parameter set (as from SW 4)**		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**+0**	**1 000**	**0.1 ms**

These MD have the same meaning as MD 392*, see also ”Functional Descriptions: Parameter set switchover”.

1484*-1508*	**Time constant setpoint filter 2nd - 8th parameter set (as from SW 4)**		Active on **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1 000**	**0.1 ms**

These MD have the same meaning as MD 1272*, see also ”Functional Descriptions: Parameter set switchover”.

1512*-1536*	**Scaling factor max. velocity 2nd - 8th parameter set (as from SW 4)**		Active in **channel of mode group in STOP**
Default value	Lower input limit	Upper input limit	Units
10 000	**1**	**99 999 999**	**$\frac{mm}{min}$ $\frac{inch}{min}$ $\frac{degr.}{min}$**

These MD have the same meaning as MD 256*, see also ”Functional Descriptions: Parameter set switchover”.

1540*-1564*	**Exact stop limit coarse 2nd - 8th parameter set (as from SW 4)**		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
40	**+0**	**16 000**	**units (MS)**
40	**+0**	**99 999 999 (SW 4.4 and higher)**	**units (MS)**

These MD have the same meaning as MD 204*, see also ”Functional Descriptions: Parameter set switchover”.

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1568*-1592*	Exact stop limit fine 2nd - 8th parameter set		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
10	+0	16 000	units (MS)
10	+0	99 999 999 (as from SW 4.4)	units (MS)

These MD have the same meaning as MD 208*, see also ”Functional Descriptions: Parameter set switchover”.

1596*-1620*	Zero speed monitoring 2nd - 8th parameter set		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
100	0	16 000	units (MS)
100	0	99 999 999 (as from SW 4.4)	units (MS)

These MD have the same meaning as MD 212*, see also ”Functional Descriptions: Parameter set switchover”.

1624*-1648*	P component compensatory controller 2nd - 8th parameter set (as from SW 4)		Active on RESET
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	1

These MD have the same meaning as MD 1420*, see also ”Functional Descriptions: Parameter set switchover”.

1652*-1676*	I component compensatory controller 2nd - 8th parameter set (as from SW 4)		Active on RESET
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	1

These MD have the same meaning as MD 1424*, see also ”Functional Descriptions: Parameter set switchover”.

1680*-1704*	D component compensatory controller 2nd - 8th parameter set (as from SW 4)		Active on RESET
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	1

These MD have the same meaning as MD 1428*, see also ”Functional Descriptions: Parameter set switchover”.

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1708*-1732*	Time constant parallel model 2nd - 8th parameter set (as from SW 4)		Active on **RESET**
Default value	Lower input limit	Upper input limit	Units
6 000	**0**	**16 000**	**0.01 ms**

These MD have the same meaning as MD 1432*, see also ”Functional Descriptions: Parameter set switchover”.These machine data are only active with gearbox interpolation.

1736*-1764*	Alarm limit velocity 1st - 8th parameter set (as from SW 4)		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
11 000	**1**	**99 999 999**	**10 000 units/s^2**

Meaning: Limitation of max. velocity for following axis. These machine data are only active with gearbox interpolation.

Note:

For parameter grouping see under ”Functional Descriptions: Parameter set switchover”.

1768*-1796*	Alarm limit acceleration 1st - 8th parameter set (as from SW 4)		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
55	**0**	**16 000**	**10 000 units/s^2**

Meaning: Limitation of max. acceleration for following axis. These machine data are only active with gearbox interpolation.

Note:

For parameter grouping see under ”Functional descriptions: Parameter set switchover”.

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6.7.1 Axis-specific MD bits 2 (axial bits 2)

NC MD	Bit No. 7	6	5	4	3	2	1	0
1800*	Display resolution				Position control resolution			

Code table for resolution

Bit 7	Bit 6	Bit 5	Bit 4	Input resolution			
Bit 7	Bit 6	Bit 5	Bit 4		Display resolution		NC MD 1800*
Bit 3	Bit 2	Bit 1	Bit 0			Position control resolution	NC MD 1800*
0	0	0	0	————	10^{-1} [mm] [degrees]	0.5 x 10^{-1} [degr.]	Metric (Degrees)
1	0	0	0	10^{-2} [mm] [degrees]	10^{-2} [mm] [degrees]	0.5 x 10^{-2} [degr.]	
0	1	0	0	10^{-3} [mm] [degrees]	10-3 [mm] [degrees]	0.5 x 10^{-3} [degr.]	
1	1	0	0	————	————	2 x 10^{-4} [degr.]	
0	0	1	0	10^{-4} [mm] [degrees]	10^{-4} [mm] [degrees]	0.5 x 10^{-4} [degr.]	
1	0	1	0	10^{-5} [mm] [degrees]	10^{-5} [mm] [degrees]	0.5 x 10^{-5} [degr.]	
0	1	1	0	————	————	————	
1	1	1	0	————	————	————	
0	0	0	1	————	10^{-1} [degrees]	0.5 x 10^{-1} [degr.]	Inches (Degrees)
1	0	0	1	————	10^{-2} [degrees]	0.5 x 10^{-2} [degr.]	
0	1	0	1	10^{-3} [inches] [degrees]	10^{-3} [inches] [degrees]	0.5 x 10^{-3} [inches] [degr.]	
1	1	0	1	10^{-4} [inches] [degrees]	10^{-4} [inches] [degrees]	0.5 x 10^{-4} [inches] [degr.]	
0	0	1	1	————	————	2 x 10^{-5} [inches]	
1	0	1	1	10^{-5} [inches] [degrees]	10^{-5} [inches] [degrees]	0.5 x 10^{-5} [inches] [degr.]	
0	1	1	1	10^{-6} [zoll] [grad]	————	————	
1	1	1	1	————	————	————	
0	1	0	0	= Standard machine data			

The display resolution determines the path of travel in "incremental feed" mode.
Input resolution see NC MD 5002.
For possible combinations, see Section entitled ”Axis (Analog) and Spindle Installation”.

Active: POWER ON

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NC MD	Bit No. 7	6	5	4	3	2	1	0
1804*	Adaptation (as from SW 2)	Quadrant error comp-ensation (as from SW 2)	Axis can travel against fixed stop (as from SW 3)	Sensor signal PLC fixed stop (as from SW 3)	Monitoring clamping tolerance act. (as from SW 3)		Automatic tacho comp-ensation (as from SW 2)	Symmetrical traversing range ENDAT absolute encoder (as from SW 6)

Standard value: 0000 0000

Bit 7 See Section entitled ”Functional Descriptions”

Bit 6 See Section entitled ”Functional Descriptions”

Bit 5 **Bit 5=0** Axis cannot move against fixed stop.

Bit 5=1 Axis can move against fixed stop.
This bit must be set for any axis which is allowed to move against the fixed stop.

Caution:

MD 1804*, bit 5, must only be set for **real** axes. It must **not** be set for fictitious main and coupled-motion axes.

Bit 4 **Bit 4=1** "Fixed stop reached" is sent to the NC via an external sensor.

Bit 4 **Bit 4=0** "Fixed stop reached" is calculated internally by the servo from the following error increase factor.

Bit 3 **Bit 3=0** Zero speed monitoring for moving against fixed stop off

Bit 3=1 Zero speed monitoring for moving against fixed stop on

Bit 1 The function ”Tacho compensation” is used to compensate for drive and tacho characteristic errors which can occur with an analog coupling (e.g. temperature problems). The function can also be used to correct incorrect tacho settings. Deviations of up to 12.5 % of the multgain (setpoint adaptation/maximum load speed) can be compensated (multgain adjustment).

The tacho compensation calculates a new compensation value if:

- a constant velocity is used for traversing and
- the velocity of the axis is greater than 6.25 % of the maximum velocity.

If one of these conditions is not fulfilled, the compensation value remains constant at the last calculated value. If the compensation value exceeds 12.5 % of the set multgain, this limiting value is used for the compensation.

A separate compensation value is derived for each traversing direction in order to be able to compensate for asymmetrical drive and tacho characteristics.

The function compensates for deviations of the real as compared to the calculated ideal following error. To ensure following error-free movement, the speed feed-forward control must be used with 100 % feedforward control factor.

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The derived following error difference is always evaluated against the actual set speed in order to derive a compensation value across the total velocity range of an axis. Otherwise a compensation proportional to the velocity would not be possible if constant velocity operation is revoked.

The compensation values are deleted when compensation is deselected (MD 1804*, bit 1 deleted). New compensation values have to be calculated if the function is reactivated.

After POWER ON the compensation values are recalculated and the previous values are deleted.

If the tacho compensation is also to be used for spindles, a C axis must be assigned to each spindle in order to set the axis-specific MD bit. Tacho compensation and feed forward control is only active for spindles in position control mode (M19 absolute, M19 through several resolutions).

Bit 0 In order to obtain a symmetrical traversing range around the zero position for finitely turning rotary axes, bit 0 must be set to 1 under MD 1804*. This will require no modulo correction within the range between -180 degrees and +180 degrees (if MD 1808*, bit 6=1) or between -8 revolutions and +8 revolutions (if MD 1808* bit 6=0) (see Section 12.11.2.4)

NC MD	Bit No. 7	6	5	4	3	2	1	0
1808*	Range extension ENDAT absolute encoder	SIPOS single-turn absolute encoder available (as from SW 2)	2nd measuring system distance coded	1st measuring system distance coded	Absolute offset MD 396* valid	Absolute encoder counting direction opposite sense	Value range extension of absolute offset	Axis with absolute encoder system

Bit 7=1 ENDAT absolute encoder overflows are stored in the SRAM of the NC-CPU and then included in the calculation of the actual position.
This function is required in the following cases:

- Rotary axes with an encoder on the motor (indirect measuring system) and a gear not equal to 1**/**2”.
- Linear axes with an encoder on the motor (indirect measuring system) and a traversing range that is greater than the traversing range of the absolute encoder.

For a more detailed description see the description of the function ”Range extension with ENDAT absolute encoder”.

Bit 7=0 ENDAT absolute encoder overflows are not stored and evaluated.

Bit 6=1 Single-turn absolute encoder present

General:

The function in ”Single-turn absolute encoder available” is required for rotary axes with a SIPOS or Endat absolute encoder which is connected directly and an unlimited traversing range. This function is used to evaluate the absolute value within one revolution only in order to avoid incorrect positioning should there be a counter overflow (danger to machine).

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Description of function:

The absolute position is made up of

- 16 bits absolute revolution information (number of revolutions),
- 14 bits resolution within one revolution,
- 7 bits fine resolution,

i.e. that 2^{16} = 65536 encoder resolutions can be displayed with a resolution of max. 14+7 bits. The encoder has 2500 encoder lines, i.e. the 14 bit ”Resolution within one revolution” is not exhausted (14 bits =16384 > 2500 · hardware multiplication 4).

Information for the ”Position within one revolution” can therefore be derived with a modulo (2500 · 4) calculation from the absolute value.

Because an overflow beyond the stated number of max. 65536 encoder revolutions is expected when a absolute encoder for (endlessly turning) rotary axes is used, an overflow compensation should be used here.

Here the function ”Single-turn absolute encoder available” provides the position required in normal circumstances within one revolution from the absolute value (run-up phase).

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If the absolute position is negative, one revolution is added to the rest of the modulo calculation.

This means that after control run-up, a position between 0 and 360° is always displayed in the basic actual value display and the service display.

The function is activated when the bit for the rotary axis (MD 564*, bit 5), the bit for the absolute encoder (MD 1808*, bit 0) and the bit for the function ”Single-turn absolute encoder available” (MD 1808*, bit 6) are set.

General limitations when using SIPOS/Endat encoder:

A simple overflow compensation is performed in the SIPOS hardware (65536 encoder revolutions are reduced to 0 encoder revolutions) which must be compatible with the ”Workpiece revolutions” in the NC control.

Where the **SIPOS/Endat absolute encoder is connected directly to the workpiece table (load side)**, the overflow compensation in the hardware is **always correct** (for every position control resolution).

The above does not apply when

- **using a measuring gear or**
- **when the encoder is connected indirectly at the motor and a motor/load gear is used.**

In such cases the gear ratio is divided into the pulse/path weighting, use of the overflow correction is limited:

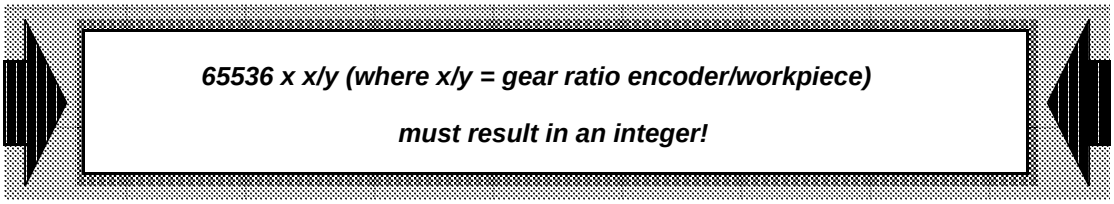
If a gear is used between the encoders and workpiece side, the absolute encoder can only be used with rotary axes/C axes if the following calculation

65536 · 2500 · 4 · (MD368*/MD364*) · position control resolution **/** 360

produces an integer value,

i.e. the maximum number of 65536 absolute encoder revolutions also corresponds to an integer number of workpiece revolutions.

The above formular can also be set to



because when the impulse weighting is correctly parameterized MD 364* always contains the N encoder line number (2500 · 4) and MD 368* always contains the position control resolution and the value 360 (degrees) for rotary axes.

Bit 6 = 1 Single-turn absolute encoder function active.

Bit 5 **Bit 5=0** The 2nd measuring system is not distance coded.

Bit 5=1 The 2nd measuring system is distance coded (see Functional Description for additional machine data which have to be set for this function).

Active: After POWER ON

Applies only to feed axes.

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Bit 4 **Bit 4=1** Measuring system with distance-coded reference marks.

Standard value: Bit 0-4 = 0

Changes in bits 2-3 are actuated on the next reference point approach in bit 4 after POWER ON.

When the SIPOS**/**Endat absolute encoder is used, the following NC machine data must be taken into account:

Axial machine data:

MD 240* Reference point ordinate (with absolute encoder only)
MD 396* Absolute offset
MD 1300* Basic distance of the reference marks
MD 1304* External pulse multiplication (not with absolute encoder)

Procedure on reference point approach

When bit 0 of MD 1808* ”Axis with absolute encoder” is set, a distinction must be made between two cases for reference point approach.

Case 1: MD 1808* bit 3 = 0

When the bit ”Absolute offset valid” is not set, reference point approach is carried out as for an axis without absolute encoder. On ”Reference point reached”, the calculated absolute offset is transferred to the axial MD 396* and MD 1808* bit 3 ”Absolute offset valid” is set for the relevant axis.
The absolute offset is calculated on the basis of the equation

Machine system = SIPOS**/**Endat system + absolute offset

or

Absolute offset = machine system - SIPOS**/**Endat system

The following applies

Machine system = desired absolute position = reference point ordinate

and

SIPOS**/**Endat system = displayed absolute position (actual value)

Note:

If a value other than 0 has been entered in MD 396*, this value must be taken into account, as it is contained in the SIPOS**/**Endat system (= displayed actual value).

Case 2: MD 1808* bit 3 = 1

When the bit ”Absolute offset valid” is set, reference point approach is suppressed, until the bit is reset by the user.

Note:

When the function G74 ”Reference point approach from part program” is used, referencing is not carried out for the second case and processing is continued with the next block.

Procedure on warm restart (POWER ON)

When bit 0 of MD 1808* ”Axis with absolute encoder” is set, MD 1808* bit 3 ”Absolute offset valid” is checked for the relevant axis. If this bit is also set, the axial interface signal ”Reference point approach” is set already on warm restart.

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Special case ”parking axis”

The axial interface signal ”Parking axis” also causes the interface signal ”Reference point reached” to be deleted for an axis with SIPOS**/**Endat absolute encoder. When bit 3 of MD 1808* is set, a new referencing is suppressed. The absolute value is not transferred until POWER ON.

Note:

Reference point approach can be carried out again when MD 1808* bit 3 is deleted.

Bit 3 **Bit 3=1** The value NC MD 396* for the absolute value is valid.

Meaning for SIPOS: After power-on the signal "reference point reached" is set for this axis.

Distance coding: The referencing procedure is performed with this value and acknowledged with "reference point reached".

Bit 2 To be able to calculate the machine absolute value after NC reset, it is necessary to know whether the value of the absolute encoder (or distance coded linear scale) gets larger or smaller as the machine absolute value increases.

Bit 2=1 Machine system and SIPOS**/**Endat absolute system (or distance-coded linear scale) are of opposite sense

Bit 2=0 Machine system and SIPOS**/**Endat absolute system (or distance-coded linear scale) are of same sense

Bit 1 **Bit 1=0** Absolute offset results from MD 396*
Bit 1=1 Absolute offset results from MD 396* +/- 99 999 999
(+/- depends on sign of MD 396*)
Default value:0

Bit 0 **Bit 0=1** The NC axis is equipped with an absolute encoder.

The absolute value is transferred on POWER ON for both measuring systems.

Caution:

When the control is being installed for the first time, you must perform POWER-ON after declaring the encoder otherwise positioning errors will occur!

NC MD	Bit No. 7	6	5	4	3	2	1	0
1812*	Sign inversion setpoint master**/** slave 2)	Torque compensation controller: controls master**/** slave 2)	Torque compensation controller: controls master**/** slave 2)	Master**/** slave operation after Power On 2)	Pos.-contrl. follow-up on error (as from SW 5)	Adaptation comp. time const. neural QEC 1)	Learning phase neural QEC 1)	Neural QEC 1)

Bit 7 Sign inversion setpoint master**/**slave

Bit 7=1 With bit 7 it is possible to take account of different ways in which the master and slave drives might be connected to the common output without having to change the polarity and the direction of travel of the individual drives (MD 5640 bit 1 and 2). This bit only has to be set if, given a positive setpoint, the axes**/**spindles would rotate in opposite directions at the mechanical coupling.

1) As from SW 4
2) As from SW 4.4

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Bit 6 Torque compensation controller output affects master

Bit 6=1 The output of the torque compensation controller is connected with bits 5 and 6. It can either affect the speed setpoint of the slave (bit 5 = 1 only), the master (bit 6 = 1 only) or the master and slave (bits 5 and 6 = 1)

Bit 5 Torque compensation controller output affects slave

Bit 5=1 The output of the torque compensation controller is connected with bits 5 and 6. It can either affect the speed setpoint of the slave (bit 5 = 1 only), the master (bit 6 = 1 only) or the master and slave (bits 5 and 6 = 1)

Bit 4 Master**/**slave operation (master-slave torque compensation control) after Power On.

Bit 4=1 If bit 4 = 1, this axis is switched to slave operation immediately after Power On (see ”Function Descriptions: Master**/**slave”). This bit is therefore only active after Power On. It is not longer possible to disable this function with a PLC signal.

Bit 3 If bit 3 is set, a master or slave axis which is also a following axis is switched over to position-controlled follow-up mode if errors occur in the master**/**slave grouping. If no "extended stopping and retract" is active, switchover is also performed if errors occur in the same mode group.

Note:

This function must not be used if the master is simultaneously the leading axis for the slave, as then an unstable control loop results.

Bit 2 The adaptation of the compensation time constant via the acceleration is activated. In this case a filter time constant for the speed setpoint pulse is used which is derived from the straight line through the filter time constants of MD 1236* and MD 1364* (see description of MD 1364*).

Bit 1 The learning phase of the neural network is activated. In this state the neural network the characteristic it has learned until now. Relearning with any contours is thus possible. This bit is ignored in automatic learning (behaviour as if this bit were set).

Bit 0 Neural quadrant error compensation is activated. Only if this bit is set is an additional speed setpoint according to the stored characteristic of the neural network injected. For this reason, a check is made to see if this bit has been set when automatic learning is activated.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
1820*	Contour monitoring not active	Pulse encoder monitoring on	No. of encoder pulses (611D) 2nd meas. system (as from SW 3)	Second meas. system with external zero mark (as from SW 3)	No. of encoder pulses (611D) 1st meas. system (as from SW 3)	First meas. system with external zero mark (as from SW 3)	Zero monitoring on	Setpoint smoothing on

Default value: 0000 0000

Bit 7 **Bit 7=1** The dynamic contour monitoring function is switched off.

Bit 6 Pulse encoder monitoring on

Bit 6=1 Monitoring is carried out to determine how many directional changes have occurred between two measuring clock pulses. If too many directional changes are detected, alarm 140* is triggered (also see description of alarm 140*).

Bit 6=0 Monitoring switched off.

Bit 5 Digital drives only:

Bit 5=0 Number of encoder intervals between two reference marks of the second measuring system is a multiple of 16

Bit 5=1 Number of encoder intervals between two reference marks of the second measuring system is a multiple of 10

Bit 4 Digital drives only:

Bit 4=0 Second measuring system without external zero mark (BERO)

Bit 4=1 Second measuring system without external zero mark (BERO) 1)

Bit 3 Digital drives only:

Bit 3=0 Number of encoder intervals between two reference marks of the first measuring system is a multiple of 16

Bit 3=1 Number of encoder intervals between two reference marks of the first measuring system is a multiple of 10

Bit 2 Digital drives only:

Bit 2=0 First measuring system without external zero mark (BERO)

Bit 2=1 First measuring system with external zero mark (BERO) 1)

Bit 1 Zero monitoring on

Bit 1=1 Monitoring is performed to detect whether pulses have been lost between two zero mark passes (do not use for distance-coded reference marks).
If so, alarm 144* is triggered (also see description of alarm 144*).

Bit 1=0 Monitoring switched off

Bit 0 Setpoint smoothing on

Bit 0=1 The setpoint smoothing filter parameterized in MD 1272* is switched on.

---

1) Speed-related errors in referencing occur with reference point approach with external zero mark (BERO).
This is caused by the delay time of the optocoupler at the input.
To avoid such errors in referencing, the maximum velocity must be limited.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
1824*	Effect of LEC on measuring systems 00=first 01=second 10=both 11=both		Setting of reference dimension allowed	Sign change actual value 2 (as from SW 2)	Set absolute system to reference dimension (as from SW 3)	Multiple assign. setpoints (as from SW 3)	2nd measuring system exists (as from SW 2)	QEC undelayed (as from SW 5)

Bit 7 Assignment of LEC to measuring system 1/2

Bit 7=0 LEC acts on one measuring system (select measuring system via bit 6)

Bit 7=1 LEC acts on both measuring systems

Bit 6 Assignment of LEC to measuring system 1/2 (no effect if Bit 7 = 1)

Bit 6=0 LEC acts on first measuring system

Bit 6=1 LEC acts on second measuring system

Bit 5 **Bit 5=1** The function "Set reference dimension" is active.

Bit 4 **Bit 4=0** Processing of the determined actual values is continued without changing the sign.

Bit 4 **Bit 4=1** The sign of the determined actual values is altered before calculation.

Identifies that the sign of the actual values determined for the second measuring system must be reversed. When setting, please make sure that the control direction in the position control loop is correct.

Active: Immediately

Applies to feed axes only.

Bit 3 With bit 3 the user can decide whether with "Set reference dimension" only the signal "Reference point reached" is set or whether the absolute system is also set to the value defined by MD 240*. Bit 3 is only active with the function "Set reference point" and does not affect normal reference point approach.

Bit 2 Digital drives only:

Bit 2=0 No multiple assignment of setpoints permitted (Power On monitoring)

Bit 2=1 Multiple assignment of setpoints is permitted (on-line monitoring when access priority problems)

Bit 1 **Bit 1=0** No second measuring system available. The MDs assigned to the second measuring system are not active. The MD bit only applies to feed axes. If a spindle/C axis is in use, MD 200* and 400* are compared to determine whether a second measuring system has been defined.

Bit 1 **Bit 1=1** A second measuring system is available. The MDs assigned to the second measuring system are active. It is possible to switch between the two measuring systems using the interface signal ”Measuring system 1/2”.

Active: After POWER ON

If a C axis has two measuring systems, the second measuring system is always that of the spindle, MD 400*. MD 1388* and MD ”2nd MS exists” have no effect with spindle C axis combinations. Measuring circuit switchover is set such that after a C axis switchover the spindle encoder is effective until the axis-specific interface signal ”Measuring circuit 2 active” has been evaluated. For C axes with one measuring system, the 1st measuring system must be the same as that of the spindle.

Bit 0 This bit must be set to 1 if quadrant error compensation is also to be active for very small axis accelerations on the first recognized zero crossover. In this case the compensation also affects a position change in very short positioning operations.

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NC MD	Bit No. 7	6	5	4	3	2	1	0
1828*							Linear scale (as from SW 6.3)	Extended parameter set switch-over (as from SW 4)

NC MD 1828* bit 1: This bit is only used for linear axes with ENDAT absolute encoders.

Bit 1 **Bit 1=1** Linear scale not available. Maximum traversing range of this axis is then + **/** - half of the maximum traversing range of the absolute encoder, symmetrical around the zero position.

Bit 1=0 Linear scale available. The traversing range of this axis does not have to be set symmetrically around the zero position. The maximum traversing range is calculated to: + **/** - the traversing range of the absolute encoder**/**8* MD 1264*.

Bit 0 **Bit 0=1** Extended parameter set switchover

Bit 0=0 Gear stages**/**parameter set switchover as in SW 1 - 3

Parameter set switchover is only possible with the option bit.

Active: After Power On

NC MD	Bit No. 7	6	5	4	3	2	1	0
1832* (from SW 6.3)				Actual value reading axis 2nd measur-ing system	Actual value reading axis 1st measur-ing system	Multiple assignment 2nd measur-ing system	Multiple assignment 1st measur-ing system	PT2 contour monitoring active

Bit 4 **Bit 4=1** This axis is an actual value reading axis at the 2nd measuring system connection (NC MD 1388*). The restrictions for reading axes therefore apply.

Bit 4=0 This axis has unrestricted use of the 2nd measuring system connection (NC MD 1388*)

Bit 3 **Bit 3=1** This axis is an actual value reading axis at the 1st measuring system connection (NC MD 200*). The restrictions for reading axes therefore apply.

Bit 3=0 This axis has unrestricted use of the 1st measuring system connection (NC MD 200*).

Bit 2 **Bit 2=1** Multiple assignment of the 2nd measuring system connection of this axis (NC MD 1388*) is permitted with digital drives. When using this measuring system connection only one of these axes must not have a Bit 4 setting under MD 1832*. Bit 4 must be set on all others.

Bit 2=0 Multiple assignment of the 2nd measuring system connection of this axis (NC MD 1388*) is not permitted.

Bit 1 **Bit 1=1** Multiple assignment of the 1st measuring system connection of this axis (NC MD 200*) is permitted with digital drives. When using this measuring system connection only one of these axes must not have a Bit 3 setting under MD 1832*. Bit 3 must be set on all others.

Bit 1=0 Multiple assignment of the 1st measuring system connection of this axis (NC MD 200*) is not permitted.

Bit 0 **Bit 0=1** The new PT2 contour monitoring is activated even if 0 is set under NC MD 3420*. By entering a compensation value between 1 and 600 under NC MD 3420*, the PT2 following error model will be calculated according to this compensation value.

Bit 0=0 The existing contour monitoring is activated as long as 0 is set under NC MD 3420*. By entering a compensation value between 1 and 600 under NC MD 3420*, this will activate the improved PT1 contour monitoring.

Active: After Power On

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NC MD	Bit No. 7	6	5	4	3	2	1	0
1844*	Vel. limitation ELG following axes (as from SW 6)		Test bit compensa-tory controller	LINK ON after POWER ON	Position overwrite permissible	Link factor switchover permissible	Reconfig. permissible	Axis can be FA

The following bits only apply to following spindles and are active after Power On.

Bit 7 **Bit 7=1** The function ”Velocity limitation of ELG following axes” is activated.

Bit 7=0 The function is not activated

Bit 5 Test bit compensatory controller

Bit 5=1 Compensatory controller test mode switched on

Bit 5=0 Compensatory controller test mode not switched on.

Bit 4 LINK ON after POWER ON

Bit 4=1 On POWER ON the gear is switched to the same condition as it was before switching off. This means, if a leading axis is traversed when link factor # 0, then the following axis is also traversed.

Bit 4=0 The gear is set to LINK OFF for all leading axes on POWER ON. LINK ON must be set explicitly via PLC or with G402, G403 or via input display.

Bit 3 Position overwrite permissible

Bit 3=1 Overwriting positions enabled

Bit 3=0 The synchronous positions entered for the leading axes must not be overwritten. I.e., synchronization must always start at the same positions.

Bit 2 Link factor switchover permissible

Bit 2=1 Switching over the link factor is permitted (with G402, G403 commands or via input display)

Bit 2=0 Switchover not permitted.

Bit 1 Reconfiguration permissible

Bit 1=1 Reconfiguration is permissible (with G401 command or via input display)

Bit 1=0 Reconfiguration not permissible

Bit 0 Axis can be following axis

Bit 0=1 Axis can be following axis

Bit 0=0 Axis **must not** be a following axis

Active: after POWER ON

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NC MD	Bit No. 7	6	5	4	3	2	1	0
1848*	Synchroni-zation in tooth pitch (as from SW 6)	Block change after position reached (as from SW 5)	Block change when synchroniz. achieved	Division-related FA overlay	Suppres-sion of accel. limit.	Block change with synchro-nism fine	Reserved	Reserved

The bits below apply to following axes only and are active immediately.

Bit 7 **Bit 7=1** The synchronization path of following rotary axes is limited to 1 revolution**/**denominator of the 1st GI link ratio. The synchronous position is approached along the shortest path or by deceleration, depending on the setting in MD 1856*, bit 4.

Bit 7=0 The synchronous position of following rotary axes is limited to 1 revolution . Above half the maximum speed the synchronous position is reached by deceleration, below half the maximum speed, along the shortest path.

Note:

If bit 4 is set in MD 1856***/**531*, synchronization must never be performed when the tool or wheel are in use.

Bit 6 **Bit 6=1** Block change of a block with position-related switch on/off (G402/G400) is delayed until the switch on**/**off position is reached.

Bit 6=0 Block change of a block with position-related switch on/off (G402/G400) is performed immediately.

Bit 5 Block change after synchronization (with on-the-fly synchronization)

Bit 5=1 On-the-fly synchronization with G403: Block change only after the synchronous position has been reached (see also PLC signal, "Synchronous position reached").

Bit 5=0 Block change immediately, i.e., as soon as synchronization is triggered. Synchronization does not start if PLC signal "Disable LINK ON" is active.

Bit 4 Division-related following axis overlay

Bit 4=1 Overlaid movements of the following axis are within the indexing grid. However, any movements of the following axis caused by the leading axis are not used to determine the set indexing position. Link and synchronization function as before.
The following axis must be defined as an indexing axis for this function to work. The indexing grid is defined in MD 1104* and MD 1108*.

Bit 4=0 Indexing grid ignored for overlay movements of the following axis.

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Bit 3 "Suppression of acceleration limitation"

Bit 3=1 "Acceleration limitation not active"
With LINK ACTIVE, the acceleration of the following axis is not limited by the control but is output directly, as determined by leading spindle. If MD value 1768* is exceeded, no alarm is triggered.

Bit 3=0 "Acceleration limitation active"
With LINK ACTIVE, the acceleration of the following axis is limited to the acceleration value set in the machine data (MD 1768*).

Note:

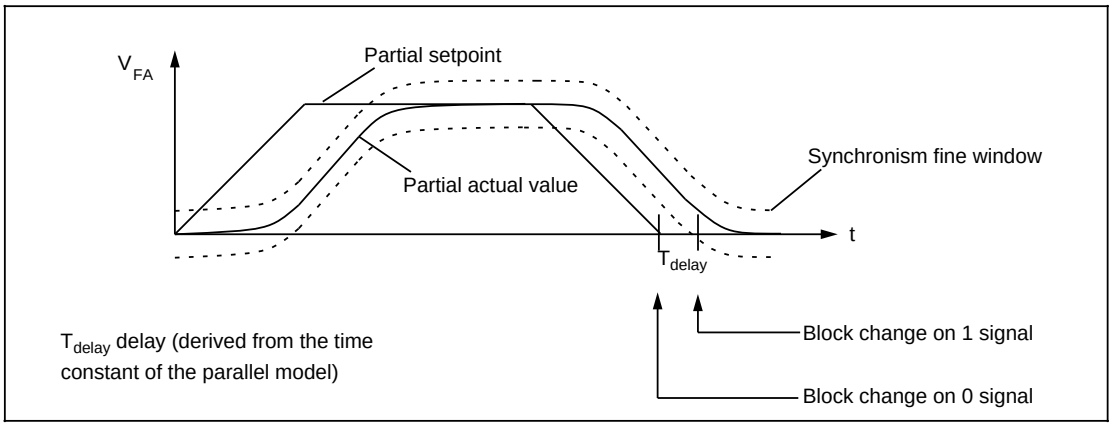
The limitation remains active until the synchronous speed or zero speed is reached:

- **On runup after switching on the link**
- **When switching from link factor**
- **When stopping the spindle by switching off the link**

Bit 2 "Block change with synchronism fine"

Bit 2=1 After an overlaid movement, block change is triggered in the NC, as soon as the following axis has reached "Synchronism fine" and all the partial setpoints of the block have been output.

Bit 2=0 Block change is triggered when the synchronism speed has been reached and all partial setpoints of the block have been output.



Block change with synchronism fine. Motor operating without disturbance. Behaviour corresponds to parallel model.

Following axis/spindle-specific machine data bits

NC MD	Bit No. 7	6	5	4	3	2	1	0
1852*			Include tool length comp.	Include program-med ZO G58...G59	Include external ZO	Include settable ZO G54...G57	Include DRF and preset	Ref. system GI positions

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The following bits are defined for the following axes. They are then active for the following axis and the leading axes activated in the GI grouping. The above values are included when calculating the synchronous position (G403).

Bit 5 **Bit 5=1** Include tool length compensations for GI position calculations

Bit 5=0 Do not include tool length compensations
Radius compensations are never included in calculations.

Active: Immediately

Bit 4 **Bit 4=1** Include programmable ZO offset (G58...G59) for GI position calculations

Bit 4=0 Do not include programmable ZO offset (G58 ... G59)

Bit 3 **Bit 3=1** Include external ZO for GI position calculations

Bit 3=0 Do not include external ZO

Bit 2 **Bit 2=1** Include ZO (G54...G57) for GI position calculations

Bit 2=0 Do not include ZO (G54...G57)

Bit 1 **Bit 1=1** Include DRF and preset for GI position calculations

Bit 1=0 Do not include DRF and preset

Bit 0 Reference system GI positions

Bit 0=1 The positions have been entered in the workpiece system; include offsets in bits 2...5 in calculation

Bit 0=0 Positions have been entered in machine system; do not include any offsets in calculation

NC MD	Bit No. 7	6	5	4	3	2	1	0
1856*				Time-optimized synchronization (as from SW 6)				Acceleration limit. of ELG follow. axes (as from SW 6)

Time-optimized tooth pitch synchronization can be set with bit 4. This means that the synchronous position is approached by deceleration when the following axis velocity is above half of the maximum velocity. Below this velocity, the synchronous position is approached by the shortest path.

Note:

This bit only takes effect if MD 1848*, bit 7, ”Synchronization in tooth pitch” is also active.

Bit 4 **Bit 4=1** The synchronized path of following rotary axes is limited to 1 revolution**/**denominator of the 1st GI link ratio . Above half the maximum speed the synchronous position is reached by deceleration, below half the maximum speed, along the shortest path.

Bit 4=0 The synchronization path of following rotary axes is limited to 1 revolution**/**denominator of the 1st GI link ratio. The synchronous position is then always approached along the shortest path.

Bit 0 **Bit 0=1** The function acceleration limitation of ELG following axes is activated.

Bit 0=0 The function is not activated.

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6.8 MDs for multi-channel display

MDs for screen

20440-20419	Multiple-channel display		Active on **Warm restart**
Default value	Lower input limit	Upper input limit	
0	**0**	**4 (as from SW 4: 6)**	**–**

Reserved for customer UMS.

20420-20439	Multiple-channel display		Active on **Warm restart**
Default value	Lower input limit	Upper input limit	
0	**0**	**4 (as from SW 4: 6)**	**–**

Reserved for system UMS.

20440	Multiple-channel display left or top		Active on **Warm restart**
Default value	Lower input limit	Upper input limit	
1	**0**	**4 (as from SW 4: 6)**	**–**

If MD 20440 is defined as 2, the basic display for channel 2 appears on the left or, in the large actual-value display, in the upper part of the display.

20441	Multi-channel display right or below		Active on **Warm restart**
Default value	Lower input limit	Upper input limit	
2	**0**	**4 (as from SW 4: 6)**	**–**

If MD 20441 is defined as 2, the basic display for channel 2 appears on the right or, in the large actual-value display, in the lower part of the display.

20442-20449	Multi-channel display reserved for the system		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**4 (as from SW 4: 6)**	**–**

Reserved for the system.

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6.9 MDs for parameter set switchover

2400*-2407*	Number of teeth motor as from SW 4 1st to 8th parameter set		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
1	**1**	**999 999**	**–**

2408*-2415*	Number of teeth spindle as from SW 4 1st to 8th parameter set		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
1	**1**	**999 999**	**–**

This machine data is used to define the speed ratio of a gear box for all parameter sets, see functional description of ""Ratio" parameter group".

2416*-2419*	Zero mark correction + as from SW 4 1st to 4th parameter set		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**- 999 999**	**999 999**	**units (MS)**

2420*	r1: Load no. of revolutions		Active
Default value	Lower input limit	Upper input limit	Units
1			

This MD is used for internal calculation only.

2421*	r2: Motor no. of revolutions		Active
Default value	Lower input limit	Upper input limit	Units
1			

This MD is used for internal calculation only.

2422*	p: Pulses per revolution		Active
Default value	Lower input limit	Upper input limit	Units
1024			

This MD is used for internal calculation only.

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2430*-2433*	Zero mark correction + as from SW 4 5th to 8th parameter set		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	- 999 999	999 999 16 000 (as from SW 4.4)	units (MS)

2434*-2441*	Zero mark correction - as from SW 4 1st to 8 th parameter set		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	- 999 999 16 000 (as from SW 4.4)	999 999 16 000 (as from SW 4.4)	units (MS)

These MDs are used to correct gear-stage-related offsets between the zero mark and reference position, see functional description of ""Ratio" parameter group".

2442*-2448*	Feedforward control factor 2nd - 8th parameter set as from SW 4		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	1 000	0.1 %

These MD have the same meaning as MD 465*, see also functional description of parameter set switchover.

2449*-2456*	Feedforward control factor D component as from SW 4 1st to 8 th parameter set		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	1 000	0.1 %

2457*-2463*	Time constant symm. filter 2nd - 8th par. set as from SW 4		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	9 999 1 000 (as from SW 4.4)	0.1 ms

These MD have the same meaning as MD 467*, see also functional description of parameter set switchover.

2464*-2470*	Time constant setpoint filter 2nd - 8th par. set as from SW 4		Active at once
Default value	Lower input limit	Upper input limit	Units
55	0	1 000 16 000 (as from SW 4.4)	0.1 ms

These MD have the same meaning as MD 486*, see also functional description of parameter set switchover.

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MDs for acceleration characteristic for spindles

2471*-2478*	Speed lim. acc. adapt. as from SW 4 1st to 8th parameter set		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
99 999	+0	99 999	rpm/or 0.1 rpm

2479*-2486*	Acceleration adaptation factor as from SW 4 1st to 8th parameter set		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
1 000	+10	10 000	0.1 %

The acceleration is reduced in all spindle modes above the speed defined in MD 2471* - 2478*. The degree of weakening can be set with the matching factor MD 2479* - 2486*.

The machine data has no effect is zero or a value above the maximum speed is entered.

The unit is defined as 0.1 or 1 rpm in MD 5200, bit 3.

2487*-2493*	Position limit for M19 2nd to 8th parameter set as from SW 4		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
2 000	+0	720 000	units/MS
2 000	+0	99 999 999 (as from SW 4.4)	units/MS
2 000	0	72 000 000	

These MD have the same meaning as MD 443*, see also ”Functional Descriptions: Parameter set switchover”.

2494*-2500*	P component comp. contr. 2nd to 8th par. set as from SW 4		Active on RESET
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	1

These MD have the same meaning as MD 487*, see also ”Functional Descriptions: Parameter set switchover”.

2501*-2507*	I component comp. contr. 2nd to 8th par. set as from SW 4		Active on RESET
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	1

These MD have the same meaning as MD 488*, see also ”Functional Descriptions: Parameter set switchover”.

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2508*-2514*	D component comp. contr. 2nd - 8th par. set as from SW 4		Active on RESET
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	1

These MD have the same meaning as MD 489*, see also ”Functional Descriptions: Parameter set switchover”.

2515*-2521*	Time constant parallel model 2nd - 8th par. set as from SW 4		Active on RESET
Default value	Lower input limit	Upper input limit	Units
6 000	0	16 000	0.01 ms

These MD have the same meaning as MD 490*, see also ”Functional Descriptions: Parameter set switchover”.

2522*-2529*	Alarm limit speed as from SW 4 1st to 8th par. set		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
MD 403* ff.+10%	0	99 999	rpm/or 0.1 rpm

These machine data are active only with gear interpolation.

2530*-2537*	Alarm limit acc. constant as from SW 4 1st to 8th par. set		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
MD 478* ff.+10%	0	50 000	ms

These machine data are active only with gear interpolation.

2546*-2552*	Tol. band synchr. "fine" 2nd - 8th par. set as from SW 4		Active on RESET
Default value	Lower input limit	Upper input limit	Units
40	0	16 000 99 999 999 (SW5.4 and higher)	1 unit (MS)

These MD have the same meaning as MD 491*, see also ”Functional Descriptions: Parameter set switchover”.

2553*-2559*	Tol. band synchr. "coarse" 2nd - 8th par. set as from SW 4		Active on RESET
Default value	Lower input limit	Upper input limit	Units
100	0	16 000 99 999 999 (SW5.4 and higher)	1 unit (MS)

These MD have the same meaning as MD 492*, see also ”Functional Descriptions: Parameter set switchover”.

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2560*-2566*	Emergency retraction threshold 2nd - 8th parameter as from SW 4		Active on RESET
Default value	Lower input limit	Upper input limit	Units
400	0	16 000 99 999 999 (SW5.4 and higher)	1 unit (MS)

These MD have the same meaning as MD 493*, see also ”Functional Descriptions: Parameter set switchover”.

2567*-2574*	Time const. speed link path 1st to 8th par. set as from SW 4		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	0.1 ms

These machine data are active only with gear interpolation.

2700*	Master for speed setpoint coupling 1)		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0	0	50	-

Machine data 2700* assigns the master spindle to a slave for speed setpoint coupling. The speed setpoint is taken from the spindle entered here and output as the speed setpoint while ignoring its own position control. The assignment is made with the axis/spindle number.

Value	0	1 - 30	41 - 46
Meaning	No axis/spindle	Axis 1 - 30	Spindle 1 - 6

2701*	Master for torque compensation control 1)		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0	0	50	-

Machine data 2701* assigns the master spindle to a slave. The torque setpoint is taken from the spindle entered here and compared with the torque setpoint of its own drive. The difference is the input variable for the torque compensation controller.

The assignment is made via the axis/spindle number.

If the default value 0 is entered, the master of the speed setpoint coupling (MD 270*) is also used for the torque compensation control.

Value	0	1 - 30	41 - 46
Meaning	No axis/spindle	Axis 1 - 30	Spindle 1 - 6

1) As from SW 4.4

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2702*	Torque distr. torque comp. controller 1)		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
500	**0**	**984**	**‰**

With MD 2702*, the input variables of the torque compensation controller are weighted to permit a parameterizable torque distribution over both drives according to the respective moments of inertia.

The standard parameterization of 500 ‰ produces a distribution according to the values in drive machine data 1725 (normalization torque setpoint interface) for both axes. If a different distribution is to be used, MD 2702* must be calculated according to the following formula:

$$\text{MD 2702*} = \frac{M_{desired_{slave}}}{M_{desired_{slave}} + M_{desired_{master}} + \frac{\text{MD 1725}_{slave}}{\text{MD 1725}_{master}}} \cdot 1000\ ‰$$

$M_{desired}$ is the ideal torque distribution between master and slave.

2703*	Torque compensation controller P component 1)		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**0**	**1 000 000**	**0.0001%**

The P gain of the torque compensation controller is parameterized in % of the ratio drive maximum speed to nominal torque of the slave drive. The input variable of the torque compensation controller is the difference in torque between master and slave, the output variable is a speed setpoint. See also MD 1812* and 523*.

Formula:

Output variable = P gain * control difference

Example:

A torque difference of 10 % of the slave nominal torque and standard parameterization 100 (= 0.01%) produces an output variable of the controller of 0.001 % of the maximum speed of the slave drive (0.01 % * 10 % = 0.001 %).

2704*	Torque comp. controller integral action time 1)		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1 000 000 99 999 999 (as from SW 4.4)**	**ms**

The integral action of the torque compensation controller is parameterized in the integral action time. The integral action is deactivated if set to the default value 0 because the proportional action (MD 2703*) already ensures an adequate static distribution of torque.

The additional integral action can produce a better distribution in multi-slave operation. Useful values are in whole seconds. See also MD 523*.

1) As from SW 4.4

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3032*-3060*	Number of teeth motor 2) 1st par. set to 8th par. set		Active on Power On
Default value	Lower input limit	Upper input limit	Units
1	1	999 999 99 999 999 (as from SW 4.4)	–

3064*-3092*	Number of teeth spindle 2) 1st par. set to 8th par. set		Active on Power On
Default value	Lower input limit	Upper input limit	Units
1	1	999 999 99 999 999 (as from SW 4.4)	–

This machine data is used to define the speed ratio of a gear box for all parameter sets, see functional description of ""Ratio" parameter group".

3096*-3124*	Zero mark correction + 2) 1st par. set to 8th par. set		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	- 999 999 16 000 (as from SW 4.4)	999 999 16 000 (as from SW 4.4)	units (MS)

3128*-3156*	Zero mark correction - 2) 1st par. set to 8th par. set		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	- 999 999 16 000 (as from SW 4.4)	999 999 16 000 (as from SW 4.4)	units (MS)

These MDs are used to correct gear-stage-related offsets between the zero mark and reference position, see functional description of ""Ratio" parameter group".

3160*-3184*	Backlash comp. 1st measuring system 2) 2nd par. set to 8th par. set		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	- 16 000	16 000	units (MS)

For axes only:

To compensate for the backlash in different gear stages.

3188*-3212*	Motor control equilibration 2nd - 8th par. set as from SW 4		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	-70 -700 (as from SW 4.4)	70 -700 (as from SW 4.4)	0.1 % of the power section current

These MD have the same meaning as MD 1292*, see also "Functional Descriptions: Parameter set switchover".

1) As from SW 4.4
2) As from SW 4

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3216*-3240*	Tol. band for synchr. "fine" 2nd - 8th parameter set as from SW 4		Active on RESET
Default value	Lower input limit	Upper input limit	Units
40	0	16 000 99 999 999 (SW 5.4 and higher)	1 unit (MS)

These MD have the same meaning as MD 1436*, see also ”Functional Descriptions: Parameter set switchover”.

3244*-3268*	Tol. band for synchr. "coarse" 2nd - 8th parameter set as from SW 4		Active on RESET
Default value	Lower input limit	Upper input limit	Units
100	0	16 000 99 999 999 (SW5.4 and higher)	1 unit (MS)

These MD have the same meaning as MD 1440*, see also ”Functional Descriptions: Parameter set switchover”.

3272*-3296*	Emergency retraction threshold 2nd - 8th parameter as from SW 4		Active on RESET
Default value	Lower input limit	Upper input limit	Units
400	0	16 000 99 999 999 (SW5.4 and higher)	1 unit (MS)

These MD have the same meaning as MD 1444*, see also ”Functional Descriptions: Parameter set switchover”.

3300*-3328*	Time const., set speed link path 1st to 8th par. set as from SW 4		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	16 000	0.1 ms

See also ”Functional Descriptions: Parameter set switchover”. These machine data are active only with gear interpolation.

3332*-3360*	Maximum jerk (as from SW 6) 1st-8th PaSe		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0	0	99 000 000	0,1 ms/s^3

See description of function Parameter set switchover and jerk limitation Section 10.4.1.5.

3364*-3388*	Acceleration (as from SW 6) 2nd-8th PaSe		Active on NC Stop
Default value	Lower input limit	Upper input limit	Units
0			

See description of function Parameter set switchover.

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3392*-3416*	Maximum velocity (as from SW 6)		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**10 000**	

See also Functional Descriptions: Collision monitoring.

3420* (from SW 6.3)	Compensation time constant for contour monitoring		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**600**	**0.1 ms**

When using a PT1 speed setpoint smoothing filter (drive MD 1502* or 1503*), the value entered there must be entered under NC MD 3420*.

By gradually adjusting the input value NC MD 3420* (up or down), a setting can be found resulting in still further reduced contour deviation during acceleration or deceleration processes.

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6.9.1 MDs for collision monitoring

3800*	Motion axis X coordinate (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	0	30	Axis no.

The motion axes are assigned to the protection zone in the protection-zone-specific machine data.

3804*	Motion axis Y coordinate (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	0	30	Axis no.

The motion axes are assigned to the protection zone in the protection-zone-specific machine data.

3808*	Motion axis Z coordinate (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	0	30	Axis no.

The motion axes are assigned to the protection zone in the protection-zone-specific machine data:

*=Protection zone number
1st protection zone=0
2nd protection zone=1
to
32nd protection zone=31

The value entered is the global axis number. ZERO means no axis.

The axes must exist and belong to the same mode group. If an error occurs, alarm 111 ”Error in collision monitoring data” is output.

The coordinates of protection zone reference point **P1** are specified relative to slide reference point **F** (protection zone reference point vector FP1) in the protection-zone-specific machine data:

3812*	Protection zone reference point vector FP1 X coordinate (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	0	99 999 999	MS

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3816*	Protection zone reference point vector FP1 Y coordinate (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	0	99 999 999	MS

3820*	Protection zone reference point vector FP1 Z coordinate (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	0	99 999 999	MS

*=Protection zone number
1st protection zone=0
2nd protection zone=1 to
32nd protection zone=31

The dimensions of protection zone Sn are entered in the following protection-zone-specific machine data:

3824*	Dimension X coordinate (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	0	99 999 999	MS

3828*	Dimension Y coordinate (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	0	99 999 999	MS

3832*	Dimension Z coordinate (as from SW 6)		POWER ON
Default value	Lower input limit	Upper input limit	Units
0	0	99 999 999	MS

*=Protection zone number
1st protection zone=0
2nd protection zone=1 to
32nd protection zone=31

Protection zone dimensions in 2 coordinates not equal to 0:
Two-dimensional monitoring only in the plane described by the coordinates in question (see: Definition of protection zone planes). In the third coordinate the protection zone is understood as infinite.

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Protection dimensions in 3 coordinates not equal to 0:
Three-dimensional monitoring

Definition:

Two-dimensional protection zone to be mutually monitored for collision must be in the same plane.

3840*	**Assigned MCS (as from SW 6)**		Active on **POWER ON**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**3**	**–**

with *= protection zone index:
1st protection zone=0
2nd protection zone=1 to
32nd protection zone=31

A machine coordinate system (MCS) must be assigned to each protection zone. These assignments are made in the protection-zone-specific machine data:

Value range:

0/1 = 1st machine coordinate system
2 = 2nd machine coordinate system
3 = 3rd machine coordinate system
4 = 4th machine coordinate system

Note:

For more detailed information please see Functional Description.

MD No.	**Bit No.**							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
3876*	Res.	Res.	Res.	Res.	Res.	Res.	Additive protection zone adjustment (as from SW 6.3)	Protection zone exists

with *=protection zone index:
1st protection zone=0
2nd protection zone=1 to
32nd protection zone=31

Monitoring of a defined protection zone can be activated with this MD.

Bit 0 **Bit 0=0** Protection zone does not exist

Bit 0=1 Protection zone exists

Active: POWER ON

Bit 1 **Bit 1=0** Additive protection zone adjustment via setting data inactive

Bit 1=1 Additive protection zone adjustment via setting data active

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MD No.	Bit No.							
	7	6	5	4	3	2	1	0
3880* (as from SW 6)	No monitoring of PZ 8	No monitoring of PZ 7	No monitoring of PZ 6	No monitoring of PZ 5	No monitoring of PZ 4	No monitoring of PZ 3	No monitoring of PZ 2	No monitoring of PZ 1

MD No.	Bit No.							
	7	6	5	4	3	2	1	0
3884* (as from SW 6)	No monitoring of PZ 16	No monitoring of PZ 15	No monitoring of PZ 14	No monitoring of PZ 13	No monitoring of PZ 12	No monitoring of PZ 11	No monitoring of PZ 10	No monitoring of PZ 9

MD No.	Bit No.							
	7	6	5	4	3	2	1	0
3888* (as from SW 6)	No monitoring of PZ 24	No monitoring of PZ 23	No monitoring of PZ 22	No monitoring of PZ 21	No monitoring of PZ 20	No monitoring of PZ 19	No monitoring of PZ 18	No monitoring of PZ 17

MD No.	Bit No.							
	7	6	5	4	3	2	1	0
3892* (as from SW 6)	No monitoring of PZ 32	No monitoring of PZ 31	No monitoring of PZ 30	No monitoring of PZ 29	No monitoring of PZ 28	No monitoring of PZ 27	No monitoring of PZ 26	No monitoring of PZ 25

with *=protection zone index:
1st protection zone=0
2nd protection zone=1 to
32nd protection zone=31

Mutual monitoring of **stationary** protection zones can be deselected in the protection-zone-specific machine data in order to reduce the CPU load.

Abbreviation: PZ=Protection zone.

MD 3880* Bit 0-7	=1:	No monitoring of protection zone 1-8
	=0:	Monitoring of protection zone 1-8 active
MD 3884* Bit 0-7	=1:	No monitoring of protection zone 9-16
	=0:	Monitoring of protection zone 9-16 active
MD 3888* Bit 0-7	=1:	No monitoring of protection zone 17-24
	=0:	Monitoring of protection zone 17-24 active
MD 3892* Bit 0-7	=1:	No monitoring of protection zone 25-32
	=0:	Monitoring of protection zone 25-32 active

Active: POWER ON

For safety reasons, monitoring must be deselected mutually, i.e., deselection of monitoring of protection zone 2 must be entered in the machine data of protection zone 1 and deselection of monitoring of protection zone 1 must be entered in the machine data of protection zone 2. Otherwise, alarm ”Error in collision monitoring data” is output.

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3900*	r1: Load no. of revolutions 1)	Active

Default value	Lower input limit	Upper input limit	Units
1			

3904*	r2: Motor no. of revolutions 1)	Active

Default value	Lower input limit	Upper input limit	Units
1			

3908*	I: Spindle pitch or g: Grating constant 1)	Active

Default value	Lower input limit	Upper input limit	Units
100 000			

3912*	I: Spindle pitch or g: Grating constant 1)	Active

Default value	Lower input limit	Upper input limit	Units
100 000			

3916*	r1: Load no. of revolutions 1)	Active

Default value	Lower input limit	Upper input limit	Units
1			

3920*	r2: Motor no. of revolutions 1)	Active

Default value	Lower input limit	Upper input limit	Units
1			

3924*	p: Pulses per revolution 1)	Active

Default value	Lower input limit	Upper input limit	Units
2 500			

3928*	I: Spindle pitch or g: Grating constant 1)	Active

Default value	Lower input limit	Upper input limit	Units
50 000			

3932*	Deadtime compensation value	Active on **Power On**

Default value	Lower input limit	Upper input limit	Units
200	**0**	**16 000**	**in % of the IPO cycle**

1) *This MD is used for internal calculation only.*

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The setpoint position of the following axis is checked in every IPO cycle to establish whether it is in the reduction range. The system is designed such that several IPO cycles elapse before changes to the setpoints of a leading axis are output to the setpoint controller of the following axis. To compensate this deadtime, the setpoint position is corrected by the predicted path. The deadtime and thus also the compensation value are dependent on the gear interpolation link type. The deadtime is 2 IPO cycles (200 %) for the setpoint link. A deadtime of 5.5 IPO cycles (550 %) is recommended for the actual value link.

3936*	**Minimum reduction factor 1)**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
200	**0**	**1 000**	**in 0.01% of the max. speed**

The distance between the deadtime-compensated setpoint position and the active limitations is calculated in this MD. The active limitations are the innermost limit values as defined by the working field boundary and the selected SW limit switch. If the distance d is smaller than the reduction range, the braking operation must be initiated. For this purpose, a permissible velocity value Vperm is calculated from the distance d to the SW limit switch and the max. acceleration value Amax.

$$V_{perm} = \sqrt{2 * d * A_{max}}$$

A reduction factor is calculated from V_{perm} and V_{max} and transmitted to the mode group channels. In a similar way to an override, the reduction factor is included in the path velocity calculation in all mode group channels.

$$\text{Reduction factor} = V_{perm}/V_{max}{}^{*}100$$

3940*	**Denominator gear encoder/load**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**5 000 000**	**–**

This MD must be parameterized for rotary axes if MD 1808*, bit 7, is set. The value of gear encoder**/**load must be entered.

Common divisors of numerators and denominators of the gear can be reduced.

Example: Gear 35**/**56 Common divisor 7 exists.

56 can thus be parameterized as the denominator, however value 8 is also permissible (reduced by the common divisor) and is recommended.

3944*	**Rough encoder position**		Active on **NC Stop**
Default value	Lower input limit	Upper input limit	Units
0	**-99 999 999**	**99 999 999**	**–**

This MD is only used to secure the data of the absolute position against unforeseen data loss in the SRAM of the NC-CPU.

This MD is only updated during power up and when all NC MDs are backed up. Further details are given in the description of the function ”Range extension with ENDAT absolute encoder”.

3948*	**Coordinate assignment (as from SW 6)**		
Default value	Lower input limit	Upper input limit	Units
			–

1 =Abscissa =X coordinate
2 =Ordinate =Y coordinate
3 =Applicate =Z coordinate

1) as from SW 5.6

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6.10 MDs for flexible memory configuration

60000	Size of UMS memory 1)		Active after SK "Reconfigure memory"
Default value	Lower input limit	Upper input limit	Units
256 KB	0	960 or 2 760 KB 2 760 KB (as from SW 4.4)	4 KB/8 KB

With the introduction of this MD it is no longer necessary to define the UMS size in the configuration file in the MMC master control.

The upper input limit depends on the NCK memory capacity (4 or 8 MB memory).

Zero means no UMS (see functional description of "Flexible memory configuration").

60001	Size of part program memory 1)		Active after SK "Reconfigure memory"
Default value	Lower input limit	Upper input limit	Units
704 KB	8	960 or 2 760 KB 4 920 KB (as from SW 4.4)	4 KB

The upper input limit depends on the NCK memory capacity (4 or 8 MB memory).

60002	Number of IKA points 1)		Active after SK "Reconfigure memory"
Default value	Lower input limit	Upper input limit	Units
4 000	0 0	65 535	1 IKA point

Zero means no IKA points.

60003	Memory for drive software MSD 1)		Active after SK "Reconfigure memory"
Default value	Lower input limit	Upper input limit	Units
0	0	1	–

If an area of the memory is reserved for MSD drive software, 194 KB memory is occupied.

Zero means no memory.

The memory is only required for digital drives. The software only loads the MSD software if the memory has been reserved for it.

Note:

The meaning of this machine data changes as from SW 6.

1) As from SW 4

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60003	Load MS drive software (as from SW 6)	POWER ON

Default value	Lower input limit	Upper input limit	Units
0	**0**	**1**	**–**

If MD 60003 and**/**or 60004 are set to 1 the memory for the drive software is automatically set to 192**/**384 Kbytes (compatible memory requirement). The memory size can also be altered by changing MD 60014 (toggling).

The following toggling options are available:

– MD 60003 and MD 60004=0 MD 60014 0 Kbytes
– MD 60003 or MD 60004=1 MD 60014 288 192 Kbytes
– MD 60003 and MD 60004=1 MD 60014 576 384 192 Kbytes

Note: See also function ”Flexible memory configuration”.

60004	Memory for drive software for FDD as from SW 4	Active **after SK "Reconfigure memory"**

Default value	Lower input limit	Upper input limit	Units
0	**0**	**1**	**–**

If an area of the memory is reserved for FDD drive software, 194 KB memory is occupied. Zero means no memory. The memory is only required for digital drives. The software only loads the FDD software if the memory has been reserved for it.

Note: The meaning of this machine data changes as from SW 6.

60004	Load FD drive software (as from SW 6)	POWER ON

Default value	Lower input limit	Upper input limit	Units
0	**0**	**1**	**–**

See machine data 60003.

60005	Number of tools as from SW 4	Active **after SK "Reconfigure memory"**

Default value	Lower input limit	Upper input limit	Units
819	**1**	**1 637**	**1 TO**

The upper input limit depends on the number of parameters per tool (see MD 60006) and the number of R parameters (see MD 60007**/**60008).

Note: The standard tool management (FB package 1) still uses the values in MD 5019, bit 0 and 1.

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60006	Number of parameters per tool as from SW 4		Active after SK "Reconfigure memory"
Default value	Lower input limit	Upper input limit	Units
10	0	10 32	1 TO

819 tools with 10 parameters each corresponds to 32760 bytes = approx. 32 KB memory.
The upper input limit depends on the NCK memory capacity (4 or 8 MB memory).

Note: The standard tool management (FB package 1) still uses the values in MD 5019, bit 0 and 1.

60007	Number of channel-spec. R parameters as from SW 4		Active after SK "Reconfigure memory"
Default value	Lower input limit	Upper input limit	Units
700	0	700	1 R parameter

See functional description of "Flexible memory configuration".

60008	Number of central R parameters as from SW 4		Active after SK "Reconfigure memory"
Default value	Lower input limit	Upper input limit	Units
600	0	9 300	1 R parameter

The upper input limit depends on the number of tools (see MD 60005/60006) and the number of channel-specific R parameters (see MD 60007).
See functional description of "Flexible memory configuration".

60009	Free remaining memory D-RAM as from SW 4		Active after SK "Reconfigure memory"
Default value	Lower input limit	Upper input limit	Units
0			Byte

Machine data reserved by the system.

60010	Free remaining memory S-RAM as from SW 4		Active after SK "Reconfigure memory"
Default value	Lower input limit	Upper input limit	Units
0			Byte

Machine data reserved by the system.

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60011	Memory configuration of NC module as from SW 4		Active after SK "Reconfigure memory"
Default value	Lower input limit	Upper input limit	Units
0			Byte

Machine data reserved by the system.

60012	Load cap. of NC CPU (as from SW 5)		Active At once
Default value	Lower input limit	Upper input limit	Units
0	-	100	%

This machine data is used simply to indicate the CPU loading. For a description, refer to the section entited ”Installation of axis and spindle”.

60013	Memory for real axes (as from SW 5)		Active Power On
Default value	Lower input limit	Upper input limit	Units
15	15	30	approx. 16 KB/axis

This MD is used to define the memory for real axes (> 15). If the user has defined more real axes than memory is available, alarm 71 is displayed.

60014	Number of memory blocks for drive software (as from SW 6)		Active Power On
Default value	Lower input limit	Upper input limit	Units
0	0	6	96 Kbytes

Memory for drive software MSD/FDD 0/2/3/4/6 blocks of 96 Kbytes each, see also machine data 60003 and 60004.

6100*	Channel 1 to channel 6 as from SW 4		Active after SK "Reconfigure memory"
Default value	Lower input limit	Upper input limit	Units
23	0	3 450	1 block buffer

This MD is used to define channel-specifically the maximum number of part program blocks that can be predecoded during execution.

See "Flexible memory configuration" functional description.

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61020	Memory for extended overstore (channel 1) (as from SW 5)		Active Power On
Default value	Lower input limit	Upper input limit	Units
1	0	1	approx. 50 KB

61021	Memory for extended overstore (channel 2) (as from SW 5)		Active Power On
Default value	Lower input limit	Upper input limit	Units
1	0	1	approx. 50 KB

61022	Memory for extended overstore (channel 3) (as from SW 5)		Active Power On
Default value	Lower input limit	Upper input limit	Units
0	0	1	approx. 50 KB

61023	Memory for extended overstore (channel 4) (as from SW 5)		Active Power On
Default value	Lower input limit	Upper input limit	Units
0	0	1	approx. 50 KB

61024	Memory for extended overstore (channel 5) (as from SW 5)		Active Power On
Default value	Lower input limit	Upper input limit	Units
0	0	1	approx. 50 KB

61025	Memory for extended overstore (channel 6) (as from SW 5)		Active Power On
Default value	Lower input limit	Upper input limit	Units
0	0	1	approx. 50 KB

As from SW5, the function "Extended overstore" is enabled in the "Flexible memory configuration" (fiel ncmemcfg.). The file can be edited via the MDD menu tree **Startup/Machine data/NC machine data/ETC/Flex.memory conf.**.

The function can be switched on or off in the channel-specific toggle field "Data for extended overstore". If the function is switched on for a channel, for which no block buffers have been defined, no memory is reserved. Switching on of the function requires a memory space of approx. 50 KB per channel. As a default, the function is switched on for channels 1 and 2.

62000-62029	Axis 1 to axis 30		Active after SK "Reconfigure memory"
Default value	Lower input limit	Upper input limit	Units
0	0	700 000	1 measured value

This MD is used to define axis-specifically how many measured values can be enabled for the function "Extended measuring".

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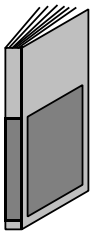
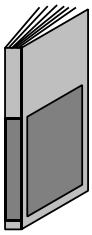
6.11 Safety Integrated (SI) data



The SINUMERIK Safety Integrated function is an option. The Safety Integrated machine and service data are described in the documentation SINUMERIK Safety Integrated (Description of Functions).



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6.12 Setting data

6.12.1 NC setting data (NC SD)

All setting data (SD) take effect immediately (without POWER ON). If program processing is in progress, they become active in the next block if they have been changed with G functions in the part program.

Breakdown of NC setting data

SD No.	0	–	999:	General values*
SD No.	2000	–	2999:	Channel-specific values*
SD No.	3000	–	3999:	Axis-specific values*
SD No.	4000	–	4999:	Spindle-specific values*
SD No.	5000	–	5399:	General bits
SD No.	5400	–	5599:	Channel-specific bits
SD No.	5600	–	5799:	Axis-specific bits
SD No.	6000	–	6999:	Axis**/**Spindle converter
SD No.	7000	–	7007:	Software cam 1)

The setting data are selected with the area switchover key and the parameter and setting data softkeys.

1) As from SW 3

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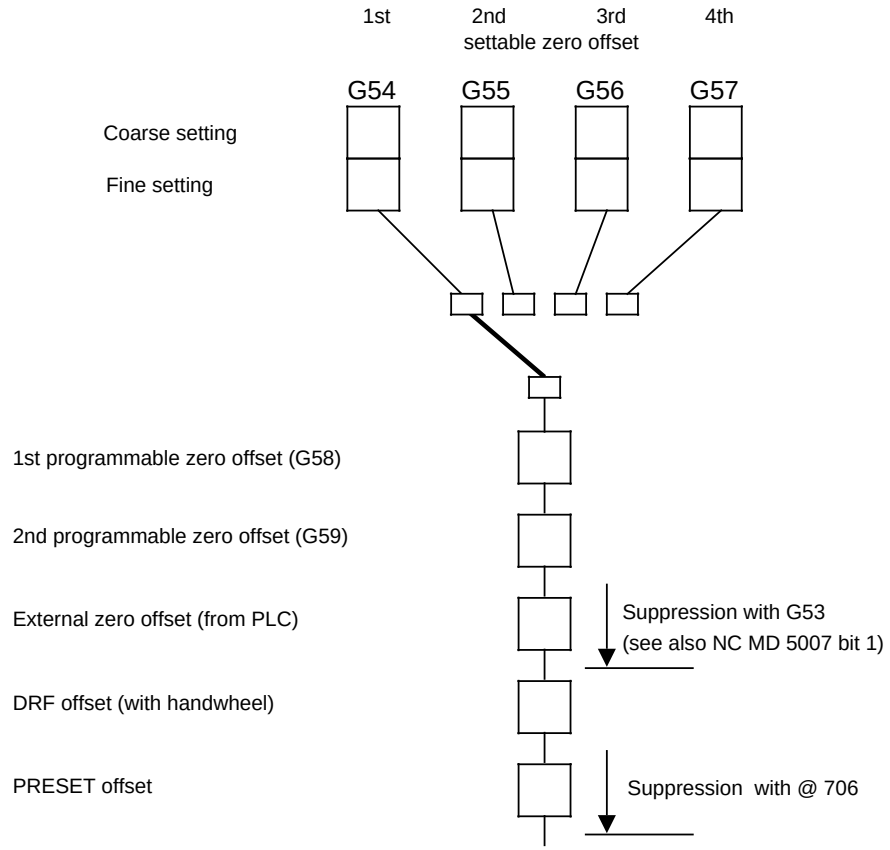
Zero offsets (ZO)

G54	1st settable zero offset (coarse + fine)
G55	2nd settable zero offset (coarse + fine)
G56	3rd settable zero offset (coarse + fine)
G57	4th settable zero offset (coarse + fine)



Initial setting for programming is **G54**!

G58	1st programmable ZO
G59	2nd programmable ZO
external ZO	external ZO from PLC The values are transmitted from the PLC via the external data input. The values can only be deleted from the PLC or with the softkey ”UMS format”.

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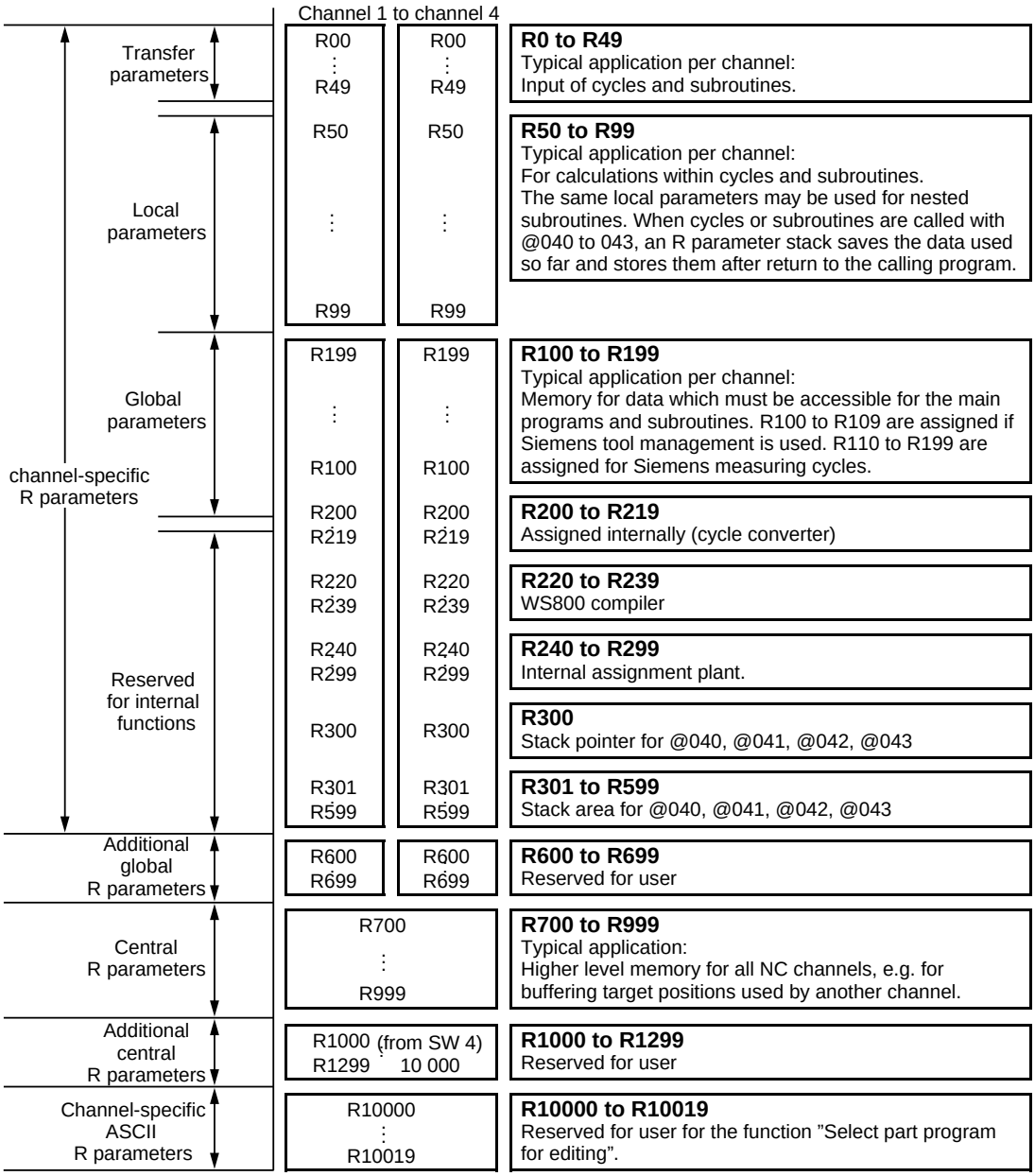
R parameters

700 parameters per channel are available for the whole system and
600 central parameters: parameters R0 to R699 are channel-specific,
parameters R700 to R1299 apply to all channels.

Structure and application of R parameters:



Note:

As from SW 4, the structure of the R parameters can be modified by the ”Flexible memory configuration” function.

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R parameter assignment

R0 – R49: **Typical application per channel**:

Input of cycles and subroutines.

R50 – R99: **Typical application per channel**:

For calculations within cycles and subroutines. The same local parameters may be used for nested subroutines. When cycles or subroutines are called with @ 040 to 043, an R parameter stack saves the data used so far and stores them after return to the calling program.

R100 – R199: **Typical application per channel**:

Memory for data which must be accessible for the main programs and subroutines. R100 to R109 are assigned if Siemens tool management is used. R110 to R199 are free for the user.

R200 – R219: Siemens assignment (cycle converter)

R220 – R239: CL800 compiler on WS800 compiler (Siemens assignment)

R240 – R299: Intended for internal assignment by Siemens as required

R300: Stack pointer for @040, @041, @042, @043 (set to 301 with each M2, M30 RESET)

R301 – R499: Stack area for @040, @041, @042, @043

R500 – R599: 100 new global R parameters per channel
Use: as for R100 to R199

R700 – R999: **Typical application**:

Higher-level memory for all NC channels, e.g. for buffering target positions used by another channel.

Note:

R parameter areas R100 to R199, R500 to R599 and R700 to R999 are provided for the user as standard.

The user can also use the other R parameters if he is not using the associated functions (CL 800 language, SIEMENS cycles or similar).

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General setting data

0	Dry run feedrate		Active on –
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1072 0000 9999 9999 (as from SW 5)**	**1 000 units/min**

If ”Dry run feedrate” is selected on the control, the tool path feedrate selected is the dry run feedrate (mm/min (G94)) and not the programmed feedrate.

1	Dyn. smoothing time thread cutting		Active on –
Default value	Lower input limit	Upper input limit	Units
0	**0**	**5**	**2^n-1 ×IPO cycle**

Programming smoothing exponent via G92 T..

This function is used to protect the drive when cutting threads and to obtain a better speed stability.

The feed ramp-up time until synchronization with the working spindle already running is reached can be programmed using the command G92 T.. . The feed ramp-up time should be matched to the running path available:

- short run-in path, short ramp-up time, low T value
- long run-in path, long ramp-up time, high T value

The programmed ramp-up time also acts as the smoothing time, i.e. the actual spindle speed is averaged via this value an even feedrate is thus obtained.

The smoothing and feed ramp-up time depends on

- the programmed value T..
- the interpolation cycle which is set in NC MD 155; this machine data should only be changed by a properly trained specialist.

The value T.. must be an integer. Possible values are 0...5. The following table shows which T value must be programmed for a set interpolation cycle in order to obtain the required feed ramp-up time:

Thread cutting with constant lead (G33)
Thread cutting with linear increasing lead (G34)
Thread cutting with linear decreasing lead (G35)

Program syntax:

N.. G33 <Coordinates of target point> <thread lead>
N.. G34 <Coordinates of target point> <initial lead> <lead change>
N.. G35 <Coordinates of target point> <initial lead> <lead change>

The action of G functions G33, G34, G35 are modal.

The programmed feedrate F has no meaning but remains modal, i.e. the feedrate is derived internally from the actual speed value of the leading spindle.

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M version:

If the control is initialized for **milling**, the actual value coupling between the spindle speed actual value and feed setpoint is **direction dependent.** If the traversing direction of the feed axis is to be altered, then the spindle direction of rotation (M3-->M4) must also be altered. Additionally, the overflow when the spindle is reversed (e.g. (M3-->M4) must be taken into account when programming the **thread depth**.

Note:

If in thread tapping blocks on milling machines, after the first thread block the direction of movement but not the spindle direction of rotation is programmed in the opposite direction, traversing is still carried out in the previous direction. The software limits switches are active.

When the software limit switches are triggered, the following error must be eliminated. The software limit switch is therefore exceeded by the following error.

T version:

If the control is initialized for **turning**, the actual value coupling between the spindle speed actual value and the feed setpoint is **not direction dependent**. This means that the spindle can continue turning in one direction while the feed axis is reprogrammed to change direction.

With G34/G35 the thread lead is altered per turn by the value programmed under address F until the maximum or minimum possible value is obtained.

The value F must be used without a sign and is derived from the known initial and final lead and thread length:

$$F = \frac{\text{Initial lead}^{\,2} - \text{final lead}^{\,2}}{2 \cdot \text{thread length}}$$

5	**PLC alarm text file** [1)]		Active on –
Default value	Lower input limit	Upper input limit	Units
1	**1**	**9 999**	**–**

When NC machine data bit 5199.4 is set, the display of the PCF files is enabled.

NC MD 5199.4 = 0 No display of PCF files
NC MD 5144.1 = 1 Display of PCF files active

The setting of NC setting data 5 (PLC alarm text files) in the setting data area "General data", defines which PCF file is to be used to display PLC alarm texts. The value range is 0 - 9999.

1) *Up to SW 2*
2) *As from SW 3*

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9	INC Variable		Active on –
Default value	Lower input limit	Upper input limit	Units
50	**0**	**9 999.9999** [1] **16 000** [2]	**–**

Incremental dimension INC Variable

The axis in question is traversed by this amount when the direction key (+ or -) is pressed.

200*	Scale factor		Active on –
Default value	Lower input limit	Upper input limit	Units
1	**0.00001**	**99.99999**	**–**

If the scale factor is selected with G51, all the following programmed axis values are altered using the scale factor (see Programming Guide for detailed description).

The scale factor is programmed together with G51 in a block.

202*	Start angle for thread		Active on –
Default value	Lower input limit	Upper input limit	Units
0	**0**	**359.999**	**Degrees**

If a starting angle for thread cutting is entered, it is easy to produce a multiple thread. This setting data can be altered via the user interface or by programming ”G92 A ...” in the part program. The option ”Extended thread package” must be active for this function.

The last angle to be entered is saved after Power off.

204*	Maximum number of predecoded blocks (as from SW 5)		Active **At once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**ca. 3 500**	**Blocks**

The number of predecoded blocks can be limited by a channel-specific setting data.

0:	Limitation is disabled, as many blocks are decoded as possible.
1 - approx. 3 500:	The number of predecoded blocks is limited to a defined value. The maximum value depends on the available memory and from the setting in the flexible memory configuration. If the existing number of block buffers is exceeded, as many blocks as possible are predecoded. The minimum value is 2 here. If the value 1 is entered it is automatically switched over to 2.

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The setting data can be written from a part program under "Program control" using the command @410 or from the PLC. A larger value can be written as the available block memory. The NC however still predecodes no more than the stated number of blocks. If the setting data is reduced when already more than the defined number of blocks has been predecoded, no more blocks are predecoded until this number is reached.

Limitation is especially useful when a program is being run in (single block processing).

206*	**Actual number of predecoded blocks (as from SW 5)**		Active on –
Default value	Lower input limit	Upper input limit	Units
			Blocks

The number of blocks actually predecoded by the NC can be read in setting data 206*. The inserted blocks in the block preparation chain are also counted.

The value is displayed under "Program control" but can also be read in the part program (@310) by the PLC. The user can use this command to control predecoding from the PLC (see also function ”Control of predecoding G171/G172”).

The value must not be overwritten. It is constantly updated by the NC when the part program is active.

Note:

The actual number of predecoded blocks never reaches the value set in the memory configuration because up to 20 buffers are used for internal memory management.

300*	**Minimum working area limitation**		Active on –
Default value	Lower input limit	Upper input limit	Units
– 99 999.999	**– 99 999.999**	**+ 99 999.999**	**mm or inches**

304*	**Maximum working area limitation**		Active on –
Default value	Lower input limit	Upper input limit	Units
+ 99999.999	**– 99 999.999**	**+ 99 999.999**	**mm or inches**

With working are limitation, the range of travel can be limited in automatic, and**/**or JOG mode (in addition to software limit switches). The axes are displayed for each mode group. The working area limitation can be altered in the program with G25**/**26.

Working are limitation has no effect in the ”Reference point approach mode”.

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312*	Scale centre NC		Active on –
Default value	Lower input limit	Upper input limit	Units
0	**– 99 999.999**	**+ 99 999.999**	**mm or inches**

The scale centre defines where the reference point for the alteration of the programmed axis positions using the scale factor lies (see Programming Guide for detailed description).

The scale centre is programmed together with G51 in the block.

320*	Clamping torque for move against fixed stop		Active on –
Default value	Lower input limit	Upper input limit	Units
0	**1**	**999**	**0.1 %**

This SD is used to define the desired clamping torque as a % of the max. torque of the component. Input in units of 0.1 %

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Spindle-specific setting data

401*	Programmable spindle speed limitation for G96		Active on –
Default value	Lower input limit	Upper input limit	Units
0	**0**	**99 999**	**0.1 rev/min**

The spindle speed is limited at constant cutting speed (G96) by the programmed spindle speed limitation. The setting data can be modified in the program using the command G92.

Units

The unit of the input values is defined by MD 520*, bit 3:

Bit 3 = 0: Unit rev/min
Bit 3 = 1: Unit 0.1 rev/min

Note

The maximum spindle speed value is determined by the minimum of the following values:

- MD 403* to 410* ” Maximum speed” per gear ratio
- MD 451* ” Maximum chuck speed”
- SD 401* ” Programmable spindle speed limitation with G96”; programmed with G92
- SD 403* ”Programmable spindle speed limitation”; programmed with G26

402*	Spindle position with M19		Active on –
Default value	Lower input limit	Upper input limit	Units
0	**0**	**35 999**	**0.01°**

This setting data specifies the angle to which the spindle is positioned when M19 is programmed in the part program (or MDA, Overstore) without specifying an S value.

If an S value is programmed with M19, it is transferred to the setting data.

Examples

- The spindle is positioned to 270 degrees with `M19 S270 LF`. The angle is entered in the setting data.
- `M19 LF` is used to position the spindle to the value and entered in the setting data.

403*	Programmable spindle speed limitation		Active on –
Default value	Lower input limit	Upper input limit	Units
100	**0**	**99 999**	**0.1 rev/min**

The maximum spindle speed is limited to this value. The setting data can be modified in the program using the command G26.

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Units

The unit of the entered values is defined in bit 3 of MD 520*:

Bit 3 = 0: Unit rev/min
Bit 3 = 1: Unit 0.1 rev/min

Note

The maximum spindle speed value is determined by the minimum of the following values:

- MD 403* to 410* ”Maximum speed” per gear ratio
- MD 451* ”Maximum chuck speed”
- SD 401* ”Programmable spindle speed limitation with G96”; programmed with G92
- SD 403* ”Programmable spindle speed limitation”; programmed with G26

Setting data bits

General bits

SD MD	Bit No. 7	6	5	4	3	2	1	0
5000	Calc. of overtravel compen-sation	L900 without safety distance of drilling axis	Cycles L97 L99 active with G620			Function ext. from UMS03 used: Turning cycles	Drilling and milling patterns	Drilling cycles
5001						Auto. storage. of PP on hard disk (as from SW 5)		Display workpiece-related ac-tual value system

SD 5000

Bit 2-0 **Bit 2-0=0** Standard cycles up to UMS02[1)] active
Bit 2-0=1 Standard cycles up to UMS03[1)] active

Bit 7 **Bit 7=1** Overtravel compensation functions
Bit 7=0 No calculation of overtravel compensation

SD 5001

Bit 2 **Bit 2=1** The part program is either stored in the source workpiece or in workpiece "STANDARD" or NCKTMP, depending on the setting in MD 5189 bit 3.

Bit 0 **Bit 0=1** The actual-value display for axes (actual position) refers to the workpiece zero and not to the machine zero (reference point)

Note on bit 0:

The display is deselected with mode group reset, it remains active after program end (M02/M30).

Channel-specific bits

SD MD	Bit No. 7	6	5	4	3	2	1	0
540*							Workp. not loaded on POWER ON (from SW 6)	Axis converter On/Off

Bit 1=1: The workpiece selected in the channel is not loaded in NCK on POWER ON. Only active in combination with MD 5025.7.

Bit 1=0: The workpiece selected in the channel is loaded in NCK on POWER ON. Only active in combination with MD 5025.7.

Bit 0=1: Axis converter On

Bit 0=0: Axis converter Off

1) Texts generated on the WS 800A NC workstation and stored in the User Memory Submodule.

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Axial bits

SD MD	Bit No. 7	6	5	4	3	2	1	0
560*						Scale factor active on machine	Rapid override not active	Feedrate override not active

Bit 2 The scale factor (G51) is active during machining.

Bit 1 Override switch for rapid traverse no longer active in the axis in question.

Bit 0 Override switch for feedrate no longer active in the axis in question.

SD	Bit No. 7	6	5	4	3	2	1	0
564*				Increments per handwheel pulse 10000	1000	100	10	1

Evaluation of handwheel pulses (applies to both handwheels) per axis

Bit 0=1 1 increment per handwheel pulse (display resolution)
Bit 1=1 10 increments per handwheel pulse (display resolution)
Bit 2=1 100 "..."
Bit 3=1 1000 "..."
Bit 4=1 10000 "..."

Spindle converter setting data

SD	Bit No. 7	6	5	4	3	2	1	0
600* to 625*	Spindle converter							

The setting data are stored as follows in binary format.

SD 600*	1st progr. spindle channel-specific	SD 602*	1st real spindle channel-specific
SD 604*	2nd progr. spindle channel-specific	SD 606*	2nd real spindle channel-specific
SD 608*	3rd progr. spindle channel-specific	SD 610*	3rd real spindle channel-specific

SD 612* spindle conversion list on/off (1=on, 0=off)

These setting data can be altered via @311, @312, @411, @412 / PLC / RS 232 C (V24).

The spindle converter only operates in the automatic, teach-in and MDA modes but not with overstore.

The automatic basic display does not show that the spindle converter is active.

Note:

See Functional Description for detailed description.

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Axis converter setting data

SD	Bit No. 7	6	5	4	3	2	1	0
626* to 699*	Axis converter							

The setting data are stored in binary format as follows.

SD 626*	1st programmed axis channel-specific	SD 628*	1st machine axis channel-specific
SD 630*	2nd programmed axis channel-specific	SD 632*	2nd machine axis channel-specific

Setting data software cam

SD	Bit No. 7	6	5	4	3	2	1	0
7000 to 7007	Software cams							

The cam positions refer to machine zero and are used in the active machine dimension system (metric or inch). No check is made that the set cam position is within the maximum positional values (maximum traversing range).

The setting data for the cam positions can be read or written using the @ functions.

The setting data are stored in binary format as follows:

SD 7000*	Minus cam of cam pair 1	SD 7002*	Minus cam of cam pair 2
SD 7001*	Plus cam of cam pair 1	SD 7003*	Plus cam of cam pair 2
SD 7004*	Minus cam of cam pair 3	SD 7006*	Minus cam of cam pair 4
SD 7005*	Plus cam of cam pair 3	SD 7007*	Plus cam of cam pair 4

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Setting data for the additive protection zone adaptation (as from SW 6)

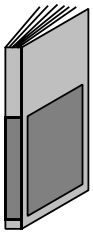
The values for the coordination of the dynamic protection zone adaptation are to be entered in the following setting data bits:

SD No.	Description	Default value	Maximum input value	Reference system	Input unit
800*	Protection zone enlargement in X+ direction	0	9999 9999	IS	–
804*	Protection zone enlargement in Y+ direction	0	9999 9999	IS	–
808*	Protection zone enlargement in Z+ direction	0	9999 9999	IS	–
812*	Protection zone enlargement in X- direction	0	9999 9999	IS	–
816*	Protection zone enlargement in Y- direction	0	9999 9999	IS	–
820*	Protection zone enlargement in Z- direction	0	9999 9999	IS	–

These setting data are activated by MD 3876* bit 1.

6.13 Cycles machine data

The cycles machine data are active only when you use the measuring cycles from Version 20. For a detailed description of the cycles machine data please refer to the



Start-up Guide
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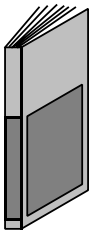

END OF SECTION

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7 Drive Machine Data (SIMODRIVE Drive MD)

7.1 611A main spindle drive machine data (MSD MD) (SW 3)

7.1.1 MSD MD input (SW 3)

The main spindle drive machine data are provided for the purpose of matching the main spindle drives and the machine tool. If no setting values are specified by the machine manufacturer or the user, then they must be carefully determined and optimized by the start-up engineer. The setting values are input by means of menu selection (see section headed "Machine Data Dialog").

7.1.2 MSD MD (data description - SW 3)

1	Speed setpoint		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**–**	**–**	**rev/min**

Display machine data for the present setpoint of the motor speed in rev/min.

2	Speed actual value		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**–**	**–**	**rev/min**

Display machine data for the present actual value of the motor speed in rev/min.

3	Motor voltage		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**–**	**–**	**V**

Display machine data for the present RMS value of the line-to-line motor voltage.

4	Capacity utilization		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**–**	**–**	**%**

Display machine data for utilization of the main spindle drive. The ratio between torque M_d and maximum torque M_{dmax} is displayed up to rated speed n_{rated}; the ratio between power P and maximum power P_{max} is displayed at speeds above the rated value.

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6	DC link voltage		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	–	–	**V**

Display machine data for the present DC link voltage.

7	Motor current		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	–	–	**A**

Display machine data for the present motor current RMS value.

8	Motor reactive power		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	–	–	**kVA**

Display machine data for the present reactive power consumption of the motor.

9	Motor active power		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	–	–	**kW**

Display machine data for the present active power consumption of the motor.

Note:

The sign indicates whether the motor is operating as a motor (+) or a generator (–).

10	Motor temperature		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	–	–	**°C**

Display machine data for the present motor temperature. The temperature is sensed through temperature resistance measuring devices in the motor stator.

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11	Status of binary inputs		Active at once
Default value	Lower output limit	Upper output limit	Units
–	–	–	**Hex**

Display machine data for the status of the binary inputs.

Value table:

Bit 0	Not assigned	
Bit 1	Image terminal 663 (module-specific pulse suppression IMPFR)	0: Pulse enable 1: Pulse disable
Bit 2	Image terminal 63 of I/RF unit (central drive pulse suppression REIMSP)	
Bit 3	Sum signal pulse enable: - Stored hardware sum signal HWFRGOUT - Pulse enable by PLC via 611D control word	
Bit 4	"Heat sink of power section XKKT too hot" message	0: Overtemperature 1: Normal temperature
Bit 5	Image terminal 112 of I/RF unit (set-up mode XEINR message)	0: Set-up mode 1: Normal mode
Bit 6	Image terminal 64 of I/RF unit (central drive enable setpoint = 0)	0: Controller enable 1: Regenerative braking
Bit 7	Not assigned	
Bit 8	Image terminal 5 of I/RF unit (motor/power section temperature prewarning X12T)	0: Normal range 1: Limit value exceeded
Bit 9-15	Not assigned	

14	Speed for max. motor operational speed motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
Maximum motor speed	**Max. speed**	**Max. speed**	**rev/min**

Machine data MD 14 defines the maximum operating speed of the main spindle motor. It acts as the reference value of the speed setpoint interface.

Note:

The velocity of a main spindle is matched in NC-MD 4030 (maximum spindle speed). The motor operating speed which corresponds to this maximum value must be entered in drive-MD 14. Allowance is made for any existing gear ratios in the relationship between NC-MD 4030 and drive-MD 14.

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19	Rounding degree speed setpoint		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**30**	**–**

Input of parameter setting for a PT2 filter (low-pass) in the speed setpoint channel. The low-pass filter is inserted on the output side of the ramp-function generator and is effective only if the speed setpoint smoothing function (MD 53, bit 4) is activated at the same time.

20	Diagnosis speed actual value		Active at once
Default value	Lower output limit	Upper output limit	Units
0000	**0000**	**–**	**Hex**

Display of the monitoring machine data "Diagnosis speed actual value". If an impermissibly large speed deviation occurs within the sampling period, then the value of the machine data is incremented. Sporadic responses by a few increments can be ignored since these do not influence the speed controller. A high disturbance level will cause the contents of MD 20 to be increased repeatedly by several increments.

Possible causes of disturbances

- Encoder shield not earthed
- Encoder defective
- Earth connection of electronics ground in MSD module faulty
- Motor earth not connected in MSD module
- Value entered for motor moment of inertia too high
- Evaluation electronics

21	n_{min} for $n_{act} < n_{min}$ message motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
12	**0**	**Rated speed**	**rev/min**

Input of response value for monitoring of the PLC status message $n_{act} < n_{min}$ (see also MD 241).

22	Creep speed pulse suppression motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
Rated speed / 256	**0**	**Rated speed**	**rev/min**

Input of response value for the internal n_{min} sensor for stopping the drive with no reverse rotation. When the speed n_{min} is reached, the drive torque is cut off and the drive coasts to a stop with any remaining kinetic energy.

Note:

This n_{min} threshold is not the same as the response value of the n_{min} monitor, but it may be set to the same value.

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23	n_x for $n_{act} < n_x$ message motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
6 000	**0**	**Maximum motor speed**	**rev/min**

Input of response value for monitoring of the PLC status message $n_{act} < n_x$ (see also MD 241).

27	Tolerance band for $n_{set} = n_{act}$ message motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
20	**0**	**$\frac{\text{Rated speed}}{16} - 1$**	**rev/min**

Input of response value for the tolerance band of the PLC status message $n_{set} < n_{act}$ (see also MD 241). The tolerance band of the $n_{set} = n_{act}$ response threshold can be defined in machine data MD 27.

28	Diagnosis		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0000	**0000**	**–**	**Hex**

Output of diagnostic messages which do not cause tripping (pulse disable).

0008 H: Temperature sensor circuit interrupted or shorted
2000 H: Division interrupt: Error in calculation routines or incorrect entry of data

29	Speed limitation motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
Maximum motor speed	**0**	**Maximum motor speed**	**rev/min**

Input of maximum motor speed (n_{max}) = speed safety limit.

31	P-gain speed controller motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
32.0	**1.0**	**120.0**	**–**

Input of P gain (K_p) for the speed controller. The speed controller has a PI function which can be set separately for eight gear stages.

Note:

A speed controller adaptation can be implemented only for gear stage 1 (see MD 203).

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32	Integral-action time speed controller motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
20	**5**	**6 000**	**ms**

Input of integral-action time (t_N) for the speed controller. The speed controller has a PI function which can be set separately for eight gear stages.

Note:

A speed controller adaptation can be implemented only for gear stage 1 (see MD 203).

35	Smoothing time torque setpoint motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
3	**3**	**1 000**	**ms**

Input of smoothing time for the torque setpoint. MD 45 and MD 46 are the corresponding machine data.

Note:

The smoothing function can be activated in machine data MD 44.

36	Encoder phase error compensation motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**-400**	**+400**	**–**

Phase errors in the encoder signals can be compensated by means of a correction function. The amplitude of this function is specified via machine data MD 36.

Note:

Default value 0 means no correction.

37	Switchover speed motor encoder evaluation motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
32 000	**0**	**32 000**	**rev/min**

Input of the switchover speed for evaluation of the motor encoder. In this case, it is possible to switch between the square-wave and SINE/COSINE evaluation modes. Square-wave evaluation is applied at speeds above the maximum value entered.

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38	Hysteresis MD 37 motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
50	**0**	**500**	**rev/min**

Input of hysteresis for machine data MD 37 (switchover speed for motor encoder evaluation).

39	1st torque limiting value motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
100	**5**	**180**	**%**

Input of the maximum permissible torque referred to the rated torque of the motor. The setting of the limit values is referred to the rated motor torque in the constant torque range. At speeds above the rated value, i.e. in the constant power range, the torque limitation is referred to the appropriate working point. With a setting of, for example, 100 %, the rated torque acts as the torque limit up to rated speed. At speeds above the rated value, the torque limit curve drops in proportion to 1/n so that the rated output is reached in each case. MD 40-MD 43, MD 47 and MD 50 are the corresponding machine data.

40	Generative limitation motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
100	**5**	**100**	**%**

Input of torque limit for braking operation (generator-mode torque limit). This input value is referred to the maximum motor-mode torque (see also MD 39).

41	2nd torque limiting value motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
50	**5**	**100**	**%**

Input of 2nd torque limit value referred to the 1st torque limit (MD 39). This 2nd torque limit can be selected via the PLC control word and machine data MD 50.

42	Switchover speed for MD 40 motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
500	**0**	**Maximum motor speed**	**rev/min**

Input of speed above which the generator-mode limit set in machine data MD 40 is applied (see also MD 39).

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43	Hysteresis MD 42 motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
20	**0**	**Maximum motor speed**	**rev/min**

Input of hysteresis for the switchover speed set in machine data MD 42 (see also MD 39).

44	Selection torque setpoint smoothing motors 1 and 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0001	**0000**	**0001**	**Hex**

Input of setting to activate torque setpoint smoothing. The torque setpoint smoothing function acts on the speed controller output. MD 35, MD 45 and 46 are the corresponding data.

0: No smoothing active

1: Activation of smoothing function at speeds above value set in machine data MD 45 and MD 274

45	Cut-in speed torque setpoint smoothing motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
4 000	**0**	**Maximum motor speed**	**rev/min**

Input of speed value above which the torque setpoint smoothing function activated in machine data MD 44 is applied.

46	Hysteresis MD 45 motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
50	**0**	**Rated speed**	**rev/min**

Input of hysteresis for the cut-in speed set in machine data MD 45.

47	M_{dx} for $M_d < M_{dx}$ message		Active at once
Default value	Lower input limit	Upper input limit	Units
–	**0**	**100**	**%**

Input of setting value for the PLC status message $M_d < M_{dx}$ (see also MD 241). This input value is referred to the currently active torque limit value.

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50	Switching speed from M_{d1} to M_{d2} motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
4 x rated motor speed	**0**	**Maximum motor speed**	**rev/min**

Input of speed at which switchover from the 1st torque limit (MD 39) to the 2nd torque limit (MD 41) takes place. This switchover is implemented only if the appropriate bit has been set in the PLC control word and the switchover speed set in MD 50 has been exceeded.

52	Transfer machine data to FEPROM		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**0001**	**Hex**

Note:

This machine data is not included in the machine data lists. During start-up in machine data dialog, the machine data is set or altered as appropriate via the configuration setting.

The machine data can be saved from the RAM to the FEPROM by setting this machine data to the value 1 H.

53	Control word		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

A range of control functions can be selected and altered by entering bit patterns in the control word.

Selection of bits:

Not assigned	Bit 0	
Ramp-function generator rapid stop	Bit 1	0: The motor remains connected to the supply after shutdown by the ramp generator rapid stop function 1: The motor is isolated from the supply when the speed drops below the internal n_{min} speed value after shutdown by the ramp generator rapid stop function
Not assigned	Bits 2-3	
Speed setpoint smoothing	Bit 4	0: Function is active only if the appropriate bit has been set in the PLC control word 1: Function is always active
Not assigned	Bits 5-8	
Inverter pulse frequency	Bits 9-10	Bit 9 = 0 and bit 10 = 0 : Selection of 3.44 kHz Bit 9 = 0 and bit 10 = 1 : Selection of 4.95 kHz Bit 9 = 1 and bit 10 = 0 : Selection of 6.60 kHz Bit 9 = 1 and bit 10 = 1 : Selection of 8.11 kHz
Division interrupt error message	Bit 11	0: Message is displayed 1: Message is concealed
Ramp-function generator automatic control	Bit 12	0: Ramp-function generator automatic control active 1: Ramp-function generator automatic control deactivated

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63	Maximum motor temperature motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**170**	**°C**

Input of maximum motor temperature. The value entered can be lower than the maximum temperature value calculated via the motor code number (MD 96) and motor data set. If the specified temperature is exceeded, the "Motor overtemperature" prewarning is output after approximately 30 s (provided it is activated) or the "Motor overtemperature" alarm given after the delay set in machine data MD 65.

64	Fixed temperature		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**170**	**°C**

Input of fixed temperature. If a value higher than 0 is entered, then the motor is operated at the specified fixed temperature value.

Note:

The motor temperature monitoring function set in machine data MD 63 is made inoperative if a fixed temperature is specified.

65	Timer motor temperature alarm		Active **at once**
Default value	Lower input limit	Upper input limit	Units
240	**0**	**600**	**s**

Input of timer for the motor temperature alarm. A warning is output as soon as the monitor responds; the drive is then tripped with an alarm message when the delay time set above has expired.

72	Address DAC2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
3048	**0000**	**FFFF**	**Hex**

Note:

This machine data is not included in the machine data lists. The DACs are configured in the course of the drive servo start-up procedure for diagnostic purposes.

Input of memory address of which the contents must be output.

3048 H: Motor utilization M_d/M_{dmax} or P/P_{max}

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73	Shift factor DAC2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**15**	**–**

Note:

This machine data is not included in the machine data lists. The DACs are configured in the course of the drive servo start-up procedure for diagnostic purposes.

Input of shift factor DAC2 for analog output. The top 8 bits from a 16-bit wide memory location are output. This machine data specifies how often the value must be shifted to the left beforehand. A shift by one position corresponds to a multiplication by 2, i.e. the shift factor allows multiplication by the power of two $2^{\text{shift factor}}$. The maximum gain which can be obtained in this way is 32768 (only the last bit is evaluated).

74	Offset DAC2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**FF80**	**007F**	**Hex**

Note:

This machine data is not included in the machine data lists. The DACs are configured in the course of the drive servo start-up procedure for diagnostic purposes.

Input of an offset value for DAC2 which is added to the value prior to analog output.

76	Address DAC1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
3044	**0000**	**FFFF**	**Hex**

Note:

This machine data is not included in the machine data lists. The DACs are configured in the course of the drive servo start-up procedure for diagnostic purposes.

Input of memory address of which the contents must be output.

3044 H: Speed actual value n_{act}

77	Shift factor DAC1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**15**	**–**

Note:

This machine data is not included in the machine data lists. The DACs are configured in the course of the drive servo start-up procedure for diagnostic purposes.

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Input of shift factor DAC1 for analog output. The top 8 bits from a 16-bit wide memory location are output. This machine data specifies how often the value must be shifted to the left beforehand. A shift by one position corresponds to a multiplication by 2, i.e. the shift factor allows multiplication by the power of two $2^{\text{shift factor}}$. The maximum gain which can be obtained in this way is 32768 (only the last bit is evaluated).

80	**Offset DAC1**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**FF80**	**007F**	**Hex**

Note:

This machine data is not included in the machine data lists. The DACs are configured in the course of the drive servo start-up procedure for diagnostic purposes.

Input of an offset value for DAC1 which is added to the value prior to analog output.

95	**Power section code number**		Active **Power On**
Default value	Lower input limit	Upper input limit	Units
7	**6**	**12**	**–**

Note:

This machine data is not included in the machine data lists. During start-up in machine data dialog, the machine data is set or altered as appropriate via the configuration setting.

Input of code number for the power section used.

Converter table:

Code number	Power section order no.	Current
6	6SN1135-1DA1 -0CA0	24**/**32**/**32A
7	6SN1135-1DA1 -0DA0	30**/**40**/**51A
8	6SN1135-1DA1 -0GA0	45**/**60**/**76A
9	6SN1135-1DA1 -0EA0	60**/**80**/**102A
10	6SN1135-1DA1 -0FA0	85**/**110**/**127A

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96	Motor code number motor 1		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
101	**99**	**332**	**–**

Note:

This machine data is not included in the machine data lists. During start-up in machine data dialog, the machine data is set or altered as appropriate via the configuration setting.

Input of code number for the motor used. The relevant motor data are stored in the software and are transferred to machine data MD 159 to MD 175 when the motor code number is changed. If individual motor data (MD 159 to MD 175) must be changed, then the value 99 (non-Siemens motor) must be entered as the motor code number.

Table of motors:

Order No.	**Rated speed**	**Rated power**	**Rated current**	**No-load current**	**Code numer**
	n_{rated} in rev/min	P_{rated} in kW	$_{rated}$ in A (for T =100 K)	$_{0}$ in A (for T =100 K)	
1PH6101-4NF4- x	1500	3.7	12.5	6.2	101
1PH6101-4NG4- x	2000	4.7	13.7	6.9	102
1PH6103-4NF4- x	1500	5.5	17.9	9.1	103
1PH6103-4NG4- x	2000	7.0	19.4	9.9	104
1PH6105-4NF4- x	1500	7.5	22.5	11.5	105
1PH6105-4NG4- x	2000	9.5	25.3	13.1	106
1PH6107-4NF4- x	1500	9.0	26.9	14.2	107
1PH6107-4NG4- x	2000	11.5	29.8	15.6	108
1PH6131-4NF4- x	1500	9.0	27.2	11.7	109
1PH6131-4NG4- x	2000	12.0	32.1	13.6	110
1PH6133-4NF0- x	1500	11.0	26.7	11.5	111
1PH6133-4NF4- x	1500	11.0	31.3	13.4	112
1PH6133-4NG4- x	2000	14.5	37.5	16.1	113
1PH6135-4NF0- x	1500	15.0	35.0	16.1	114
1PH6135-4NF4- x	1500	15.0	41.3	18.8	115
1PH6135-4NG4- x	2000	20.0	50.6	22.8	116
1PH6137-4NF4- x	1500	18.5	50.2	22.9	117
1PH6137-4NG4- x	2000	24.0	57.8	26.5	118
1PH6138-4NF0- x	1500	22.0	51.5	24.6	119
1PH6138-4NF4- x	1500	22.0	61.0	28.7	120
1PH6138-4NG4- x	2000	28.0	66.1	31.4	121
1PH6161-4NF0- x	1500	22.0	53.5	23.9	122
1PH6161-4NF4- x	1500	22.0	60.8	26.9	123
1PH6161-4NG4- x	2000	28.0	68.1	31.3	124

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Order No.	Rated speed	Rated power	Rated current	No-load current	Code number
	n_{rated} in rev/min	P_{rated} in kW	$_{rated}$ in A (for T =100 K)	$_{0}$ in A (for T =100 K)	
1PH6163-4NF0- x	1500	30.0	72.5	33.3	125
1PH6163-4NF4- x	1500	30.0	86.0	40.3	126
1PH6163-4NG4- x	2000	38.0	84.0	37.5	127
1PH6167-4NF0- x	1500	37.0	79.6	36.3	128
1PH6167-4NF4- x	1500	33.0	95.7	43.5	129
1PH6167-4NG4- x	2000	45.0	91.0	41.0	130
1PH6107-4NC4- x	750	5.0	22.7	11.7	131
1PH6133-4NB4- x	525	4.5	26.0	9.8	132
1PH6137-4NB4- x	525	7.9	43.6	18.6	133
1PH6163-4NB4- x	500	11.5	66.2	27.8	134
1PH6167-4NB4- x	500	14.5	78.0	34.4	135
1PH6133-4NG0- x	2000	14.5	31.5	14.5	136
1PH6137-4NG0- x	2000	24.0	50.0	23.2	137
1PH6167-4NG4- x	2000	45.0	83.3	32.2	138
1PH6163-4NZ0- x	950	19.0	56.0	25.2	139
1PH6105-4NZ4- x	3000	12.0	27.0	15.6	140
1PH6167-4NG0- x	2000	45.0	85.0	29.5	141
1PH6186-4NB4- x	500	22.0	66.0	35.5	160
1PH6186-4NB4- x	610	26.8	66.0	35.5	161
1PH6206-4NB4- x	500	32.0	96.0	48.0	162
1PH6186-4NE4- x	1250	42.0	86.0	46.0	163
1PH6186-4NF4- x	1500	50.0	100.0	52.0	164
1PH6206-4NE4- x	1250	63.0	125.0	64.0	165
1PH6206-4NF4- x	1500	76.0	149.0	68.0	166
1PH6186-4NB9- x	700	30.8	67.0	35.0	167
1PH6133-4NB8- Y	525	4.5	15.3	6.4	200
1PH6133-4NB8- D	1250	4.3	13.5	8.0	201
1PH6137-4NB8- Y	525	7.9	25.2	11.7	202
1PH6137-4NB8- D	1250	7.5	22.5	13.5	203
1PH6163-4NB8- Y	500	11.5	39.5	14.3	204
1PH6163-4NB8- D	1250	11.5	35.2	20.8	205
1PH6167-4NB8- Y	500	14.5	45.5	17.9	206
1PH6167-4NB8- D	1250	14.5	40.5	23.2	207
1PH6186-4NB8- Y	500	22.0	55.0	31.0	208
1PH6186-4NB8- D	1250	22.0	50.0	35.0	209
1PH6206-4NB8 Y	500	32.0	76.0	38.0	210

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Order No.	Rated speed	Rated power	Rated current	No-load current	Code number
	n_{rated} in rev/min	P_{rated} in kW	$_{rated}$ in A (for T =100 K)	$_{0}$ in A (for T =100 K)	
1PH6206-4NB8- D	1250	32.0	73.0	49.0	211
DMR160.80.6. RIF	200	12.6	60.0	36.4	212
DMR160.80.6. rif	1300	12.6	33.3	26.0	213
1PH4103-4NF2- x	1500	7.5	25.2	11.5	300
1PH4103-4NG6- x	2000	8.5	36.4	17.7	301
1PH6105-4NF2- x	1500	11.0	36.6	16.4	302
1PH6105-4NG6- x	2000	12.0	24.4	51.3	303
1PH4107-4NF2- x	1500	14.0	45.0	19.0	304
1PH4107-4NG6- x	2000	16.0	55.5	26.9	305
1PH4133-4NF2- x	1500	15.0	53.1	17.4	306
1PH4133-4NF6- x	1500	14.0	55.9	21.4	307
1PH4135-4NF2- x	1500	22.0	70.7	25.5	308
1PH4135-4NF6- x	1500	20.0	76.6	29.7	309
1PH6137-4NF2- x	1500	27.0	81.9	30.3	310
1PH6137-4NF6- x	1500	25.0	92.8	35.9	311
1PH4138-4NF2- x	1500	30.0	97.3	33.8	312
1PH4138-4NF6- x	1500	28.0	102.2	40.0	313
1PH4163-4NF2- x	1500	37.0	103.0	44.0	314
1PH4163-4ND6- x	1000	25.0	103.8	42.4	315
1PH4167-4NF2- x	1500	46.0	115.0	49.2	316
1PH4167-4ND6- x	1000	31.0	129.4	50.7	317
1PH4168-4NF2- x	1500	52.0	143.0	58.8	318
1PH4168-4ND6- x	1000	35.0	143.9	58.6	319
1PH2093-6WF4	1500	7.5	32.1	10.9	320
1PH2095-6WF4	1500	10.0	28.4	13.6	321
1PH2113-6WF4	1500	15.0	53.3	21.8	322
1PH2115-6WF4	1500	16.5	52.7	21.9	323
1PH2117-6WF4	1500	18.0	58.9	24.7	324
1PH2118-6WF4	1500	23.0	78.9	32.8	325
1PH2092-4WG4	2000	4.7	20.6	10.6	326
1PH2096-4WG4	2000	10.0	41.6	21.5	327
1PH2123-4WF4	1500	11.5	54.5	21.1	328
1PH2127-4WF4	1500	21.0	80.8	33.4	329
1PH2128-4WF4	1500	25.0	97.1	37.4	330
1PH2143-4WF4	1500	30.0	96.5	41.8	331
1PH2147-4WF4	1500	38.0	111.3	43.7	332

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97	Boot		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**0002**	**Hex**

Note:

This machine data is not included in the machine data lists. During start-up in machine data dialog, the machine data is set or altered as appropriate via the configuration setting.

This machine data indicates whether the main spindle drive (MSD) is in the bootstrap mode (MD 97 = 0) or the normal mode (MD > 0). There are two possible options for implementing booting in the MSD bootstrap mode:

1. The machine data MD 95, MD 96, MD 98 and MD 238 are input; by setting MD 97 to 1H, the default settings resulting from MD 95, MD 96 and MD 238 are entered for all other machine data.
2. All machine data are entered, for example, by loading a machine data file. The bootstrap mode is terminated by setting MD 97 to 2H.

98	No. of encoder marks motor measuring system		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
2 048	**128**	**4 096**	**–**

Note:

This machine data is not included in the machine data lists. During start-up in machine data dialog, the machine data is set or altered as appropriate via the configuration setting.

Input of encoder mark number (increments per revolution) of the encoder used.

99	Firmware version		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**0.00**	**99.99**	**–**

Output of loaded firmware version (e.g. 3.02).

103	Frequency torque setpoint filter motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
300	**50**	**450**	**Hz**

Input of filter frequency. The 3dB transition frequency for the low-pass filter or the mid-frequency for the bandstop is specified here (see MD 117) for the digital filter in the torque setpoint channel.

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104	Grading torque setpoint filter motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
1.00	**0.10**	**10.00**	**–**

Input of filter quality for the bandstop in the torque setpoint channel (see MD 117).

1.00: Basis quality=1

116	Correction P-gain current controller motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**-255**	**255**	**–**

The current controller P-gain, which is calculated according to the motor, converter and converter switching frequency, can be corrected by an offset in this machine data. A positive value in MD 116 results in a higher gain and a negative value in a lower gain than the gain value calculated. The total gain obtained by adding the calculated value and the correction in MD 116 is displayed in MD 316.

117	Selection torque setpoint filter motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**0001**	**Hex**

The digital filter is activated and deactivated in this machine data. A digital filter can be implemented in the torque setpoint channel with machine data MD 103, MD 104 and MD 117.

0: Digital filter deactivated

1: Digital filter activated

118	Type torque setpoint filter motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**0001**	**Hex**

The filter type is selected in this machine data (see MD 117).

0: Bandstop characteristic

1: Low-pass characteristic

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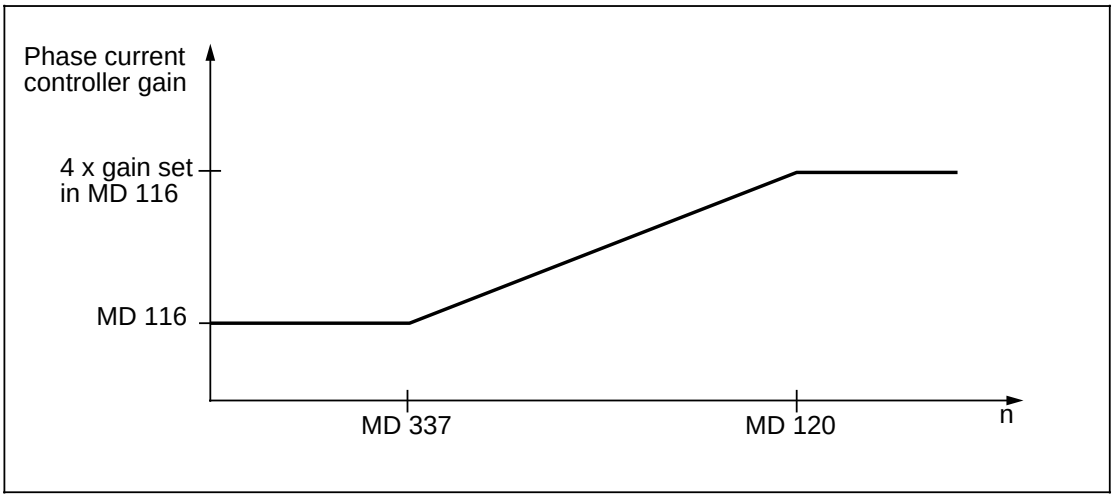
120	Switchover speed current controller adaptation motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
MD 172	**500**	**10 000**	**rev/min**

Input of switchover speed for the current controller adaptation. The phase current controller gain is adapted as a function of speed. The specified speed is the speed at which the phase current controllers reach their maximum gain.



150	Module identifier		Active at once
Default value	Lower output limit	Upper output limit	Units
–	–	–	**Hex**

Display machine data for module identifier.

Value table:

Bit 0-3	Motor measuring circuit	0H	Measuring circuit for incremental encoder with sinusoidal voltage signals
		1H	Measuring circuit for incremental encoder with sinusoidal current signals
		FH	Not fitted
Bit 4-7	Not assigned		Measuring circuit
Bit 8-11	Spindle measuring circuit	0H	Measuring circuit for incremental encoder with sinusoidal voltage signals
		1H	Measuring circuit for incremental encoder with sinusoidal current signals
		FH	Not fitted
Bit 12-15	Not fitted		

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159	Motor moment of inertia motor 1		Active on Power On
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0.002**	**32.000**	**kgm²**

Input of motor moment of inertia as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

160	Motor rated power motor 1		Active on Power On
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**150.0**	**kW**

Input of motor rated power as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

161	Motor rated current motor 1		Active on Power On
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**200.0**	**A**

Input of motor rated current as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

162	Motor rated voltage motor 1		Active on Power On
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**500.0**	**V**

Input of motor rated voltage as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

163	Motor rated speed motor 1		Active on Power On
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**4 096**	**rev/min**

Input of motor rated speed as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

164	Motor rated frequency motor 1		Active on Power On
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**409.6**	**Hz**

Input of motor rated frequency as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

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165	Motor no-load voltage motor 1		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**500.0**	**V**

Input of motor no-load voltage as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

166	Motor no-load current motor 1		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**200.0**	**A**

Input of motor no-load current as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

167	Stator resistance cold motor 1		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**32 767**	**m**

Input of stator resistance (cold) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

168	Rotor resistance cold motor 1		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**32 767**	**m**

Input of rotor resistance (cold) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

169	Stator leakage reactance motor 1		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**32 767**	**m**

Input of stator leakage reactance as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

170	Rotor leakage reactance motor 1		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**32 767**	**m**

Input of rotor leakage reactance as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

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171	Magnetizing reactance motor 1		Active on Power On
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**65 535**	**m**

Input of magnetizing reactance as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

172	Upper speed X_h characteristic motor 1		Active on Power On
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**100**	**24 000**	**rev/min**

Input of upper speed limit for the X_h characteristic (magnetizing reactance X_n) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

In the field-weakening range, the magnetizing reactance X_n increases linearly from the saturated value at the speed at which field weakening begins to the unsaturated value at the upper limit speed of the X_h characteristic (see diagram MD 175).

173	Speed at start of field weakening motor 1		Active on Power On
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**100**	**6 000**	**rev/min**

Input of speed at which field weakening starts as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

In the field-weakening range, the magnetizing reactance X_n increases linearly from the saturated value at the speed at which field weakening begins to the unsaturated value at the upper limit speed of the X_h characteristic (see diagram MD 175).

174	Motor maximum speed motor 1		Active on Power On
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**20 000**	**min**

Input of motor maximum speed as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

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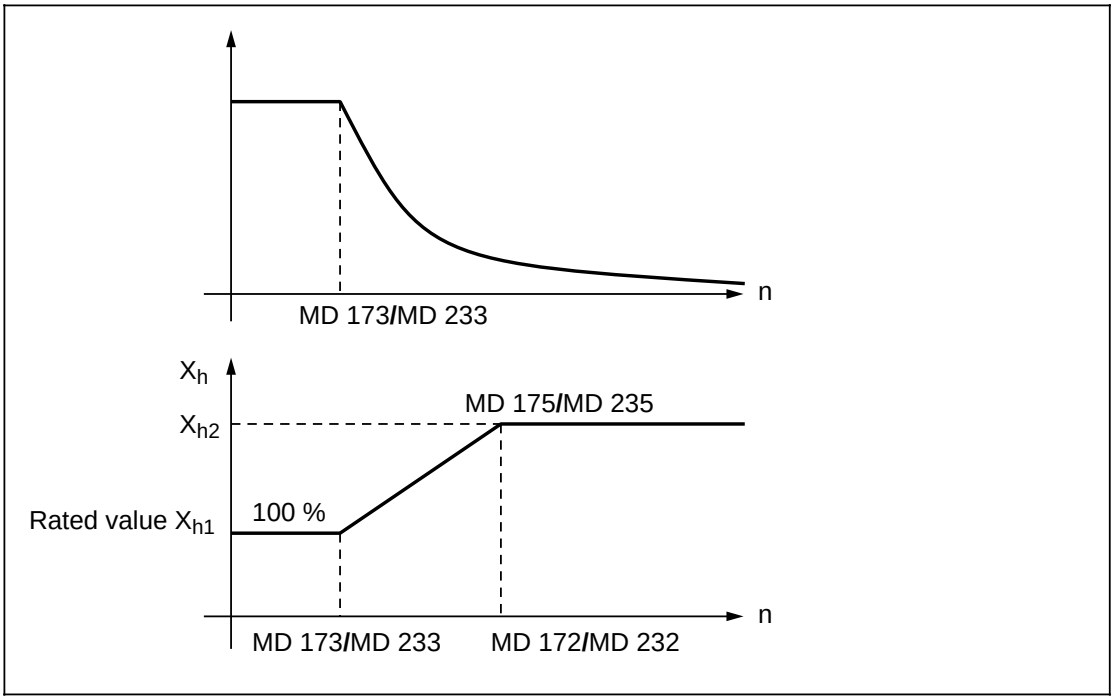
175	Gain factor X_h-characteristic motor 1		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**100**	**300**	**%**

Input of gain factor (X_{h2}/X_{h1}) of the X_h characteristic (magnetizing reactance) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

In the field-weakening range, the magnetizing reactance X_n increases linearly from the saturated value at the speed at which field weakening begins to the unsaturated value at the upper limit speed of the X_h characteristic (see diagram MD 175).



Note:

If the value is unknown, then 100 % should be entered in order to obtain constant magnetizing reactance over the entire speed range.

176	Breakdown torque reduction factor motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**1**	**150**	**%**

Input of breakdown torque reduction factor as specified on the motor data sheet. The point at which the breakdown torque limit is applied can be altered in this machine data.

Settings of higher than 100 % increase the point at which the limit is applied and vice versa with settings of lower than 100 %.

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179	Selection min/max memory		Active at once
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**0002**	**Hex**

This function allows variables to be monitored in the software. The address of the monitored variable is entered in machine data "Address of monitored variable" (MD 181).

The minimum value is displayed in machine data "Display minimum value" (MD 182) and the maximum value in machine data "Display maximum value" (MD 183).

0: Function deactivated
1: Function activated with absolute-value evaluation
2: Function activated with bipolar evaluation

180	Enable motor switchover		Active at once
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**0001**	**Hex**

Input for enabling of motor switchover (star-delta switchover). This machine data ensures a wide range of constant power. At low speeds, the drive is operated with a star connection (high torque) and at high speeds with a delta connection (high breakdown torque). The star-delta switchover can take place when the motor is running.

The switchover is described in more detail below:

The PLC requests a star-delta switchover via a bit in the control word. As soon as the drive has evaluated this control bit, the motor pulses are suppressed and an appropriate "pulse suppression" signal sent to the PLC. Only after arrival of this signal may the PLC separate motor contactor 1. The PLC must wait until motor contactor 1 is open before it reverses the winding connection by closing motor contactor 2. At the same time, the motor data are reloaded in the drive. Once motor contactor 2 is closed, the PLC signals to the drive that contactor switchover has taken place. As soon as the drive has processed this signal, the motor pulses are enabled (provided, of course, that all motor data have been reloaded), thus completing the star-delta switchover operation.

0: Switchover disabled
1: Switchover enabled

Note:

A "Star-delta switchover" function block (FX 82) also exists. However, this may **only** be used for digital main spindle drives (see Configuring Instructions, Function Blocks PLC 135 WB2/WD, Package 0: Basic functions).

181	Address for min/max memory		Active at once
Default value	Lower input limit	Upper input limit	Units
0D02	**0000**	**FFFF**	**Hex**

Input of address for the variable to be monitored. The min/max memory is activated in MD 179.

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182	Minimum value min/max memory		Active at once
Default value	Lower output limit	Upper output limit	Units
–	0000	–	Hex

Output of minimum value of a previously defined variable (see MD 181). The value is displayed in hexadecimal format.

183	Maximum value min/max memory		Active at once
Default value	Lower output limit	Upper output limit	Units
–	0000	–	Hex

Output of maximum value of a previously defined variable (see MD 181). The value is displayed in hexadecimal format.

185	Address for monitoring 1		Active at once
Default value	Lower input limit	Upper input limit	Units
0C06	0000	FFFF	Hex

Input of address 1 to be monitored for variable relay function 1.

186	Threshold for monitoring 1		Active at once
Default value	Lower input limit	Upper input limit	Units
0000	0000	FFFF	Hex

Input of threshold value 1 of address 1 to be monitored for variable relay function 1.

187	ON-delay monitoring 1		Active at once
Default value	Lower input limit	Upper input limit	Units
0	0	10.00	s

Input of ON-delay 1 of address 1 to be monitored for variable relay function 1.

188	Drop delay monitoring 1		Active at once
Default value	Lower input limit	Upper input limit	Units
0	0	10.00	s

Input of drop delay 1 of address 1 to be monitored for variable relay function 1.

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189	Hysteresis monitoring 1		Active at once
Default value	Lower input limit	Upper input limit	Units
0001	0000	FFFF	Hex

Input of hysteresis of threshold value 1 of address 1 to be monitored for variable relay function 1.

190	Address for monitoring 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0C06	0000	FFFF	Hex

Input of address 2 to be monitored for variable relay function 2.

191	Threshold for monitoring 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0000	0000	FFFF	Hex

Input of threshold value 2 of address 2 to be monitored for variable relay function 2.

192	ON-delay monitoring 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0	0	10.00	s

Input of ON-delay 2 of address 2 to be monitored for variable relay function 2.

193	Drop delay monitoring 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0	0	10.00	s

Input of drop delay 2 of address 2 to be monitored for variable relay function 2.

194	Hysteresis monitoring 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0001	0000	FFFF	Hex

Input of hysteresis of threshold value 2 of address 2 to be monitored for variable relay function 2.

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195	Lower adaptation speed motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
1 000	0	(Max. speed) –2	rev/min

Input of lower adaptation speed for the speed controller. The speed controller machine data can be adapted, i.e. the P gain and reset time altered as a function of speed, in gear stage 1. The machine data from MD 31 and MD 32 are applied at speeds below the value specified in this machine data (see diagram MD 203).

196	Upper adaptation speed motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
1 200	0	(Max. speed)	rev/min

Input of upper adaptation speed for the speed controller. The speed controller machine data can be adapted, i.e. the P gain and reset time altered as a function of speed, in gear stage 1. The machine data from MD 198 and MD 201 are applied at speeds above the value specified in this machine data (see diagram MD 203).

198	P-gain upper adaptation speed motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
24.0	0	120.0	–

Input of P-gain for the upper adaptation speed. This machine data contains the P-gain at speeds above the value entered in MD 196 (see diagram MD 203).

199	Reduction factor P-gain motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
100	1	200	%

Input of P-gain reduction factor for the upper adaptation speed. This machine data contains the multiplication factor for the P-gain characteristic (see diagram MD 203).

201	Integral-action time upper adaptation speed motor 1		Active at once
Default value	Lower input limit	Upper input limit	Units
80	5	6 000	ms

Input of integral-action time for the upper adaptation speed. This machine data contains the integral-action time at speeds above the value set in MD 196 (see diagram MD 203).

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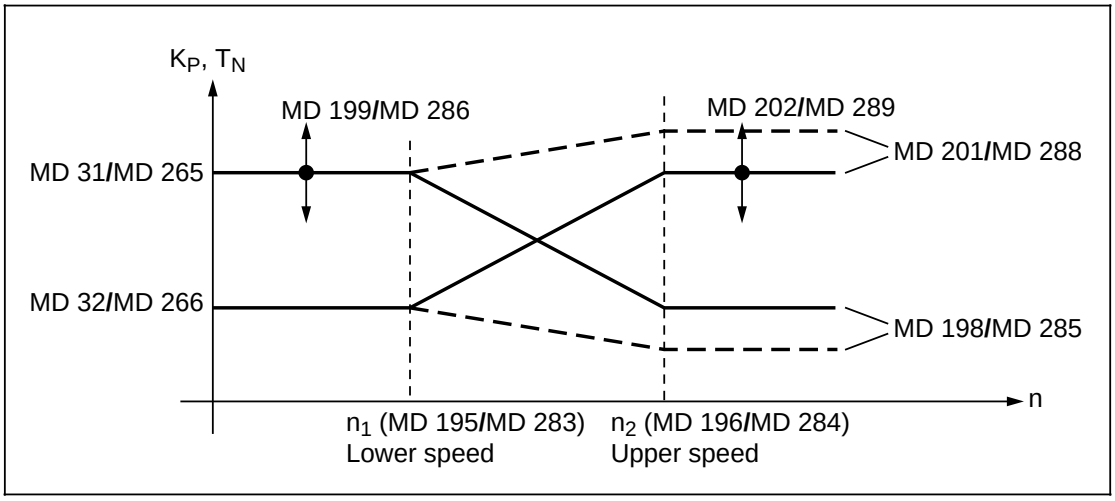
202	Reduction factor reset time motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**1**	**200**	**%**

Input of reset time reduction factor for the upper adaptation speed. This machine data contains the multiplication factor for the reset time characteristic (see diagram MD 203).

203	Selection adaption speed controller motor 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**7**	**–**

Input of activation point for speed controller adaption. The diagram shows how the individual machine data influence the speed characteristic.



0: No speed controller adaption
1: No function assigned at present
2: Speed controller adaption activated
3: No function assigned at present

Note:

The speed controller adaption function is available only for operation in gear stage 1.

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206	Selection transient recorder		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**0001**	**Hex**

This machine data is provided to activate the transient recorder function with which two signals can be recorded in a 1 ms cycle for a limited time period.

Conditions with respect to status (start, stop and trigger conditions) for the transient recorder function must be set in machine data MD 207 to MD 218.

0: Transient recorder function deactivated
1: Transient recorder function activated

207	Setting transient recorder		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**0010**	**Hex**

Input of operating mode of transient recorder.

The following functions can be selected:

1H: The recording can be started immediately via MD 206 without start or stop conditions.
2H: After MD 206 has been set, the recording does not start until the start condition (MD 208, MD 209) has been fulfilled. Recording takes place without a stop condition.
4H: The recorder memories can be preset with this setting. The contents of MD 217 are written to the recorder memories.
5H: After MD 206 has been set, the recording starts immediately until the stop condition (MD 210, MD 211) has been fulfilled.
6H: With this setting, recording takes place with both a start and stop condition.

208	Address for start condition		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

Input of address for the variable which is significant for starting the recording (see also MD 206).

209	Threshold for start condition		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

Input of threshold (value) with which the contents of the variable specified in MD 208 are compared in order to initiate the recording (see also MD 206).

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210	Address for stop condition		Active at once
Default value	Lower input limit	Upper input limit	Units
0000	0000	FFFF	Hex

Input of address for the variable which is significant for stopping the recording (see also MD 206).

211	Threshold for stop condition		Active at once
Default value	Lower input limit	Upper input limit	Units
0000	0000	FFFF	Hex

Input of threshold (value) with which the contents of the variable specified in MD 210 are compared in order to stop the recording (see also MD 206).

212	Address for signal 1		Active at once
Default value	Lower input limit	Upper input limit	Units
0C00	0000	FFFF	Hex

Input of address of recording signal 1 (see also MD 206).

213	Address for signal 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0C04	0000	FFFF	Hex

Input of address of recording signal 2 (see also MD 206).

214	Start output of recording		Active at once
Default value	Lower input limit	Upper input limit	Units
0000	0000	0001	Hex

Input of start for the output of the transient recorder function (see also MD 206).

The contents of the recorder memory are output via 2 DACs as soon as the above machine data is set to 1H. The output is repeated cyclically.

215	Shift factor signal 1		Active at once
Default value	Lower input limit	Upper input limit	Units
0	0	15	–

Input of shift factor for signal 1 (see also MD 206). The top 8 bits from a 16-bit wide memory location are output. This machine data specifies how often the value must be shifted to the left beforehand.

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216	Shift factor signal 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**15**	**–**

Input of shift factor for signal 2 (see also MD 206). The top 8 bits from a 16-bit wide memory location are output. This machine data specifies how often the value must be shifted to the left beforehand.

217	Trigger signal value 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

Input of low amplitude for the trigger signal value (see also MD 206).

A 1 ms long trigger signal can be output on commencement of the analog output.

218	Trigger signal value 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
7FFF	**0000**	**FFFF**	**Hex**

Input of high amplitude for the trigger signal value (see also MD 206).

A 1 ms long trigger signal can be output on commencement of the analog output.

219	Motor moment of inertia motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0.002**	**32.000**	**kgm^2**

Input of motor moment of inertia as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

220	Motor rated power motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**150.0**	**kW**

Input of motor rated current as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

221	Motor rated current motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**200.0**	**A**

Input of motor rated power as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

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222	Motor rated voltage motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**500.0**	**V**

Input of motor rated voltage as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

223	Motor rated speed motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**4 096**	**1/min**

Input of motor rated speed as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

224	Motor rated frequency motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**409.6**	**Hz**

Input of motor rated frequency as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

225	Motor no-load voltage motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**500.0**	**V**

Input of motor no-load voltage as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

226	Motor no-load current motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**200.0**	**A**

Input of motor no-load current as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

227	Stator resistance cold motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**32 767**	**m**

Input of stator resistance (cold) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

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228	Rotor resistance cold motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**32 767**	**m**

Input of rotor resistance (cold) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

229	Stator leakage reactance motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**32 767**	**m**

Input of stator leakage reactance as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

230	Rotor leakage reactance motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**32 767**	**m**

Input of rotor leakage reactance as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

231	Magnetizing reactance motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**65 535**	**m**

Input of magnetizing reactance as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

232	Upper speed X_h characteristic motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**100**	**10 000**	**rev/min**

Input of the upper speed limit for the X_h characteristic (magnetizing reactance) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238). In the field-weakening range, the magnetizing reactance X_h increases linearly from the saturated value at the speed at which field weakening begins to the unsaturated value at the upper limit speed of the X_h characteristic (see diagram MD 175).

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233	Speed at start of field weakening motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**100**	**6 000**	**rev/min**

Input of speed at which field weakening starts as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238). In the field-weakening range, the magnetizing reactance X_h increases linearly from the saturated value at the speed at which field weakening begins to the unsaturated value at the upper limit speed of the X_h characteristic (see diagram MD 175).

234	Motor maximum speed motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**20 000**	**rev/min**

Input of motor maximum speed as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238).

235	Gain factor X_h-characteristic motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**100**	**300**	**%**

Input of gain factor (X_{h2}/X_{h1}) of the X_h characteristic (magnetizing reactance) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 238). In the field-weakening range, the magnetizing reactance X_h increases linearly from the saturated value at the speed at which field weakening begins to the unsaturated value at the upper limit speed of the X_h characteristic (see diagram MD 175).

Note:

If the value is unknown, then 100 % must be entered in order to obtain constant magnetizing reactance over the entire speed range.

236	Breakdown torque reduction factor motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**1**	**150**	**%**

Input of breakdown torque reduction factor as specified on the motor data sheet. The point at which the breakdown torque limit is applied can be altered in this machine data.

Settings of higher than 100 % increase the point at which the limit is applied and vice versa with settings of lower than 100 %.

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238	Motor code number motor 2		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
101	**99**	**332**	**–**

Note:

This machine data is not included in the machine data lists. During start-up in machine data dialog, the machine data is set or altered as appropriate via the configuration setting.

Input of code number for the motor used. The relevant motor data are stored in the software and are transferred to machine data MD 219 to MD 235 when the motor code number is changed. If individual motor data (MD 219 to MD 235) must be changed, then the value 99 (non-Siemens motor) must be entered as the motor code number.

See machine data MD 96 for table of motors.

241	Programmable message 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
2	**1**	**20**	**–**

A function can be assigned to programmable message 1 in this machine data. The range of available functions is listed in the table below.

The default setting corresponds to **Ramp-up complete**.

Table of functions:

Function	Function number (setting value of MD 241 ... MD 246)	Default setting of MD 241 ... MD 246
$\lvert n_{act} \rvert < n_{min}$	1	MD 243
Ramp-up complete	2	MD 241
$\lvert M_d \rvert < M_{dx}$	3	MD 242
$\lvert n_{act} \rvert < n_x$	4	MD 244
Motor overtemperature prewarning	5	--
Heat sink overtemperature prewarning	6	--
Variable relay function 1 (MD 185 - MD 189)	7	MD 246
Variable relay function 2 (MD 190 - MD 194)	8	--
$n_{act} = n_{set}$	20	MD 245

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Description of user-programmable messages:

- $|n_{act}| < n_{min}$ (function no. 1)
  The PLC status message is set when $|n_{act}| < n_{min}$. Settable in MD 21.

- Ramp-up complete (function no. 2)

  The PLC status message is set when the actual speed value corresponds to the setpoint, allowing for the tolerance band set in MD 27. This status message is not output when the speed fluctuates as a result of load changes.

- $|M_d| < M_{dx}$ (function no. 3)

  The PLC status message is set when $|M_d| > M_{dx}$. The percentage setting in MD 47 is referred to the currently active speed-dependent torque limit. If the PLC status message $n_{act} = n_{set}$ is set when the speed setpoint is changed, then the PLC status message $|M_d| < M_{dx}$ cannot be reset for at least 800 ms after the PLC status message $n_{act} = n_{set}$ has been reset.

- $|n_{act}| < n_x$ (function no. 4)

  The PLC status message is set when $|n_{act}| < n_x$. Settable in MD 23.

- Motor overtemperature prewarning (function no. 5)

  The PLC status message is set when the maximum motor temperature is reached (MD 63 for motor 1, MD 291 for motor 2). If the message does not disappear, then the drive module is shut down with the "Motor overtemperature" alarm after the delay which can be set in MD 65.

- Heat sink overtemperature prewarning (function no. 6)

  The PLC status message is set when the temperature switch of the main heat sink responds. If the message does not disappear, then the drive module is shut down after approximately 2 minutes with the "Heat sink overtemperature" alarm.

- Variable relay function 1 (function no. 7)

MD 185	Address for monitoring 1	0000 ... FFFFH
MD 186	Threshold for monitoring 1	0000 ... FFFFH
MD 187	ON-delay monitoring 1	0 ... 10.00 ms
MD 188	Drop delay monitoring 1	0 ... 10.00 ms
MD 189	Hysteresis monitoring 1	0000 ... FFFFH

- Variable relay function 2 (function no. 8)

MD 190	Address for monitoring 2	0000 ... FFFFH
MD 191	Threshold for monitoring 2	0000 ... FFFFH
MD 192	ON-delay monitoring 2	0 ... 10.00 ms
MD 193	Drop delay monitoring 2	0 ... 10.00 ms
MD 194	Hysteresis monitoring 2	0000 ... FFFFH

- $n_{act} = n_{set}$ (function no. 20)

  The PLC status message is set when severe speed fluctuations occur as a result of load changes.

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242	Programmable message 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
3	**1**	**20**	**–**

A function can be assigned to programmable message 2 in this machine data.

The default setting corresponds to $\mathbf{M_d > M_{dx}}$ (see MD 241 for other settings).

243	Programmable message 3		Active **at once**
Default value	Lower input limit	Upper input limit	Units
1	**1**	**20**	**–**

A function can be assigned to programmable message 3 in this machine data.

The default setting corresponds to $\mathbf{n_{act} < n_{min}}$ (see MD 241 for other settings).

244	Programmable message 4		Active **at once**
Default value	Lower input limit	Upper input limit	Units
4	**1**	**20**	**–**

A function can be assigned to programmable message 4 in this machine data.

The default setting corresponds to $\mathbf{n_{act} < n_x}$ (see MD 241 for other settings).

245	Programmable message 5		Active **at once**
Default value	Lower input limit	Upper input limit	Units
20	**1**	**20**	**–**

A function can be assigned to programmable message 5 in this machine data.

The default setting corresponds to **variable relay function 1** (MD 185, see MD 241 for other settings).

246	Programmable message 6		Active **at once**
Default value	Lower input limit	Upper input limit	Units
7	**1**	**20**	**–**

A function can be assigned to programmable message 6 in this machine data.

The default setting corresponds to **variable relay function 2** (MD 190, see MD 241 for other settings).

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247	Control word message		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

By setting bits 0 to 5, it is possible to invert the function of the appropriate messages (MD 241 to MD 246). In bits 8 and 9, it is possible to choose between sign-specific or absolute-value-based interrogation of the memory address limit values (MD 185, MD 190).

Value table:

Bit 0	Programmable message 1 inverted	0001H
Bit 1	Programmable message 2 inverted	0002H
Bit 2	Programmable message 3 inverted	0004H
Bit 3	Programmable message 4 inverted	0008H
Bit 4	Programmable message 5 inverted	0010H
Bit 5	Programmable message 6 inverted	0020H
Bits 6-7	Not assigned	
Bit 8	Sign evaluation monitoring 1	0040H
Bit 9	Sign evaluation monitoring 2	0080H
Bits 10-15	Not assigned	

254	Display of active functions 1		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**–**	**–**	**Hex**

Display of low word in drive control word.

Value table:

Bit 0	ZK1 reset	0: Not active 1: Active
Bit 1	Parking axis	
Bit 2-6	Not assigned	
Bit 7	Ramp-function generator active	
Bit 8	Not assigned	
Bit 9	Ramp-function generator rapid stop	
Bit 10	2nd torque limit	
Bit 11	Speed setpoint smoothing	
Bit 12-15	Not assigned	

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255	Display of active functions 2		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	–	–	**Hex**

Display of high word in drive control word

Value table:

Bit 0-2	New active parameter set/gear stage	0: Not active 1: Active
Bit 3	Motor switchover (star-delta switchover)	
Bit 4	Not assigned	
Bit 5	Motor switchover complete	
Bit 6	Speed controller I-component = zero	
Bit 7	Pulse enable	
Bit 8	Current controller enable	
Bit 9	Speed controller enable	
Bit 10-11	Operating mode	
Bit 12	Not assigned	
Bit 13	Travel to fixed stop	
Bit 14	Not assigned	
Bit 15	Sign of life from NC	

258	Speed for max. motor operational speed motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
Maximum motor speed	–	**Maximum motor speed**	**rev/min**

Machine data MD 258 defines the maximum operating speed of the main spindle motor. It acts as the reference value of the speed setpoint interface.

Note:

The velocity of a main spindle is matched in NC-MD 4030 (maximum spindle speed). The motor operating speed which corresponds to this maximum value must be entered in drive-MD 258. Allowance is made for any existing gear ratios in the relationship between NC-MD 4030 and drive-MD 258.

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260	n_{min} for $n_{act} < n_{min}$ message motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
12	**0**	**Rated speed**	**rev/min**

Input of response value for monitoring of the PLC status message $n_{act} < n_{min}$ (see also MD 241).

261	Creep speed pulse suppression motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
$\frac{\text{Rated speed}}{256}$	**0**	**Rated speed**	**rev/min**

Input of response value for the internal n_{min} sensor for stopping the drive with no reverse rotation. When the speed n_{min} is reached, the drive torque is cut off and the drive coasts to a stop with any remaining kinetic energy.

Note:

This n_{min} threshold is not the same as the response value of the n_{min} monitor, but it may be set to the same value.

262	n_x for $n_{act.} < n_x$ message motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
6 000	**0**	**Maximum motor speed**	**rev/min**

Input of response value for monitoring of the PLC status message $n_{act} < n_x$ (see also MD 241).

263	Tolerance band for $n_{set} = n_{act}$ message motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
20	**0**	**$\frac{\text{Rated speed}}{16} - 1$**	**rev/min**

Input of response value for the tolerance band of the PLC status message $n_{set} > n_{act}$ (see also MD 241). The tolerance band of the $n_{set} = n_{act}$ response threshold can be defined in machine data MD 263.

264	Speed limitation motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
Maximum motor speed	**0**	**Maximum motor speed**	**rev/min**

Input of maximum motor speed (n_{max}) = speed safety limit.

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265	P-gain speed controller motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
32.0	**1.0**	**120.0**	**–**

Input of P gain (K_p) for the speed controller. The speed controller has a PI function which can be set separately for eight gear stages.

Note:

A speed controller adaptation can be implemented only for gear stage 1 (see MD 293).

266	Integral-action time speed controller motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
20	**5**	**6 000**	**ms**

Input of integral-action time (t_N) for the speed controller. The speed controller has a PI function which can be set separately for eight gear stages.

Note:

A speed controller adaptation can be implemented only for gear stage 1 (see MD 293).

267	Switchover speed motor encoder evaluation motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
32 000	**0**	**32 000**	**rev/min**

Input of the switchover speed for evaluation of the motor encoder. In this case, it is possible to switch between the square-wave and SINE/COSINE evaluation modes. Square-wave evaluation is applied at speeds above the maximum value entered.

268	Hysteresis MD 267 motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
50	**0**	**500**	**rev/min**

Input of hysteresis for machine data MD 267 (switchover speed for motor encoder evaluation).

269	1st torque limiting value motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
100	**5**	**180**	**%**

Input of the maximum permissible torque referred to the rated torque of the motor. The setting of the limit values is referred to the rated motor torque in the constant torque range. At speeds above the rated value, i.e. in the constant power range, the torque limitation is referred to the appropriate working point.

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With a setting of, for example, 100 %, the rated torque acts as the torque limit up to rated speed. At speeds above the rated value, the torque limit curve drops in proportion to 1/n so that the rated output is reached in each case. MD 270 - MD 273, MD 47 and MD 290 are the corresponding machine data.

270	Generative limitation motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**5**	**100**	**%**

Input of torque limit for braking operation (generator-mode torque limit). This input value is referred to the maximum motor-mode torque (see also MD 269).

271	2nd torque limiting value motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
50	**5**	**100**	**%**

Input of 2nd torque limit value referred to the 1st torque limit (MD 269). This 2nd torque limit can be selected via the PLC control word and machine data MD 290.

272	Switchover speed for MD 270 motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
500	**0**	**Maximum motor speed**	**rev/min**

Input of speed above which the generator-mode limit set in machine data MD 270 is applied (see also MD 269).

273	Hysteresis MD 272 motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
20	**0**	**Maximum motor speed**	**rev/min**

Input of hysteresis for the switchover speed set in machine data MD 272 (see also MD 269).

274	Cut-in speed torque setpoint smoothing motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
4 000	**0**	**Maximum motor speed**	**rev/min**

Input of speed value above which the torque setpoint smoothing function activated in machine data MD 44 is applied.

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275	Hysteresis MD 274 motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
50	**0**	**Rated speed**	**rev/min**

Input of hysteresis for the cut-in speed set in machine data MD 274.

276	Frequency torque setpoint filter motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
300	**50**	**450**	**Hz**

Input of filter frequency. The 3dB transition frequency for the low-pass filter or the mid-frequency for the bandstop is specified here (see MD 280) for the digital filter in the torque setpoint channel.

277	Grading torque setpoint filter motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
1.00	**0.10**	**10.00**	**–**

Input of filter quality for the bandstop in the torque setpoint channel (see MD 280).
1.00: Basis quality=1

278	Correction P-gain current controller motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**-255**	**255**	**–**

The current controller P-gain, which is calculated according to the motor, converter and converter switching frequency, can be corrected by an offset in this machine data. A positive value in MD 278 results in a higher gain and a negative value in a lower gain than the gain value calculated. The total gain obtained by adding the calculated value and the correction in MD 278 is displayed in MD 316.

280	Selection torque setpoint filter motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**0001**	**Hex**

The digital filter is activated and deactivated in this machine data. A digital filter can be implemented in the torque setpoint channel with machine data MD 276, MD 277 and MD 280.

0: Digital filter deactivated
1: Digital filter activated

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281	Type torque setpoint filter motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0000	0000	0001	Hex

The filter type is selected in this machine data (see MD 280).

0: Bandstop characteristic
1: Low-pass characteristic

283	Lower adaptation speed motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
1 000	0	(max. speed) –2	rev/min

Input of lower adaptation speed for the speed controller. The speed controller machine data can be adapted, i.e. the P gain and reset time altered as a function of speed, in gear stage 1. The machine data from MD 265 and MD 266 are applied at speeds below the value specified in this machine data (see diagram MD 203).

284	Upper adaptation speed motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
1 200	0	max. speed	rev/min

Input of upper adaptation speed for the speed controller. The speed controller machine data can be adapted, i.e. the P gain and reset time altered as a function of speed, in gear stage 1. The machine data from MD 285 and MD 288 are applied at speeds above the value specified in this machine data (see diagram MD 203).

285	P-gain upper adaptation speed motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
24.0	0	120.0	–

Input of P-gain for the upper adaptation speed. This machine data contains the P-gain at speeds above the value entered in MD 284 (see diagram MD 203).

286	Reduction factor P-gain motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
100	1	200	%

Input of P-gain reduction factor for the upper adaptation speed. This machine data contains the multiplication factor for the P-gain characteristic (see diagram MD 203).

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288	Integral-action time upper adaptation speed motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
80	**5**	**6 000**	**ms**

Input of integral-action time for the upper adaptation speed. This machine data contains the integral-action time at speeds above the value set in MD 284 (see diagram MD 203).

289	Reduction factor reset time motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
100	**1**	**200**	**%**

Input of integral-action time reduction factor for the upper adaptation speed. This machine data contains the multiplication factor for the integral-action time characteristic (see diagram MD 203).

290	Switching speed from M_{d1} to M_{d2} motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
4 x motor rated speed	**0**	**Motor maximum speed**	**rev/min**

Input of speed at which switchover from the 1st torque limit (MD 269) to the 2nd torque limit (MD 271) takes place. This switchover is implemented only if the appropriate bit has been set in the control word and the switchover speed set in MD 290 has been exceeded.

291	Maximum motor temperature motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
Depends on motor	**0**	**170**	**°C**

Input of maximum motor temperature. The value entered can be lower the maximum temperature value calculated via the motor code number (MD 238) and motor data set. If the specified temperature is exceeded, the "Motor overtemperature" prewarning is output after approximately 30 s (provided it is activated) or the "Motor overtemperature" alarm given after the delay set in machine data MD 65.

292	Switchover speed current controller adaptation motor 2		Active at once
Default value	Lower input limit	Upper input limit	Units
MD 232	**500**	**10 000**	**rev/min**

Input of switchover speed for the current controller adaptation. The phase current controller gain is adapted as a function of speed. The specified speed is the speed at which the phase current controllers reach their maximum gain.

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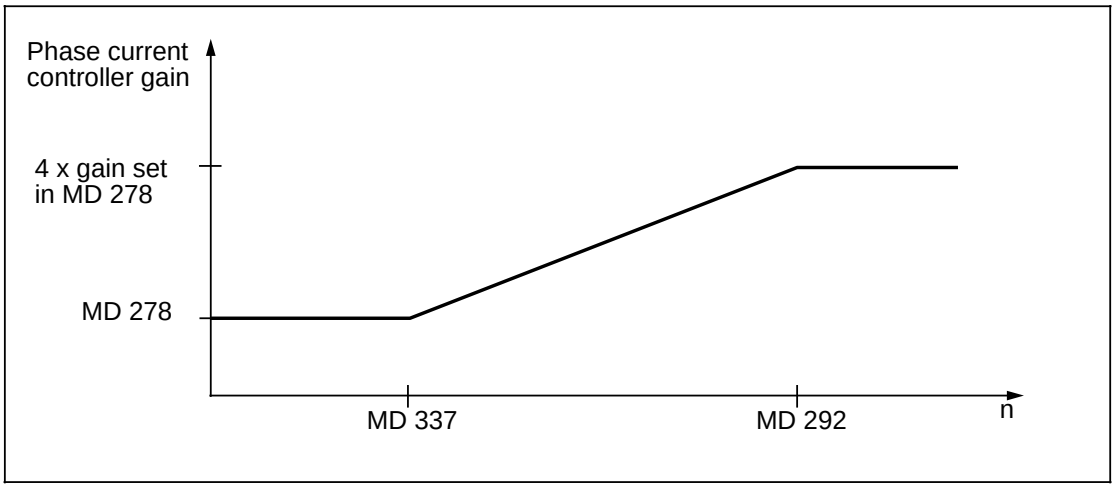

293	Selection adaption speed controller motor 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**7**	**–**

Input of activation point for speed controller adaption. The diagram shows how the individual machine data influence the speed characteristic (see MD 203 for diagram).

0: No speed controller adaption
1: No function assigned at present
2: Speed controller adaption activated
3: No function assigned at present

Note:

The speed controller adaption function is available only for operation in gear stage 1.

311	Current with I/f control		Active **at once**
Default value	Lower input limit	Upper input limit	Units
40.0	**0.0**	**100.0**	**%**

The I/f control is used to assist diagnosis in the event of encoder faults. The current amplitude can be specified in this machine data.

312	Frequency for I/f control		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**-800.0**	**800.0**	**Hz**

The I/f control is used to assist diagnosis in the event of encoder faults. The frequency can be specified in this machine data. The sign determines the direction of rotation.

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313	Selection I/f control		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1**	**Hex**

The I/f control diagnosis aid is activated by entering bit 0 = 1. This control is used to check encoder faults. A variable speed (without encoder evaluation) can be specified via MD 311 (current) and MD 312 (frequency).

Bit 0	Activate I/f control
Bit 1-15	Not assigned

316	Display P-gain current controller		Active at once
Default value	Lower output limit	Upper output limit	Units
–	**–**	**–**	**–**

Display machine data for the current controller P gain. The current controller P gain is calculated according to the motor, converter and converter switching frequency and can be corrected by an offset in machine data MD 116 (P-gain current controller motor 1) and MD 278 (P-gain current controller motor 2). The resulting value is displayed in MD 316. When the star-delta switchover function is enabled, the display is referred to the currently active operating mode.

337	Creep speed angle controller		Active at once
Default value	Lower input limit	Upper input limit	Units
300	**0**	**600**	**rev/min**

Input of creep speed of angle controller. At speeds above the value entered here, the I-action component of the phase current controllers is disabled and the angle controller of the FCS (Frequency-Compensated Spindle drive) control enabled.

338	Hysteresis MD 337		Active at once
Default value	Lower input limit	Upper input limit	Units
25	**0**	**256**	**rev/min**

Input of hysteresis for creep speed in MD 337. The value corresponding to half the hysteresis width in rev/min must be entered.

399	Data version		Active at once
Default value	Lower output limit	Upper output limit	Units
–	**0**	**65 535**	**–**

Display machine data for the data version of the machine data set.

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7.2 611D feed drive machine data (SW 3)

7.2.1 FDD MD input (SW 3)

The feed drive machine data are provided for the purpose of matching the feed drives and the machine tool. If no setting values are specified by the machine manufacturer or the user, then they must be carefully determined and optimized by the start-up engineer. The setting values are input by means of menu selection (see section headed ”Machine Data Dialog”).

7.2.2 FDD MD (data description - SW 3)

1000	**Current controller cycle**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
125.0	**62.5**	**125.0**	**µs**

The basic clock cycle of the module is derived from the current controller clock cycle of the axis: Current controller clock cycle = Module basic clock cycle. The module basic clock cycle is used as a basis for generating the interrupt signals for the processor and the inverter signals of the pulse-width-modulator. Other clock cycles are derived from the basic cycle by means of software functions.

Input values are 62.5 µs or 125 µs.

Intermediate values are not permissible (parameterization error).

Notes:

- Exceeding the computing time on the current controller clock cycle level is not permissible and will lead to tripping of the drive.
- In the case of double-axis modules, both drives must be parameterized with the same current controller clock cycle (otherwise parameterization error).

1001	**Speed controller cycle**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
125.0	**62.5**	**125.0**	**µs**

The speed controller clock cycle is derived from the current controller clock cycle of the axis: Current controller clock cycle speed controller clock cycle. The time-slice management ZSV (sequence control) is initialized with this machine data. If the number of drives per module is increased, then a longer speed controller cycle time will be required (e.g. single-axis module 62.5 µs, double-axis module = 125 µs).

Setting values of clock cycle are 62.5 µs or 125 µs.

Intermediate values are not permissible (parameterization error).

Note:

Exceeding the computing time on the speed controller clock cycle level is not permissible and will lead to tripping of the drive.

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1002	Monitoring cycle		Active on Power On
Default value	Lower input limit	Upper input limit	Units
100 000	**4 000**	**100 000**	**µs**

The interrupt clock cycle is used for high-priority monitoring purposes. Note: The input value for the clock cycle must be a whole multiple of 4 ms (parameterization error).

m x 4000 µs m=1, 2, 3, ..., 25

Note:

The interrupt level must not be exceeded otherwise the drive will be tripped.

1005	No. encoder marks motor measuring system		Active on Power On
Default value	Lower input limit	Upper input limit	Units
2 048	**128**	**8 192**	**Incr/rev**

Input of number of encoder increments per motor revolution of the motor measuring system.

Note:

The indirect measuring system must always be configured for FDD/MSD.

1100	Frequency pulse-width modulation		Active on Power On
Default value	Lower input limit	Upper input limit	Units
3 200	**2 000**	**8 000**	**Hz**

The frequency of the sampling triangle in the PWM inverter is defined in this machine data. The frequency values are set as an MMC function (see attached table).

Value table:

f_{PBM} in Hz	T_{PBM} in µs
2000	500.0*
2064.5....	484.375
2133.3....	468.75
2206.8....	453.125
2285.7....	437.5*
2370.3....	421.875
2461.5....	406.25
2560	390.625

* *A preselection with synchronous sampling period (TPWM) with respect to the controller cycles can be made via the toggle button.*

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f_{PBM} in Hz	T_{PBM} in µs
2666.6....	375.0*
2782.6....	359.375
2909.0....	343.75
3047.6....	328.125
3200	312.5*
3368.4....	296.875
3555.5....	281.25
3764.7....	265.625
4000	250.0*
4266.6....	234.375
4571.4....	218.75
4923.0....	203.125
5333.3....	187.5*
5818.1....	171.875
6400	156.25
7111.1....	140.625
8000	125*

Note:

The pulse frequency can be specified only in the quantization given in the table above. Other frequency inputs are rounded up or down to the next closest table value, e.g. 3150 Hz to 3200 Hz.

1101	**Calc. dead time current closed-loop**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
50	**0**	**124**	**µs**

The calculation dead time is the time which elapses between the start of a current control clock cycle (input of current setpoint) and the activation of the control voltage setpoints on the gating unit ASIC. The standard default value is automatically loaded during initial start-up when machine data M1102 is input. In order to make the setpoints on all power sections "valid" simultaneously (to achieve uniform dynamic response), the time required to calculate the most complex axis (double axis) is entered.

Setting values (worstcase), execution times: 40 µs = single-axis module
50 µs = double-axis module

Note:

Limits of calculation dead time (violation leads to error message)

MD 1101 < MD 1000 x 31.25 µs (=current controller clock cycle)

$$\text{MD 1101} < \frac{1}{4 \times \text{MD 1100}} \left(= \frac{T_{PBM}}{4}\right)$$

* *A preselection with synchronous sampling period (TPWM) with respect to the controller cycles can be made via the toggle button.*

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1102	Motor code number		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**65 535**	**–**

Input of motor order number (machine-readable product designation for Siemens motors). This number is transferred to the drive in the form of a motor code number. The user does not need to input a value (see also MD 1106). The following motor data are automatically transferred from an internal motor table by means of the motor code number:

- Motor rated current (MD 1103)
- Maximum motor current (MD 1104)
- Pole pair number of motor (MD 1112)
- Torque constant (MD 1113)
- Voltage constant (MD 1114)
- Armature resistance (MD 1115)
- Armature inductance (MD 1116)
- Motor moment of inertia (MD 1117)
- Current controller P gain (MD 1120)
- Current controller reset time (MD 1121)
- Motor rated speed (MD 1400)
- Maximum motor speed (MD 1401)

If a valid motor order number cannot be entered in this machine data (e.g. for a motor make other than Siemens), then all these machine data must be entered manually.

Motor table:

Order No.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1FT6102-8AB7X-XXXX	1500	1001
1FT6105-8AB7X-XXXX	1500	1002
1FT6108-8AB7X-XXXX	1500	1003
1FT6132-6AB7X-XXXX	1500	1004
1FT6134-6AB7X-XXXX	1500	1005
1FT6136-6AB7X-XXXX	1500	1006
1FT6061-6AC7X-XXXX	2000	1101
1FT6062-6AC7X-XXXX	2000	1102
1FT6064-6AC7X-XXXX	2000	1103
1FT6081-8AC7X-XXXX	2000	1104
1FT6082-8AC7X-XXXX	2000	1105
1FT6084-8AC7X-XXXX	2000	1106
1FT6086-8AC7X-XXXX	2000	1107
1FT6102-8AC7X-XXXX	2000	1108
1FT6105-8AC7X-XXXX	2000	1109
1FT6108-8AC7X-XXXX	2000	1110
1FT6132-6AC7X-XXXX	2000	1111
1FT6134-6AC7X-XXXX	2000	1112

Order No.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1FT6136-6AC7X-XXXX	2000	1113
1FT6041-4AF7X-XXXX	3000	1201
1FT6044-4AF7X-XXXX	3000	1202
1FT6108-8AC7X-XXXX	2000	1110
1FT6132-6AC7X-XXXX	2000	1111
1FT6134-6AC7X-XXXX	2000	1112
1FT6136-6AC7X-XXXX	2000	1113
1FT6041-4AF7X-XXXX	3000	1201
1FT6044-4AF7X-XXXX	3000	1202
1FT6061-6AF7X-XXXX	3000	1203
1FT6062-6AF7X-XXXX	3000	1204
1FT6064-6AF7X-XXXX	3000	1205
1FT6081-8AF7X-XXXX	3000	1206
1FT6082-8AF7X-XXXX	3000	1207
1FT6084-8AF7X-XXXX	3000	1208
1FT6086-8AF7X-XXXX	3000	1209
1FT6102-8AF7X-XXXX	3000	1210
1FT6105-8AF7X-XXXX	3000	1211

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Order No.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1FT6132-6AF7X-XXXX	3000	1212
1FT6061-6AH7X-XXXX	4500	1301
1FT6062-6AH7X-XXXX	4500	1302
1FT6064-6AH7X-XXXX	4500	1303
1FT6081-8AH7X-XXXX	4500	1304
1FT6082-8AH7X-XXXX	4500	1305
1FT6084-8AH7X-XXXX	4500	1306
1FT6086-8AH7X-XXXX	4500	1307
1FT6102-8AH7X-XXXX	4500	1308
1FT6031-6AK7X-XXXX	6000	1401

Order No.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1FT6034-6AK7X-XXXX	6000	1402
1FT6041-6AK7X-XXXX	6000	1403
1FT6044-6AK7X-XXXX	6000	1404
1FT6061-6AK7X-XXXX	6000	1405
1FT6062-6AK7X-XXXX	6000	1406
1FT6064-6AK7X-XXXX	6000	1407
1FT6081-8AK7X-XXXX	6000	1408
1FT6082-8AK7X-XXXX	6000	1409
1FT6084-8AK7X-XXXX	6000	1410

1103	Motor rated current		Active **at once**
Default value	Lower input limit	Upper input limit	Units
1.0	**0.0**	**500**	**A**

Input of rated current consumption (RMS value) in operation at rated torque and rated speed as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

1104	Maximum motor current		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
2.0	**0.0**	**500**	**A**

Input of maximum permissible motor current (RMS value) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102). To ensure reliable monitoring and limitation, the setting in this machine data should not be reduced (see also MD 1105).

1105	Reduction of maximum motor current		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**0**	**100**	**%**

Input of reduction factor for the maximum permissible motor current. The maximum motor current (MD 1104) is the reference value for the specified percentage.

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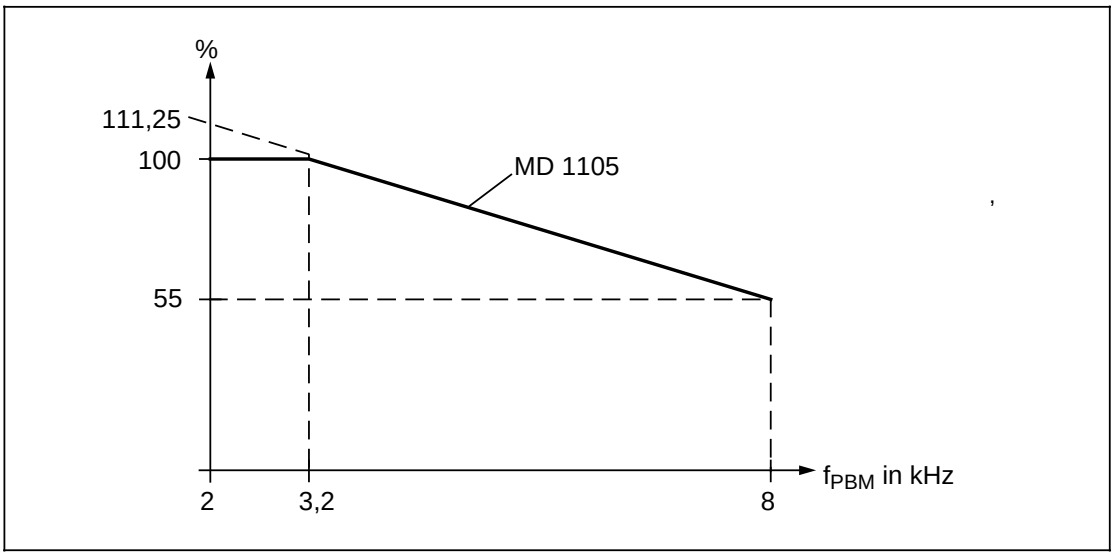
Derating (reduction) characteristics can be incorporated via this machine data, e.g. derating as a function of the pulse frequency (MD 1100).



$$\text{MD 1191} = \frac{\text{MD 1107}}{8 \times \sqrt{2} \times \text{MD1118}}$$

$$I_{\text{limit power section}}\,(\text{MD 1108}) = \min\left(100\%;\ 55\% + 45\% \times \frac{8000 - f_{PBM}\,(\text{MD 1100})}{8000 - 3200}\right) \times \left(\frac{I_{\text{limit transistor}}\,(\text{MD 1107})}{\sqrt{2}}\right)$$

$$I_{\text{red. max. motor}}\,(\text{MD 1105}) = \min\left(100\%;\ \frac{I_{\text{motor}}}{I_{\text{max. motor}}\,(\text{MD 1104})} \times 100\%\ \ \frac{I_{\text{limit power section}}\,(\text{MD 1108})}{I_{\text{max. motor}}\,(\text{MD 1104})} \times 100\%\right)$$

I_{motor} = Machining-specific input by user

Example:

$I_{\text{limit transistor}}$ (MD 1107) = 25 A

Pulse frequency (MD 1100) = 4000 Hz

$$I_{\text{limit power section}}\ (\text{MD 1108}) = \min\left(100\%;\ 55\% + 45\% \times \frac{8000 - 4000}{8000 - 3200}\right) \times \frac{25\ \text{A}}{\sqrt{2}}$$

$I_{\text{limit power section}}$ (MD 1108) = min (100%; 92.5%) x 17.678 A

$I_{\text{limit power section}}$ (MD 1108) = 92.5% x 17.678 A = 16.35 A

$I_{\text{max. motor}}$ (MD 1104) = 20 A

I_{motor} = 15 A

$$I_{\text{red. max. motor}}\ (\text{MD 1105}) = \min\left(100\%;\ \frac{15}{20\ \text{A}} \times 100\%;\ \ \frac{16.35\ \text{A}}{20\ \text{A}} \times 100\%;\right)$$

$I_{\text{red. max. motor}}$ (MD 1105) = min (100%; 75%; 81.75%)

$I_{\text{red. max. motor}}$ (MD 1105) = 75 %

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1106	Power section code		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**00FF**	**Hex**

When the power section order number (machine-readable product designation for Siemens power sections) is input during initial start-up, it is converted to a code number as an MMC function (the user need not enter a code number). The following power section data are automatically transferred from an internal power section table through the input of the code number:

- Limit current transistor (MD 1107)
- maximum thermal current of the power section (MD 1108)

Format of power section code number:

Power section type	
0	MSD
1	FDD
2	Not assigned
3	
4	
5	
6	
7	
8	
9	
A	
B	
C	
D	
E	
F	

Amperage	
0	No power section specified
1	3 **/** 6 A
2	5 **/** 10 A
3	Not assigned
4	9 **/** 18 A
5	Not assigned
6	18 **/** 36 A
7	28 **/** 56 A
8	Not assigned
9	56 **/** 112 A
A	70 **/** 140 A
B	Not assigned
C	
D	
E	
F	

1107	Limit current transistor		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
200	**1**	**500**	**A**

Input of maximum permissible current of power section. This input makes allowance for the rating of the transistors minus thermal reserves (approximately 20 %). The maximum current must be set as a peak value independently of the pulse frequency. This machine data is automatically parameterized for Siemens power sections by the machine data "Power section code" (MB 1106).

Caution:

This data serves as the basis for normalizing the current actual value sensor and **must not be changed** by the user after automatic presetting of its values.

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1108	Limit current power section		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
200	**1**	**500**	**A**

Input of maximum thermally permissible current of power section. The input is an RMS value. This machine data is automatically parameterized for Siemens power sections by the machine data "Power section code" (MD 1106).

1110	Reduction factor max. motor current set-up mode		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
1	**0**	**100**	**%**

Input of reduction factor for set-up mode. The transistor limit current (MD 1107) acts as the reference value. Please note that if the current limit calculated for set-up mode exceeds the maximum unit-specific current value, then it will be reduced to this value. The maximum permissible unit-specific current is calculated as a minimum value from MD 1104 (maximum motor current) x 2 x MD 1105 (reduction max. motor current), maximum current of power section (e.g. 9/18A 100% corresponds to 18 A_{RMS}) and MD 1108 (power section limit current) x 2.

Example:

Max. motor current	(MD 1104) =	5 A
Reduction max. motor current	(MD 1105) =	100 %
Transistor limit current	(MD 1107) =	25 A
Power section limit current	(MD 1108)	18 A

Unit-specific max. permissible current (normal mode) = min. (100 % x 5 A; 25 A; 18 A x 2)
Unit-specific max. permissible current (normal mode) = 5 A

Example 1: Reduction factor max. motor current set-up mode (MD 1110) = 50 %

Unit-specific permissible current (set-up mode) = min. (5 A; 25 A x 0.5)
Unit-specific permissible current (set-up mode) = 5 A

Example 2: Reduction factor max. motor current set-up mode (MD 1110) = 10 %

Unit-specific permissible current (set-up mode) = min. (5 A; 25 A x 0.1)
Unit-specific permissible current (set-up mode) = 2.5 A

1112	Number of pole pairs motor		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
3	**0**	**4**	**–**

Input of number of pole pairs of motor as specified on the motor data sheet (non-Siemens motor) or through automatic parameterization using machine data "Motor code number" (MD 1102). The numbers of pole pairs encountered in practice are 2, 3 and 4. The pole pair number 0 is entered when motor/power section combinations which have not been enabled are loaded.

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1113	Torque constant		Active on Power On
Default value	Lower input limit	Upper input limit	Units
5	**0.1**	**5**	**Nm/A**

Input of torque constant as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102). The torque constant is the quotient of rated torque : rated current (RMS) for permanent-field synchronous motors.

1114	Voltage constant		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0	**1**	**300**	**V**

Input of voltage constant as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102). The voltage constant is measured as an induced voltage (EMF) under no-load conditions at n = 1000 rev/min as the RMS value of the motor terminals (line-to-line).

1115	Armature resistance		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0	**0**	**20**	**V/A**

Input of ohmic resistance of the armature winding (phase value) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

1116	Armature inductance		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0	**0**	**100**	**mH**

Input of armature rotating-field inductance as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

1117	Motor moment of inertia		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0	**0**	**32 (as from SW 5)**	**kgm^2**

Input of motor moment of inertia as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102 - in motors without a holding brake).

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1120	P-gain current controller		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**10 000**	**V/A**

Input of proportional gain of current controller or automatic parameterization using machine data "Motor code number" (MD 1102). It defines the relationship between control voltage setpoint and control deviation current.

1121	Integral-action time current controller		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**10 000**	**µs**

Input of control quantity "Integral-action time of current controller" or automatic parameterization using machine data "Motor code number" (MD 1102).

Note:

Integral arm can be disabled by entering the value $T_N = 0$.

1200	Selection current setpoint filter		Active at once
Default value	Lower input limit	Upper input limit	Units
1	**0**	**4**	**–**

Input of number of current setpoint filters. Band-stop and low-pass filters are available; these are set via the machine data "Configuration current setpoint filter" (MD 1201).

Selection of number of filters:

0	No current setpoint filter activated
1	Filter 1 activated
2	Filters 1 and 2 activated
3	Filters 1, 2 and 3 activated
4	Filters 1, 2, 3 and 4 activated

Note:

Before a filter is activated, the filter type and the appropriate filter machine data must be input.

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1201	Type current setpoint filter		Active at once
Default value	Lower input limit	Upper input limit	Units
Low-pass	**Low-pass**	**Band-stop**	**–**

Input of configuration of 4 current setpoint filters. Band-stop and low-pass filters are available. The adjustable filter parameters are entered in the appropriate machine data.

1st filter	Bit 0	0	Low-pass (see MD 1202/1203)
		1	Band-stop (see MD 1210/1211)
2nd filter	Bit 1	0	Low-pass (see MD 1204/1205)
		1	Band-stop (see MD 1213/1214)
3rd filter	Bit 2	0	Low-pass (see MD 1206/1207)
		1	Band-stop (see MD 1216/1217)
4th filter	Bit 3	0	Low-pass (see MD 1208/1209)
		1	Band-stop (see MD 1219/1220)

Note:

Before the filter type is configured, the appropriate filter machine data must be input.

1202	Natural frequency current setpoint filter 1		Active at once
Default value	Lower input limit	Upper input limit	Units
2 000	**0**	**8 000**	**Hz**

Input of natural frequency for current setpoint filter 1 (PT2 low-pass). An entry of < 10 Hz as the natural frequency of the low-pass filter initializes the filter as a proportional element with a gain of 1 independently of the associated damping. The filter is activated via machine data MD 1200 and MD 1201.

Note:

Current setpoint filter 1 is preset to the current controller sampling time MD 1000 = 125 µs for damping of the encoder torsional natural frequency.

For a current controller sampling time of MD 1000 = 62.5 µs, we recommend that the natural frequency be changed to f_0 = 3000 Hz to achieve an optimum dynamic response of the controller.

1203	Damping current setpoint filter 1		Active at once
Default value	Lower input limit	Upper input limit	Units
0.7	**0.05**	**5**	**–**

Input of damping for current setpoint filter 1 (PT2 low-pass). The filter is activated via machine data MD 1200 and MD 1201. 0.7 $\hat{=}$ 70 % 1 $\hat{=}$ 100 %

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Note:

- Current setpoint filter 1 is preset to the current controller sampling time MD 1000 = 125 µs for damping of the encoder torsional natural frequency.

1204	Natural frequency current setpoint filter 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**8 000**	**Hz**

Input of natural frequency for current setpoint filter 2 (PT2 low-pass). An entry of < 10 Hz as the natural frequency of the low-pass filter initializes the filter as a proportional element with a gain of 1 independently of the associated damping. The filter is activated via machine data MD 1200 and MD 1201.

1205	Damping current setpoint filter 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
1.0	**0.05**	**5**	**–**

Input of damping for current setpoint filter 2 (PT2 low-pass). The filter is activated via machine data MD 1200 (selection current setpoint filter) and MD (type current setpoint filter) 1201.

1206	Natural frequency current setpoint filter 3		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**8 000**	**Hz**

Input of natural frequency for current setpoint filter 3 (PT2 low-pass). An entry of < 10 Hz as the natural frequency of the low-pass filter initializes the filter as a proportional element with a gain of 1 independently of the associated damping. The filter is activated via machine data MD 1200 and MD 1201.

1207	Damping current setpoint filter 3		Active **at once**
Default value	Lower input limit	Upper input limit	Units
1.0	**0.05**	**5**	**–**

Input of damping for current setpoint filter 3 (PT2 low-pass). The filter is activated via machine data MD 1200 (selection current setpoint filter) and MD (type current setpoint filter) 1201.

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1208	Natural frequency current setpoint filter 4		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**8 000**	**Hz**

Input of natural frequency for current setpoint filter 4 (PT2 low-pass). An entry of < 10 Hz as the natural frequency of the low-pass filter initializes the filter as a proportional element with a gain of 1 independently of the associated damping. The filter is activated via machine data MD 1200 and MD 1201.

1209	Damping current setpoint filter 4		Active at once
Default value	Lower input limit	Upper input limit	Units
1.0	**0.05**	**5**	**–**

Input of damping for current setpoint filter 4 (PT2 low-pass). The filter is activated via machine data MD 1200 (selection current setpoint filter) and MD (type current setpoint filter) 1201.

1210	Block frequency current setpoint filter 1		Active at once
Default value	Lower input limit	Upper input limit	Units
3 500.0	**1**	**7 999.0**	**Hz**

Input of block frequency for current setpoint filter 1 (band-stop). When block frequencies of < 10 Hz are input, the filter is deactivated (proportional element with a gain of 1). The filter is activated via machine data MD 1200 and MD 1201.

Note:

The maximum block frequency input value is limited by the sampling frequency of the control (MD 1000) (parameterization error).

$$\text{MD 1210} < \frac{1}{2 \times \text{MD 1000}} = \frac{1}{2 \times T_{sampl.}}$$

$$\text{MD 1000} = T_{sampl.} = \left\{ \begin{array}{r} 62.5\ \mu s \\ 125.0\ \mu s \end{array} \right\} \Rightarrow \text{MD 1210} < \left\{ \begin{array}{l} 8000\ Hz \\ 4000\ Hz \end{array} \right\}$$

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1211	Bandwidth current setpoint filter 1		Active at once
Default value	Lower input limit	Upper input limit	Units
500	**0**	**1 000**	**Hz**

Input of 3dB bandwidth for current setpoint filter 1 (band-stop). The filter is activated in machine data MD 1200 and MD 1201.

Note:

When 0 is entered for the bandwidth, the filter is parameterized as a proportional element with a gain of 1.

1213	Block frequency current setpoint filter 2		Active at once
Default value	Lower input limit	Upper input limit	Units
3 500.0	**1**	**7 999.0**	**Hz**

Input of block frequency for current setpoint filter 2 (band-stop). When block frequencies of < 10 Hz are input, the filter is deactivated (proportional element with a gain of 1). The filter is activated via machine data MD 1200 and MD 1201.

Note:

The maximum block frequency input value is limited by the sampling frequency of the control (MD 1000) (parameterization error).

$$\text{MD 1213} < \frac{1}{2 \times \text{MD 1000}} = \frac{1}{2 \times T_{sampl.}}$$

$$\text{MD 1000} = T_{sampl.} = \left\{ \begin{array}{c} 62.5\ \mu s \\ 125.0\ \mu s \end{array} \right\} \Rightarrow \text{MD 1213} < \left\{ \begin{array}{c} 8000\ Hz \\ 4000\ Hz \end{array} \right\}$$

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1214	Bandwidth current setpoint filter 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
500	**0**	**1 000**	**Hz**

Input of 3dB bandwidth for current setpoint filter 2 (band-stop). The filter is activated in machine data MD 1200 and MD 1201.

Note:

When 0 is entered for the bandwidth, the filter is parameterized as a proportional element with a gain of 1.

1216	Block frequency current setpoint filter 3		Active **at once**
Default value	Lower input limit	Upper input limit	Units
3 999.0	**1**	**7 999.0**	**Hz**

Input of block frequency for current setpoint filter 3 (band-stop). When block frequencies of < 10 Hz are input, the filter is deactivated (proportional element with a gain of 1). The filter is activated via machine data MD 1200 and MD 1201.

Note:

The maximum block frequency input value is limited by the sampling frequency of the control (MD 1000) (parameterization error).

$$\text{MD 1216} < \frac{1}{2 \times \text{MD 1000}} = \frac{1}{2 \times I_{sampl.}}$$

$$\text{MD 1000} = T_{sampl.} = \left\{ \begin{array}{r} 62.5\ \mu s \\ 125.0\ \mu s \end{array} \right\} \Rightarrow \text{MD 1216} < \left\{ \begin{array}{r} 8000\ Hz \\ 4000\ Hz \end{array} \right\}$$

1217	Bandwidth current setpoint filter 3		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**0**	**1 000**	**Hz**

Input of 3dB bandwidth for current setpoint filter 3 (band-stop). The filter is activated in machine data MD 1200 and MD 1201.

Note:

When 0 is entered for the bandwidth, the filter is parameterized as a proportional element with a gain of 1.

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1219	Block frequency current setpoint filter 4		Active **at once**
Default value	Lower input limit	Upper input limit	Units
3 999.0	**1**	**7 999.0**	**Hz**

Input of block frequency for current setpoint filter 4 (band-stop). When block frequencies of < 10 Hz are input, the filter is deactivated (proportional element with a gain of 1). The filter is activated via machine data MD 1200 and MD 1201.

Note:

The maximum block frequency input value is limited by the sampling frequency of the control (MD 1000) (parameterization error).

$$\text{MD 1219} < \frac{1}{2 \times \text{MD 1000}} = \frac{1}{2 \times T_{sampl.}}$$

$$\text{MD 1000} = T_{sampl.} = \left\{ \begin{array}{r} 62.5\ \mu s \\ 125.0\ \mu s \end{array} \right\} \Rightarrow \text{MD 1219} < \left\{ \begin{array}{r} 8000\ Hz \\ 4000\ Hz \end{array} \right\}$$

1220	Bandwidth current setpoint filter 4		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**0**	**1 000**	**Hz**

Input of 3dB bandwidth for current setpoint filter 4 (band-stop). The filter is activated in machine data MD 1200 and MD 1201.

Note:

When 0 is entered for the bandwidth, the filter is parameterized as a proportional element with a gain of 1.

1400	Motor rated speed		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
1 500	**0**	**6 000**	**rev/min**

Input of motor rated speed as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

1401	Maximum motor operational speed		Active **at once**
Default value	Lower input limit	Upper input limit	Units
1 500	**0**	**7 200**	**rev/min**

Machine data MD 1401 defines the maximum operational speed of the feed motor. It is used as a reference value for the speed setpoint interface and for the machine data "Monitoring speed motor" (MD 1405). Its default value is set by means of motor selection (MD 1102) to the rated motor speed as specified on the motor data sheet.

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Note:

The velocity of a feed axis is matched with NC-MD 2560 (maximum axis velocity). The motor speed which corresponds to this maximum value must be entered in drive-MD 1401. Allowance is made for the spindle pitch plus any existing gear ratios, etc. in the relationship between NC-MD 2560 and drive-MD 1401.

1402	Reduction factor max. motor speed set-up mode		Active **at once**
Default value	Lower input limit	Upper input limit	Units
1	**0**	**100**	**%**

Input of reduction factor for set-up mode. The maximum permissible speed (MD 1401) and the motor speed monitor (MD 1405) are the references for the reduction factor, i.e. the maximum motor speed in set-up mode is calculated from MD 1402 x MD 1405 x MD 1401.

1403	Creep speed pulse suppression		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**7 200**	**rev/min**

Input of creep speed for pulse suppression. If the absolute speed actual value drops below the specified speed limit, e.g. owing to cancellation of the controller enabling command, in the course of a creep operation, the pulses are suppressed by a software function and the drive shut down until it is re-enabled by SERVO. The default value 0 means that the machine data is deactivated; pulse suppression is then implemented solely via the machine data "Timer pulse suppression" (MD 1404).

The functionality of this machine data is required:

1. With high inertia as zero speed may not be reached in some cases.
2. To reliably preclude overshoot during positioning.

Note:

Under normal circumstances, shutdown is implemented sequentially on the drive and servo sides with variously adjustable timers (NC-MD 156, NC-MD 12240) and, in the event of a fault, only on the drive side with timer MD 1404.

1404	Timer pulse suppression		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**0**	**1 000**	**ms**

Input of timer for pulse suppression by means of drive. In the event of a fault (in generator braking mode), the control pulses for the power section transistors are suppressed on the drive side after expiry of the time set in the adjustable timer. Monitoring takes place sequentially on the drive and servo sides with variously adjustable timers.

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Note:

Under normal circumstances, shutdown is implemented sequentially on the drive and servo sides, with variously adjustable timers (NC-MD 156, NC-MD 12240) and, in the event of a fault, only on the drive side with timer MD 1404.

1405	Monitoring speed motor		Active at once
Default value	Lower input limit	Upper input limit	Units
110	**100**	**110**	**%**

Input of maximum permissible speed setpoint as a limit value for the speed actual value monitor. The machine data "Maximum motor speed" (MD 1401) is applied as the reference value.

1407	P-gain speed controller		Active at once
Default value	Lower input limit	Upper input limit	Units
0.3	**0**	**100 000**	**Nm/s^{-1}**

Input of P-gain of the speed control loop in the lower speed range (n < lower speed threshold in MD 1411). The P-gain values in the lower speed range (MD 1407) and the upper speed range (MD 1408) are not subject to any mutual restrictions. See machine data "Adaptation lower speed threshold" (MD 1411) for diagram.

Note:

Before the P-gain is set to 0, the associated integral-action component (MD 1409) must be deactivated to maintain controller stability.

MD 1407 is active over the entire speed range when the "Speed controller adaptation" is deactivated (MD 1413 = 0).

1408	P-gain upper adaptation speed		Active at once
Default value	Lower input limit	Upper input limit	Units
0.3	**0**	**100 000**	**Nm/s^{-1}**

Input of P-gain of the speed control loop in the upper speed range (n > upper speed threshold in MD 1412). The P-gain values in the lower speed range (MD 1407) and the upper speed range (MD 1408) are not subject to any mutual restrictions. See machine data "Adaptation lower speed threshold" (MD 1411) for diagram.

Note:

Before the P-gain is set to 0, the associated integral-action component (MD 1410) must be deactivated to maintain controller stability.

MD 1408 is not active when the "Speed controller adaptation" is deactivated (MD 1413 = 0).

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1409	Integral-action time speed controller		Active **at once**
Default value	Lower input limit	Upper input limit	Units
10	**0**	**500**	**ms**

Input of integral-action time of speed control loop in the lower speed range (N < lower speed threshold MD 1411). The integral-action times in the lower speed range (MD 1409) and the upper speed range (MD 1410) are not subject to any mutual restrictions. See machine data "Adaptation lower speed threshold" (MD 1411) for diagram.

Note:

Setting the integral-action time to zero deactivates the appropriate speed range (suppression of integral gain and integrator contents = > torque step changes cannot be precluded - see also Note in MD 1410).

MD 1409 is active over the entire speed range when the "Speed controller adaptation" is deactivated (MD 1413 = 0).

Caution:

When the adaptation function is active, deactivation of the I-action component for only one speed range (MD 1409 = 0 and MD 1410 0 or vice versa) should be avoided (to prevent problem of torque step changes through resetting of the integral value on transition from adaptation to constant range).

1410	Integral-action time upper adaptation speed		Active **at once**
Default value	Lower input limit	Upper input limit	Units
10	**0**	**500**	**ms**

Input of integral-action time of speed control loop in upper speed range (N > upper speed threshold MD 1412). The integral-action times in the lower speed range (MD 1409) and the upper speed range (MD 1410) are not subject to any mutual restrictions. See machine data "Adaptation lower speed threshold" (MD 1411) for diagram.

Note:

Setting the integral-action time to zero deactivates the I-action component for the range which is greater than the machine data "Adaptation upper speed threshold (MD 1412) (see also Note in MD 1409).

MD 1410 is not active when the "Speed controller adaptation" is deactivated (MD 1413 = 0).

Caution:

When the adaptation function is active, deactivation of the I-action component for only one speed range (MD 1409 = 0 and MD 1410 0 or vice versa) should be avoided (to prevent problem of torque step changes through resetting of the integral value on transition from adaptation to constant range).

1411	Lower adaptation speed		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**7 200**	**rev/min**

Input of lower speed threshold for adaptation of the speed controller machine data. When the adaptation function is active, the control machine data MD 1407 and MD 1409 are applied at speeds n < MD 1411. In the adaptation range MD 1411 < n < MD 1412, linear interpolation takes place between the two control machine data sets.

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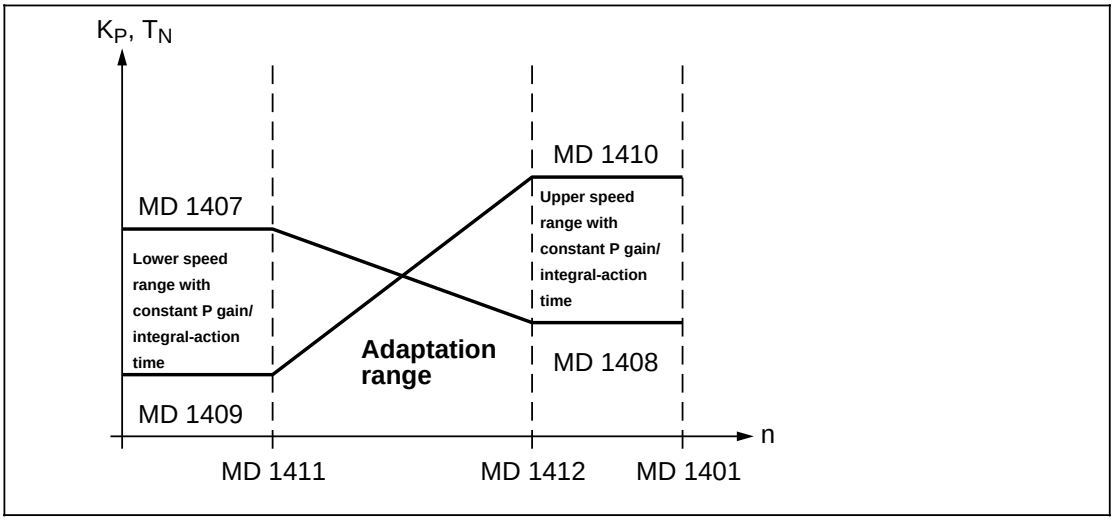
Graphic representation:

Adaptation of speed controller machine data by means of characteristic



1412	Upper adaptation speed		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**7 200**	**rev/min**

Input of upper speed threshold for adaptation of the speed controller machine data. When the adaptation function is active, the control machine data MD 1408 and MD 1410 are applied at speeds n > MD 1412. In the medium range MD 1411 < n < MD 1412, linear interpolation takes place between the two control machine data sets.

See machine data "Adaptation lower speed threshold" (MD 1411) for diagram.

1413	Selection adaption speed controller		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1**	**–**

This machine data allows adaptation of the speed controller machine data to be controlled as a function of speed.

Input 0: The adaptation function is not active. The settings in control machine data MD 1407 and MD 1409 are applicable over the entire speed range. Control machine data MD 1408 and MD 1410 are not taken into account.

Input 1: The adaptation function is active. See machine data MD 1411 and MD 1412 for description.

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1414	Natural frequency reference model speed control loop		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**8 000**	**Hz**

Input of natural frequency for the "Speed control loop" reference model. The filter is deactivated if a value of < 10 Hz is entered (proportional element with a gain of 1).

Note:

Machine data 1414, 1415 and 1416 must be set in each case to the same value for interpolating axes.

1415	Damping reference model speed control loop		Active at once
Default value	Lower input limit	Upper input limit	Units
1	**0.5**	**5**	**–**

Input of damping for the "Speed control loop" reference model. This is a reference model (PT2) for the speed control loop with a controller of the PIR type. The higher the input value, the stronger the damping effect.

Note:

Machine data 1414, 1415 and 1416 must be set in each case to the same value for interpolating axes.

1416	Symmetrization reference model speed loop		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1.0**	**–**

Input of symmetrization for the "Speed control loop" reference model. This machine data simulates the calculation dead time of the speed control loop. The simulation is in this case calculated as an approximation of an interrupted dead time. The response of the reference model can in this way be matched to the controlled system response of the closed, P-controlled speed control loop.

1417	n_x for $n_{act} < n_x$		Active at once
Default value	Lower input limit	Upper input limit	Units
6000.0	**0**	**7 200**	**rev/min**

Input of threshold speed for monitoring purposes; if the actual speed value does not reach the set threshold speed in terms of absolute value, a message is transferred to the SERVO. The monitoring function is not activated unless the default value is changed.

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1418	n_{min} for $n_{act} < n_{min}$		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**7 200**	**rev/min**

Input of threshold speed for monitoring purposes; if the actual speed value does not reach the set threshold speed in terms of absolute value, a message is transferred to the SERVO. The monitoring function is not activated unless the default value is changed.

1421	Time constant integrator feedback		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**1 000.0**	**ms**

The speed controller loop integrator is reduced via a weighted feedback to a low-pass response of the 1st order with the configured time constant. Machining movements via the integrator in the case of non-linear controlled system characteristics (friction around the zero-speed point) can thus be restricted or prevented.

Note:

The integrator feedback is activated when MD 1421 is set to 1.0.

1502	Time constant speed setpoint filter		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**500**	**ms**

Input of time constant for speed setpoint filter (PT1 low-pass). The filter is deactivated when the data is set to zero.

1600	Concealable power on 611D alarms		Active at once
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

This machine data allows power on 611D alarms to be concealed. The monitoring function is activated if the appropriate bit = 0. All 611D monitoring functions are activated as standard.

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Bit 0	Internal error **cannot be concealed**
Bit 1	Not assigned
Bit 2	Measuring circuit error, phase current R
Bit 3	Measuring circuit error, phase current S
Bit 4	Measuring circuit error, position measuring system motor
Bit 5	Measuring circuit error, position measuring system motor (absolute track optical encoder)
Bits 6-7	Not assigned
Bit 8	Zero monitoring position (zero mark) measuring system motor
Bits 9-14	Not assigned
Bit 15	Temperature power section shutdown

Note:

Power on 611D alarms can be acknowledged only via a hardware reset.

1601	**Concealable reset 611D alarms**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

This machine data allows reset 611D alarms to be concealed or disabled. The alarm is active if the appropriate bit = 0. All 611D alarms are activated as standard.

Bit 0	Configuration error cannot be concealed
Bits 1-7	Not assigned
Bit 8	Speed controller at fixed stop
Bits 9-13	Not assigned
Bit 14	Shutdown motor overtemperature
Bit 15	Not assigned

Note:

Reset 611D alarms can be acknowledged via a software reset.

1602	**Motor temperature warning limit**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
120	**0**	**200**	**°C**

Input of maximum permissible motor temperature. The temperature is detected by appropriate sensors and evaluated in the drive. A message is transferred to the SERVO when the warning limit is reached.

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1603	Timer motor temperature alarm		Active at once
Default value	Lower input limit	Upper input limit	Units
240	0	600	s

Input of timer for the motor temperature alarm. When the value set in "Motor temperature warning" (MD 1602) is exceeded, a message is transferred to the SERVO and a time monitor activated. If the timer runs out before the temperature drops below the limit, the drive initiates a generator braking operation and suppresses the transistor drive signals for the appropriate axis after MD 1404 (pulse suppression) in conjunction with MD 1403 (creep speed).

Note:

Changing the timer setting will not influence a time monitoring function already in progress (counter started). The change will become applicable when the motor temperature has dropped below the warning limit (MD 1601).

1604	ZK undervoltage warning threshold		Active at once
Default value	Lower input limit	Upper input limit	Units
200	0	600	V

Input of DC-link undervoltage warning threshold. When the voltage drops below this value, a message is sent to the SERVO. This message is output on the 1st page of the FDD service display: DC link "off".

1605	Timer speed controller at fixed stop		Active at once
Default value	Lower input limit	Upper input limit	Units
200	20	10 000	ms

Input of "Speed controller at fixed stop" timer. The output of the speed controller (current setpoint value) is monitored. In the event of a fault, the control pulses for the power section transistors are suppressed on the drive side when the timer setting has expired.

Note:

Setting values of MD 1065 < MD 1404 (Timer pulse suppression) are rejected as parameterization errors.

The monitoring function is independent of internal operating modes (feedforward control, function generator, etc.).

1700	Status of binary inputs		Active at once
Default value	Lower output limit	Upper output limit	Units
0000	0000	7FFF	Hex

This machine data is used to display the status of the binary inputs.

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Bit 0	Control unit enable (internal module function), including marking according to MD 1003, bit 5
Bit 1	Image terminal 663 (module-specific pulse suppression IMPFR)
Bit 2	Image terminal 63/48 of I/RF unit (central drive pulse suppression REIMSP)
Bit 3	Sum signal pulse enable: – Stored hardware sum signal – Axial pulse enable by PLC via 611D control word
Bit 4	"Heat sink of power section XKKT too hot" message: Low active signal
Bit 5	Image terminal 112 of I/RF unit (set-up mode message XEINR): Low active signal
Bit 6	Image terminal 64/63 of I/RF unit (Central drive enable setpoint = 0)
Bit 7	Not assigned
Bit 8	Image terminal 5 of I/RF unit (motor/power section temperature prewarning X12T): Low active signal
Bits 9-15	Not assigned

1701	**DC link voltage**		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0000**	**32 767**	**V**

This machine data is used to display the voltage level at the DC link in normal or set-up mode. The DC-link voltage U_{DClink} is measured continuously.

1702	**Motor temperature**		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0000**	**32 767**	**°C**

This machine data is used to display the motor temperature. The motor temperature is measured by appropriate sensors and evaluated in the drive.

1706	**Speed setpoint**		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0.0	**0**	**32 767.0**	**rev/min**

This machine data is used to display the speed setpoint which represents the unfiltered summation setpoint. It comprises the component of the position controller output and the speed feedforward control arm. Time-synchronous unlatching (scanning) of machine data MD 1706, MD 1707 and MD 1708 is not provided. The appropriate machine data is unlatched by the read request of the non-cyclical communications protocol.

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1707	Speed actual value		Active at once
Default value	Lower output limit	Upper output limit	Units
0.0	**0000**	**32 767.0**	**rev/min**

This machine data is used to display the actual speed value and represents the unfiltered actual speed value. Time-synchronous unlatching (scanning) of machine data MD 1706, MD 1707 and MD 1708 is not provided. The appropriate machine data is unlatched by the MMC request "Read variables" via the STF ES communications interface.

1708	Smoothed current actual value		Active at once
Default value	Lower output limit	Upper output limit	Units
0.0	**0000**	**32 767.0**	**%**

This machine data is used to display the smoothed current actual value. The torque-producing current actual value is smoothed by a PT1 element with constant coefficients. These coefficients correspond to time constants of 20 ms (with a current controller cycle of 62.5 µs) and 40 ms (with a current controller cycle of 125 µs). In this case, the smoothed current actual value is displayed as a percentage. 100 % corresponds to the maximum current of the power section (e.g. with an 18/36A power section 100 % = 36A RMS).

1710	Significance current representation		Active at once
Default value	Lower output limit	Upper output limit	Units
0.0	**0**	**32 767.0**	**µA**

This machine data is used to display the significance of the current representation. The significance of bit 0 (internal current actual value representation) is shown to the user to allow allocation of the internal current status representation to the physical ampere values. The maximum power section current is present internally in normalized representation.

Note:

This machine data is calculated only once during ramp-up; its value cannot therefore be changed during operation.

1711	Significance speed representation		Active at once
Default value	Lower output limit	Upper output limit	Units
0.0	**0**	**32 767.0**	**rev/min**

This machine data is used to display the significance of the speed representation. The significance of bit 0 (internal speed actual value representation) is shown to the user to allow allocation of the internal speed status significance to the physical revolution values. A speed is present internally in the units of the encoder system and referred to the current speed controller clock cycle.

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Note:

This machine data is calculated only once during ramp-up; its value cannot therefore be changed during operation.

1720	CRC diagnosis parameter		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0000	**0**	**FFFF**	**Hex**

This machine data is used to display detected CRC errors (cyclical redundancy check). The counter information is output with every read request and is 5 bits in width (bit 4...bit 0 or counter reading 0...31).

Note:

It cannot be guaranteed in all cases that the CRC error is assigned to the appropriate drive. When the address is faulty, the "wrong" module indicates the error.

1797	Data version		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0**	**32 767**	**–**

Output of current data version (machine data list).

1798	Firmware date		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0**	**32 767**	**–**

Output of coded software version in decimal format. The date is coded as such: DDMMY, where DD stands for day, MM for month and Y for the last number in the year.

Example: 01.06.1993 $\hat{=}$ 01063_{dec}

1799	Firmware version		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0**	**32 767**	**–**

Output of current software version (configuration management).

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7.3 611D drive machine data (FDD/MSD - as from SW 4)

7.3.1 Drive MD input (as from SW 4)

The drive machine data are provided for the purpose of matching the drives (FDD/MSD) and the machine tool. If no setting values are specified by the machine manufacturer or the user, then they must be carefully determined and optimized by the start-up engineer. The setting values are input by means of menu selection (see section headed "Machine Data Dialog").

Notes:

- The machine data apply generally for FDD and MSD, but there are a few MDs that apply specifically to FDD or MSD. Appropriate mention is made in such cases under the relevant machine data.
- A number of motor-dependent machine data exist for the MSD. These machine data can be identified by an "X" in the first position. The data for the 1st motor start with 1000, those for the 2nd motor with 2000. (Example: motor rated speed MD X400 is MD 1400 for motor 1 and MD 2400 for motor 2).

7.3.2 Drive MD (data description)

1000	**Current controller cycle**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
125.0	**62.5**	**125.0**	**µs**

The basic clock cycle of the module is derived from the current controller clock cycle of the axis: Current controller clock cycle = Module basic clock cycle. The module basic clock cycle is the basis for the generation of the interrupt signals for the processor and for the generation of the inverter signals of the pulse-width modulator. Other clock cycles are derived from the basic cycle by means of software functions.

Input values are 62.5 µs or 125 µs.

Notes:

- Intermediate values are not permissible (parameterization error).
- Exceeding the computing time on the current controller clock cycle level is not permissible and will lead to tripping of the drive.
- In the case of double-axis modules, both drives must be parameterized with the same current controller clock cycle (otherwise parameterization error).

1001	**Speed controller cycle**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
125.0	**62.5**	**125.0** **500 (as from SW 6)**	**µs**

The speed controller clock cycle is derived from the current controller clock cycle of the axis: Current controller clock cycle speed controller clock cycle. The time-slice management ZSV (sequence control) is initialized with this machine data.

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SIN 840C with 611D controller ...	Current controller cycle MD 1000	Speed controller cycle MD 1001	Comments
Single-axis performance	125 µs	125 µs	Default value
Single-axis performance	62.5 µs	62,5 µs	Minimum
Single-axis performance	125 µs	250 µs	as from SW 6
Single-axis performance	125 µs	500 µs	as from SW 6
2-axis performance	125 µs	125 µs	Default value/minimum
2-axis performance 1 axis present	62.5 µs	62,5 µs	Minimum
2-axis standard	125 µs	125 µs	Default value/minimum
2-axis standard 1 axis present	125 µs	125 µs	Default value/minimum

Table: Possible current and speed controller cycle combinations

Notes:

- Intermediate values are not permitted (parameterization error).
- Exceeding the computing time on the speed controller clock cycle level is not permissible and will lead to tripping of the drive.

1002	Monitoring cycle		Active on Power On
Default value	Lower input limit	Upper input limit	Units
100 000	**4 000**	**100 000**	**µs**

The interrupt clock cycle is used for high-priority monitoring purposes. Note: The input value for the clock cycle must be a whole multiple of 4 ms (parameterization error). For the default value, the monitoring cycle time is 100 ms.

m x 4000 µs m = 1, 2, 3 ... 25

Note:

The interrupts level must not be exceeded. If it is, the drive shuts down.

1003	Configuration STS		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0330	**0000**	**FFFF**	**Hex**

Caution:

Do **not** modify this machine data, the default corresponds to the optimum configuration. (For Siemens service only)

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1004	Configuration structure		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**7FFF**	**Hex**

Input of the configuration for control structures, speed measuring systems and functionality referred to the SIMODRIVE System 611D.

Value table:

Bit 0	Speed torque feedforward channel of drive	0 = Not active 1 = Active
Bit 1	Not assigned	
Bit 2	Higher dynamic response (single axis module only)	0 = Current before speed control calculation 1 = Speed before current control calculation
Bit 3	Reserved	
Bit 4	Integrator control (as from SW 6)	0 = Integrator control in speed controller active. The integrator is stopped when the current or voltage setpoint reaches the limit. 1 = Integrator control in speed controller not active. Value limited to 2x the torque limit. Always active with ”Travel to fixed stop”.
Bit 5-15	Not assigned	

Caution:

Speed before current control is possible **only with one active axis** on the module.

The default is: current before speed control (bit 2 = 0).

1005	No. encoder marks motor measuring system		Active on Power On
Default value	Lower input limit	Upper input limit	Units
2 048	**128**	**8 192**	**Incr/rev**

Input of number of encoder increments per motor revolution of the motor measuring system.

Note:

The indirect measuring system must always be configured for FDD**/**MSD.
(Not for pure AM**/**Vf operation)

1007	No. encoder marks direct measuring system		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0	**0**	**65 535**	**Incr/rev, incr/mm**

Input of the encoder increments per revolution for a linear or rotary direct measuring system.

Note:

Value 0 in the display means that no direct measuring system is available. This MD is currently of no importance.

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1008	Encoder phase error compensation		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**- 20.0**	**20.0**	**Degrees**

With this machine data, a phase error compensation is performed. On unconditioned signal encoders (e.g. ERN 1387), phase errors can occur between the A and B tracks. These can be noticed by a rougher speed actual value, i.e. the actual value has twice the encoder marking frequency imposed on it if a fault occurs. Especially in the case of geared encoders, the phase errors can assume magnitude that have an effect on the control quality. (Acoustic)

Note:

This machine data is switched active with bit 1 of the machine data Configuration act. val. acquisition (MD 1011).

1011	Configuration act. val. acquisition, motor measuring system		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

Input of the configuration for actual value functions related to the SIMODRIVE System 611D.

Value table:

Bit 0	Adaptation of direction of rotation gear encoder is fitted	0=Positive direction of rotation of motor (clockwise) 1=Negative direction of rotation of motor (counterclockwise)
Bit 1	Phase error compensation	0=not active 1=active
Bit 2	Reserved	
Bit 3	Incremental encoder Absolute encoder with Endat interface	=0 =1
Bit 4	Rotary measuring system Linear measuring system	=0 =1
Bit 5	Motor measuring system for AM operation	=0 available =1 not available
Bit 6	Absolute track via electr. rev. Absolute track via mec. rev.	=1 (e.g. Hall-type pulse generator) =0 (e.g. ERN 1387)
Bit 8	Linear scale has several zero marks: One is selected by the NC	=1
Bit 12	Identify rough position	=1
Bit 13	Identify fine position	=1
Bits 14-15	Transmission rate EnDat encoder	00= 100 kHz 01= 500 kHz 10= 10 kHz 11= 2 kHz

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1012	Function switch		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

Input of the configuration for switch-on functionality referred to the SIMODRIVE System 611D.

Value table:

Bit 0	Ramp-up encoder follow-up	0 = not active 1 = active
Bit 1	Reserved	
Bit 2	Drive ready terminal-dependent	0 = the drive is ready when no ZK1 alarm is active 1 = the drive is ready when those of the following conditions apply simultaneously: – no ZK1 alarm – terminal 63=1 (I/R module) – terminal 64=1 (I/R module) – terminal 663=1 (drive module)
Bit 3	Not assigned	
Bit 4	ZK2 parameterization errors	0 = ZK2 parameterization errors are not supported (default setting). An error cause shutdown (servo disable) 1 = ZK2 parameterization errors are supported: An error causes a warning to be displayed on the screen
Bits 5-15	Not assigned	

1013	Enable motor switchover		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**100**	**Hex**

Various motor switchover variants can be enabled

The function motor switchover in the control means switchover between motor data set 1 (MD 1xxx) and 2 (2xxx).

Possible switchover variants are:

- Star/delta switchover, motor data set 1 star connection, motor data set 2 delta connection. Switchover of the motor windings must be performed externally with contactors that are controlled by the PLC. Synchronization with the drive is performed by the control and status word of the cyclic interface.
- Switchover between two real motors. Motor data set 1 for motor 1, motor data set 2 for motor 2. Motor switchover is performed externally using contactors, synchronization via control and status words.

Note:

The machine for the 2nd motor must be parameterized in order to be able to enable the star/delta switchover. The drive considers the 2nd motor to be parameterized if machine data MD 2102 does not include the value 0.

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1021	Multiturn resolution absolute encoder motor (as from SW 5)		Active on Power On
Default value	Lower input limit	Upper input limit	Units
4 096	**0**	**65 535**	**rev/min**

Number of revolutions of the motor that can be represented

1022	Measuring increments of the absolute track motor (as from SW 5)		Active on Power On
Default value	Lower input limit	Upper input limit	Units
8 192	**512**	**8 388 607**	**Incr/rev**

Number of measuring increments per mechanical revolution for serial transmission of the absolute position value.

1023	Servo loop motor absolute track (as from SW 5)		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

Bit 0	Lighting failed	Replace encoder
Bit 1	Signal amplitude to small	Replace encoder
Bit 2	Code connection defective	Replace encoder
Bit 3	Overvoltage	Switch on/off, replace encoder
Bit 4	Undervoltage	Switch on/off, replace encoder
Bit 5	Overcurrent	Switch on/off, replace encoder
Bit 6	Battery change necessary	Change battery
Bit 7 + Bit 13	= 0 = 1 CRC error on ENDAT interface	Check hardware, cable, encoder; replace, if necessary
Bit 7 + Bit 13	= 0 = 1 Check error	Check hardware, cable, encoder; replace, if necessary
Bit 7 + Bit 13	= 0 = 1 Error on correction of abs. track through incremental track	Check hardware, cable, encoder; replace, if necessary
Bit 8	Reserved	-
Bit 9	C/D track in encoder EQN 1325 defective	Switch on/off, replace encoder
Bit 10	Protocol cannot be cancelled	Switch on/off, replace encoder
Bit 11	SSI level detected on data line hardware	Check encoder type, replace
Bit 12	TIMEOUT on reading measured value	Repeat, replace hardware
Bit 13	See bit 7	
Bit 14	Reserved	-
Bit 15	Encoder defective	Replace encoder

Note:

The system acknowledges an interchange of the encoder systems ERN 1387 (previous incremental system) and EQN 1325 (absolute encoder system) during parameterization or connection by aborting the measured value acquisition. The following incorrect combinations are possible:

ERN 1387 present, EQN 1325 parameterized:
Abortion via recognition of missing EnDat interface on ERN 1387 (MD 1023, bit 11 or bit 12 set)

Only for FDD:
EQN 1325 present, ERN 1387 parameterized:
Abortion via recognition of missing C/D tracks for EQN 1325 (MD 1023, bit 9 set)

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Note regarding bit 9:

Incorrect parameterization, e.g. not on EQN MD 1011 (configuration actual-value acquisition, indirect measuring system)
or MD 1030 (configuration actual-value acquisition, direct measuring system)
or obsolete hardware (not suitable for EQN)
or no encoder connected
or incorrect encoder cable (for ERN instead of for EQN).

1030	Configuration actual-value acquisition, direct measuring system		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFF**	**Hex**

Input of the configuration for actual-value functions with reference to the SIMODRIVE system 611D, direct measuring system.

Bit 0 - 2	Not assigned	
Bit 3	Encoder type	0= incremental encoder 1= absolute encoder with EnDat interface
Bit 4	Design of the measuring system	0= rotary measuring system 1= linear measuring system
Bits 5-13	Not assigned	
Bits 14-15	Transmission rate EnDat encoder	00= 100 kHz 01= 500 kHz 10= 10 kHz 11= 2 kHz

1031	Multiturn resolution absolute encoder direct measuring system		Active on Power On
Default value	Lower input limit	Upper input limit	Units
4096	**0000**	**65535**	**rev**

Number of revolutions of the absolute encoder, direct measuring system, that can be represented. The value can only be read.

1032	Measuring increments of the absolute track, direct measuring system		Active on Power On
Default value	Lower input limit	Upper input limit	Units
8192	**0**	**8 388 607**	**Incr/rev**

The number of measuring increments per revolution for serial transmission of the absolute position value, direct measuring system. The value can only be read.

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1033	Direct servo loop absolute track (SW 5 and higher)		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

Bit 0	Lighting failed	Replace encoder
Bit 1	Signal amplitude too small	Replace encoder
Bit 2	Code connection defective	Replace encoder
Bit 3	Overvoltage	Switch on/off, replace encoder
Bit 4	Undervoltage	Switch on/off, replace encoder
Bit 5	Overcurrent	Switch on/off, replace encoder
Bit 6	Battery change necessary	Change battery
Bit 7	Reserved	-
Bit 8	Reserved	-
Bit 9	Reserved	-
Bit 10	Protocol cannot be cancelled	Switch on/off, replace encoder
Bit 11	SSI level detected on data line hardware	Check encoder type, replace
Bit 12	TIMEOUT on reading measured value	Repeat, replace hardware
Bit 13	CRC error	Replace hardware
Bit 14	Reserved	-
Bit 15	Encoder defective	Replace encoder

1100	Frequency pulse-width modulation		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
4 000/3 200	**2 000**	**8 000**	**Hz**

The frequency of the sampling triangle in the PWM inverter is defined in this machine data. The default depends on the motor type (FDD≙4000, MSD≙3200) and is configured by the drive configuration at the time of start-up. The frequency values are set as an MMC function (see attached table).

Value table:

Default value	f_{PBM} in Hz	T_{PBM} in µs
–	2000	500.0*
–	2285.7....	437.5*
–	2666.6....	375.0*
MSD	3200	312.5*
FDD	4000	250.0*
–	5333.3....	187.5*
–	8000	125*

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Notes:

- The pulse frequency can be specified only in the quantization given in the table above. Other frequency inputs are rounded up or down to the next closest table value, e.g. 3150 Hz to 3200 Hz.

1101	**Calc. dead time current closed-loop**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
62	**0**	**124**	**µs**

The calculation dead time is the time which elapses between the start of a current control clock cycle (input of current setpoint) and the activation of the control voltage setpoints on the gating unit ASIC. The standard default value is automatically loaded during initial start-up when machine data M1102 is input. As from software version 5 the default value is automatically loaded during initial start-up and with the function "Calculate controller data" on the basis of given configuration (1 axis/2 axis FDD/MSD etc.). In order to make the setpoints on all power sections "valid" simultaneously (to achieve uniform dynamic response), the time required to calculate the most complex axis (double axis) is entered.

Note:

Limits of calculation dead time

MD 1101 < MD 1000 (=current controller clock cycle)

$$\text{MD 1101} < \frac{1}{4 \times \text{MD 1100}} \left(= \frac{T_{PBM}}{4} \right)$$ for 611 D hardware

Module:

Complete module	Drive module
6SN1130 - 1 DAXX - XXXX	6SN11XX - ODC 1X - XXXX
6SN 1130 - 1 DBXX - XXXX	6SN11XX - ODH 1X - XXXX
Default: 62 µs	

$$< \frac{1}{\text{MD 1100}} \left(= T_{PBM} \right)$$ for 611 D hardware standard/performance

Controller components

Standard	Performance
6SN1118 - X DM XX - XXXX	6SN1118 - XDG2X - XXXX 6SN1118 - XDH2X - XXXX
Default: 100 µs	Default: 62 µs

* *A preselection with synchronous sampling period (T_{PWM}) with respect to the controller cycles can be made via the toggle button.*

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1102	Motor code number		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**65 535**	**–**

Input of motor order number (machine-readable product designation for Siemens motors). This number is transferred to the drive in the form of a motor code number. The user does not need to input a value (see also MD 1106). The following motor data are automatically transferred from an internal motor table by means of the motor code number:

- MD 1103: Motor rated current (FDD**/**MSD)
- MD 1104: Maximum motor current (FDD)
- MD 1112: Pole pair number of motor (FDD)
- MD 1113: Torque constant (FDD)
- MD 1114: Voltage constant (FDD)
- MD 1115: Armature resistance (FDD)
- MD 1116: Armature inductance (FDD)
- MD 1117: Motor moment of inertia (FDD**/**MSD)
- MD 1118: Motor zero-speed current (FDD)
- MD 1130: Motor rated power (MSD)
- MD 1132: Motor rated voltage (MSD)
- MD 1134: Motor rated frequency (MSD)
- MD 1135: Motor no-load voltage (MSD)
- MD 1136: Motor no-load current (MSD)
- MD 1137: Stator resistance cold (MSD)
- MD 1138: Rotor resistance cold (MSD)
- MD 1139: Stator leakage reactance (MSD)
- MD 1140: Rotor leakage reactance (MSD)
- MD 1141: Main field reactance (MSD)
- MD 1142: Starting speed field weakening (MSD)
- MD 1143: Upper speed L_h characteristic (MSD)
- MD 1144: Gain factor L_h characteristic (MSD)
- MD 1146: Motor maximum speed (FDD**/**MSD)
- MD 1400: Motor rated speed (FDD**/**MSD)
- MD 1602: Maximum motor temperature (FDD**/**MSD)

Note:

If a valid motor order number cannot be entered in this machine data (e.g. for a motor make other than Siemens), then all these machine data must be entered manually.

Motor table: MSD motors

Order no.	**Rated speed**	**Motor code no.**
	n_{rated} in rev**/**min	
1PH6101-4NF4- x	1500	101
1PH6101-4NG4- x	2000	102
1PH6103-4NF4- x	1500	103
1PH6103-4NG4- x	2000	104
1PH6105-4NF4- x	1500	105
1PH6105-4NG4- x	2000	106

Order no.	**Rated speed**	**Motor code no.**
	n_{rated} in rev**/**min	
1PH6107-4NF4- x	1500	107
1PH6107-4NG4- x	2000	108
1PH6131-4NF4- x	1500	109
1PH6131-4NG4- x	2000	110
1PH6133-4NF0- x	1500	111
1PH6133-4NF4- x	1500	112

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Motor table: MSD motors

Order no.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1PH6133-4NG4- x	2000	113
1PH6135-4NF0- x	1500	114
1PH6135-4NF4- x	1500	115
1PH6135-4NG4- x	2000	116
1PH6137-4NF4- x	1500	117
1PH6137-4NG4- x	2000	118
1PH6138-4NF0- x	1500	119
1PH6138-4NF4- x	1500	120
1PH6138-4NG4- x	2000	121
1PH6161-4NF0- x	1500	122
1PH6161-4NF4- x	1500	123
1PH6161-4NG4- x	2000	124
1PH6163-4NF0- x	1500	125
1PH6163-4NF4- x	1500	126
1PH6163-4NG4- x	2000	127
1PH6167-4NF0- x	1500	128
1PH6167-4NF4- x	1500	129
1PH6167-4NG4- x	2000	130
1PH6107-4NC4- x	750	131
1PH6133-4NB4- x	525	132
1PH6137-4NB4- x	525	133
1PH6163-4NB4- x	500	134
1PH6167-4NB4- x	500	135
1PH6133-4NG0- x	2000	136
1PH6137-4NF2- x	2000	137
1PH6167-4NG4- x	2000	138
1PH6163-4NZ0- x	950	139
1PH6105-4NZ4- x	3000	140
1PH6131-4NZ0- x	1500	141
1PH6168-4NF0- x	1500	142
1PH6137-4NZ0- x	750	143
1PH6186-4NB4- x	500	160
1PH6186-4NB4- x	610	161
1PH6206-4NB4- x	500	162
1PH6186-4NE4- x	1250	163

Order no.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1PH6186-4NF4- x	1500	164
1PH6206-4NE4- x	1250	165
1PH6206-4NF4- x	1500	166
1PH6186-4NB9- x	700	167
1PH6226-4NF4- x	1500	168
1PH6133-4NB8- Y	525	200
1PH6133-4NB8- D	1250	201
1PH6137-4NB8- Y	525	202
1PH6137-4NB8- D	1250	203
1PH6163-4NB8- Y	500	204
1PH6163-4NB8- D	1250	205
1PH6167-4NB8- Y	500	206
1PH6167-4NB8- D	1250	207
1PH6186-4NB8- Y	500	208
1PH6186-4NB8- D	1250	209
1PH6206-4NB8- Y	500	210
1PH6206-4NB8- D	1250	211
DMR160.80.6. RIF	200	212
DMR160.80.6. RIF	1300	213
1PH6226-4NB8- Y	500	214
1PH6226-4NB8- D	500	215
1PH4103-4NF2- x	1500	300
1PH6105-4NF2- x	1500	302
1PH4107-4NF2- x	1500	304
1PH4133-4NF2- x	1500	306
1PH4135-4NF2- x	1500	308
1PH6137-4NF2- x	1500	310
1PH4138-4NF2- x	1500	312
1PH4163-4NF2- x	1500	314
1PH4167-4NF2- x	1500	316
1PH4168-4NF2- x	1500	318
1PH2093-6WF4	1500	320
1PH2095-6WF4	1500	321
1PH2113-6WF4	1500	322

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Motor table: MSD motors

Order no.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1PH2115-6WF4	1500	323
1PH2117-6WF4	1500	324
1PH2118-6WF4	1500	325
1PH2092-4WG4	2000	326
1PH2096-4WG4	2000	327
1PH2123-4WF4	1500	328
1PH2127-4WF4	1500	329
1PH2128-4WF4	1500	330
1PH2143-4WF4	1500	331
1PH2147-4WF4	1500	332
1PH2182-6WC4	750	333
1PH2184-6WP4	600	334
1PH2186-6WB4	500	335
1PH2188-6WB4	500	336
1PH2254-6WB4	500	337
1PH2256-6WB4	500	338

Order no.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1PH7131-xNF4	1500	406
1PH7133-xND4	1000	408
1PH7133-xNG4	2000	409
1PH7137-xND4	1000	411
1PH7137-xNG4	2000	412
1PH7163-xND4	1000	414
1PH7163-xNF4	1500	415
1PH7167-xNF4	1500	417
1PH7184-2NEx	1250	418
1PH7184-2NBx	500	419
1PH7186-2NEx	1250	420
1PH7186-2NBx	500	421
1PH7224-2NFx	1500	422
1PH7224-2NCx	700	423
1PH7184-xNTx	500	424
1PH7186-xNTx	500	425
Non-Siemens motor		099

Motor table: FDD motors

Order no.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1FT6102-8AB7X-XXXX	1500	1001
1FT6105-8AB7X-XXXX	1500	1002
1FT6108-8AB7X-XXXX	1500	1003
1FT6132-6AB7X-XXXX	1500	1004
1FT6134-6AB7X-XXXX	1500	1005
1FT6136-6AB7X-XXXX	1500	1006
1FT6061-6AC7X-XXXX	2000	1101
1FT6062-6AC7X-XXXX	2000	1102
1FT6064-6AC7X-XXXX	2000	1103
1FT6081-8AC7X-XXXX	2000	1104
1FT6082-8AC7X-XXXX	2000	1105
1FT6082-8AC7X-XXXX	2000	1105
1FT6084-8AC7X-XXXX	2000	1106
1FT6086-8AC7X-XXXX	2000	1107
1FT6102-XAC7X-XXXX	2000	1108

Order no.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1FT6105-XAC7X-XXXX	2000	1109
1FT6108-8AC7X-XXXX	2000	1110
1FT6132-6AC7X-XXXX	2000	1111
1FT6134-6AC7X-XXXX	2000	1112
1FT6136-6AC7X-XXXX	2000	1113
1FT6105-8SC7X-XXXX	2000	1159
1FT6108-8SC7X-XXXX	2000	1160
1FT6132-8SC7X-XXXX	2000	1161
1FT6134-8SC7X-XXXX	2000	1162
1FT6041-4AF7X-XXXX	3000	1201
1FT6044-XAF7X-XXXX	3000	1202
1FT6061-XAF7X-XXXX	3000	1203
1FT6062-XAF7X-XXXX	3000	1204
1FT6064-XAF7X-XXXX	3000	1205
1FT6081-8AF7X-XXXX	3000	1206

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Motor table: FDD motors

Order no.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1FT6082-XAF7X-XXXX	3000	1207
1FT6084-XAF7X-XXXX	3000	1208
1FT6086-XAF7X-XXXX	3000	1209
1FT6102-8AF7X-XXXX	3000	1210
1FT6105-8AF7X-XXXX	3000	1211

Order no.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1FT6132-6AF7X-XXXX	3000	1212
1FT6084-8SF7X-XXXX	3000	1258
1FT6086-8SF7X-XXXX	3000	1259
1FT6105-8SF7X-XXXX	3000	1261
1FT6061-6AH7X-XXXX	4500	1301
1FT6062-6AH7X-XXXX	4500	1302

Motor table: FDD motors

Order no.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1FT6064-6AH7X-XXXX	4500	1303
1FT6081-8AH7X-XXXX	4500	1304
1FT6082-8AH7X-XXXX	4500	1305
1FT6084-8AH7X-XXXX	4500	1306
1FT6086-8AH7X-XXXX	4500	1307
1FT6102-8AH7X-XXXX	4500	1308
1FT6084-8SH7X-XXXX	4500	1356
1FT6086-8SH7X-XXXX	4500	1357
1FT6031-6AK7X-XXXX	6000	1401
1FT6034-1AK7X-XXXX	6000	1402
1FT6041-6AK7X-XXXX	6000	1403
1FT6044-6AK7X-XXXX	6000	1404
1FT6061-6AK7X-XXXX	6000	1405
1FT6062-6AK7X-XXXX	6000	1406

Order no.	Rated speed	Motor code no.
	n_{rated} in rev/min	
1FT6064-6AK7X-XXXX	6000	1407
1FT6081-8AK7X-XXXX	6000	1408
1FT6082-8AK7X-XXXX	6000	1409
1FT6084-8AK7X-XXXX	6000	1410
1FT6084-8SK7X-XXXX	6000	1460
1FT6086-8SK7X-XXXX	6000	1461
1FK6042-6AF7x-XXXX	3000	2201
1FK6060-6AF7x-XXXX	3000	2202
1FK6063-6AF7x-XXXX	3000	2203
1FK6080-6AF7x-XXXX	3000	2204
1FK6083-6AF7x-XXXX	3000	2205
1FK6100-8AF7x-XXXX	3000	2206
1FK6101-8AF7x-XXXX	3000	2207
1FK6103-8AF7x-XXXX	3000	2208
1FK6040-6AK7x-XXXX	6000	2402

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1103	Motor rated current		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**500.0**	**A**

Input of rated current consumption (RMS value) in operation at rated torque and rated speed as specified on the motor data sheet (non-Siemens motor) or by automatic parameterization using machine data "Motor code number" (MD 1102).

1104	Maximum motor current		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**500.0**	**A**

Input of maximum permissible motor current (RMS value) as specified on the motor data sheet (non-Siemens motor) or by automatic parameterization using machine data "Motor code number" (MD 1102). To ensure reliable monitoring and limitation, the setting in this machine data should not be reduced (see also MD 1105).

1105	Reduction of maximum motor current		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**0**	**100**	**%**

Input of reduction factor for the maximum permissible motor current. The maximum motor current (MD 1104) is the reference value for the specified percentage.

Note:

This machine data is relevant for FDD drives **only**.

1106	Power section code number		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

When the power section order number (machine-readable product designation for Siemens power sections) is input during initial start-up, it is converted to a code number as an MMC function (the user need not enter a code number). The following power section data are automatically transferred from an internal power section table through the input of the code number:

- MD 1107: Transistor limit current, power section
- MD 1108: Thermal limit current, power section
- MD 1109: Limit current power section S6
- MD 1111: Rated current power section

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Format of power section code number:

Value table:

Code	Drive type	Current	PS	Comments
6	MSD	24/32/32 A	50 A	
7	MSD	30/40/51 A	80 A	
8	MSD	45/60/76 A	120 A	
9	MSD	60/80/102 A	160 A	
A	MSD	85/110/127 A	200 A	
B	MSD	120/150/193 A	300 A	
C	MSD	200/250/257 A	400 A	
D	MSD	45/60/76 A	108 A	
11	FDD	3/6 A	8 A	
12	FDD	5/10 A	15 A	
14	FDD	9/18 A	25 A	
16	FDD	18/36 A	50 A	
17	FDD	28/56 A	80 A	
19	FDD	56/112 A	160 A	
1A	FDD	70/140 A	200 A	
28	FDD	140/210 A	400 A	as from SW 4.1

1107	**Transistor limit current, power section**		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
200.0	**1.0**	**500.0**	**A**

Input of maximum permissible current of power section. This machine data is automatically parameterized for Siemens power sections by the machine data "Power section code" (MD 1106).

Caution:

This data serves as the basis for normalizing the current actual value sensor and **must not be changed** by the user after automatic presetting of its values.

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1108	Thermal limit current, power section		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
200.0	**1.0**	**500.0**	**A**

Input of maximum thermally permissible current of power section. The input is an RMS value. This machine data is automatically parameterized for Siemens power sections by the machine data "Power section code number" (MD 1106). The value entered must correspond to the limit value specified on the power section rating plate.

Caution:

This data acts as the upper thermal loading limit and **must not be changed** by the user after automatic presetting of its values.

1109	Limit current power section S6		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
200.0	**1.0**	**500.0**	**A**

This machine data is used to enter the maximum permissible current of the power section referred to the S6 duty cycle (intermittent operation). The input is an RMS value. This machine data is automatically parameterized for Siemens power sections by machine data "Power section code number" (MD 1106). The value entered must correspond to the S6 current specified on the rating plate of the appropriate MSD power section.

Caution:

This data **must not be changed** by the user after automatic presetting of its values.

Note:

This data is relevant **only** for MSD drives.

1111	Rated current power section		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
200.0	**1.0**	**500.0**	**A**

The maximum permissible power section continuous current is entered in this machine data. The input is an RMS value. This machine data is automatically parameterized for Siemens power sections by machine data "Power section code number" (MD 1106). The value entered must correspond to the rated current specified on the rating plate of the appropriate power section.

Caution:

This data **must not be changed** by the user after automatic presetting of its values.

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1112	Number of pole pairs motor		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**4**	**–**

Input of number of pole pairs of motor as specified on the motor data sheet (also non-Siemens motor) or through automatic parameterization using machine data "Motor code number" (MD 1102). The pole pair number 0 is entered when motor**/**power section combinations which have not been enabled are loaded.

Note:

This data is relevant **only** for FDD drives.

Pole pair number limit

MSD	FDD			
	Linear motor	Rotating motor		
		CD track	Hall sensor etc.	
			Encoder marks > 2048	Encoder marks < 2049
4	16	6	64	16

If these limits are exceeded, the drive outputs an error message.

1113	Torque constant		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**300.0 (as from SW 6)**	**Nm/A**

Input of torque constant as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102). The torque constant is the quotient of rated torque : rated current (RMS) for permanent-field synchronous motors.

Note:

This data is relevant **only** for FDD drives.

1114	Voltage constant		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**300.0**	**V**

Input of voltage constant as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).
The voltage constant is measured as an induced voltage (EMF) under no-load conditions at n = 1000 rev**/**min as the RMS value of the motor terminals (line-to-line).

Note:

This data is relevant **only** for FDD drives.

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1115	Armature resistance		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**20.0**	

Input of ohmic resistance of the armature winding (phase value) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

Note:

This data is relevant **only** for FDD drives.

1116	Armature inductance		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**100.0**	**mH**

Input of armature rotating-field inductance as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

Note:

This data is relevant **only** for FDD drives.

1117	Motor moment of inertia		Active **at once***
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**32.0 (SW 5 and higher)**	**kgm^2**

Input of motor moment of inertia as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102 - in motors without a holding brake).

*** Active on "Power On" until SW < 6**

1118	Motor zero-speed current		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**500.0**	**A**

Input of motor zero-speed current as specified on motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102). The above machine data corresponds to the thermally permissible continuous current at zero motor speed with an overtemperature of 100 kelvin.

Note:

This data is relevant **only** for FDD drives.

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1119	Inductance of series reactor		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**65.0**	**mH**

A series reactor is usually required for stable operation of the current controller on high-speed special asynchronous motors or low-leakage asynchronous motors. In this way the inductance of the reactor is taken into account in the current model.

Note:

This machine data only applies to main spindle drives.

1120	P-gain current controller		Active **at once**
Default value	Lower input limit	Upper input limit	Units
10.0	**0.0**	**10 000.0**	**V/A**

Input of proportional gain of current controller or automatic parameterization (initialization) through operator action **Calulate controller data**.

1121	Integral-action time current controller		Active **at once**
Default value	Lower input limit	Upper input limit	Units
2000.0	**0.0**	**8 000.0**	**µs**

Input of control quantity "Integral-action time of current controller" or automatic parameterization (initialization) through operator action **Calulate controller data**.

Note:

Integral arm can be disabled by entering the value $T_N = 0$.

1124	Symmetr. ref. model current control loop (up to SW 4)		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0.5	**0.0**	**1.0**	**–**

Input of the symmetrizing possibility for the reference model current control loop. This machine data emulates the calculation deadtime of the current control loop. The emulation is calculated as approximation of a broken deadtime (see graphic representation MD 1416). This allows the behaviour of the reference model to be adapted to the controlled system behaviour of the closed P-controlled current control loop.

Caution:

This machine data is **only** relevant for Siemens-internal purposes and must **not be modified**.

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1129	cos power factor		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0.8	**0.0**	**1.0**	

cos is required for the calculation of the equivalent circuit diagrams from the data on the rating plate.

Note:

This machine data **only** applies to main spindle drives.

1130	Motor rated power		Active on Power On
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**1 500.0**	**kW**

Input of motor rated power as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 96).

Note:

This data is relevant **only** for MSD drives.

1132	Motor rated voltage		Active on Power On
Default value	Lower input limit	Upper input limit	Units
380.0	**0.0**	**5 000.0**	**V**

Input of motor rated voltage as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

1134	Motor rated frequency		Active on Power On
Default value	Lower input limit	Upper input limit	Units
50.0	**0.0**	**3 000.0**	**Hz**

Input of motor rated frequency as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

Note:

This data is relevant **only** for MSD drives.

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1135	Motor no-load voltage		Active at once*
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**500.0**	**V**

Input of motor no-load voltage as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

Note:

This data is relevant **only** for MSD drives.

*** Active on "Power On" until SW < 6**

1136	Motor no-load current		Active at once*
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**500.0**	**A**

Input of motor no-load current as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

Note:

This data is relevant **only** for MSD drives.

*** Active on "Power On" until SW < 6**

1137	Stator resistance cold		Active at once*
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**120.0**	

Input of stator resistance (cold) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

Note:

This data is relevant **only** for MSD drives.

*** Active on "Power On" until SW < 6**

1138	Rotor resistance cold		Active at once*
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**120.0**	

Input of rotor resistance (cold) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

Note:

This data is relevant **only** for MSD drives.

*** Active on "Power On" until SW < 6**

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1139	Stator leakage reactance		Active at once*
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**100.0**	

Input of stator leakage reactance as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

Note:

This data is relevant **only** for MSD drives.

*** Active on "Power On" until SW < 6**

1140	Rotor leakage reactance		Active at once*
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**100.0**	

Input of rotor leakage reactance as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

Note:

This data is relevant **only** for MSD drives.

*** Active on "Power On" until SW < 6**

1141	Magnetizing reactance		Active at once*
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**1 000.0**	

Input of magnetizing reactance as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

Note:

This data is relevant **only** for MSD drives.

*** Active on "Power On" until SW < 6**

1142	Speed at start of field weakening		Active at once*
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**50 000.0**	**rev/min**

Input of speed at which field weakening starts as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102). In the field-weakening range, the magnetizing inductivity L_h increases linearly from the saturated value at the speed at which field weakening begins to the unsaturated value at the upper limit speed of the L_h characteristic (see diagram MD 1144).

Note:

This data is relevant **only** for MSD drives.

*** Active on "Power On" until SW < 6**

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1143	Upper speed L_h characteristic motor 1		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**50 000.0**	**rev/min**

Input of upper speed limit for the L_h characteristic (magnetizing inductivity L_h) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102). In the field-weakening range, the magnetizing reactance X_n increases linearly from the saturated value at the speed at which field weakening begins to the unsaturated value at the upper limit speed of the L_h characteristic (see diagram MD 1144).

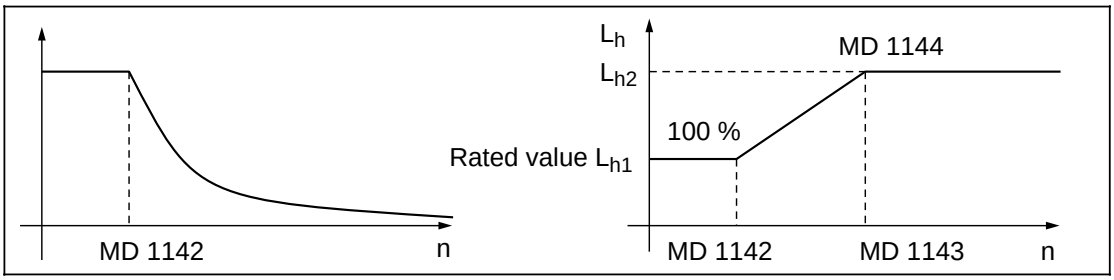
Notes:

- This machine data **only** applies to main spindle drives.
- As from SW 5, this machine data is no longer used.

1144	Gain factor L_h-characteristic		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0.0	**100.0**	**500.0**	**%**

Input of gain factor (L_{h2}/L_{h1}) of the L_h characteristic (magnetizing reactance) as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102). In the field-weakening range, the magnetizing inductivity L_h increases linearly from the saturated value at the speed at which field weakening begins to the unsaturated value at the upper limit speed of the L_h characteristic.

Graphic representation:



Notes:

- If the value is unknown, then 100 % should be entered in order to obtain constant magnetizing reactance over the entire speed range.
- This data is relevant **only** for MSD drives.
- As from SW 5, this machine data is no longer used.

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1145	Breakdown torque reduction factor		Active at once
Default value	Lower input limit	Upper input limit	Units
100.0	**5.0**	**1 000.0**	**%**

Input of breakdown torque reduction factor as specified on the motor data sheet. The point at which the breakdown torque limit is applied can be altered in this machine data.

Settings of higher than 100 % increase the point at which the limit is applied and vice versa with settings of lower than 100 % (see graphic representation MD 1230).

Note:

This data is relevant **only** for MSD drives.

1146	Motor maximum speed		Active on Power On
Default value	Lower input limit	Upper input limit	Units
1 500.0	**0.0**	**50 000.0**	**rev/min**

Input of motor maximum speed as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

1147	Speed limitation		Active at once
Default value	Lower input limit	Upper input limit	Units
7 000.0/8 000.0	**0.0**	**50 000.0**	**rev/min**

Input of the maximum permissible speed of the motor or an automatic parameterization (initialization) is calculated or taken over and performed for this machine data through the operator action **Calculate controller data** on the basis of the machine data Motor rated speed (MD 1400) x 120% for FDD and Motor maximum speed (MD 1146) for MSD. If the speed actual value is exceeded by more than 2% of the set limit, the motor torque limit is internally set to 0, i.e. further acceleration is prevented. If the setting is made accordingly, it is possible for the ”Speed controller at stop” monitoring function to respond (response threshold MD 1606 < MD 1147 and response time MD 1605 short). The default depends on the motor type (FDD =̂ 7000, MSD =̂ 8000) and is configured by the drive configuration by the time of start-up.

Note:

Only the minimum from the input value and the value specified according to the motor is effective.

1148	Speed at breakdown (as from SW 6)		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**-100 000.0**	**100 000.0**	**rev/min**

Speed display at which torque curve drops after 1/n2 function

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1150	P gain flux controller		Active at once
Default value	Lower input limit	Upper input limit	Units
400.0	**0.0**	**100 000.0**	**A/Vs**

Input of the proportional gain of the flux controller or automatic paramterization (initialization) through the operator action **Calculate controller data**.

Note:

This data is relevant **only** for MSD drives.

1151	Integral-action time flux controller		Active at once
Default value	Lower input limit	Upper input limit	Units
10.0	**0.0**	**500.0**	**ms**

Input of the control variable integral-action time flux controller or automatic paramterization by the operator action **Calculate controller data**.

1160	Speed for start of flux detection		Active at once
Default value	Lower input limit	Upper input limit	Units
1 500.0	**200.0**	**50 000.0**	**rev/min**

Above the set speed flux detection is active, below the set speed a flux model is used. The parameter default is set for "Calculate controller data" and should not be changed.

Note:

This machine data **only** applies to main spindle drives.

1161	DC link fixed voltage		Active at once
Default value	Lower input limit	Upper input limit	Units
600 0 (as from SW 6)	**0**	**700**	**V**

By specifying a DC link fixed voltage > 0V DSP internal DC link measurement is deactived here, i.e. MD 1701 (between loop voltage display) is inactive (display: "*").

The given voltage is included instead of the measurement in:

- DC link adaptation
- Flux acquisition (MSD)

The permissibility of an activation of the DC link measurement (MD 1161=0) is monitored in accordance with hardware configuration 5 (error message 300765).

Caution:

It is **not** possible to activate emergency retractive functions with deactivated DC link measurement (MD 1161 > 0) (error message 300764).

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1190	Evaluation torque limit value		Active at once
Default value	Lower input limit	Upper input limit	Units
100	**0**	**10 000**	**Nm**

This drive machine data does not have any effects on hardware and software.

1191	Matching factor servo limiting torque		Active at once
Default value	Lower input limit	Upper input limit	Units
1.0	**0.0**	**100.0**	**–**

From drive software version 1.00 to 2.00, the interface of the torque setpoints has been set uniformly to 8-times the rated torque since FDD and MSD are grouped together.

In order to be compatible to earlier MSD software where this is necessary, a matching factor is inserted into the interface of the torque limiting value. When upgrading the FDD sofware, this makes it possible to retain the previous standardization and must then be determined as follows:

$$\text{MD 1191} = \frac{\text{MD 1107}}{8 \times \sqrt{2} \times \text{MD1118}}$$

1200	No. current setpoint filters		Active at once
Default value	Lower input limit	Upper input limit	Units
1	**0**	**4**	**–**

Input of number of current setpoint filters. Band-stop and low-pass filters are available; these are set via the machine data "Type current setpoint filter" (MD 1201).

Selection of number of filters:

0	No current setpoint filter activated
1	Filter 1 activated
2	Filters 1 and 2 activated
3	Filters 1, 2 and 3 activated
4	Filters 1, 2, 3 and 4 activated

Note:

Before a filter is activated, the filter type and the appropriate filter machine data must be input.

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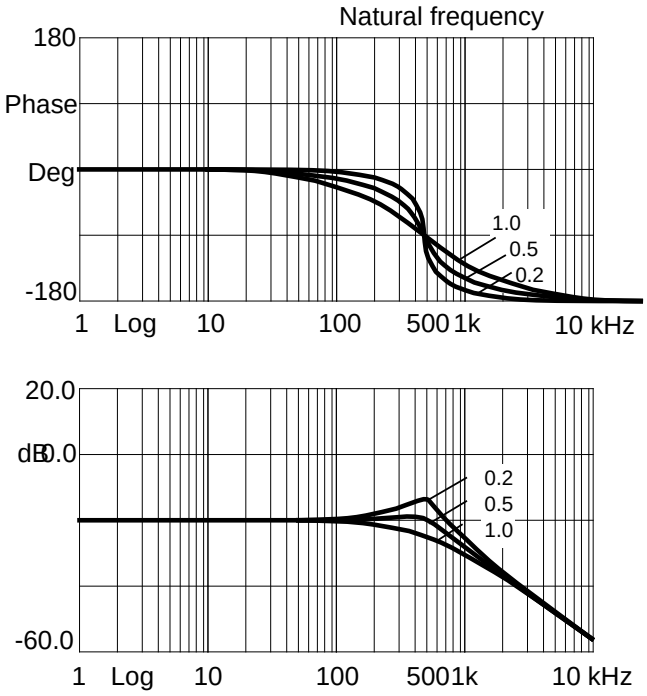
Example: Low-pass

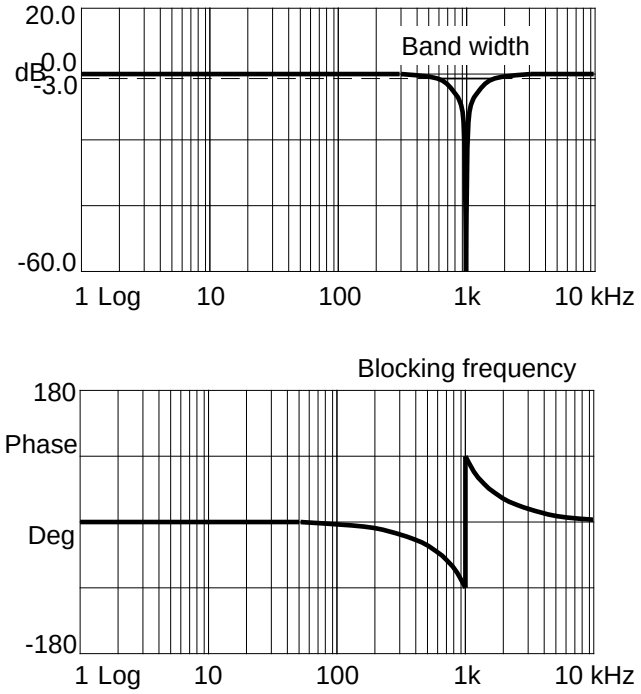
Low-passes and band-stops are used in damping resonances above and at the limit of stability of the speed control loop (see diagrams below).

Specified: Natural frequency 500 Hz with 0.2, 0.5 or 1.0 input



Example: Band-stop filter

Specified: Blocking frequency 1 kHz with 1 kHz bandwidth 0 Hz bandwidth numerator (damping)



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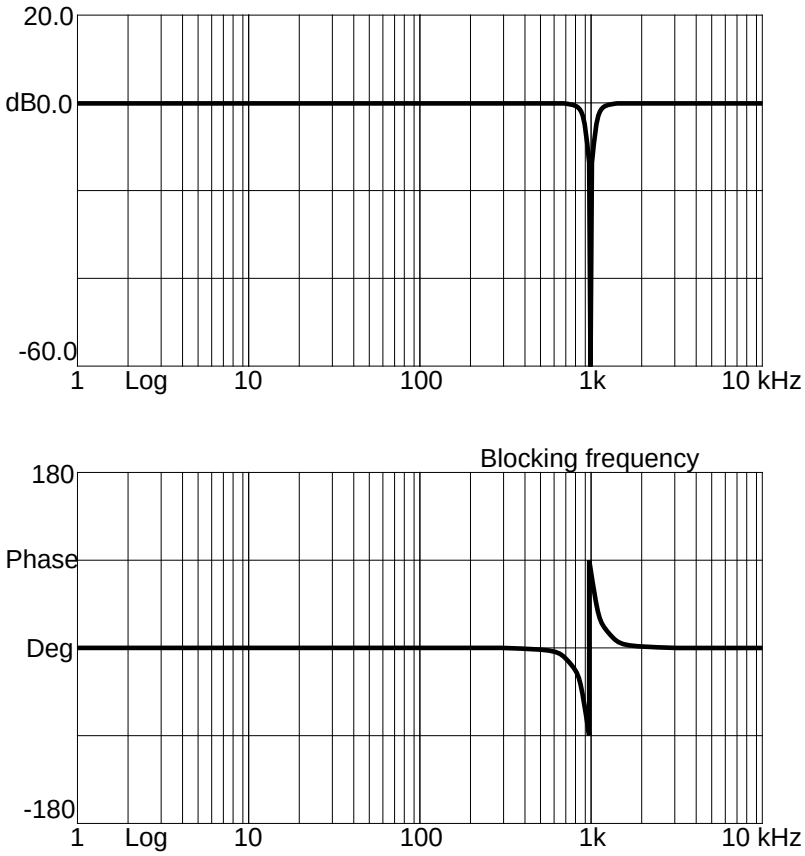
Specified: Blocking frequency 1 kHz with 500 Hz bandwidth 0 Hz bandwidth numerator (damping)



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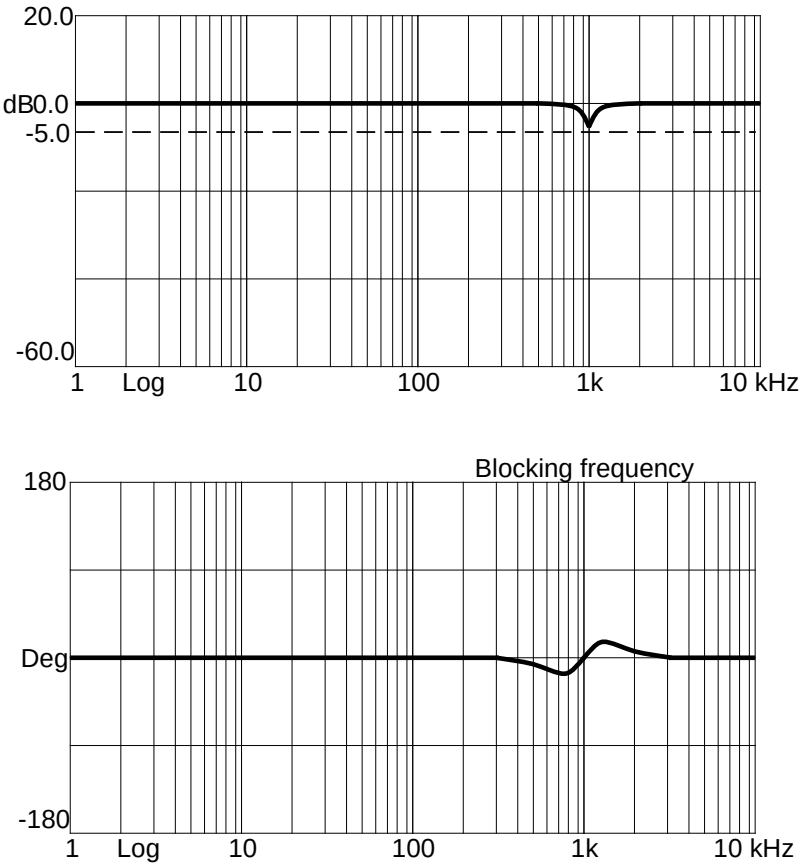
Specified: Blocking frequency 1 kHz, 500 Hz bandwidth and 250 Hz bandwidth numerator (damping)



1201	**Type current setpoint filter**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
Low-pass	**Low-pass**	**Band-stop**	**–**

Input of configuration of 4 current setpoint filters. Band-stop and low-pass filters are available. The adjustable filter parameters are entered in the appropriate machine data.

Value table:

1st filter	Bit 0	0	Low-pass (see MD 1202**/**1203)
		1	Band-stop (see MD 1210**/**1211**/**1212)
2nd filter	Bit 1	0	Low-pass (see MD 1204**/**1205)
		1	Band-stop (see MD 1213**/**1214**/**1215)

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3rd filter	Bit 2	0	Low-pass (see MD 1206/1207)
		1	Band-stop (see MD 1216/1217/1218)
4th filter	Bit 3	0	Low-pass (see MD 1208/1209)
		1	Band-stop (see MD 1219/1220/1221)

Note:

Before the filter type is configured, the appropriate filter machine data must be input.

1202	Natural frequency current setpoint filter 1		Active at once
Default value	Lower input limit	Upper input limit	Units
2 000.0	**0.0**	**8 000.0**	**Hz**

Input of natural frequency for current setpoint filter 1 (PT2 low-pass). An entry of < 10 Hz as the natural frequency of the low-pass filter initializes the filter as a proportional element with a gain of 1 independently of the associated damping. The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

Notes:

- Current setpoint filter 1 is preset to the current controller sampling time MD 1000 = 125 µs for damping of the encoder torsional natural frequency.
- For a current controller sampling time of MD 1000 = 62.5 µs, we recommend that the natural frequency be changed to f_0 = 3000 Hz to achieve an optimum dynamic response of the controller.

1203	Damping current setpoint filter 1		Active at once
Default value	Lower input limit	Upper input limit	Units
0.7	**0.05**	**5.0**	**–**

Input of damping for current setpoint filter 1 (PT2 low-pass). The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).
0.7 ≙ 70% 1 ≙ 100%

Note:

- Current setpoint filter 1 is preset to the current controller sampling time MD 1000 = 125 µs for damping of the encoder torsional natural frequency.

1204	Natural frequency current setpoint filter 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**8 000.0**	**Hz**

Input of natural frequency for current setpoint filter 2 (PT2 low-pass). An entry of < 10 Hz as the natural frequency of the low-pass filter initializes the filter as a proportional element with a gain of 1 independently of the associated damping. The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

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1205	Damping current setpoint filter 2		Active at once
Default value	Lower input limit	Upper input limit	Units
1.0	**0.05**	**5.0**	**–**

Input of damping for current setpoint filter 2 (PT2 low-pass). The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

1206	Natural frequency current setpoint filter 3		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**8 000.0**	**Hz**

Input of natural frequency for current setpoint filter 3 (PT2 low-pass). An entry of < 10 Hz as the natural frequency of the low-pass filter initializes the filter as a proportional element with a gain of 1 independently of the associated damping. The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

1207	Damping current setpoint filter 3		Active at once
Default value	Lower input limit	Upper input limit	Units
1.0	**0.05**	**5.0**	**–**

Input of damping for current setpoint filter 3 (PT2 low-pass). The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

1208	Natural frequency current setpoint filter 4		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**8 000.0**	**Hz**

Input of natural frequency for current setpoint filter 4 (PT2 low-pass). An entry of < 10 Hz as the natural frequency of the low-pass filter initializes the filter as a proportional element with a gain of 1 independently of the associated damping. The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

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1209	Damping current setpoint filter 4		Active **at once**
Default value	Lower input limit	Upper input limit	Units
1.0	**0.05**	**5.0**	**–**

Input of damping for current setpoint filter 4 (PT2 low-pass). The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

1210	Block frequency current setpoint filter 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
3 500.0	**1.0**	**7 999.0**	**Hz**

Input of block frequency for current setpoint filter 1 (band-stop). When block frequencies of < 10 Hz are input, the filter is deactivated (proportional element with a gain of 1). The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

Note:

The maximum block frequency input value is limited by the sampling frequency of the servo control (MD 1000) (parameterization error).

$$\text{MD 1210} \quad \frac{1}{2 \times \underbrace{T_{\text{sampl. I-controller}}}_{\boxed{= \text{MD 1000 [s]}}}}$$

$T_{\text{sampl.}}$ (MD 1000) $\left\{ \begin{array}{c} 62.5\ \mu s \\ 125.0\ \mu s \end{array} \right\}$ MD 1210 $\left\{ \begin{array}{c} 8000\ Hz \\ 4000\ Hz \end{array} \right\}$

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1211	Bandwidth current setpoint filter 1		Active at once
Default value	Lower input limit	Upper input limit	Units
500.0	**5.0**	**7 999.0**	**Hz**

Input of -3dB bandwidth for current setpoint filter 1 (band-stop). The filter is activated in machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

Note:

When 0 is entered for the bandwidth, the filter is parameterized as a proportional element with a gain of 1.

1212	Numerator bandwidth current setpoint filter 1		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**7 999.0**	**Hz**

Input of numerator bandwidth for the damped band-stop. When a value of 0 is entered, the filter is initialized as an undamped band-stop. The filter is activated via machine data MD 1200 (No. setpoint current filters) and MD 1201 (Type current setpoint filter).

Note:

The value entered in MD 1212 (Numerator bandwidth current setpoint filter 1) must not be higher than twice the value entered in MD 1211 (Bandwidth current setpoint filter 1).

1213	Block frequency current setpoint filter 2		Active at once
Default value	Lower input limit	Upper input limit	Units
3 500.0	**1.0**	**7 999.0**	**Hz**

Input of block frequency for current setpoint filter 2 (band-stop). When block frequencies of < 10 Hz are input, the filter is deactivated (proportional element with a gain of 1). The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

Note:

The maximum block frequency input value is limited by the sampling frequency of the servo control (MD 1000) (parameterization error).

$$\text{MD 1213} \quad \frac{1}{2 \times \underbrace{T_{\text{sampl. I-controller}}}_{\boxed{= \text{MD 1000 [s]}}}}$$

$T_{\text{sampl.}}$ (MD 1000) $\left\{ \begin{array}{l} 62.5\ \mu s \\ 125.0\ \mu s \end{array} \right\}$ MD 1213 $\left\{ \begin{array}{l} 8000\ Hz \\ 4000\ Hz \end{array} \right\}$

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1214	Bandwidth current setpoint filter 2		Active at once
Default value	Lower input limit	Upper input limit	Units
500.0	**5.0**	**7 999.0**	**Hz**

Input of -3dB bandwidth for current setpoint filter 2 (band-stop). The filter is activated in machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

Note:

When 0 is entered for the bandwidth, the filter is parameterized as a proportional element with a gain of 1.

1215	Numerator bandwidth current setpoint filter 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**7 999.0**	**Hz**

Input of numerator bandwidth for the damped band-stop. When a value of 0 is entered, the filter is initialized as an undamped band-stop. The filter is activated via machine data MD 1200 (No. setpoint current filters) and MD 1201 (Type current setpoint filter).

Note:

The value entered in MD 1215 (Numerator bandwidth current setpoint filter 2) must not be higher than twice the value entered in MD 1214 (Bandwidth current setpoint filter 2).

1216	Block frequency current setpoint filter 3		Active at once
Default value	Lower input limit	Upper input limit	Units
3 500.0	**1.0**	**7 999.0**	**Hz**

Input of block frequency for current setpoint filter 3 (band-stop). When block frequencies of < 10 Hz are input, the filter is deactivated (proportional element with a gain of 1). The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

Note:

The maximum block frequency input value is limited by the sampling frequency of the servo control (MD 1000) (parameterization error).

$$\text{MD 1216} \quad \frac{1}{2 \times \underbrace{T_{\text{sampl. I-controller}}}_{= \text{MD 1000 [s]}}}$$

$T_{\text{sampl.}}$ (MD 1000)	MD 1216
62.5 µs	8000 Hz
125.0 µs	4000 Hz

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1217	Bandwidth current setpoint filter 3		Active at once
Default value	Lower input limit	Upper input limit	Units
500.0	**5.0**	**7 999.0**	**Hz**

Input of -3dB bandwidth for current setpoint filter 3 (band-stop). The filter is activated in machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

Note:

When 0 is entered for the bandwidth, the filter is parameterized as a proportional element with a gain of 1.

1218	Numerator bandwidth current setpoint filter 3		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**7 999.0**	**Hz**

Input of numerator bandwidth for the damped band-stop. When a value of 0 is entered, the filter is initialized as an undamped band-stop. The filter is activated via machine data MD 1200 (No. setpoint current filters) and MD 1201 (Type current setpoint filter).

Note:

The value entered in MD 1218 (Numerator bandwidth current setpoint filter 3) must not be higher than twice the value entered in MD 1217 (Bandwidth current setpoint filter 3).

1219	Block frequency current setpoint filter 4		Active at once
Default value	Lower input limit	Upper input limit	Units
3 500.0	**1.0**	**7 999.0**	**Hz**

Input of block frequency for current setpoint filter 4 (band-stop). When block frequencies of < 10 Hz are input, the filter is deactivated (proportional element with a gain of 1). The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

Note:

The maximum block frequency input value is limited by the sampling frequency of the servo control (MD 1000) (parameterization error).

$$\text{MD 1219} \quad \frac{1}{2 \times \underbrace{T_{\text{sampl. I-controller}}}_{= \text{MD 1000 [s]}}}$$

$T_{\text{sampl.}}$ (MD 1000)		MD 1219	
	62.5 µs		8000 Hz
	125.0 µs		4000 Hz

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1220	Bandwidth current setpoint filter 4		Active at once
Default value	Lower input limit	Upper input limit	Units
500.0	**5.0**	**7 999.0**	**Hz**

Input of -3dB bandwidth for current setpoint filter 4 (band-stop). The filter is activated in machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

Note:

When 0 is entered for the bandwidth, the filter is parameterized as a proportional element with a gain of 1.

1221	Numerator bandwidth current setpoint filter 4		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**7 999.0**	**Hz**

Input of numerator bandwidth for the damped band-stop. When a value of 0 is entered, the filter is initialized as an undamped band-stop. The filter is activated via machine data MD 1200 (No. setpoint current filters) and MD 1201 (Type current setpoint filter).

Note:

The value entered in MD 1221 (numerator bandwidth current setpoint filter 4) must not be higher than twice the value entered in MD 1220 (Bandwidth current setpoint filter 4).

1230	1st torque limiting value		Active at once
Default value	Lower input limit	Upper input limit	Units
100.0	**5.0**	**900.0**	**%**

Input of maximum permissible torque referred to the normalized torque of the motor. Since the power and breakdown torque limitations (MD 1235, MD 1236, MD 1145) are active in the upper speed range, this machine data is significant only in the lower speed range. The default value is set such that the acceleration torque is active up to rated speed for feed drives and the rated torque up to rated speed for main spindle drives; the power and breakdown torque limitations are then effective from rated speed onwards for both drive types.

The default setting for main spindle drives is 100 %; the default setting for feed drives is implemented by means of "**Calculate controller data**" which determines the value by means of the following formula:

$$\text{FDD: MD X230} = \frac{\text{MD 1104}}{\text{MD 1118}} \times 100\%$$

Since the current limit (MSD - MD 1238, FDD - MD 1104) also limits the maximum torque which can be specified, an increase in the torque limit may, in some cases, only result in a higher torque if the current limit can also be raised.

The following applies particularly to feed drives: In order to achieve significantly shorter ramp-up times to maximum speed, the power and current limits must also be raised.

Caution:

Overloading of the motor for long periods may lead to an inadmissibly high temperature rise (shutdown on motor overtemperature) and even cause irreparable damage to the motor. Corresponding machine data are MD 1104, MD 1145 and MD 1231 to MD 1239.

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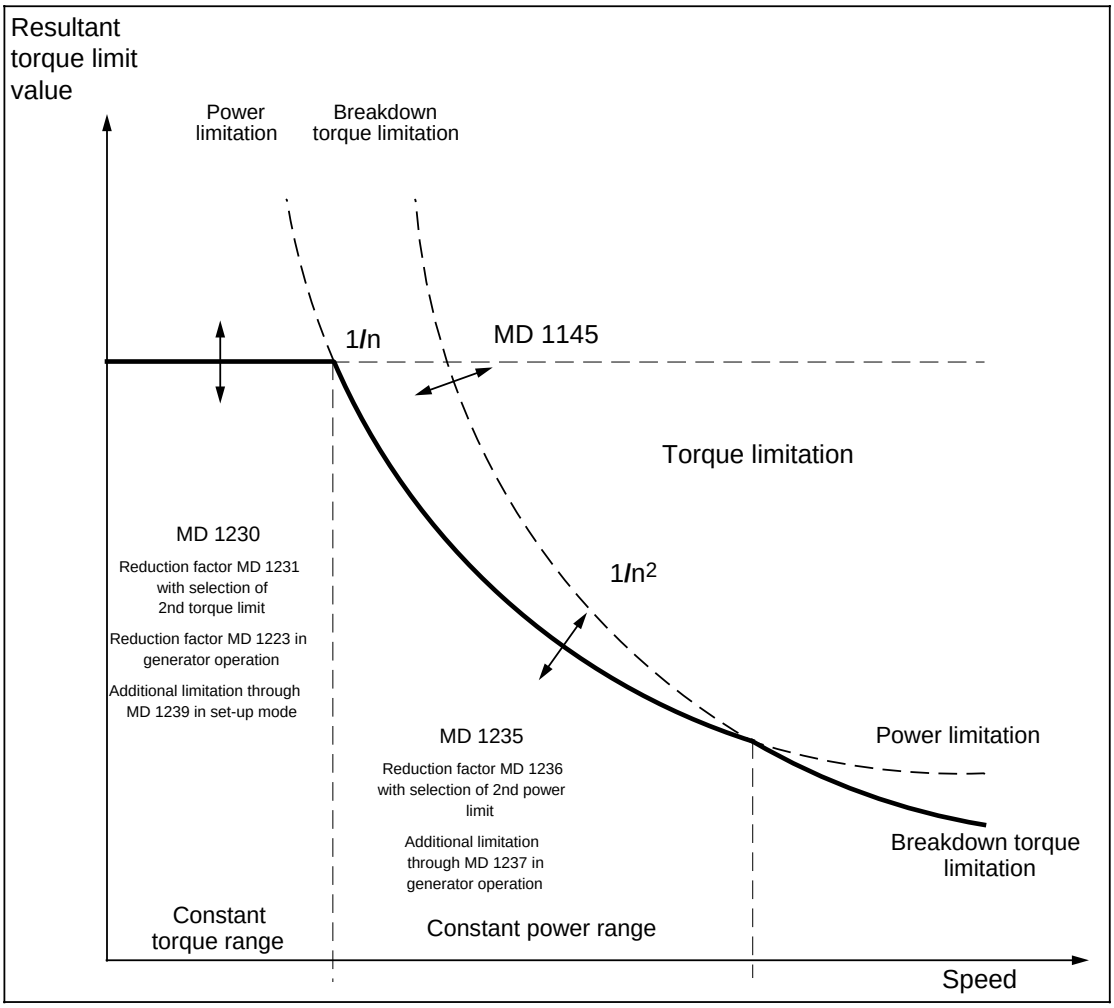

1231	2nd torque limiting value		Active at once
Default value	Lower input limit	Upper input limit	Units
100.0	**5.0**	**100.0**	**%**

The 2nd torque limit value entered in MD 1231 acts as a reduction factor referred to the 1st torque limit value (MD 1230). It becomes active only if the 2nd torque limit value is selected via the PLC control word and the motor speed exceeds the value set in MD 1232 with hysteresis (MD 1234).

1232	Switching speed from MD 1230 to MD 1231		Active at once
Default value	Lower input limit	Upper input limit	Units
6 000.0	**0.0**	**50 000.0**	**rev/min**

Input of speed above which switchover from the 1st torque limit to the 2nd torque limit (MD 1231) can take place. A settable hysteresis (MD 1234) is applied during switchover. The 2nd torque limit value is activated only if the motor speed exceeds the speed threshold with hysteresis and if the 2nd torque limit value has been selected via the PLC control word.

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1233	Generative limitation		Active at once
Default value	Lower input limit	Upper input limit	Units
100.0	**5.0**	**100.0**	**%**

Input of torque limit for braking operation (generator-mode torque limit). This input value is referred to the maximum motor-mode torque. If the 2nd torque limit is active, then the reference value is derived from machine data MD 1230 and MD 1231. It is otherwise based on machine data MD 1230 (1st torque limiting value).

1234	Hysteresis P: 1232		Active at once
Default value	Lower input limit	Upper input limit	Units
50.0	**5.0**	**1 000.0**	**rev/min**

Input of hysteresis for switchover speed set in machine data 1232 (Switching speed M_{d1} to M_{d2}).

1235	1st power limit value		Active at once
Default value	Lower input limit	Upper input limit	Units
100.0	**5.0**	**900.0**	**%**

Input of maximum permissible output referred to normalizing motor power. In the case of feed drives, the default values for this machine data are automatically set through a new start-up process or by executing **Calculate controller data**. The default values for machine data 1235 are calculated from the following formula:

$$\text{FDD: MD X235} = \frac{\text{MD 1104}}{\text{MD 1118}} \times 100\%$$

100 % is entered as the default setting for MSD. The default settings are such that the output is limited to the rated value at speeds above rated speed; in the case of feed drives, the following formula is applied above rated speed:

$$\frac{\text{Motor speed}}{\text{Rated speed}} \times \text{acceleration torque} = \text{constant}$$

The following applies in particular to main spindle drives: If the speed at which field weakening commences is higher than the rated value, it is possible to shorten the ramp-up times and increase the power yield simply by raising the power limit (with unaltered current limit). Since the current limit (MD 1238) can also limit the maximum torque which can be specified, a further increase in the power limit may, in some cases, only result in a higher torque if the current limit can also be raised.

Caution:

Overloading of the motor for long periods may lead to an inadmissibly high temperature rise (shutdown on motor overtemperature) and even cause irreparable damage to the motor. Corresponding machine data are MD 1104, MD 1145 and MD 1231 to MD 1239.

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1236	2nd power limit value		Active at once
Default value	Lower input limit	Upper input limit	Units
100.0	**5.0**	**100.0**	**%**

The 2nd power limit value entered in MD 1236 acts as a reduction factor referred to the 1st power limit value (MD 1235). It becomes active only if the 2nd torque limit value is selected via the PLC control word and the motor speed exceeds the value set in MD 1232 (Switching speed from M_{d1} to M_{d2}) with hysteresis (MD 1234).

1237	Generative maximum output		Active at once
Default value	Lower input limit	Upper input limit	Units
100.0	**0.3 0.1 (as from SW 6)**	**500.0**	**kW**

Input of generative maximum output. This machine data allows the regenerative energy fed back via the infeed**/**regenerative feedback module to be limited. If an uncontrolled infeed**/** regenerative feedback module is used, it is particularly important to set this machine data to an appropriately low value.

1238	Current limit value		Active at once
Default value	Lower input limit	Upper input limit	Units
150.0	**0.0**	**400.0**	**%**

Input of maximum permissible motor current referred to the motor rated current. In order to shorten the ramp-up times, it may be advisable to set the current limit to values higher than 100 % and to increase the power and torque limits (MD 1230, MD 1239) at the same time.

Note:

This machine data is relevant **only** for main spindle drives.

Caution:

Overloading of the motor for long periods may lead to an inadmissibly high temperature rise (shutdown on motor overtemperature) and even cause irreparable damage to the motor.

1239	Torque limit setup mode		Active at once
Default value	Lower input limit	Upper input limit	Units
1.0	**0.5**	**100.0**	**%**

Input of torque limit value in set-up mode referred to the motor rated torque. Machine data 1239 is not active in normal operation. In set-up mode, the torque limit applied is based on the minimum value calculated from the limits for normal operation and the value set in this machine data (see diagram for MD 1230). Set-up mode is selected by means of terminal 112 on the infeed**/**regenerative feedback module.

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1245	Threshold speed-dependent torque setpoint smoothing		Active at once
Default value	Lower input value	Upper input value	Units
0.0	**0.0**	**50 000.0**	**rev/min**

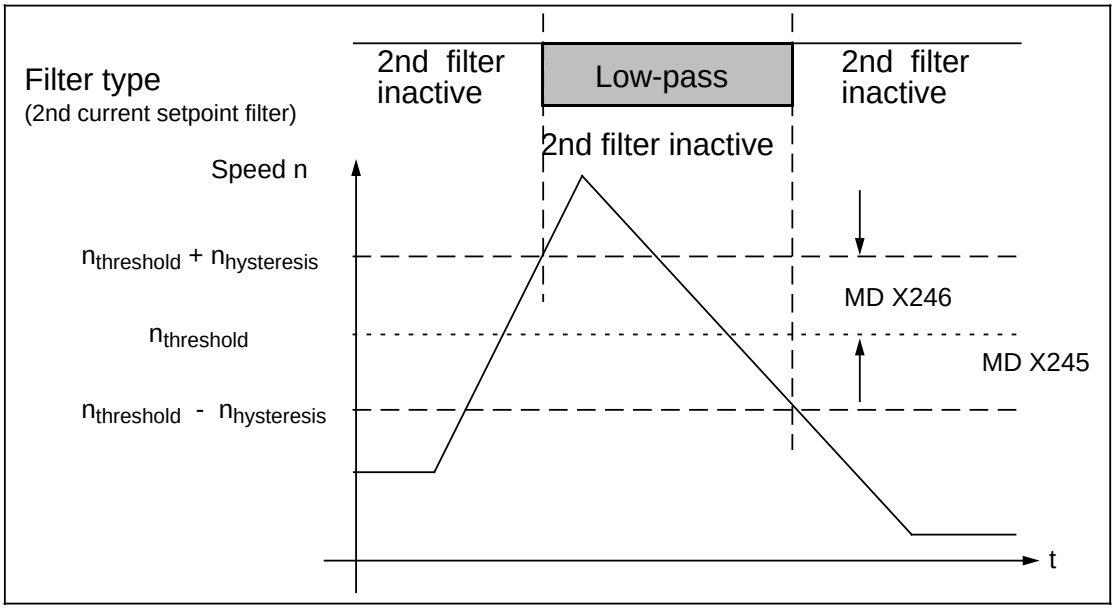
Input of speed value above which the torque setpoint smoothing function selected in machine data "Type current setpoint filter" (MD 1201) with the 2nd filter (low-pass/band-stop) is activated. The user can apply this speed-dependent torque setpoint smoothing function to reduce the speed ripple at high speeds (main spindle drives).

If 0 is entered as the threshold value, then the filter remains active as a low-pass filter over the entire speed range. When other values are entered, two switchover speeds are calculated from machine data MD 1245 (Threshold speed-dependent torque setpoint smoothing) and MD 1246 (Hysteresis speed-dependent torque setpoint smoothing).

$n_{upper} = n_{threshold} + n_{hysteresis}$

$n_{lower} = n_{threshold} - n_{hysteresis}$

Graphic representation:



Functionality: The switchover from "Feedthrough" to "Low-pass" takes place when the absolute value of the actual speed exceeds the value n_{upper} ($|n_{act}| \geq n_{upper}$) and vice versa from "Low-pass" to "Feedthrough" when the absolute value of the actual speed drops below the value n_{lower} ($|n_{act}| < n_{lower}$). If the value 0 is entered for the hysteresis, then the two switchover speeds are identical.

1246	Hysteresis speed-dependent torque setpoint smoothing		Active at once
Default value	Lower input value	Upper input value	Units
50.0	**0.0**	**1 000.0**	**rev/min**

Input of hysteresis for the cut-in speed set in machine data "Threshold speed-dependent torque setpoint smoothing" (MD 1245).

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1250	Corner freq. curr. act. val. smooth.		Active **at once**
Default value	Lower input value	Upper input value	Units
100.0	**0.0**	**8 000.0**	**Hz**

Input of -3dB corner frequency f_o of cross-current actual value smoothing function (PT1 low-pass) for display purposes. Time constant T1 of the PT1 filter is calculated from the formula $T1 = 1/(2\ f_o)$. The cross-current actual value is displayed in machine data "Smoothed current actual value" (MD 1708). The smoothed cross-current actual value is likewise transferred to the PLC data channel. This machine data has no effect on the control.

Note:

The filter is deactivated if values of < 1 Hz are entered.

1251	Time constant motor load (as from SW 6)		Active **at once**
Default value	Lower input value	Upper input value	Units
0.0	**0.0**	**1 000.0**	**ms**

The set time constant is used to smooth the motor load signal (MD 1722) in order to obtain a steadier display.

1252	Corner freq. torque setp. smoothing		Active **at once**
Default value	Lower input value	Upper input value	Units
100.0	**0.0**	**8 000.0**	**Hz**

Input of -3dB corner frequency fo of torque setpoint smoothing function (PT1 low-pass) for display purposes. Time constant T1 of the PT1 filter is calculated from the formula $T1 = 1/(2\ f_o)$. The smoothed value is transferred to the PLC data channel. This machine data has no effect on the control.

Note:

The filter is deactivated if values of < 1 Hz are entered.

1254	Time constant current monitoring		Active **at once**
Default value	Lower input value	Upper input value	Units
0.5	**0.0**	**2.0**	**ms**

Smoothing of current space vector for its monitoring (error 300501). Smoothing is used to prevent unauthorized triggering of the monitoring when the current suddenly changes because of the application, e.g. low-inductance, high-speed asynchronous motors.

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1400	Motor rated speed		Active on Power On
Default value	Lower input value	Upper input value	Units
1 450.0	**0.0**	**25 000.0 50 000.0 (as from SW 6)**	**rev/min**

Input of motor rated speed as specified on the motor data sheet (non-Siemens motor) or automatic parameterization using machine data "Motor code number" (MD 1102).

1401	Max. motor operational speed		Active on Power On
Default value	Lower input value	Upper input value	Units
0.0	**0.0**	**50 000.0**	**rev/min**

Machine data MD 1401 defines the maximum operational speed of the motor. It is used as a reference value for the speed setpoint interface and for the machine data "Monitoring speed motor" (MD 1405). The default values are calculated by means of **Calculate controller data** for feed drives on the basis of the motor rated speed according to the motor data sheet and on the basis of the maximum speed for main spindle drives.

Note:

The velocity of a feed axis is matched with NC MD 2560 (maximum axis velocity). The motor speed which corresponds to this maximum value must be entered in drive-MD 1401. Allowance is made for the spindle pitch plus any existing gear ratios, etc. in the relationship between NC MD 2560 and drive MD 1401.

1403	Creep speed pulse suppression		Active at once
Default value	Lower input value	Upper input value	Units
0.0/2.0	**0.0**	**7 200.0**	**rev/min**

Input of creep speed for pulse suppression. If the absolute speed actual value drops below the specified speed limit, e.g. owing to cancellation of the controller enabling command, in the course of a creep operation, the pulses are suppressed by a software function and the drive shut down until it is re-enabled by SERVO. If the controller enabling command has been cancelled before the time set in machine data "Timer pulse suppression" (MD 1404) has elapsed, the pulses are suppressed even if the speed has not dropped below the threshold value. The default setting is dependent on the motor type (FDD=0, MSD=2) and is parameterized by the drive configuration during start-up. The default value 0 means that the machine data is deactivated; pulse suppression is then implemented solely via the machine data "Timer pulse suppression" (MD 1404).

The functionality of this machine data is required if overshoot must be prevented when zero speed is reached after cancellation of the controller enabling command.

Note:

Under normal circumstances, shutdown is implemented sequentially on the drive and servo sides with variously adjustable timers (NC MD 156, NC MD 12240) and, in the event of a fault, only on the drive side with timer MD 1404.

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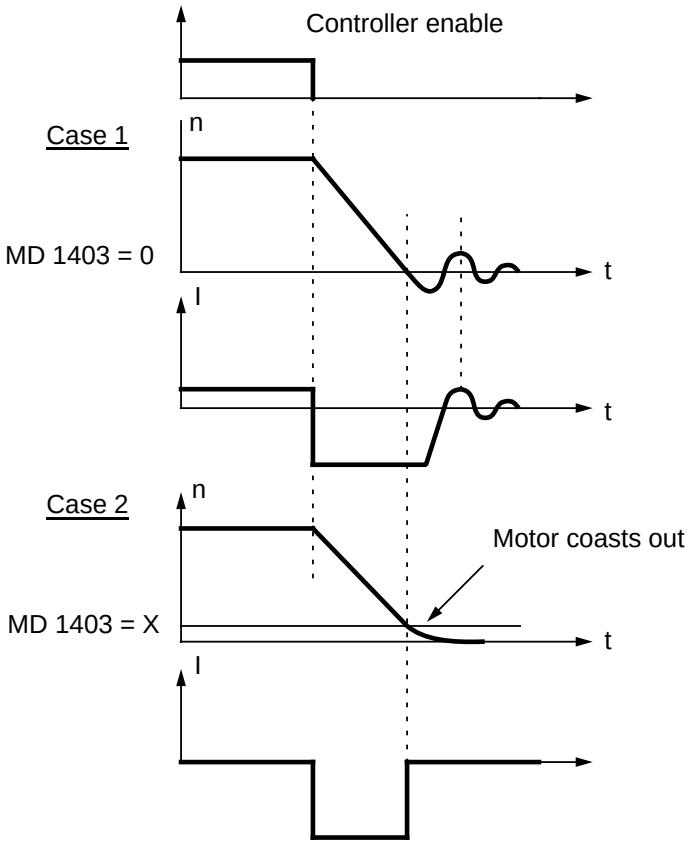

1404	Timer pulse suppression		Active **at once**
Default value	Lower input value	Upper input value	Units
100.0/5 000.0	**0.0**	**100 000.0**	**ms**

Input of timer for pulse suppression by drive. In the event of a fault (in generator braking mode or with controller disabled), the control pulses for the power section transistors are suppressed on the drive side after expiry of the time set in the adjustable timer. The pulses are suppressed beforehand if the speed drops below the threshold set in machine data "Creep speed pulse suppression" (MD 1403) before the timer expires. Monitoring takes place sequentially on the drive and servo sides with variously adjustable timers. The default setting is dependent on the motor type (FDD≙100, MSD≙5000) and is parameterized by the drive configuration during start-up.

Note:

Under normal circumstances, shutdown is implemented sequentially on the drive and servo sides, with variously adjustable timers (NC MD 156, NC MD 12240) and, in the event of a fault, only on the drive side with timer MD 1404.

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1405	Monitoring speed motor		Active **at once**
Default value	Lower input value	Upper input value	Units
110.0/100.0	**100.0**	**110.0**	**%**

Input as percentage of maximum permissible speed setpoint as limit value for speed setpoint monitoring. Machine data "Speed for max. motor operational speed" (MD 1401) acts as the reference value. A message is output when the monitoring speed is exceeded. The default setting is dependent on the motor type (FDD≙110, MSD≙100) and is parameterized either by means of **Calculate controller data** or by the drive configuration during start-up.

Note:

As from SW 6:
In addition to MD 1405, the speed limit parameterized in MD 1147 is also used for limiting the speed setpoint value for MSD.

The speed setpoint limit (Nsetmax) can then be defined as follows:

N_{max1}=1.02 (minimum of MD 1146, MD 1147)

N_{max2}=MD 1401 x MD 1405

N_{setmax}=Minimum of N_{max1}, N_{max2}

1406	Speed controller type		Active on **Power On**
Default value	Lower input value	Upper input value	Units
1	**1**	**1**	**–**

Input of speed controller type (PI controller) with speed setpoint smoothing (PI) or with reference model (PIR). Variant 1 can be parameterized by setting the appropriate filter machine data via a control structure.

Caution:

This machine data is relevant **only** for Siemens internal procedures.

1407	P-gain speed controller		Active **at once**
Default value	Lower input value	Upper input value	Units
0.3	**0.0**	**100 000.0**	**Nm/s^{-1}**

Input of P-gain of the speed control loop in the lower speed range (n < lower speed threshold in MD 1411) or automatic parameterization (initialization) via operation **"Calculate controller data"** for MSD. The P-gain values in the lower speed range (MD 1407) and the upper speed range (MD 1408) are not subject to any mutual restrictions. See machine data "Adaptation lower speed threshold" (MD 1411) for diagram.

Notes:

- Before the P-gain is set to 0, the associated integral-action component (MD 1409) must be deactivated to maintain controller stability.
- MD 1407 is active over the entire speed range when the "Speed controller adaptation" is deactivated (MD 1413 = 0).

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1408	P-gain upper adaptation speed		Active at once
Default value	Lower input value	Upper input value	Units
0.3	**0.0**	**100 000.0**	**Nm/s^{-1}**

Input of P-gain of the speed control loop in the upper speed range (n > upper speed threshold in MD 1412) or automatic parameterization (initialization) via operation **"Calculate controller data"** for MSD. The P-gain values in the lower speed range (MD 1407) and the upper speed range (MD 1408) are not subject to any mutual restrictions. See machine data "Adaptation lower speed threshold" (MD 1411) for diagram.

Notes:

- Before the P-gain is set to 0, the associated integral-action component (MD 1410) must be deactivated to maintain controller stability.
- MD 1408 is not active when the "Speed controller adaptation" is deactivated (MD 1413 = 0).

1409	Integral-action time speed controller		Active at once
Default value	Lower input value	Upper input value	Units
10.0	**0.0**	**500.0**	**ms**

Input of integral-action time of speed control loop in the lower speed range (N < lower speed threshold MD 1411) or automatic parameterization (initialization) via operation **"Calculate controller data"** for MSD. The integral-action times in the lower speed range (MD 1409) and the upper speed range (MD 1410) are not subject to any mutual restrictions. See machine data "Adaptation lower speed threshold" (MD 1411) for diagram.

Notes:

- Setting the integral-action time to zero deactivates the appropriate speed range (suppression of integral gain and integrator contents torque step changes cannot be precluded - see also Note in MD 1410).
- MD 1409 is active over the entire speed range when the "Speed controller adaptation" is deactivated (MD 1413 = 0).

Caution:

When the adaptation function is active, deactivation of the I-action component for only one speed range (MD 1409 = 0 and MD 1410 0 or vice versa) should be avoided (to prevent problem of torque step changes through resetting of the integral value on transition from adaptation to constant range).

1410	Integral-action time upper adaptation speed		Active at once
Default value	Lower input value	Upper input value	Units
10.0	**0.0**	**500.0**	**ms**

Input of reset time of speed control loop in upper speed range (N > upper speed threshold MD 1412) or automatic parameterization (initialization) via operation **"Calculate controller data"** for MSD. The reset times in the lower speed range (MD 1409) and the upper speed range (MD 1410) are not subject to any mutual restrictions. See machine data "Adaptation lower speed threshold" (MD 1411) for diagram.

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Notes:

- Setting the reset time to zero deactivates the I-action component for the range which is greater than the machine data "Adaptation upper speed threshold (MD 1412) (see also Note in MD 1409).
- MD 1410 is not active when the "Speed controller adaptation" is deactivated (MD 1413 = 0).

Caution:

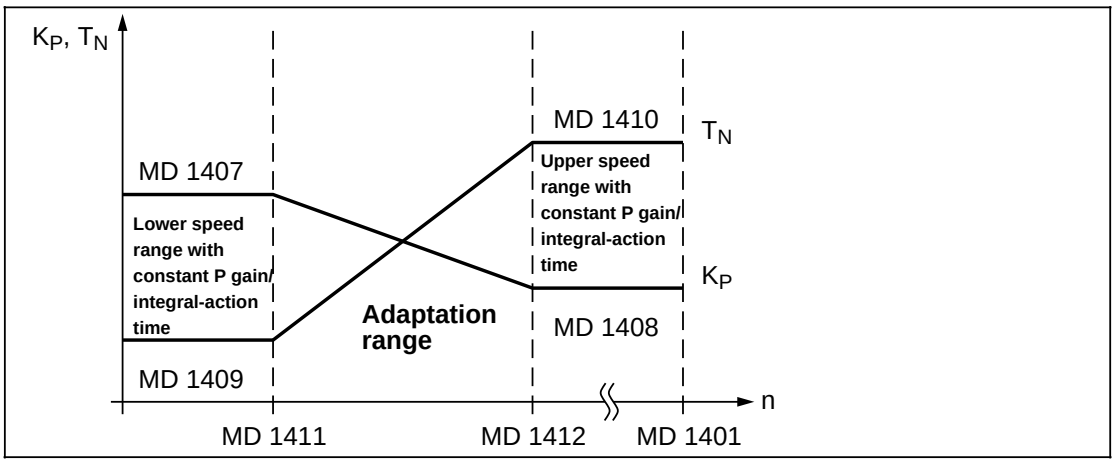
When the adaptation function is active, deactivation of the I-action component for only one speed range (MD 1409 = 0 and MD 1410 0 or vice versa) should be avoided (to prevent problem of torque step changes through resetting of the integral value on transition from adaptation to constant range).

1411	**Lower adaptation speed**		Active **at once**
Default value	Lower input value	Upper input value	Units
0.0	**0.0**	**50 000.0**	**rev/min**

Input of lower speed threshold for adaptation of the speed controller machine data or automatic parameterization (initialization) via operation **"Calculate controller data"** for MSD. When the adaptation function is active, the control machine data MD 1407 and MD 1409 are applied at speeds n < MD 1411. In the adaptation range MD 1411 < n < MD 1412, linear interpolation takes place between the two control machine data sets.

Graphic representation:

Adaptation of speed controller machine data by means of characteristic



1412	**Upper adaptation speed**		Active **at once**
Default value	Lower input value	Upper input value	Units
0.0	**0.0**	**50 000.0**	**rev/min**

Input of upper speed threshold for adaptation of the speed controller machine data or automatic parameterization (initialization) via operation **"Calculate controller data"** for MSD. When the adaptation function is active, the control machine data MD 1408 and MD 1410 are applied at speeds n > MD 1412. In the medium range MD 1411 < n < MD 1412, linear interpolation takes place between the two control machine data sets. See machine data "Adaptation lower speed threshold" (MD 1411) for diagram.

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1413	Selection adaptation speed controller		Active **at once**
Default value	Lower input value	Upper input value	Units
0	**0**	**1**	**–**

This machine data allows adaptation of the speed controller machine data to be controlled as a function of speed.

Input 0: The adaptation function is not active. The settings in control machine data MD 1407 and MD 1409 are applicable over the entire speed range. Control machine data MD 1408 and MD 1410 are not taken into account.

Input 1: The adaptation function is active. See machine data MD 1411 and MD 1412 for description.

Note:

The adaptation function is automatically activated by the **Calculate controller data** operation for main spindle drives.

1414	Natural frequency reference model speed		Active **at once**
Default value	Lower input value	Upper input value	Units
0.0	**0.0**	**8 000.0**	**Hz**

Input of natural frequency for the "Speed control loop" reference model. The filter is deactivated if a value of < 10 Hz is entered (proportional element with a gain of 1).

Note:

Machine data MD 1414, MD 1415 and MD 1416 must be set in each case to the same value for interpolating axes.

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1415	Damping reference model speed control loop		Active at once
Default value	Lower input value	Upper input value	Units
1.0	**0.5**	**5.0**	**–**

Input of damping for the "Speed control loop" reference model. This is a reference model (PT2) for the speed control loop with a controller of the PIR type. The higher the input value, the stronger the damping effect.

Note:

Machine data MD 1414, MD 1415 and MD 1416 must be set in each case to the same value for interpolating axes.

1416	Symmetrization reference model speed		Active at once
Default value	Lower input value	Upper input value	Units
0.0	**0.0**	**1.0**	**–**

Input of symmetrization for the "Speed control loop" reference model. This machine data simulates the calculation dead time of the speed control loop. The simulation is in this case calculated as an approximation of an interrupted dead time. The response of the reference model can in this way be matched to the controlled system response of the closed, P-controlled speed control loop.

1417	Message n_x for $n_{act} < n_x$		Active at once
Default value	Lower input limit	Upper input limit	Units
6 000.0	**0.0**	**50 000.0**	**rev/min**

Input of threshold speed for monitoring purposes; if the actual speed value does not reach the set threshold speed in terms of absolute value, a message is transferred to the SERVO.

1418	Message n_{min} for $n_{act} < n_{min}$		Active at once
Default value	Lower input limit	Upper input limit	Units
5.0	**0.0**	**25 000.0 50 000.0 (as from SW 6)**	**rev/min**

Input of threshold speed for monitoring purposes; if the actual speed value does not reach the set threshold speed in terms of absolute value, a message is transferred to the SERVO.

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1420	Maximum motor speed set-up mode		Active at once
Default value	Lower input limit	Upper input limit	Units
30.0	**0.0**	**50 000.0**	**rev/min**

Input of maximum motor speed for set-up mode. During set-up, the absolute speed setpoint value is limited to the value specified above. If the speed setpoint is limited to the value set in MD 1420, a message is also output.

1421	Time constant integrator feedback		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**1 000.0**	**ms**

The speed controller loop integrator is reduced via a weighted feedback to a low-pass response of the 1st order with the configured time constant.

Effect:

The speed controller integrator output is limited to a value which is proportional to the setpoint-actual value difference (steady-state proportional operating characteristic).

Applications:

- Machining motions with zero position setpoint and dominant static friction can be suppressed (at the cost of a permanent position setpoint/actual value difference).
- Prevention of strain on rigidly coupled axes or spindles (synchronous spindle).
- Prevention of overshooting during positioning.

Note:

The integrator feedback is activated when MD 1421 is set to 1.0.

1424	Symmetr. speed feedfwd ctrl channel		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**50 000.0**	**µs**

Input of time constant of the 1st-order balancing filter in the speed feedforward control channel of the speed/torque feedforward control. The setpoint response of the closed current conrol loop can be adjusted by entering an appropriate time value in MD 1424, resulting in symmetrization of the higher-level speed control loop. Allowance is automatically made for the time constants of the active current setpoint filters (low-pass filters only) when the balancing filter is initialized.

Note:

When the value 0 is entered, the filter is only deactivated (proportional element with gain factor 1) if no low passes are currently active as the current setpoint filter.

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1425	Symmetr.calc.deadtime I-controller		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**1.0**	**–**

Selection of a filter in the speed feedforward control channel to simulate the calculation dead time of the current control loop. Effective only when the speed/torque feedforward control function is active.
MD 1004, bit 0.

Machine data MD 1425 (input: Calculation dead time referred to speed controller cycle) allows the setpoint response in the speed feedforward control channel of the speed controller to be adapted to the controlled system performance of the closed speed control loop, thus ensuring symmetrization of the higher-level speed control loop.

1426	Tolerance band for $n_{set} = n_{act}$ signal		Active at once
Default value	Lower input limit	Upper input limit	Units
20.0	**0.0**	**10 000.0**	**rev/min**

Input of threshold value for the tolerance band of PLC status signals "$n_{act} = n_{min}$" and "Power-up procedure completed". The signal "$n_{set} = n_{act}$" is activated if the actual speed value enters the tolerance band set around the speed setpoint and remains there for a period corresponding to the delay time set in MD 1427. The signal is deactivated as soon as the actual speed leaves the tolerance band. The delay time is applied only if the ramp-function generator executes the edge change active passive.

The "Power-up procedure completed" signal is activated at the same time as the "$n_{set} = n_{act}$" signal; however, it is locked in the active state until the next setpoint change, even if the actual speed value leaves the tolerance band. The "Power-up procedure completed" signal is deactivated immediately if the setpoint changes.

Functionality in as from SW 6

As long as the control signals that the speed setpoint is being adjusted, the tolerance band is ”frozen” at the last setpoint value. The signal is cleared when the setpoint leaves the tolerance band. It therefore does not drop out when the setpoint jumps within a tolerance range.

See also ramp-up measurement, MD 1723: ACTUAL_RAMP_TIME

1427	Delay time $n_{set} = n_{act}$ signal		Active at once
Default value	Lower input limit	Upper input limit	Units
200.0	**0.0**	**500.0**	**ms**

Input of delay time for response of $n_{set} = n_{act}$ signal depending on tolerance band (MD 1426).

1428	Threshold torque M_{dx}		Active at once
Default value	Lower input limit	Upper input limit	Units
90.0	**0.0**	**100.0**	**%**

Input of setting value (specified as percentage) for machine data "Threshold torque". This machine data defines the torque limit value at which the message "$M_d < M_{dx}$" is deactivated. The input value is referred to the presently valid torque limit value. Analogously to this value, the maximum permissible torque is dependent on the working point above the rated speed value in the constant power (field weakening) range, thus resulting in a threshold torque curve which drops in relation to the 1/n function or from the breakdown torque 1/n2.

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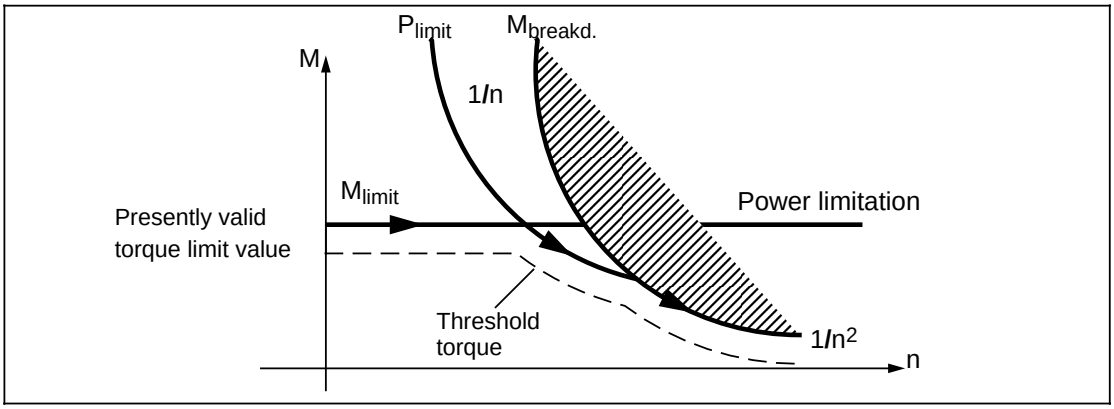
Torque threshold characteristic for the message $M_d < M_{dx}$.



The "$M_d < M_{dx}$" message is locked in the active state as long as the "Power-up procedure competed" message is not active. If the latter message is active, then the delay time set in MD 1429 must also elapse before the "$M_d < M_{dx}$" message is deactivated.

1429	**Delay time $M_d < M_{dx}$ message**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
800.0	**0.0**	**1 000.0**	**ms**

Input of delay time which must elapse before the "$M_d < M_{dx}$" message can be deactivated after the "Power-up procedure completed" message. The "$M_d < M_{dx}$" message remains locked in the active position as long as "Power-up procedure completed" is not active or the delay time has not yet elapsed.

1500	**Number of speed setpoint filters**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**2**	**–**

Input to specify number of speed setpoint filters. A selection of band-stop and low-pass filters (PT2/PT1) are available which can be set via machine data MD 1501 "Type of speed setpoint filter".

Selection of number of filters:

0	No speed setpoint filter active
1	Filter 1 active
2	Filters 1 and 2 active

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Relation between control word (MD 11004) and control word (MD 11002).

MD 1500	Status	MD 1500 > 0	MD 1500 > 0	MD 1500=0
Type of 1st filter	-	Low-pass (MD 1501.0 = 0)	Band-stop (MD 1501.0 = 1)	Inactive (MD 1501.0 = 0 or 1)
Control word MD 11004, bit 11	1	Status word MD 11002, bit 11 = 1	Status word MD 11002, bit 11 = 1	Status word MD 11002, bit 11 = 1
Control word MD 11004, bit 11	0	Status word MD 11002, bit 11 = 0	Status word* MD 11002, bit 11 = 1	Status word MD 11002, bit 11 = 1

- The 1st speed setpoint filter can be **switched on/off** via the control word (MD 11004, bit 11) only, if it is parameterized as low-pass (MD 1501, bit 0=0). It is not possible, if it has been parameterized as band-stop (MD 1501, bit 0=1).
- The status word (MD 11002, bit 11) indicates the active**/**inactive state of the 1st speed setpoint filter only, if the filter is parameterized and selected as low-pass and is active (MD 1550>0, MD 1501, bit 0=0).

1501	**Type speed setpoint filter**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**0303**	**Hex**

Input of configuration of 2 speed setpoint filters. A selection of band-stop and low-pass filters (PT2**/**PT1) are available. The adjustable filter parameters are entered in the appropriate machine data.

Applications:

- The set speed filter type "band-stop filter" is used to dampen axis-specific resonant frequencies in the position control loop.

  Depending on the requirement, the function "band-stop filter" can be set in three configurations:
  - Simple band-stop filter, MD 1514**/**MD 1517 and MD 1515**/**MD 1518
  - Band-stop filter with settable damping of the amplitude response, other relevant machine data MD 1516**/**MD 1519
  - Band-stop filter with settable damping of the amplitude response and raising or lowering of the amplitude response after the blocking frequency, other relevant machine data MD 1520**/**MD 1521.
- Interpolation with speed setpoint stairs - the speed setpoints are output in the position controller cycle which can be set to a much greater value than the speed controller cycle (low-pass).

Low-pass**/**band-stop	1st filter Bit 0	0	Low-pass (see MD 1502**/**1506**/**1507)
		1	Band-stop (see MD 1514**/**1515**/**1516**/**1520)
	2nd filter Bit 1	0	Low-pass (see MD 1502**/**1508**/**1509)
		1	Band-stop (see MD 1517**/**1518**/**1519**/**1521)
PT2**/**PT1 with low-pass	1st filter Bit 8	0	PT2 low-pass (see MD 1506**/**1507)
		1	PT1 low-pass (see MD 1502)
	2nd filter Bit 9	0	PT2 low-pass (see MD 1508**/**1509)
		1	PT1 low-pass (see MD 1503)

** Band-stop cannot be deactivated via control word*

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Note:

Before the filter type is configured, the appropriate filter machine data must be input.

1502	Time constant speed setpoint filter 1		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**500.0**	**ms**

Input of time constant for speed setpoint filter 1 (PT1 low-pass). The filter is deactivated when the data is set to zero.

1503	Time constant speed setpoint filter 2		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**500.0**	**ms**

Input of time constant for speed setpoint filter 2 (PT1 low-pass). The filter is deactivated when the data is set to zero.

1506	Natural frequency speed setpoint filter 1		Active at once
Default value	Lower input limit	Upper input limit	Units
2 000.0	**10.0**	**8 000.0**	**Hz**

Input of natural frequency for speed setpoint filter 1 (PT2 low-pass). An entry of < 10 Hz as the natural frequency of the low-pass filter initializes the filter as a proportional element with a gain of 1 independently of the associated damping. The filter is activated via machine data MD 1500 (No. speed setpoint filters) and MD 1501 (Type speed setpoint filter).

Note:

With interpolating axes, the speed setpoint filter must always be parameterized immediately.

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1507	Damping speed setpoint filter 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0.7	**0.2**	**5.0**	**–**

Input of damping for current setpoint filter 1 (PT2 low-pass). The filter is activated via machine data MD 1200 (No. current setpoint filters) and MD 1201 (Type current setpoint filter).

Note:

- With interpolating axes, the speed setpoint filter must always be parameterized immediately.

1508	Natural frequency speed setpoint filter 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
2 000.0	**10.0**	**8 000.0**	**Hz**

Input of natural frequency for speed setpoint filter 2 (PT2 low-pass). An entry of < 10 Hz as the natural frequency of the low-pass filter initializes the filter as a proportional element with a gain of 1 independently of the associated damping. The filter is activated via machine data MD 1500 (No. speed setpoint filters) and MD 1501 (Type speed setpoint filter).

Note:

With interpolating axes, the speed setpoint filter must always be parameterized immediately.

1509	Damping speed setpoint filter 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0.7	**0.2**	**5.0**	**–**

Input of damping for speed setpoint filter 2 (PT2 low-pass). The filter is activated via machine data MD 1500 (No. speed setpoint filters) and MD 1501 (Type speed setpoint filter).

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1514	Block frequency speed setpoint filter 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
3 500.0	**1.0**	**7 999.0**	**Hz**

Input of block frequency for speed setpoint filter 1 and parameterization as simple band-stop filter. The filter is activated via machine data MD 1500 (number of setpoint filters) and MD 1501 (type speed setpoint filter). The machine data MD 1516**/**MD 1519 (bandwidth numerator speed setpoint filter) and MD 1520**/**MD 1521 (band-stop filter natural frequency speed setpoint filter) keep their default values.

Formula:

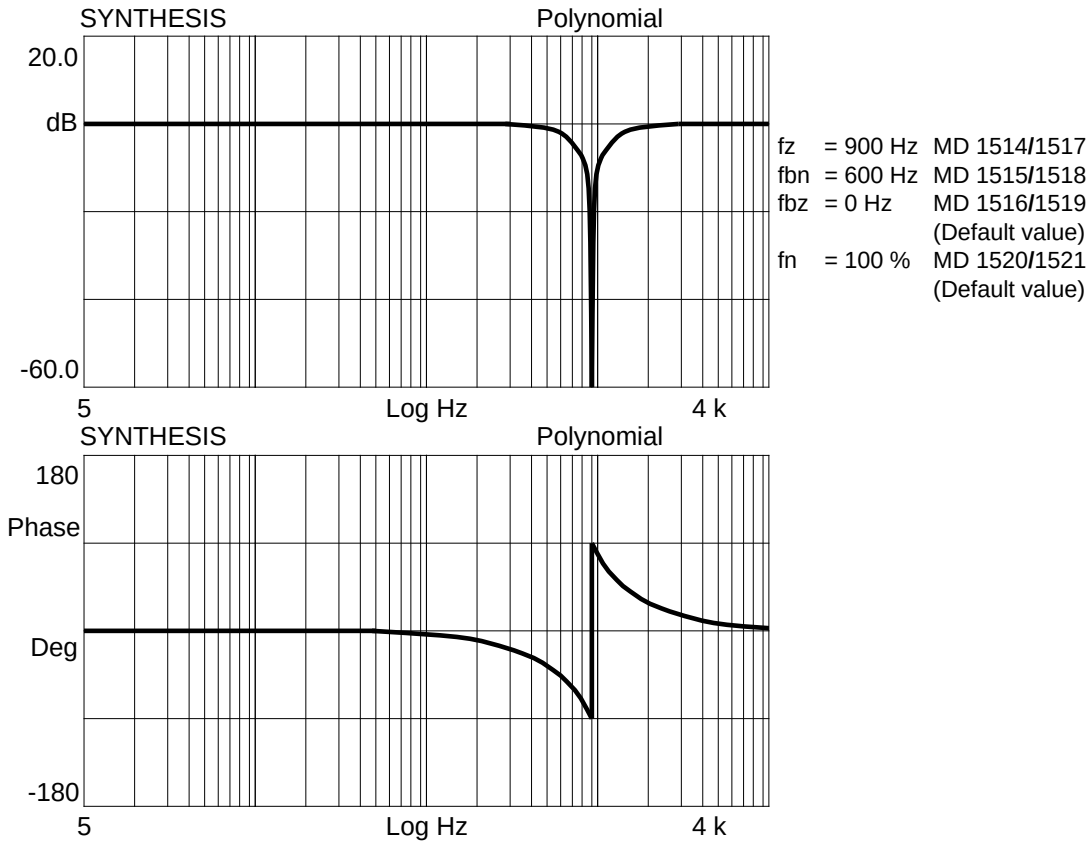
$$H(s) = \frac{1+s \cdot (2 \cdot \ \cdot fbz/(2 \cdot \ \cdot fz)^2)+s^2 \cdot 1/(2 \cdot \ \cdot fz)^2}{1+s \cdot (2 \cdot \ \cdot fbn/(2 \cdot \ \cdot fn)^2)+s^2 \cdot 1/(2 \cdot \ \cdot fn)^2}$$

Input:

fz	= MD 1514**/**1517	Blocking frequency speed setpoint 1/ speed setpoint 2 [Hz], (point of resonance)
fbn	= MD 1515**/**1518	Bandwidth denominator filter 1/filter 2 [Hz]
fbz	= MD 1516**/**1519	Bandwidth numerator filter 1/filter 2 [Hz]
fn	= MD 1520**/**1521	Band-stop filter natural frequency filter 1/filter 2 [%] percentage with reference to MD 1514 or MD 1517

$$fn = \frac{\text{MD 1520 (MD 1521)}}{100} \rightarrow \text{MD 1514 (MD 1517) [\%]}$$

Example:



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Note:

The maximum block frequency input value is limited by the sampling frequency of the servo control (MD 1001) (parameterization error).

$$MD\ 1514 < \frac{1}{2 \times \underbrace{T_{sampl.\ speed\ controller}}_{= MD\ 1001\ [\ s\ ]}}$$

$T_{sampl.}$ (MD 1001) { 62.5 µs / 125.0 µs } MD 1514 { 8000 Hz / 4000 Hz }

1515	**Bandwidth speed setpoint filter 1**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
500.0	**5.0**	**7 999.0**	**Hz**

Input of -3dB bandwidth for speed setpoint filter 1 (band-stop). The filter is activated in machine data MD 1500 (No. speed setpoint filters) and MD 1501 (Type speed setpoint filter).

Note:

When 0 is entered for the bandwidth, the filter is parameterized as a proportional element with a gain of 1.

1516	**Numerator bandwidth speed setpoint filter 1**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**7 999.0**	**Hz**

Input of numerator bandwidth for the damped band-stop.

The ratio of the bandwidth numerator to the bandwidth denominator determines the drop in the amplitude response at the blocking frequency. If fbz < fbn, the amplitude drops and if fbz > fbn the amplitude rises. The latter case is unrealistic because it would cause an excessive frequency response and therefore overshooting in the controller.

If fbz=fbn, the amplitude remains constant over the entire frequency range.

Formula:

$$\frac{1+s \cdot (2 \cdot \ \cdot fbz/(2 \cdot \ \cdot fz)^2)+s^2 \cdot (1/(2 \cdot \ \cdot fz)^2)}{1+s \cdot (2 \cdot \ \cdot fbn/(2 \cdot \ \cdot fz)^2)+s^2 \cdot (1/(2 \cdot \ \cdot fz)^2)} \quad \frac{1 + s \cdot (2 \cdot Dz/2 \cdot \ \cdot fz) + s^2 \cdot 1/(2 \cdot \ \cdot fz)^2}{1 + s \cdot (2 \cdot Dn/2 \cdot \ \cdot fz) + s^2 \cdot 1/(2 \cdot \ \cdot fz)^2}$$

Input:

fz	: Blocking frequency	MD 1514/1517
Dz	: Damping numerator	
fbz = 2 · Dz · fz	: Bandwidth numerator	MD 1515/1518
Dn	: Damping denominator	
fbz = 2 · Dn · fn	: Bandwidth denominator	MD 1516/1519
fn=100%	: Band-stop filter natural frequency	MD 1520/1521 (default value)

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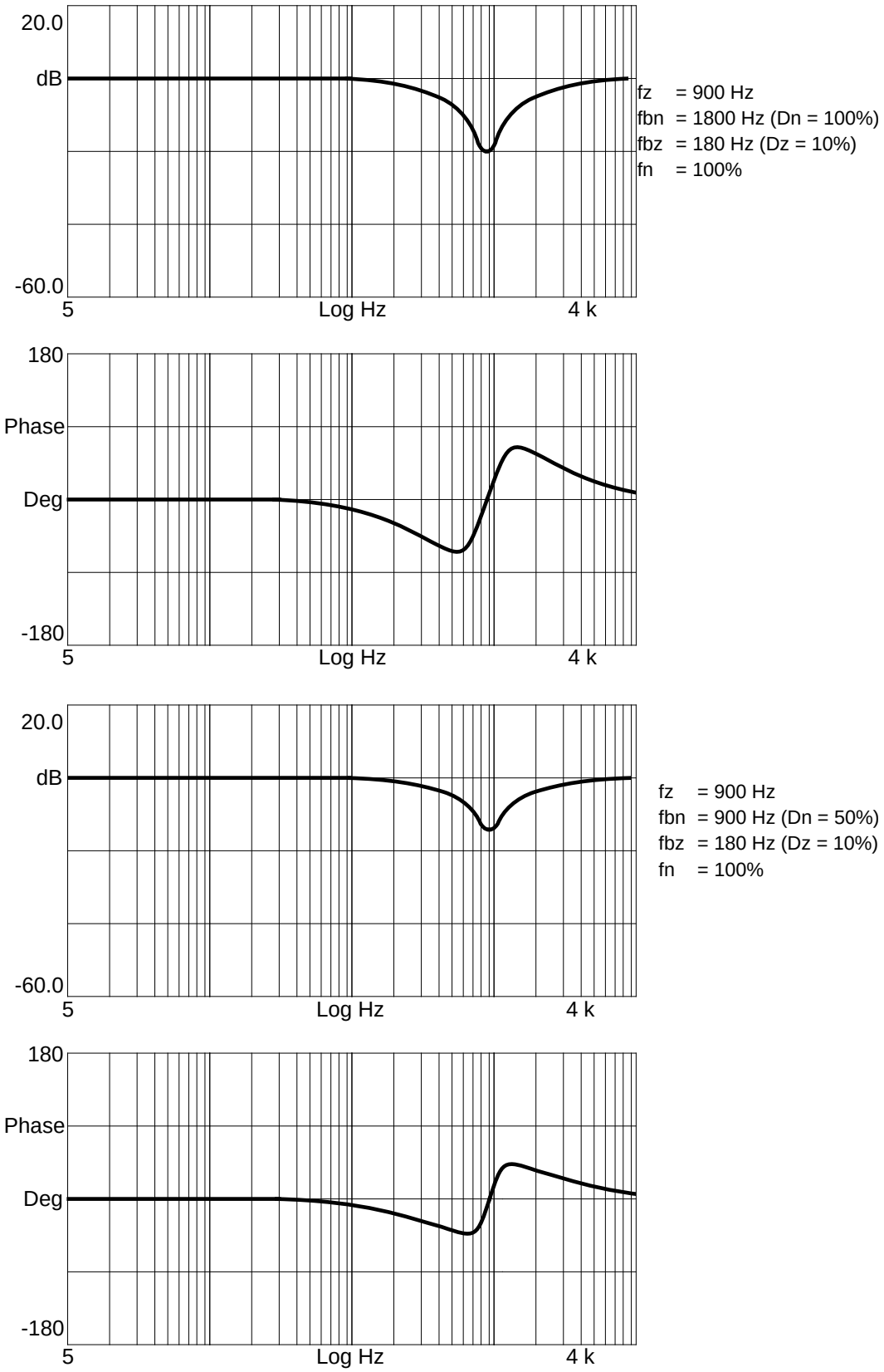
Example:



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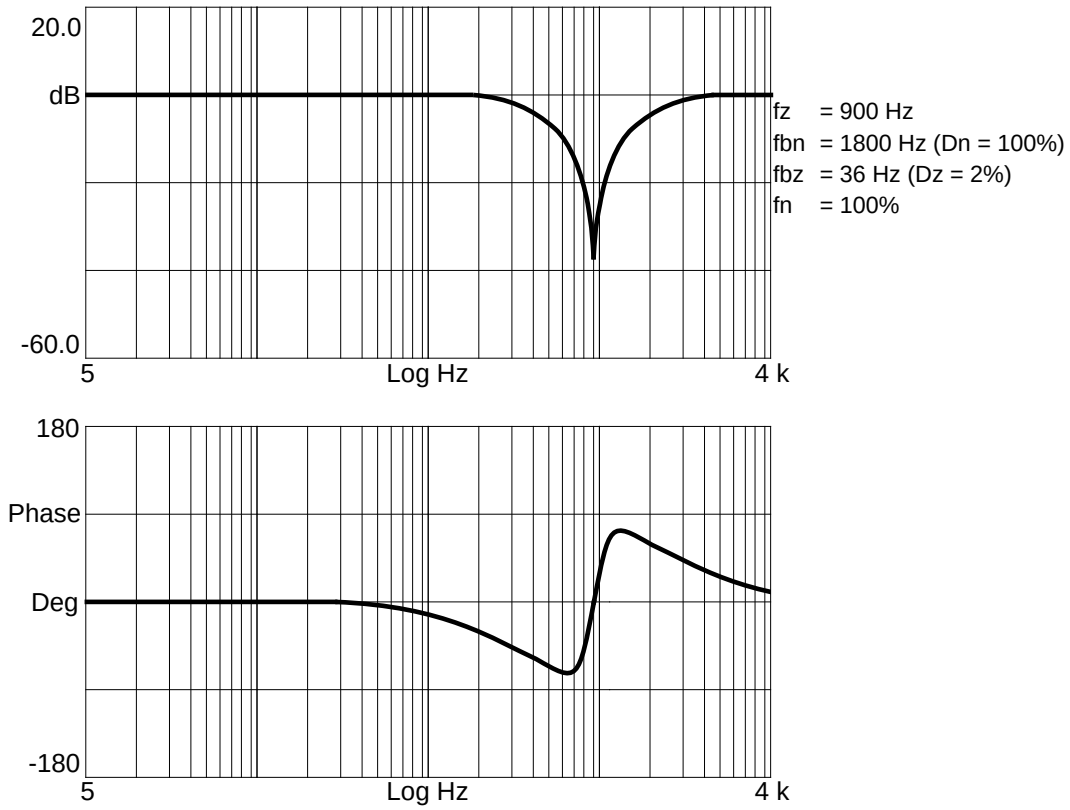

Note:

The value entered in MD 1516 (Numerator bandwidth speed setpoint filter 1) must not be greater than twice the value set in MD 1515 (bandwidth speed setpoint filter 1).

1517	**Stop frequency speed setpoint filter 2**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
3 500.0	**1.0**	**7 999.0**	**Hz**

The description of this machine data is the same as that for machine data **MD 1514**!

1518	**Bandwidth speed setpoint filter 2**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
500.0	**5.0**	**7 999.0**	**Hz**

Input of 3dB bandwidth for speed setpoint filter 2 (band-stop). The filter is activated via machine data MD 1500 (No. speed setpoint filters) and MD 1501 (Type speed setpoint filter).

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Note:

When 0 is entered for the bandwidth, the filter is parameterized as a proportional element with a gain of 1.

1519	Numerator bandwidth speed setpoint f. 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**7 999.0**	**Hz**

The description of this machine data is the same as that for machine data **MD 1516**!

1520	Band-stop filter natural frequency speed setpoint f. 1		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**1**	**141**	**%**

Input of the band-stop filter natural frequency for raising or lowering the amplitude response after the blocking frequency (MD 1514**/**1517).

The machine data (MD 1520**/**MD 1521) are used to match different axis dynamic responses to a standard dynamic response (low-pass filter). The standard dynamic response is based on that of the axis with the lowest resonant frequency.

Formula:

$$\frac{1+s\cdot(2\cdot\ \cdot fbz/(2\cdot\ \cdot fz)^2)+s^2\cdot(1/(2\cdot\ \cdot fz)^2)}{1+s\cdot(2\cdot\ \cdot fbn/(2\cdot\ \cdot fn)^2)+s^2\cdot(1/(2\cdot\ \cdot fn)^2)} \qquad \frac{1+s\cdot(2\cdot Dz/2\cdot\ \cdot fz)+s^2\cdot 1/(2\cdot\ \cdot fz)^2}{1+s\cdot(2\cdot Dn/2\cdot\ \cdot fn)+s^2\cdot 1/(2\cdot\ \cdot fn)^2}$$

Input:

fz	: Blocking frequency	MD 1514**/**1517
Dz	: Damping numerator	
fbz = 2 · Dz · fz	: Bandwidth numerator	MD 1515**/**1518
Dn	: Damping denominator	
fbn = 2 · Dn · fn	: Bandwidth denominator	MD 1516**/**1519
fn=MD 1520[%]·fz	: Band-stop filter natural frequency	MD 1520**/**1521 (default value)

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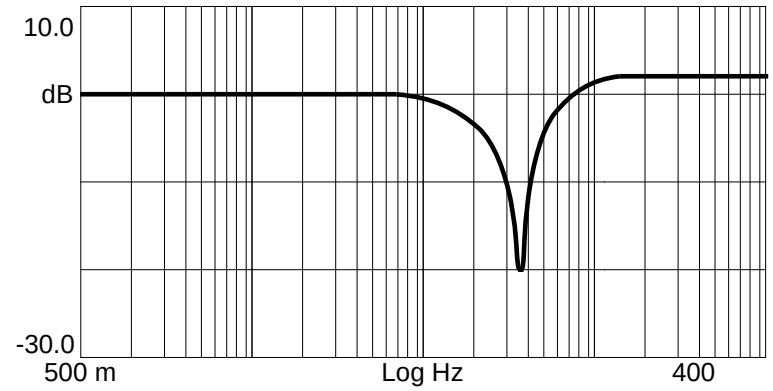
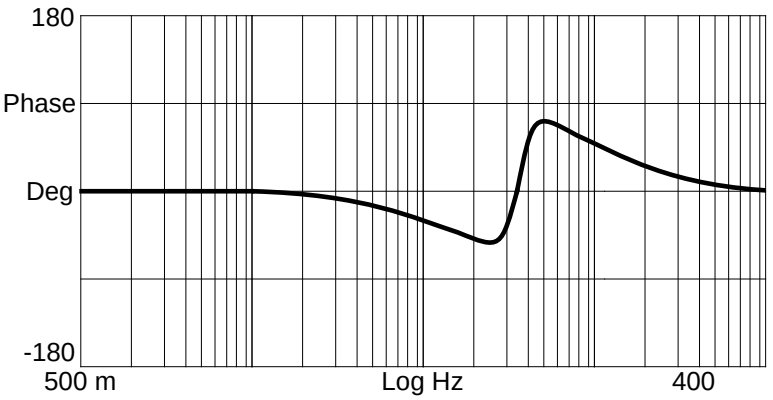
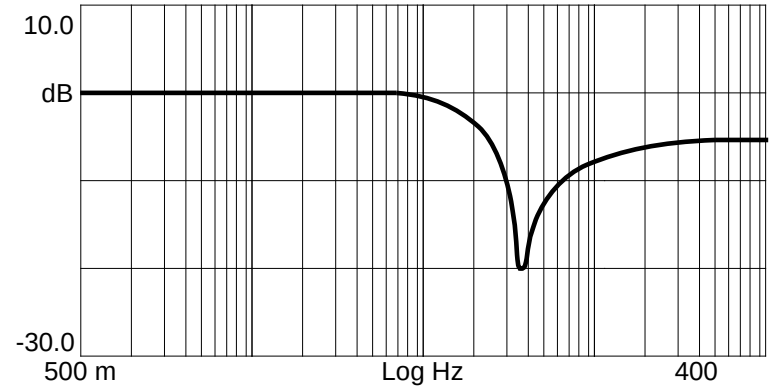
Example:

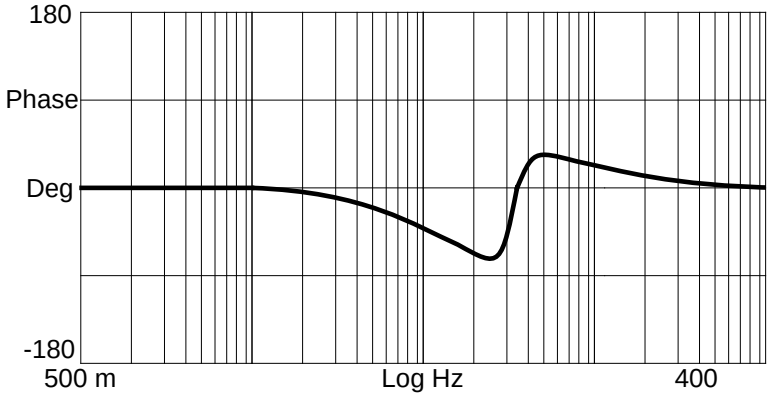


fz = 54 Hz
Dz = 10%
fn = 40 Hz
Dn = 70%





fz = 35 Hz
Dz = 6%
fn = 40 Hz
Dn = 70%



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1521	Band-stop filter natural frequency set speed filter 2		Active **at once**
Default value	Lower input limit	Upper input limit	Units
100	**1**	**141**	**%**

The description of this machine data is the same as that for machine data **MD 1520**!

1600	Concealable alarms (Power On)		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

This machine data allows power on 611D alarms to be concealed. The monitoring function is activated if the appropriate bit = 0. All 611D monitoring functions are activated as standard.

Value table:

Bit 0	Internal error **cannot be concealed**
Bit 1	Space vector monitoring (as from SW 5 FDD/MSD)
Bit 2	Not assigned
Bit 3	Not assigned
Bit 4	Measuring circuit, motor measuring system
Bit 5	Absolute track monitoring
Bit 6	Not assigned
Bit 7	Not assigned
Bit 8	Zero mark monitoring, motor measuring system
Bit 9	Converter limit frequency too high
Bit 10	Medium frequency measurement, speed too high - **not concealable**
Bit 11	Medium frequency measured-value memory full - **not concealable**
Bits 12-14	Not assigned
Bit 15	Power section temperature monitor

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Note:

Reset 611D alarms can be acknowledged via a software reset.

Caution:

Concealing the reset alarms may result in irreparable damage to the power section.

1601	Concealable alarms (Reset)		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

This machine data allows reset 611D alarms to be concealed or disabled. The alarm is active if the appropriate bit = 0. All 611D alarms are activated as standard.

Value table:

Bit 0	Configuration error - **not concealable**
Bits 1-5	Not assigned
Bits 6	Flux controller at stop
Bits 7	Current controller at stop
Bit 8	Speed controller at fixed stop
Bit 9	Encoder limit frequency exceeded
Bits 10-11	Not assigned
Bit 12	Speed too high for system power-up
Bit 13	Temperature motor shutdown (temperature)
Bit 14	Temperature motor shutdown (timer)
Bit 15	Not assigned

Note:

Reset 611D alarms can be acknowledged via a software reset.

Caution:

Concealing the reset alarms may result in irreparable damage to the power section or the motor.

1602	Motor temperature warning threshold		Active **at once**
Default value	Lower input limit	Upper input limit	Units
120	**0**	**200**	**°C**

Input of thermally constant permissible motor temperature or automatic parameterization using machine data "Motor code number" (MD 1102). The temperature is detected by appropriate temperature sensors and evaluated in the drive. A message is transferred to the SERVO when the warning limit is exceeded (see also MD 1603 and MD 1607). Reset 611D alarms can be switched to 611D warnings via MD 1012 bit 4 making the conceal function ineffective.

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1603	Timer motor temperature alarm		Active at once
Default value	Lower input limit	Upper input limit	Units
240	**0**	**600**	**s**

Input of timer for the motor temperature alarm. When the value set in "Motor temperature warning" (MD 1602) is exceeded, a message is transferred to the SERVO and a time monitor activated. If the timer runs out before the temperature drops below the limit, the drive initiates a generator braking operation and suppresses the transistor drive signals for the appropriate axis after MD 1404 (pulse suppression) in conjunction with MD 1403 (creep speed).

Note:

Changing the timer setting will not influence a time monitoring function already in progress (counter started). The change will become applicable when the motor temperature has dropped below the warning limit (MD 1602).

1604	DC link undervoltage warning threshold		Active at once
Default value	Lower input limit	Upper input limit	Units
200	**0**	**600 680 (as from SW 6)**	**V**

Input of DC-link undervoltage warning threshold. When the voltage drops below this value, a message is sent to the SERVO. This message is output on the 1st page of the FDD service display: DC link "off".

1605	Timer n controller at fixed stop		Active at once
Default value	Lower input limit	Upper input limit	Units
200.0	**20.0**	**10 000.0**	**ms**

Input of "Speed controller at fixed stop" timer. The status of the current at the current setpoint limit is monitored. In the event of a fault, the control pulses for the power section transistors are suppressed on the drive side when the timer setting has expired.

Caution:

When MD 1605 is set to a value lower than the setting in MD 1404 (timer pulse suppression), the generator-mode braking operation may be aborted with error message "Speed controller at fixed stop"; the drive then coasts to a standstill.

1606	Threshold n controller at fixed stop		Active at once
Default value	Lower input limit	Upper input limit	Units
8 000.0/30.0	**0.0**	**50 000.0**	**rev/min**

Input of speed threshold for "Speed controller at fixed stop" alarm (see MD 1605 for details). The default setting depends on the motor type (FDD=8000, MSD=30) and is parameterized by the drive configuration during start-up.

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1607	Switchoff limit motor temperature		Active **at once**
Default value	Lower input limit	Upper input limit	Units
155	**0**	**200**	**°C**

Input of motor temperature at which motor must be switched off. The motor temperature is detected via temperature sensors and evaluated in the drive. The motor is braked in generator mode when the shutdown limit is reached. A ZK1 message is transmitted to the SERVO (see also MD 1602 and MD 1603).

Notes:

- The temperature monitoring functions (warning + timer and unconditional shutdown) are not subject to any mutual restrictions, i.e. MD 1607 may be set lower than MD 1602. In this case, the motor is switched off without prior warning.
- The motor temperature sensing function is accurate within the 3 - 5 % range.

1608	Fixed temperature		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**200**	**°C**

Input of fixed temperature. If a value higher than 0 is entered, temperature measurement no longer has any effect. The motor is operated at this fixed temperature.

Note:

The motor temperature monitoring function set in machine data MD 63 is made inoperative if a fixed temperature is specified.

1610	Diagnosis functions		Active on **Power On**
Default value	Lower input limit	Upper input limit	Units
0000/0001	**0000**	**0003**	**Hex**

This machine data can be used to activate diagnostic functions. The function is active when the appropriate bit is set to 1.
The default setting is dependent on the drive type (FDD=000, MSD=001).

Value table:

Bit 0	Load test monitoring = dn**/**dt monitoring
Bit 1	Concentricity monitoring active
Bits 2-15	Not assigned

Notes:

- The 611D diagnostic functions are not active in the default setting with the exception of the dn**/**dt monitoring function which is always active for MSD drives.
- The monitoring function is not dependent on internal operating modes (feedforward control, function generator, etc.).

Caution:

This machine data is relevant **only** for internal Siemens processes and **must not be altered**.

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1611	Response threshold dn/dt		Active at once
Default value	Lower input limit	Upper input limit	Units
800	**0**	**1 600**	**%**

Input of response threshold for dn/dt monitoring function.

Caution:

This machine data is required for the load test. It is relevant **only** for internal Siemens processes and **must not be altered**.

1612	Config. shutdown react. PO alarms		Active at once
Default value	Lower input limit	Upper input limit	Units
0DBC/FFFF	**0000**	**FFFF**	**Hex**

Input bit field for switching over the appropriate 611D power ON alarm. It is possible to select one of two shutdown reactions, i.e. pulse disable (bit = 1) or controller disable (bit=0 = n_{set}=0 = generator-mode braking), i.e. when the pulse disable reaction is selected, the controller disable reaction is deactivated. The default setting is dependent on the motor type (FDD=0D3C, MSD=FFFF) and is parameterized by the drive configuration during start-up.

Note:

The MSD default setting (FFFF) must be selected when the FDD H option is used.

Caution:

The alarms may be deactivated or concealed through machine data MD 1600 - Concealable alarms (power ON), i.e. they may be **inactive**.

Value table:

Bit 0	Pulse disable in response to internal errors/faults	1 = on 0 = off
Bit 1	Not assigned	
Bits 2-5	Reserved	
Bit 6	Pulse disable NC sign-of-life (as from SW 6)	1 = on (MSD) 0 = off (FDD)
Bit 7		
Bit 8	Pulse disable, zero monitoring	1 = on 0 = off
Bit 9	Pulse disable, converter limit frequency	1 = on 0 = off
Bits 10-11	Reserved	
Bits 12-14	Not assigned	
Bit 15	Pulse disable, heat sink temperature	1 = on 0 = off

*) As from SW 5.2 (840C) reserved; prior to SW 5.2 always bit 7=1

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1613	Config. shutdown react. RESET alarms		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0100/FFFF	**0000**	**FFFF**	**Hex**

Input bit field for switching over the appropriate 611D reset alarm. It is possible to select one of two shutdown reactions, i.e. pulse disable (bit = 1) or controller disable (bit = 0 ≙ nset = 0 ≙ generator-mode braking), i.e. when the pulse disable reaction is selected, the controller disable reaction is deactivated. The default setting is dependent on the motor type (FDD = 0100, MSD = FFFF) and is parameterized by the drive configuration during start-up.

Note:

The MSD default setting (FFFF) must be selected when the FDD H option is used.
611D messages can be switched to reset alarms via MD 1012 bit 4.

Caution:

The alarms may be deactivated or concealed through machine data MD 1601 - Concealable alarms (reset), i.e. they may be **inactive**.

Value table:

Bit 0	Pulse disable, configuration error	1 = on 0 = off
Bits 1-7	Not assigned	
Bit 8	Reserved	
Bit 9	Pulse disable, encoder limit frequency	1 = on 0 = off
Bits 10-12	Not assigned	
Bit 13	Pulse disable abs. motor encoder temperature	1 = on 0 = off
Bit 14	Pulse disable on motor temperature warning	1 = on 0 = off
Bit 15	Not assigned	

1615	Concentricity monitoring tolerance		Active **at once**
Default value	Lower input limit	Upper input limit	Units
2.0	**0.0**	**100.0**	**rpm**

Load test: Setting the tolerance range for concentricity monitoring. If the tolerance range is violated (underrange or overrange) by the actual speed, counter "Diagnostics concentricity monitoring" MD 1724 is incremented.

1620	Bits variable message function		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

Input bit field for controlling the variable message function.

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Value table:

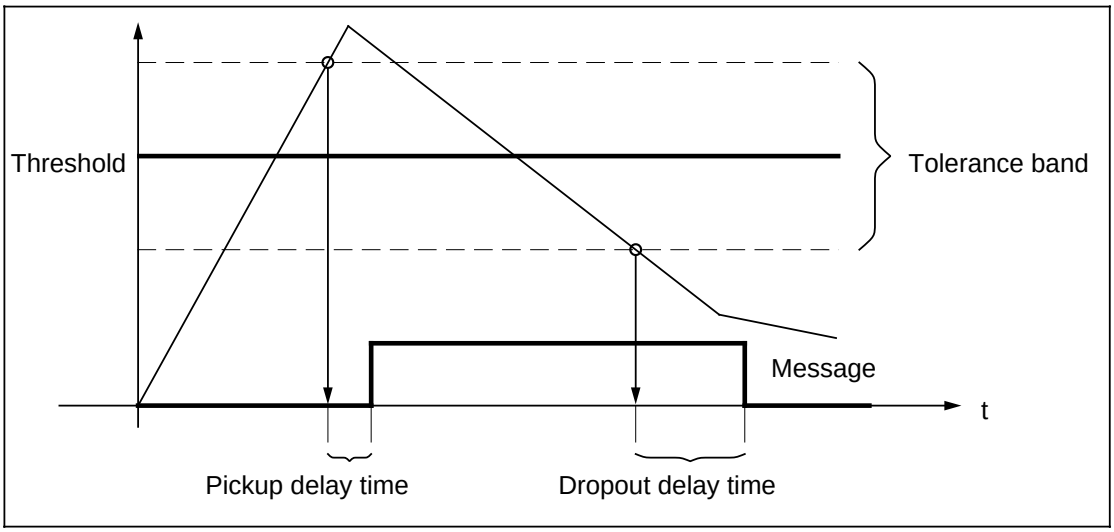
Bit 0	Variable message function	0 = not active 1 = active
Bit 1	Segment variable message function	0 = address space X 1 = address space Y
Bit 2	Comparison variable message function	0 = comparison without sign 1 = comparison with sign

Note:

Bit 1 is effective **only** if signal number 0 is selected in MD 1621 (signal number variable message function).

The variable message function monitors a freely selectable memory location from address space X or Y in the data RAM for violation of a threshold specified by the user. A tolerance band can also be set for this threshold value which is taken into account when the threshold is scanned for violation. This message is output via operational message with bit 5 and can be linked to a pickup or dropout delay. The message function is executed in a 4 ms cycle.

Graphic representation



Note:

The quantity to be monitored can be selected by specifying either a signal number or a physical address; the physical address, however, is relevant **only** for Siemens servicing purposes.

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Machine data which correspond to this machine data are as follows:

- Signal number variable message function (MD 1621)
- Address variable message function (MD 1622)
- Threshold variable message function (MD 1623)
- Hysteresis variable message function (MD 1624)
- Pickup delay variable message function (MD 1625)
- Delayed dropout variable message function (MD 1626)

Note:

Changes to inputs in machine data MD 1621 to MD 1624 while the monitoring function is already active (MD 1620 - bit 0 = 1) do not automatically result in re-initialization, i.e. reset to zero, of message bit 5. If a bit reset is required, the monitoring function must be deactivated and then re-activated by means of MD 1620, bit 0, after the machine data has been altered.

1621	**Signal number variable message function**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**100**	**–**

Input of signal number of memory location to be monitored via the variable message function.

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Value table:

Signal number	**Signal designation**	**Scaling** (LSB corresponds to:)
0	Physical address	–
1	-	–
2	Current I_R	MD 1710
3	Current I_S	MD 1710
4	Current I_d	MD 1710
5	Current I_q	MD 1710
6	Current setpoint I_q (limited after filter)	MD 1710
7	Current setpoint I_q (before filter)	MD 1710
8	Motor speed actual value	MD 1711
9	Speed setpoint	MD 1711
10	Speed setpoint reference model	MD 1711
11	Torque setpoint (speed controller output)	MD 1713
12	Torque setpoint limit	MD 1713
13	Capacity utilization ($m_{set}/m_{set,limit}$)	8000H≙100%
14	Active power	0.01 kW
15	Rotor flux setpoint	MD 1712
16	Rotor flux actual value	MD 1712
17	Cross voltage U_q	MD 1709
18	Direct-axis voltage U_d	MD 1709
19	Current setpoint I_d	MD 1710
20	Motor temperature	0.1 °C
21	DC link voltage	1 V
22	Zero mark signal, motor measuring system	–
23	Bero signal	–
24	Absolute actual speed value	MD 1711
25	Slip frequency setpoint	$\frac{2000 \times 2}{800000H \times 1s^{-1}}$
26	Rotor position (electrical)	MD 1714
27	Torque setpoint speed controller	MD 1713
28	Compensation torque	MD 1713
29	Command voltage Q injection	MD 1709
30	Command voltage D injection	1709

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1622	Address variable message function		Active at once
Default value	Lower input limit	Upper input limit	Units
0000	0000	FFFF	Hex

Input of address of memory location to be monitored via the variable message function.

Note:

This machine data is operative **only** if the signal number is set to 0 (see MD 1621).

1623	Threshold variable message function		Active at once
Default value	Lower input limit	Upper input limit	Units
000000	000000	FFFFFF	Hex

Input of threshold for the memory location address entered in machine data "Address variable message function" (MD 1622) to be monitored via the variable message function. In conjunction with machine data "Hysteresis variable message function" (MD 1624), this machine data defines the actual value to be checked by the monitoring function (see diagram under MD 1620).

Note:

Depending on the setting of bit 2 in machine data "Bits variable message function" (MD 1620, the numerical value entered in MD 1623 is interpreted either as an unsigned value (bit 2 = 0) or a signed value (bit 2 = 1).

1624	Hysteresis variable message function		Active at once
Default value	Lower input limit	Upper input limit	Units
000000	000000	FFFFFF	Hex

Input of hysteresis (tolerance band) for the memory location address entered in machine data "Address variable message function" (MD 1622) which is to be monitored by the variable message function. In conjunction with machine data "Threshold variable message function" (MD 1623), this machine data defines the actual value to be checked by the monitoring function (see diagram under MD 1620).

Note:

Regardless of the setting of bit 2 in machine data "Bits variable message function" (MD 1620), the numerical value entered in MD 1624 is interpreted either as an unsigned value (bit 2 = 0) or a signed value (bit 2 = 1).

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1625	Pickup delay variable message function		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**10 000**	**ms**

Input of ON (pickup) delay time for setting of the message if the threshold (with hysteresis) is exceeded (see diagram under MD 1620).

Note:

Changes to machine data MD 1625 and MD 1626 (Delayed dropout variable message function) has an effect on a time monitoring function which is already in progress. The monitoring function is initialized with the newly entered time data.

1626	Delayed dropout variable message function		Active at once
Default value	Lower input limit	Upper input limit	Units
0	**0**	**10 000**	**ms**

Input of OFF (dropout) delay time for resetting of the message if the monitored quantity drops below the threshold (with hysteresis) (see diagram under MD 1620).

Note:

Changes to machine data MD 1625 (Pickup delay variable message function) and MD 1626 has an effect on a time monitoring function which is already in progress. The monitoring function is initialized with the newly entered time data.

1630	Response threshold ZWK monitor only		Active at once
Default value	Lower input limit	Upper input limit	Units
550	**0**	**600**	**V**

Input of response threshold of DC link voltage; if the voltage drops below this value, only the DC link voltage is monitored (motor temperature monitoring is discontinued). If the voltage rises above the threshold value again, then the normal monitoring function is resumed.

Note:

This machine data is described under the additional function "Extended shutdown and retraction (G420...G426)", see Programming Guide 840C.

1631	Response voltage generator axis		Active at once
Default value	Lower input limit	Upper input limit	Units
450	**280**	**570** **650 (as from SW 6)**	**V**

Input of response threshold of DC link voltage; if the voltage drops below this value, a drive defined as a generator axis (MD 1636) switches over to generator mode.

Note:

This machine data is described under the additional function "Extended shutdown and retraction (G420...G426)", see Programming Guide 840C.

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1632	Voltage step for generator control		Active at once
Default value	Lower input limit	Upper input limit	Units
30	**0**	**300**	**V**

Input of response threshold of DC link voltage. In conjunction with machine data "Response voltage generator axis" (MD 1631), this data defines the voltage range for the upper threshold of the two-step controller for generator operation.

Note:

This machine data is described under the additional function "Extended shutdown and retraction (G420...G426)", see Programming Guide 840C.

1633	Cutout threshold generative mode		Active at once
Default value	Lower input limit	Upper input limit	Units
510	**0**	**580 660 (as from SW 6)**	**V**

Input of cutout threshold of DC link voltage. If the voltage exceeds this threshold value, the motor switches from generator mode back to normal operation.

Note:

This machine data is described under the additional function "Extended shutdown and retraction (G420...G426)", see Programming Guide 840C.

1634	Response threshold emergency retraction		Active at once
Default value	Lower input limit	Upper input limit	Units
400	**0**	**580 660 (as from SW 6)**	**V**

Input of response threshold of DC link voltage; if the voltage drops below this value, emergency retraction responses are initiated according to the operating modes selected in machine data "Drive modes emergency retraction" (MD 1636).

Note:

This machine data is described under the additional function "Extended shutdown and retraction (G420...G426)", see Programming Guide 840C.

1635	Minimum speed generator axis		Active at once
Default value	Lower input limit	Upper input limit	Units
0.0	**0.0**	**50 000.0**	**1/min**

Input of minimum DC link generator speed. Bit 3 in the ZK2 register is set if the speed drops below the value set here. This message is output to inform the NC that the drive operaing in generator mode (MD 1636) has reached a speed at which the NC should initiate an emergency retraction.

Note:

This machine data is described under the additional function "Extended shutdown and retraction (G420...G426)", see Programming Guide 840C.

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1636	Drive operating modes Emergency retraction		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**7**	**-**

Input to select various operating modes in the drive operating modes word. It defines 8 operating modes for the following cases of failure:
- Sign-of-life failure
- DC-link voltage < MD 1633 or MD 1631
- Activation of the autonomous drive emergency retraction through the NC

Table Drive operating modes Emergency retraction

Value input	Operating mode
0	Normal mode
1	Monitoring mode
2	Delayed regenerative braking
3	Delayed regenerative braking only with sign-of-life failure
4	Emergency retraction
5	Emergency retraction only with sign-of-life failure
6	Generator operation with possible return to normal mode
7	Generator operation without possible return to normal mode

*This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.*

1637	Delay time regenerative braking		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**10000**	**ms**

Input of the time delay by which regenerative braking is delayed in the case of a failure.

*This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.*

Input of the emergency retraction time, for which the emergency retraction speed (MD 1639) is given as setpoint speed in the case of a failure.

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1638	Emergency retraction time		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**10000**	**ms**

*This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.*

1639	Emergency retraction speed		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0.0	**-4194304**	**4194304**	**rev/min**

Input of the emergency retraction speed, which is given as setpoint speed during the emergency retraction time (MD 1638) in the case of a failure.

*This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.*

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1650	Diagnosis control		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

Input to select a variety of diagnostic functions in the diagnostic control word.

Caution:

This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.

Value table:

Bit 0	Min**/**max memory	0 = not active 1 = active
Bit 1	Segment min**/**max memory	0 = DSP address name X 1 = DSP address name Y
Bit 2	Comparison with sign	0 = without sign 1 = with sign
Bits 3-7	Not assigned	
Bit 8 (up to SW 4.4)	Voltage-controlled V_q operation	0 = normal operation 1 = V_q operation active
Bit 9	Reserved	
Bits 10-15	Not assigned	

Notes:

Bit 1 is effective **only** if signal number 0 is selected in MD 1651 (signal number min/max memory).

- Diagnostic function "Min/max memory"

  This function can be used to calculate the value range within which a specific memory location moves over a prolonged period. The function is executed in the current controller cycle (fastest cycle) in order to ensure reliable detection of all system quantities.

  The quantity to be monitored can be selected through specifying either a signal number or a physical address (see MD 1651).

  The comparison of the value with the maximum and minimum values can be implemented either with or without sign (bit 2).

  Corresponding machine data are as follows:

  – Diagnosis control (MD 1650, bits 0, 1, 2)
  – Signal number min**/**max memory (MD 1651)
  – Memory location min**/**max memory (MD 1652)
  – Minimum value min**/**max memory (MD 1653)
  – Maximum value min**/**max memory (MD 1654)

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- Diagnostic function "Voltage-controlled V_q operation" (up to SW 4)

  A voltage-controlled operating mode (V/F mode) is applied in order to diagnose speed or current sensor faults. In this operating mode, voltages V_q and V_d = 0 as well as a frequency are input as controlled quantities. As a result of the transformation (d/q R/S/T), a constantly changing rotating field is applied to the motor via the trigger equipment ASIC, making it possible to attain a speed within the n_{rated}/5 range in V/F operation. The system oscillates at higher speeds.

  Corresponding machine data are as follows:

  – Motor frequency V/F mode (MD 1660)
  – Ratio V/F during V/F mode (MD 1661)

- If MD 1661 is set to an excessively high value, the resulting I_d current at n_{rated}/5 causes a temperature rise in the drive and an additional increase in oscillation at high speeds.

- If MD 1661 is set to a very low value, the resulting I_q current value is too low, making it impossible for the drive to follow the specified frequency.

- An operating status message is transmitted to the SERVO by means of bit 28 in the status word.

- The current and speed controllers are **not active** in V/F mode

- Unfavourable parameter settings may cause **excessively high currents** to occur in V/F mode; the existing current monitoring function therefore remains active.

1651	**Signal number min/max memory**		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**100**	**–**

Input of signal number of memory location to be monitored by the min/max memory function.

Caution:

This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.

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Value table:

Signal number	**Signal designation**	**Scaling** (LSB corresponds to:)
0	Physical address	–
1	-	–
2	Current I_R	MD 1710
3	Current I_S	MD 1710
4	Current I_d	MD 1710
5	Current I_q	MD 1710
6	Current setpoint I_q (limited after filter)	MD 1710
7	Current setpoint I_q (before filter)	MD 1710
8	Motor speed actual value	MD 1711
9	Speed setpoint	MD 1711
10	Speed setpoint reference model	MD 1711
11	Torque setpoint (speed controller output)	MD 1713
12	Torque setpoint limit	MD 1713
13	Capacity utilization ($m_{set}/m_{set,limit}$) (see MD 1621)	8000H≙100%
14	Active power	0.01 kW
15	Rotor flux setpoint	MD 1712
16	Rotor flux actual value	MD 1712
17	Cross voltage U_q	MD 1709
18	Direct-axis voltage U_d	MD 1709
19	Current setpoint I_d	MD 1710
20	Motor temperature	0.1 °C
21	DC link voltage	1 V
22	Zero mark signal, motor measuring system	–
23	Bero signal	–
24	Absolute actual speed value	MD 1711
25	Slip frequency setpoint	$\frac{2000 \times 2}{800000H \times 1s^{-1}}$
26	Rotor position (electrical)	MD 1714
27	Torque setpoint speed controller	MD 1713
28	Compensation torque	MD 1713
29	Command voltage Q injection	MD 1709
30	Command voltage D injection	MD 1709

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1652	Memory location min/max memory		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

Input of address of memory location to be monitored via the min**/**max memory function.

Note:

This machine data is operative **only** if the signal number is set to 0 (see MD 1651).

Caution:

This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.

1653	Minimum value min/max memory		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0000 0000	**0000 0000**	**FFFF FFFF**	**Hex**

Output of display value of min**/**max memory minimum value.

1654	Maximum value min/max memory		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0000 0000	**0000 0000**	**FFFF FFFF**	**Hex**

Output of display value of min**/**max memory maximum value.

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1655	Segment memory location monitor		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**1**	**–**

This machine data addresses the memory location segment for the monitoring function.

Value table:

0	DSP address space X
1	DSP address space Y

MD 1655 defines the DSP address in conjunction with MD 1656 (offset address). The contents of the DSP address can be displayed via machine data "Value display monitor" (MD 1657).

Caution:

This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.

1656	Address memory location monitor		Active **at once**
Default value	Lower input limit	Upper input limit	Units
0000	**0000**	**FFFF**	**Hex**

This machine data addresses the memory location offset address for the monitoring function. MD 1656 defines the DSP address in conjunction with MD 1655 (memory location segment). The contents of the DSP address can be displayed via machine data "Value display monitor" (MD 1657).

Caution:

This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.

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1657	Value display monitor		Active at once
Default value	Lower output limit	Upper output limit	Units
0000 0000	0000 0000	FFFF FFFF	Hex

Output of monitoring function display value. This machine data displays the content of the address resulting from the segment (MD 1655) and the offset (MD 1656).

1658	Value input monitor		Active at once
Default value	Lower input limit	Upper input limit	Units
0000 0000	0000 0000	FFFF FFFF	Hex

A 24-bit value can be entered in this machine data. The value is written in the monitoring function to the address specified by the segment (MD 1655) and the offset (MD 1656). The value is not written until machine data "Value acceptance monitor" (MD 1659) has been set to 1.

Caution:

This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.

1659	Value acceptance monitor		Active at once
Default value	Lower input limit	Upper input limit	Units
0	0	1	–

This machine data writes the value (MD 1658) to the addressed memory location (MD 1655, MD 1656) if the value "1" has been entered to initiate the write operation. On completion of the write operation, the machine data is automatically reset to "0".

Caution:

This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.

1660	Motor frequency V/f mode (SW 4.4 only)		Active at once
Default value	Lower input limit	Upper input limit	Units
1.0	-10000.0	10000.0	Hz

Input of a setpoint frequency (electrical) for the drive in voltage-controlled V/f mode. The + or – sign corresponds to the appropriate direction of rotation of the motor.

Note:

- This machine data is only used for diagnostics and may only be used or applied by trained service personnel.

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1661	Ratio V/f during V/f mode (SW 4.4 only)		Active at once
Default value	Lower input limit	Upper input limit	Units
2.4	**0.0**	**100.0**	**V/Hz**

Input of a voltage**/**frequency ratio value for the drive in voltage-controlled V**/**F operation.

The following applies to the V_q voltage applied to the drive:

U_q = MD 1661 x MD 1660

Note:

- This machine data has a diagnostic function and may only be used or applied by trained service personnel.

1662	Change motor frequency V/F range (SW 4.4 only)		Active at once
Default value	Lower input limit	Upper input limit	Units
5.0	**0.0**	**10 000.0**	**Hz/s**

Input of a change in the motor frequency for V**/**F operation via frequency increment for the V**/**F ramp-up control to the electrical setpoint frequency of the drive.

Note:

- This machine data has a diagnostic function and may only be used or applied by trained service personnel.
-

1665	Op. time factor IPO/NREG cyc. f. RFG (SW 4.4 only)		Active at once
Default value	Lower input limit	Upper input limit	Units
2.0	**0.0**	**20.0**	**–**

Note:

This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.

Input of an operating time factor between interpolation and speed controller cycles for the ramp-function generator.

During ramp-up, the acceleration rate determined by the ramp specification of the SERVO may be higher than the rate which is actually permissible in the drive, i.e. the drive would continue to accelerate during relatively rapid reversing operations while the SERVO is already initiating a braking operation.

The ramp-function generator automatic control is provided to eliminate this problem. This automatic control ensures that the speed setpoint supplied by the SERVO is linked to the actual speed value of the 611D by means of a tolerance "± DELTA" in cases where the specified accelerate rate is too high. The ramp-function generator is then halted by means of the ZK3 operational message when DELTA (pos. ramp distance = ZK3 bit 7) or - DELTA (neg. ramp distance = ZK3 bit 6) is applied.

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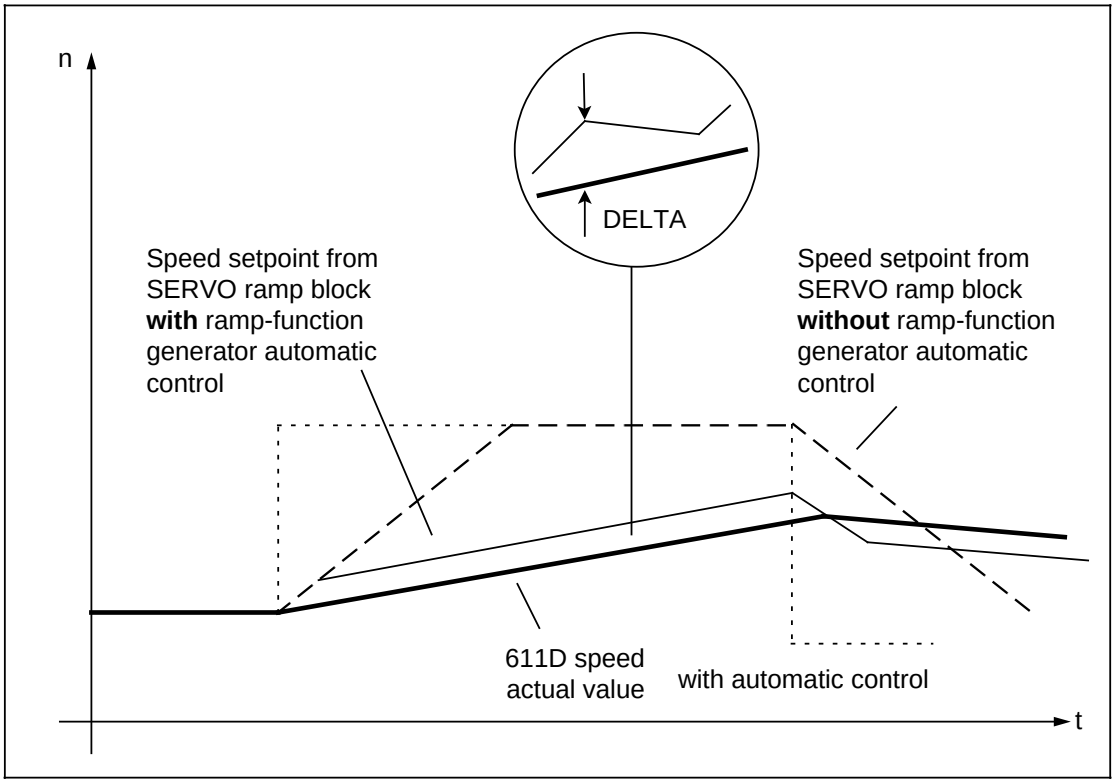
Examples:

1. $\left(\frac{n_{set}}{t} > 0 \; ; \; n_{set} - n_{act}\right)$ > DELTA (ZK3 Bit 7 halt ramp block)

2. $\left(\frac{n_{set}}{t} < 0 \; ; \; n_{set} - n_{act}\right)$ > – DELTA (ZK3 Bit 6 halt ramp block)

Graphic representation: Ramp-function generator with and without ramp-function generator automatic control



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When DELTA is calculated, it must be taken into account that the torque setpoint limitation $m_{set,limit}$ may change in cyclic operation. This limitation acts on the maximum speed difference n_{max}.

$$n_{max} = \frac{m_{set,\,limit}}{\text{n-controller P-gain}} \times \frac{\text{IPO cycle}}{\text{Speed controller cycle}}$$

Since the speed setpoint is specified by the NC, there is an operating time between the 611D speed controller and the NC which is taken into account in the DELTA calculation through machine data "Op. time factor IPO/NREG cyc. f. RFG" (MD 1665).

DELTA = n_{max} x MD 1665 (operating time factor)

Caution:

This machine data is relevant **only** for Siemens-internal purposes and **must not be altered**.

1700	**Status of binary inputs**		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0000	**0000**	**7FFF**	**Hex**

This machine data is used to display the status of the binary inputs.

Value table:

Bit 0	Control unit enable (internal module function), including marking according to MD 1003, bit 5	0: off 1: on
Bit 1	Pulse enable (terminal 663) (module-specific pulse suppression)	
Bit 2	Pulse enable (terminal 63**/**48) of I**/**RF unit (central drive pulse suppression)	
Bit 3	Sum signal HW pulse enable: – Stored hardware sum signal – Axial pulse enable by PLC via 611D control word	
Bit 4	Temp. monitor heat sink responded	
Bit 5	Setup mode (terminal 112) of I**/**RF unit (set-up mode message)	
Bit 6	Drive enable (terminal 64**/**63) of I**/**RF unit (Central drive enable setpoint = 0)	
Bit 7	Not assigned	
Bit 8	Motor and power section temp. prewarning	0: off 1: on
Bits 9-15	Not assigned	

1701	**DC link voltage**		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0**	**32 767**	**V**

This machine data is used to display the voltage level at the DC link in normal or set-up mode. The DC-link voltage V_{DClink} is measured continuously.

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1702	Motor temperature		Active at once
Default value	Lower output limit	Upper output limit	Units
0	0	32 767	°C

This machine data is used to display the motor temperature. The motor temperature is measured by appropriate sensors and evaluated in the drive.

1703	Lead time conver. motor meas. syst. (up to SW 4)		Active at once
Default value	Lower output limit	Upper output limit	Units
0	0	32 767	µs

This machine data is used to display or diagnose the lead time for the motor measuring system converters. A converter lead time is required if the converter times are greater than the ASIC cycle time. This machine data is valid only for indirect measuring systems.

1704	Lead time conversion dir. meas. sys. (up to SW 4)		Active at once
Default value	Lower output limit	Upper output limit	Units
0	0	32 767	µs

This machine data is used to display or diagnose the lead time for the motor measuring system converters. A converter lead time is required if the converter times are greater than the ASIC cycle time. This machine data is valid only for direct measuring systems.

1705	Voltage setpoint (effective) (as from SW 6)		Active at once
Default value	Lower output limit	Upper output limit	Units
–	–	–	V_{eff} (line-to-line)

Voltage setpoint display. The signal can be output via DAC.

MD 1705 = $\sqrt{U^2_{qset} + U^2_{dset}}$

1706	Speed setpoint		Active at once
Default value	Lower output limit	Upper output limit	Units
0.0	-100000.0	100000.0	rev/min

This machine data is used to display the speed setpoint which represents the unfiltered summation setpoint. It comprises the component of the position controller output and the speed feedforward control arm. Time-synchronous unlatching (scanning) of machine data MD 1706, MD 1707 and MD 1708 is not provided. The appropriate machine data is unlatched by the read request of the non-cyclical communications protocol.

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1707	Speed actual value		Active at once
Default value	Lower output limit	Upper output limit	Units
0.0	**-100000.0**	**100000.0**	**rev/min**

This machine data is used to display the actual speed value and represents the unfiltered actual speed value. Time-synchronous unlatching (scanning) of machine data MD 1706, MD 1707 and MD 1708 is not provided. The appropriate machine data is unlatched by the MMC request "Read variables" via the STF ES communications interface.

1708	Smoothed current actual value		Active at once
Default value	Lower output limit	Upper output limit	Units
0.0	**-100000.0**	**100000.0**	**%**

This machine data is used to display the smoothed current actual value. The torque-producing current actual value is smoothed by a PT1 element with the coefficient (MD 1250). In this case, the smoothed current actual value is displayed as a percentage. 100 % corresponds to the maximum current of the power section (e.g. with an 18/36A power section 100 % = 36A RMS).

1709	Significance voltage representation		Active at once
Default value	Lower output limit	Upper output limit	Units
0.0	**-100000.0**	**100000.0**	**–**

This machine data is used to display the significance of the voltage representation. The user is informed of the percentage significance of bit 0 so that he can assign the internal voltage status representation to the control setting of the pulse inverter. The maximum actuating voltage is available internally in standardized representation as a function of the pulse frequency.

V_{LSB}= MD 1709 = $\frac{V_{DC\ link}}{2}$

Note:

This machine data is calculated only once during power-up; it cannot therefore be changed during operation.

1710	Significance current representation		Active at once
Default value	Lower output limit	Upper output limit	Units
0.0	**-100000.0**	**100000.0**	**µA**

This machine data is used to display the significance of the current representation. The user is informed of the significance of bit 0 (internal current actual value representation) so that he can assign the internal current status representation to the physical ampere values. The maximum power section current is available internally in standardized representation.

Note:

This machine data is calculated only once during power-up; it cannot therefore be changed during operation.

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1711	Significance speed representation		Active at once
Default value	Lower output limit	Upper output limit	Units
0.0	**-100000.0**	**100000.0**	**rev/min**

This machine data is used to display the significance of the speed representation. The user is informed of the significance of bit 0 (internal speed actual value representation) so that he can assign the internal speed status representation to the physical rotation values. A speed is available internally in the units of the encoder system and referred to the currently valid speed controller cycle.

Note:

This machine data is calculated only once during power-up; it cannot therefore be changed during operation.

1712	Significance rotor flux represent.		Active at once
Default value	Lower output limit	Upper output limit	Units
0.0	**-100000.0**	**100000.0**	**µVs**

This machine data is used to display the significance of the rotor flux representation. The user is informed of the significance of bit 0 so that he can assign the internal rotor flux status representation to the physical values in Vs. The rotor flux scaling is available as an internal data.

Note:

This machine data is calculated only once during power-up and from the power ON data after every motor switchover.

1713	Significance torque representation		Active at once
Default value	Lower output limit	Upper output limit	Units
0.0	**-100000.0**	**100000.0**	**µNm**

This machine data is used to display the significance of the torque representation. The user is informed of the percentage significance of bit 0 so that he can assign the internal torque status representation.

Note:

This machine data is calculated only once during power-up from power ON data.

1714	Significance rotor position representation		Active at once
Default value	Lower output limit	Upper output limit	Units
-	**-100000.0**	**100000.0**	**Degrees**

This machine data is the display data of the significance of the rotor position representation. The user is given the significance of bit 0 so that he can assign the internal representation of the rotor position to the physical values in electrical degrees.

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1719	Current actual value (effective) (as from SW 6)		Active at once
Default value	Lower output limit	Upper output limit	Units
–	–	–	A_{eff}

Current actual value display. The signal can be output via DAC.

MD 1719 = $\sqrt{i^2_{qact} + i^2_{dact}}$

1720	CRC diagnosis parameter		Active at once
Default value	Lower output limit	Upper output limit	Units
0000	0000	FFFF	Hex

This machine data displays the CRC (cyclic redundancy check) errors which have been detected. The counter information is output on every read request and is 5 bits in width (bit 4...bit 0 or counter content 0...31).

Note:

It cannot always be assured that the CRC errors are assigned to the appropriate drives. With an incorrect address, the "wrong" module indicates the error (if present).

1721	Diagnosis speed actual value		Active at once
Default value	Lower output limit	Upper output limit	Units
0000	0000	FFFF	Hex

Display of the monitoring machine data "Diagnosis speed actual value". If an impermissibly large speed deviation occurs within the sampling period, then the value of the machine data is incremented. Sporadic responses by a few increments can be ignored since these do not influence the speed controller. A high disturbance level will cause the contents of MD 1721 to be increased repeatedly by several increments.

Possible causes of disturbances:

- Encoder shield not earthed
- Encoder defective
- Earth connection of electronics ground in MSD module faulty
- Motor earth not connected in MSD module
- Value entered for motor moment of inertia too high
- Evaluation electronics

Note:

The function is activated with MD 1610, bit 0, and the threshold entered in MD 1611.

1722	Capacity utilization		Active at once
Default value	Lower output limit	Upper output limit	Units
0	-100000.0	100000.0	%

Display machine data for utilization of drive capacity. The display shows the ratio "torque setpoint M_d to present torque limit $M_{dmax.}$" Values lower than 100% indicate system reserves.

Smoothing to obtain a steadier display of the signal can be set in MD 1251, time constant motor load.

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1723	Ramp-up time		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0**	**32767**	**ms**

Load test: The ramp-up time of the drive is indicated in this machine data. The ramp-up time is the time between one 0-1 edge of the control word signal "Ramp-function generator active" and the moment the actual speed enters the tolerance range around the setpoint speed defined by MD 1426.

Functionality in as from SW 6

If the speed actual value does not exceed the tolerance band by the speed setpoint, the ramp-up time is not evaluated, i.e. MD 1723=0. The ramp-up time is evaluated sensibly when the drive is operated at the torque limit, i.e. a greater setpoint-actual value difference remains. The setting for acceleration, MD 35200: GEAR_STEP_SPEEDCTRL_ACCEL, must be large enough.

Note:

If, for example, the acceleration suffices to follow the setpoint ramp in the lower speed range but not in the upper range, only the time during which the tolerance band was exceeded and not the ramp-up time is displayed.

1724	Diagnostics concentricity monitoring		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0**	**32767**	**–**

Load test: When concentricity monitoring is activated, this machine data counts how often the actual speed leaves the tolerance range around the setpoint speed defined by MD 1615. This machine data can only be read.

1725	Scaling torque setpoint interface		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0.0	**0.0**	**100000.0**	**Nm**

This machine data contains the reference value for the torque setpoints and limit values to be transferred from the NC to the drive.

Note:

This machine data is calculated only once during power-up from Power On data.

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1730	Operating mode (display)		Active at once
Default value	Lower output limit	Upper output limit	Units
0000	**0000**	**FFF**	**Hex**

This data indicates the current operating mode.

Bit 0	FDD	0: off 1: on
Bits 1-3	Not assigned	
Bit 4	MSD	0: off 1: on
Bits 5-11	Not assigned	
Bit 12	V/f	0: off 1: on

1731	Image ZK1-PO register		Active at once
Default value	Lower output limit	Upper output limit	Units
0000	**0000**	**FFFF**	**Hex**

This machine data displays the **internal** ZK1 Power On register. The machine data "Concealable alarms" (Power On MD 1600) is **not** taken into account for MD 1731.

Note:

This display value is reset only after Power On (hardware reset).
See drive MD 1600 for bit assignment.

1732	Image ZK1-RES register		Active at once
Default value	Lower output limit	Upper output limit	Units
0000	**0000**	**FFFF**	**Hex**

This machine data displays the **internal** ZK1 reset register. The machine data "Concealable alarms" (reset MD 1601) is **not** taken into account for MD 1732.

Note:

This display value can only be reset through an NC reset process (software reset).
See drive MD 1601 for bit assignment.

1733	NPFK diagnosis counter		Active at once
Default value	Lower output limit	Upper output limit	Units
0	**0**	**32 767**	**–**

This diagnostic machine data indicates how many times the motor temperature or DC link measurement executed by the low-priority frequency channel was erroneous, i.e. this data acts as an indirect hardware indicator (HW diagnostic statement) for the low-priority frequency channel.

Note:

This machine data is always reset when the drive is switched on.

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1735	CPU load (as from SW 6)		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0**	**100**	**%**

The processor capacity displays the remaining available CPU time online.

1790	Measuring circuit type indirect measuring system		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0**	**32 767**	**–**

This machine data displays the measuring circuit code number of the **indirect** measuring system (motor).

Value table:

0	Voltage raw signals
1-7	Reserved

1791	Measuring circuit type direct measuring system		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**-1**	**32 767**	**–**

This machine data displays the measuring circuit code number of the **direct** measuring system if one is inserted.

Value table:

-1	No measuring system present
0	Voltage raw signals
1	Current raw signals (FDD)
2-7	Reserved

1797	Data version		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0**	**32 767**	**–**

Output of present data version (machine data list).

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1798	Firmware date		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0**	**32 767**	**–**

Output of coded software version in decimal notation. The software version is output in the following form: DDMMY, where DD = day, MM = month and Y = last digit of the year.

Example: 01.06.1993 ≙ 01063_{dec}

1799	Firmware version		Active **at once**
Default value	Lower output limit	Upper output limit	Units
0	**0**	**32 767**	**–**

Output of present software version in decimal notation, e.g. 21000. The latter corrresponds to version 2.10**/**00.

Drive machine data MSD: 2nd motor

Drive machine data, MSD for 2nd motor are listed below.

They only differ from the 1st motor by a number, not in their meaning:

- the first number is 2.

Example

MD 1005 No. of encoder marks motor measuring system 1st motor
MD 2005 No. of encoder marks motor measuring system 2nd motor

The meaning of the MDs of the 2nd motor are identical to the MDs of the same name of the 1st motor: see description for 1st motor.

MD No. Motor 2	**Title**	**MD No. Motor 1**
2005	No. encoder marks motor measuring system	1005
2102	Motor code number (up to SW 4)	1102
2103	Motor rated current	1103
2117	Motor moment of inertia	1117
2119	Inductance of series reactor	1119
2120	P-gain current controller	1120
2121	Integral-action time current controller	1121
2125	Ramp-up time 1 for V**/**f operation	1125
2126	Ramp-up time 2 for V**/**f operation	1126
2127	Voltage when f=0 V**/**f operation	1127
2129	cos phi power factor	1129
2130	Motor rated power	1130

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MD No. Motor 2	Title	MD No. Motor 1
2132	Motor rated voltage	1132
2134	Motor rated frequency	1134
2135	Motor no-load voltage	1135
2136	Motor no-load current	1136
2137	Stator resistance cold	1137
2138	Rotor resistance cold	1138
2139	Stator leakage reactance	1139
2140	Rotor leakage reactance	1140
2141	Magnetizing reactance	1141
2142	Speed at start of field weakening	1142
2143	Upper speed L_h characteristic	1143
2144	Gain factor L_h characteristic	1144
2145	Breakdown torque reduction factor	1145
2146	Motor maximum speed	1146
2147	Speed limitation	1147
2150	P-gain flux controller	1150
2151	Integral-action time flux controller	1151
2160	Speed for start of flux detection	1160
2191	Adaptation servo limit torque	1191
2230	1st torque limiting value	1230
2231	2nd torque limiting value	1231
2232	Switching speed from M_{d1} to M_{d2}	1232
2233	Generative limitation	1233
2234	Hysteresis P: 1232	1234
2235	1st power limit value	1235
2236	2nd power limit value	1236
2238	Current limit	1238
2239	Torque limit setup mode	1239
2245	Threshold speed M. setp. smoothing	1245
2246	Hysteresis speed M. setp. smoothing	1246
2400	Motor rated speed	1400
2401	Maximum motor operational speed	1401
2403	Creep speed pulse suppression	1403
2405	Monitoring speed motor	1405
2407	P-gain speed controller	1407
2408	P-gain upper adaptation speed	1408
2409	Integral-action time speed controller	1409

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MD No. Motor 2	Title	MD No. Motor 1
2410	Integral-action time upper adaptation speed	1410
2411	Lower adaptation speed	1411
2412	Upper adaptation speed	1412
2413	Selection adaptation speed controller	1413
2414	Natural frequency ref. model speed	1414
2417	Message n_x for $n_{act} < n_x$	1417
2418	Message n_{min} for $n_{act} < n_{min}$	1418
2426	Tolerance band for $n_{set} = n_{act}$ message	1426
2602	Motor temperature warning threshold	1602
2607	Switchoff limit motor temperature	1607
2608	Fixed temperature	1608
2711	Significance speed representation	1711
2712	Significance rotor flux representation	1712
2713	Significance torque representation	1713
2714	Significance rotor position representation	1714
2725	Scaling torque setpoint interface	1725

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7.4 FDD/MSD-specific diagnosis/service machine data (as from SW 3)

7.4.1 Output of diagnosis/service machine data (as from SW 3)

The diagnosis/service machine data provide an overview and evaluation of signals and states of the FDD/MSD drives.

7.4.2 Servo service data (SSD)

3000	Acceleration (QEC – as from SW 4)		Active at once
Default value	Lower output limit	Upper output limit	Units
–	-9999999.9	9999999.9	mm/s^2

This machine data displays the acceleration rate at the instant at which the appropriate axis executed the last speed zero crossing when quadrant error compensation (QEC) is active. The display is called by means of softkey **Service QEC** in the "Circularity test" menu.

Note:

This machine data is effective only if one of the two quadrant error compensation modes is active.

3001	Compensation amplitude (QEC – as from SW 4)		Active at once
Default value	Lower output limit	Upper output limit	Units
–	-99999.999	99999.999	%

This machine data displays the compensation amplitude at the instant at which the appropriate axis executed the last speed zero crossing when quadrant error compensation (QEC) is active. The display is called by means of softkey **Service QEC** in the "Circularity test" menu.

Note:

This machine data is effective only if one of the two quadrant error compensation modes is active.

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3002	Quadrant error (QEC – as from SW 4)		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**-99999.999**	**99999.999**	**mm/ms**

This machine data displays the quadrant error plane at the instant at which the appropriate axis executed the last speed zero crossing when quadrant error compensation (QEC) is active. The display is called by means of softkey **Service QEC** in the "Circularity test" menu.

Note:

This machine data is effective only if one of the two quadrant error compensation modes is active.

3003	Duration of measurement (QEC – as from SW 4)		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**-99999999**	**99999999**	**ms**

This machine data displays the error measurement time at the instant at which the appropriate axis executed the last speed zero crossing. The display is called by means of softkey **Service QEC** in the "Circularity test" menu.

Note:

This machine data is effective only if one of the two quadrant error compensation modes is active.

7.4.3 Diagnosis/service MD (data description - as from SW 3)

10000-10014 10029[1)]	Drive configuration (as from SW 4)		Active on **Power on**
Default value	Lower output limit	Upper output limit	Units
0000	**0000**	**FFFF**	**Hex**

The "Drive configuration" machine data contains the descriptive information for a drive module which is actually installed. In the case of a two-axis module, the data contains two sets of information. Machine data 10000 to 10014 are assigned to physical addresses 1 to 15.

Bits 0 - 7	Drive number:	These bits assign the physical drive address to the logical drive number (1 - 15) for digital drives.
Bit 8	Active identifier:	0 ≙ positive (no machine data required) 1 ≙ active (used as control axis**/**machine data required)
Bits 9 - 11	Module type:	000 ≙ Single-axis module (1) 010 ≙ Two-axis module (left - 2L) 011 ≙ Two-axis module (right - 2R)
Bit 12	Drive type:	0 ≙ FDD 1 ≙ MSD

1) As from SW 5

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10100-10114 10119 [1]	Module order code (as from SW 4)	Active on **Power on**

Default value	Lower output limit	Upper output limit	Units
0	**0**	**65535**	**-**

The "Module order code" machine data contains the selected module in the form of a decimal code number. In the case of two-axis modules, the data contains two sets of information. Machine data 10100 to 10114 are assigned to physical addresses 1 to 15.

10200-10214 10229 [1]	Power section code (as from SW 4)	Active on **Power on**

Default value	Lower output limit	Upper output limit	Units
0000	**0000**	**FFFF**	**Hex**

The "Power section code" machine data contains the required or used amperages for the selected module according to the hexadecimal code number (see also MD 1106). In the case of two-axis modules, the data contains two sets of information. Machine data 10200 to 10214 are assigned to physical addresses 1 to 15.

10900	Data version (as from SW 4)	Active

Default value	Lower output limit	Upper output limit	Units
–	–	–	–

10901	Firmware version (as from SW 4)	Active

Default value	Lower output limit	Upper output limit	Units
–	–	–	–

10902	Firmware data (as from SW 4)	Active

Default value	Lower output limit	Upper output limit	Units
–	–	–	–

10903	Hardware configuration (as from SW 4)	Active

Default value	Lower output limit	Upper output limit	Units
–	–	–	–

10903.0 Mixed I/O
10903.1 DCM

1) As from SW 5

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11000	Ramp-up phase		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**0000**	**0505**	–

The "Ramp-up phase" machine data contains the control word for the ramp-up control of the 611D components. This machine data is provided for every logical, digital drive number. The high byte displays the ramp-up status as specified by the SERVO; the low byte displays the status acknowledged by the drive.

High byte Bits 8 - 15	Output of ramp-up status specified by SERVO
Low byte Bits 0 - 7	Output of ramp-up status acknowledged by the drive

11001	CRC error		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**0000**	**FFFF**	**Hex**

The "CRC error" machine data (cyclical error block check) contains 4 error counters for bus transmission errors between the NC and drive which have been detected by a hardware monitor.

Errors are detected by ASICs (DCM, DCS, PCU 0 and PCU 1) which are involved in the transmission.

The error counters are reset after an NCK power on reset and cease to be incremented once they have reached their maximum value.

The machine data is formatted as follows:

High byte Bits 12-15	Error counter DCM (Drive Communication Master)	: No. of errors on reading from the digital drive
High byte Bits 8-11	Error counter DCS (Drive Communication Slave)	: No. of errors on writing from the digital drive
Low byte Bits 4 - 7	Error counter PCU 1 (Position Control Unit≙Motor measuring system)	: Number of errors on writing to PCU 1
Low byte Bits 0 - 3	Error counter PCU 0 (Position Control Unit≙Direct measuring system)	: Number of errors on writing to PCU 0

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11002	Status word 1	Active after ramp-up of 611D link

Default value	Lower output limit	Upper output limit	Units
–	0000	FFFF	Hex

This machine data contains the low-order status bits (bits 0 - 15) of the cyclical status word at the interface between SERVO and 611D.

Bit 0	Status class 1 (ZK 1) message	0 : off 1 : on
Bits 1-6	Assigned to or reserved for internal system functions	
Bit 7 - SW 4	Motor switchover active	0 : off 1 : on
Bit 8	Set-up mode actual	0 : off 1 : on
Bit 9	Ramp-function generator rapid stop actual	
Bit 10	2nd torque limit actual	
Bit 11 - SW 4	Speed setpoint smoothing (filter 1) actual	
Bits 12-15	Assigned to or reserved for internal system functions	

11003	Status word 2	Active after ramp-up of 611D link

Default value	Lower output limit	Upper output limit	Units
–	0000	FFFF	Hex

This machine data contains the high-order status bits (bits 16-31) of the cyclical status word at the interface between SERVO and 611D.

Bits 0-2	Set of actual parameters	0 to 7_{Dec}
Bit 3	Motor selection actual	0 : star 1 : delta
Bit 4	Assigned to or reserved for internal system functions	
Bit 5	Drive ready	0 : off 1 : on
Bit 6	Integrator inhibit actual	
Bit 7	Pulse enable actual	
Bit 8	Current controller enable actual	
Bit 9	Speed controller enable actual	
Bit 10	Command variable actual	0 : torque 1 : speed
Bit 11	Master/slave operation actual	
Bit 12 - SW 4	U/f operation	0 : off 1 : on
Bit 13	Travel against fixed stop actual	
Bit 14	C axis mode actual	
Bit 15 - SW 4	Independent braking initiated (generative stop)	0 : off 1 : on

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11004	Status word 1		Active after ramp-up of 611D link
Default value	Lower output limit	Upper output limit	Units
–	0000	FFFF	Hex

This machine data contains the low-order status bits (bits 0-15) of the cyclical status word at the interface between SERVO and 611D.

Bit 0	DC link 1 reset	
Bit 1	Parking axis setpoint	0 : on 1 : off
Bits 2-4	Assigned to or reserved for internal system functions	
Bit 5	Function generator setpoint	0 : on 1 : off
Bit 6	Assigned to or reserved for internal system functions	
Bit 7 - SW 4	Ramp-function generator setpoint	0 : on 1 : off
Bit 8	Assigned to or reserved for internal system functions	
Bit 9	Ramp-function generator rapid stop setpoint	0 : off 1 : on
Bit 10	2nd torque limit setpoint	
Bit 11	Speed setpoint smoothing setpoint	
Bits 12-15	Assigned to or reserved for internal system functions	

11005	Status word 2		Active after ramp-up of 611D link
Default value	Lower output limit	Upper output limit	Units
–	0000	FFFF	Hex

This machine data contains the high-order status bits (bits 16-31) of the cyclical status word at the interface between SERVO and 611D.

Bits 0-2	Set of set parameters	0 to 7_{Dec}
Bit 3	Motor selection setpoint	0 : star 1 : delta
Bit 4	Assigned to or reserved for internal system functions	
Bit 5 - SW 4	Motor switchover	0 : off 1 : on
Bit 6	Integrator inhibit setpoint	
Bit 7	Pulse enable PLC setpoint	
Bit 8 - SW 4	Current controller enable setpoint	
Bit 9	Speed controller enable NC setpoint	

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Bit 10 - SW 4	Command variable	0 : torque 1 : speed
Bits 11-12	(Bit 11:) Master-slave operation setpoint	
Bit 13	Travel against fixed stop setpoint	0 : off 1 : on
Bit 14	C axis mode setpoint	
Bit 15	Sign of life	

11006	**Status class 2**		Active **after ramp-up of 611D link**
Default value	Lower output limit	Upper output limit	Units
–	**0000**	**FFFF**	**Hex**

This machine data contains the warnings of a digital drive. It is stored on an axis-specific basis at the interface between the SERVO and the 611D.

Bit 0	DC link (off≙DC link fault)	0 : off 1 : on
Bit 1 - SW 4	DC link voltage emergency retraction (MD 1634)	
Bit 2 - SW 4	Emergency retraction/generator mode active	
Bit 3 - SW 4	Generator speed < minimum speed	0 : on 1 : off
Bits 4-13	Assigned to or reserved for internal system functions	
Bit 14	Motor temperature warning	0 : off 1 : on
Bit 15	Heat sink temperature warning	

11007	**Status class 3**		Active **after ramp-up of 611D link**
Default value	Lower output limit	Upper output limit	Units
–	**0000**	**FFFF**	**Hex**

This machine data contains the warnings of a digital drive. The machine data is stored on an axis-specific basis at the interface between the SERVO and the 611D. For bits 6 to 15 there is no evaluation or connection to the PLC.

Bit 0 - SW 3	Programmable message 1	0 : off 1 : on
Bit 0 - SW 4	Ramp-up completed	
Bit 1 - SW 3	Programmable message 2	
Bit 1 - SW 4	I M_d I< M_{dx}	
Bit 2 - SW 3	Programmable message 3	

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Bit 2 - SW 4	I n_{act} I < n_{min}	0 : off 1 : on
Bit 3 - SW 3	Programmable message 4	
Bit 3 - SW 4	I n_{act} I < n_x	
Bit 4 - SW 3	Programmable message 5	
Bit 4 - SW 4	n_{soll} = n_{ist}	
Bit 5 - SW 3	Programmable message 6	
Bit 5 - SW 4	Variable message function	
Bit 6 - SW 4	(n_{set} - n_{act}) < DELTA (–)	
Bit 7 - SW 4	(n_{set} - n_{act}) > DELTA (+)	0 : off 1 : on
Bit 8 - SW 4	Actuating voltage $U_{stell(q)}$ > U_{max}	
Bit 9 - SW 4	Current setpoint I_{set} > I_{max}	
Bit 10	Assigned to or reserved for system-internal functions	
Bit 11 - SW 4	Set speed n_{set} > $n_{Uewa-Motor}$	0 : off 1 : on
Bit 12 - SW 4	Actuating voltage $U_{stell(d)}$ > U_{max}	
Bit 13 - SW 4	Torque setpoint m_{set} >m_{limit}	
Bits 14-15	Assigned to or reserved for system-internal functions	

11008	**Drive status**		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**0**	**5**	**–**

This machine data defines the ramp-up and operating status of the digital drives on an axis-specific basis. The status is generated during ramp-up in the SERVO and updated accordingly when the machine data is accessed.

Bit 0	Drive off
Bit 1	Drive on (after establishment of drive link)
Bit 2	On-line (communications connection between NC and drive)
Bit 3	Bootstrapping (drive must be booted)
Bit 4	Connected in (drive has ramped up to setpoint)
Bit 5	Ready (drive in control circuit, power connected) ≙ MD 11003.5

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11009	Capacity utilization (as from SW 4)		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**0000**	**7FFF**	**Hex**

This machine data specifies the capacity utilization of the digital drive as a percentage (0 ... 7FFF H≙ 0 ... 100%).

11010	Torque setpoint (as from SW 4)		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**-32 768**	**32 767**	–

This machine data specifies the torque setpoint of the digital drive as a percentage (-32768 ... 32767≙ -200% ... 200%). The torque corresponding to 100 % (internal notation 4000 H) is stored in machine data "Scaling torque setpoint interface" (MD 1725).

11011	Active power (as from SW 4)		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**-327.68**	**327.67**	**kW**

This machine data specifies the active power of the digital drive.

11012	Current actual value (as from SW 4)		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**-32 768**	**32 767**	–

This machine data specifies the current actual value of the digital drive as a percentage (-32768 ... 32767≙ -200% ... 200%). The limit current corresponding to 100 % (internal notation 4000 H) is stored in the machine data "Transistor limit current power section" (MD 1107).

11013	Speed actual value (as from SW 4)		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**-200**	**200**	**%**

This machine data specifies the current actual value of the digital drive. The actual speed value corresponding to 100 % (internal notation 4000 H) is stored in the machine data "Speed for max. motor operational speed" (MD 1401).

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12000	Position actual value		Active **at once**
Default value	Lower output limit	Upper output limit	Units
–	**-99999999**	**99999999**	–

Output of currently valid position actual value which is dependent on the position control for rotary axes (NC-MD 5640.5) and position control resolution (NC-MD 18000.0-3). The information is output in the drive service displays.

12001	v-max (FDD)/n-setpoint max (MSD) (as from SW 4)		Active
Default value	Lower output limit	Upper output limit	Units
–	–	–	–

12002	Position controller cycle (as from SW 4)		Active
Default value	Lower output limit	Upper output limit	Units
–	–	–	–

12003	Actual gear stage (as from SW 4)		Active
Default value	Lower output limit	Upper output limit	Units
–	–	–	–

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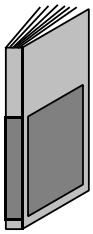
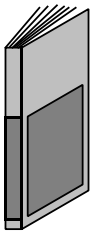
7.5 Safety Integrated (SI) data



Note:
The SINUMERIK Safety Integrated function is an option.
The Safety Integrated machine and service data are described in the documentation SINUMERIK Safety Integrated (Description of Functions).



END OF SECTION

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8 PLC Machine Data (PLC MD)

8.1 General

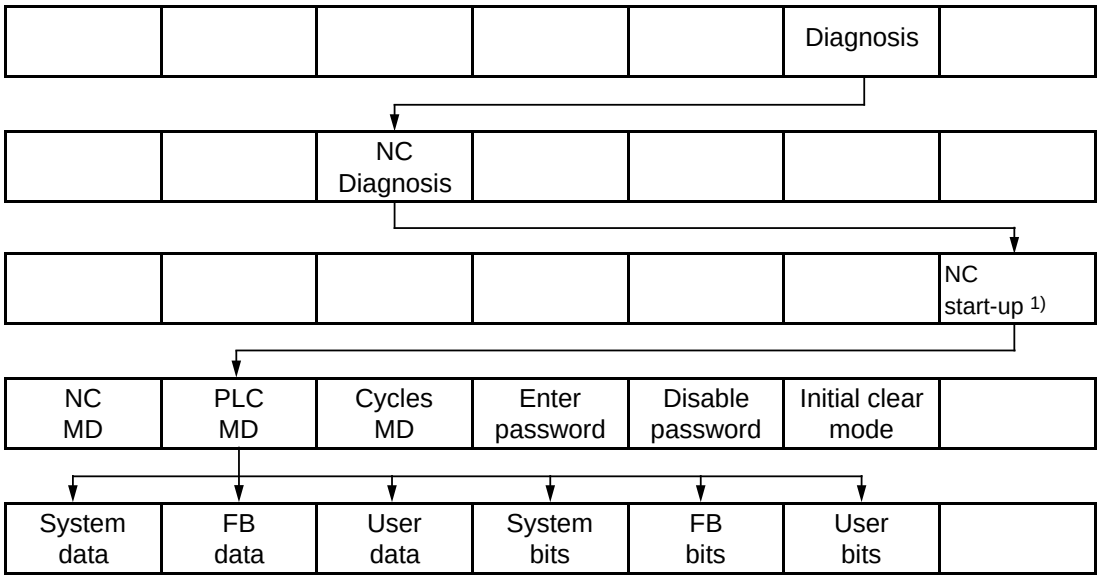
8.1.1 Entering PLC MD (up to SW 2)

You must set the PLC machine data (PLC MD) to adapt the PLC system program to the machine tool and to the PLC user program.

The PLC MD are transferred from the machine data area to the data blocks on a PLC cold restart. There they are available to the PLC user program. PLC MD cannot be entered directly into the data blocks.

The PLC MD that influence the PLC system program do take effect until a cold restart has been performed. (A cold restart is performed on a change from initial clear mode to normal mode).

Selecting PLC MD (up to SW 2)



You cannot modify the PLC MD until you have entered a password.

Note

The description of the functions of the bits always refer to the function that is active when the bit is **set**. The function that is active when the bit is **not** set is simply the negation of this description. MD not described have been set to zero either when the standard MC were loaded or when the control was started up, or they have been set to a default value indicating the control configuration.

Note

As from SW 3, start-up of the PLC-MD is performed in the MDD. For further details, refer to Section MDD.

1) *You can prevent selection of "NC start-up" with the key switch, if NC MD 5006 bit 5 = "1".*

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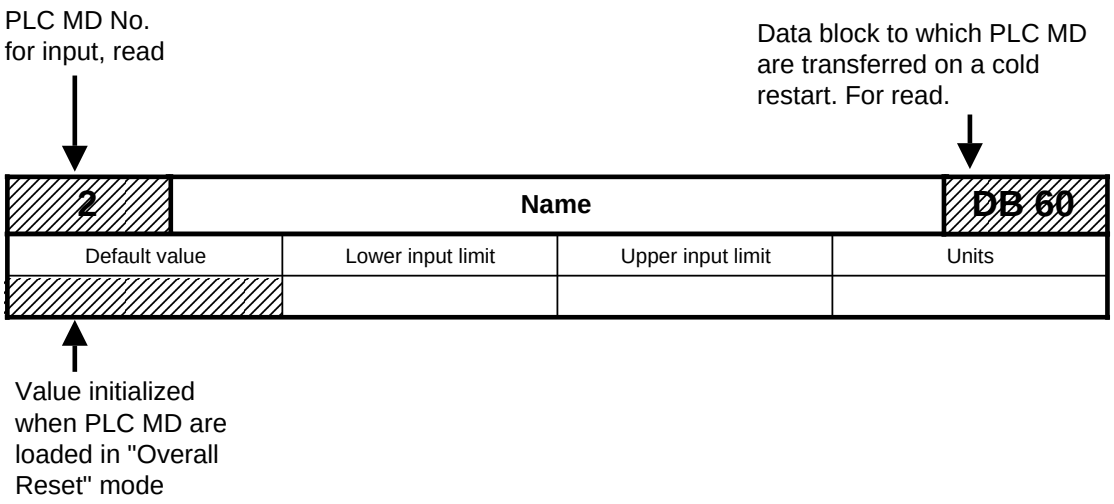
8.1.2 Breakdown of the PLC MD

PLC MD	DB	Description	Softkey	Section
0 to 839	DB60	MD for operating system	System data	8.2
2000 to 2849	DB61	MD for function blocks	FB data	8.3
4000 to 4049	DB62	MD for user	User data	8.4
6000 to 6599	DB63	MD bits for operating system	System bits	8.5
7000 to 7799	DB64	MD bits for function blocks	FB bits	8.6
8000 to 8199	DB65	MD bits for user	User bits	8.7

Example:



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8.2 PLC MD for the operating system (system data)

2	Time base for calling OB 5		DB 60 DW 2
Default value	Lower input limit	Upper input limit	Units
1	**+1**	**3**	**2.5 ms**

3	Time base for calling OB 6		DB 60 DW 3
Default value	Lower input limit	Upper input limit	Units
1	**+1**	**9**	**10 ms**

4	Time base for calling OB 7		DB 60 DW 4
Default value	Lower input limit	Upper input limit	Units
1	**+1**	**255**	**100 ms**

You can use the organization blocks OB 5, OB 6 and OB 7 for time-controlled program execution.

You can vary the time base by specifying a factor. This factor is specific to the block:

Blocks	Normal time base	Factor
OB 5	2.5 ms	1 to 3
OB 6	10 ms	1 to 9
OB 7	100 ms	1 to 255

You must not specify zero as a factor.
If you want to use OB 5, set PLC MD 6051.0 to 0 to enable OB 5 to be invoked. See also PLC MD 6050 (enable block for processing) and PLC MD6048 (processing delay).

5	Last STEP 5 timer		DB 60 DW 5
Default value	Lower input limit	Upper input limit	Units
64	**-1**	**+255**	**–**

The processing of timers causes a certain amount of work for the PLC operating system. Should a user program require e.g. only timers 1 to 20, entry of the number 20 tells the operating system that it should process only these timers. This saves processor time, and can even reduce the PLC cycle time.

An entry of "-1" disables **all** timers.

The extension to 255 is only possible with option N05; otherwise 127 timers are available.

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8 1)	Last active channel		DB 60 DW 8
Default value	Lower input limit	Upper input limit	Units
1	1	4	–

9 1)	Last active spindle		DB 60 DW 9
Default value	Lower input limit	Upper input limit	Units
1	1	6	–

10 1)	Last active axis		DB 60 DW 10
Default value	Lower input limit	Upper input limit	Units
3	1	30	–

These entries inform the PLC operating system of the numbers of the last channel, spindle and axis.

See also PLC MD 6000, 6012 and 6016

Example:

PLC-MD 8 = 4, PLC MD 6000 = 0000 0111

Informs the PLC operating system that channels 1, 2 and 3 can be processed.

The PLC operating system processes DB10, DB11 and DB12 and transfers them to the NC-PLC interface.

After each restart, the PLC system obtains the information required from the relevant NC machine data and stores it in the data blocks DB60 and DB63, which means that

- the other PLC MD remain active
- the PLC processes only those channels, spindles and axes actually defined via NC MD
- any changes in the number of channels, spindles or axes will become effective only after a PLC restart.

11	Last byte to reset in input image		DB 60 DW 11
Default value	Lower input limit	Upper input limit	Units
127	64	127	–

12	Last byte to reset in output image		DB 60 DW 12
Default value	Lower input limit	Upper input limit	Units
127	64	127	–

You can use this MD to specify the last input byte/output byte to be reset in the input image**/**output image on a cold or warm restart. This means that the bytes not used by the process peripherals can be utilized as additional retentive flag bytes.

---

1) As from SW 3, these PLC MDs are irrelevant.

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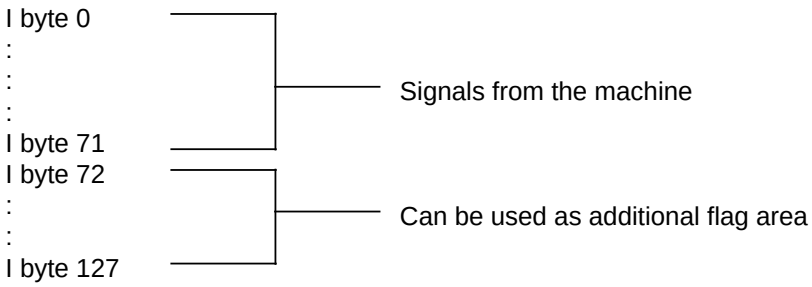
Example:

Value in PLC MD 11 = 71 when 1st machine control panel in PLC MD 128 is set to start address 64.



Max. 128 bytes on 135 WB

13	Reserved	DB 60 DW 13
14	Reserved	DB 60 DW 14

Default value	Lower input limit	Upper input limit	Units
0	**–**	**–**	**–**

17	No. of wait cycles for assigned UI	DB 60 DW 17

Default value	Lower input limit	Upper input limit	Units
1	**0**	**10**	**–**

This timeout is specified as the number of PLC cycles that are allowed to elapse before the user interface (UI) is enabled, and applies to all user interfaces on a PLC. When the timeout has expired, a negative acknowledgement is sent in response to a frame sent to the user interface.

Default value: 1 i.e. the user interface must be free again after one PLC cycle

Max. input value: 10 i.e. the user interface must be free again after ten PLC cycles

See also Computer Link

18	No. of the UI during synchronization	DB 60 DW 18

Default value	Lower input limit	Upper input limit	Units
0	**0**	**31**	**–**

A frame sent to the host computer can be output only via this user interface during synchronization. See Computer Link.

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19	No. of function numbers		DB 60 DW 19
Default value	Lower input limit	Upper input limit	Units
3	**0**	**10**	**–**

Number of function numbers for a UI kernel sequence initiation.

Input values:
0 = UI kernel sequence initiation not allowed in this PLC

1...10 (max.) = UI kernel sequence initiation allowed.
The input value specifies the number of function numbers, beginning with MD DB60, DW20, for a UI kernel sequence initiation.

3 = Default value

See Computer Link.

20-29	Function no. for kernel sequence initiation		DB 60 DW 20-29
Default value	Lower input limit	Upper input limit	Units
see table	**0**	**255**	**–**

Default value	
MD	**Value**
20	25
21	26
22	30
23 . . 29	0 . . 0

See Computer Link.

30	No. of interrupt byte on interface PLC/PLC 135 WD		DB 60 DW 30
31	**Spare**		DB 60 DW 31
Default value	Lower input limit	Upper input limit	Units
- 1	**- 1**	**127**	**–**

This tells the PLC operating system the number of the interrupt byte to be processed on the interface module.

Enter - 1 if no byte is to be processed. If a high-speed input is to be processed, it must be interfaced over the IF PLC module's X141 connector. There can be as many as eight inputs. The relevant input byte is specified in this MD.

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You can enable the individual bits in PLC MD 6052, and set the positive or negative edge to be evaluated in PLC MD 6055. A rapid input is possible only when bit 0 of PLC MD 6051 is set to "0". OB2 is invoked when bit 2 of PLC MD 6050 is "0".

33	**No. of user interfaces command channel**		**DB 60 DW 33**
Default value	Lower input limit	Upper input limit	Units
0	**0**	**8**	**–**

Here you can set the number of user interfaces in DB41. You must enable the function in PLC MD 6026, bit 1. The value 8 in MD 33 means that the user can enter a maximum of 8 job requests in DB 41.

You should not enter a larger value than necessary, as the PLC OS scans the requests every 20 ms (affecting the runtime of the PLC program). The following functions can be initiated over the command channel:

- S external
- Coupled motion of axes (with option 6FC5 150-0AS02-0AA0)
- Transmit (with option 6FC5 150-0AD04-0AA0)
- Division increment
- Position specification
- M19 through several revolutions

34 - 123	**Start addresses of DMP submodules, DMP IM, lines**		**DB 60 DW 34-123**
Default value	Lower input limit	Upper input limit	Units
see table	**- 1**	**254**	**–**

DMP = Distributed machine peripherals (byte number).

MD 34 to 123 define the start addresses of the input and outputs for each DMP submodule interfaced. At the same time, the PLC and the DMP interface submodule check, service and monitor the submodules.

Enter - 1 if no DMP submodule is interfaced. PLC MD 94 defaults to 64, thus interfacing the signals from the machine control panel, beginning with input/output byte 64, to the IF PLC.

Notes:

- See the Interface Description, Part 2 for a detailed description.
- Central interrupts and DMPs generating interrupts must not be used at the same time.

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Table for MD 34 to 123

	PLC MD, DB60 DW	Interface	MPC line No.	Terminal block No.	PLC MD standard value	Terminal block rotary switch position
1ST INT DMP	34	1	1 MPC LINE 1 CONNECTOR X111 OR X121	1	- 1	E
	35	1	1	2	- 1	D
	36	1	1	3	- 1	C
	37	1	1	4	- 1	B
	38	1	1	5	- 1	A
	39	1	1	6	- 1	9
	40	1	1	7	- 1	8
	41	1	1	8	- 1	7
	42	1	1	9	- 1	6
	43	1	1	10	- 1	5
	44	1	1	11	- 1	4
	45	1	1	12	- 1	3
	46	1	1	13	- 1	2
	47	1	1	14	- 1	1
	48	1	1	15	- 1	0
	49	1	2 MPC LINE 2 CONNECTOR X131 OR X141	1	- 1	E
	50	1	2	2	- 1	D
	51	1	2	3	- 1	C
	52	1	2	4	- 1	B
	53	1	2	5	- 1	A
	54	1	2	6	- 1	9
	55	1	2	7	- 1	8
	56	1	2	8	- 1	7
	57	1	2	9	- 1	6
	58	1	2	10	- 1	5
	59	1	2	11	- 1	4
	60	1	2	12	- 1	3
	61	1	2	13	- 1	2
	62	1	2	14	- 1	1
	63	1	2	15	- 1	0
2ND INT DMP (NOT SW1+2)	64	2	1 MPC LINE 1 CONNECTOR X111 OR X121	1	- 1	E
	65	2	1	2	- 1	D
	66	2	1	3	- 1	C
	67	2	1	4	- 1	B
	68	2	1	5	- 1	A
	69	2	1	6	- 1	9
	70	2	1	7	- 1	8
	71	2	1	8	- 1	7
	72	2	1	9	- 1	6
	73	2	1	10	- 1	5
	74	2	1	11	- 1	4
	75	2	1	12	- 1	3
	76	2	1	13	- 1	2
	77	2	1	14	- 1	1
	78	2	1	15	- 1	0

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	PLC MD, DB60 DW	Interface	MPC line No.	Terminal block No.	PLC MD standard value	Terminal block rotary switch position
2ND INT DMP (NOT SW1+2)	79	2	2 MPC LINE 2 CONNECTOR X131 OR X141	1	- 1	E
	80	2	2	2	- 1	D
	81	2	2	3	- 1	C
	82	2	2	4	- 1	B
	83	2	2	5	- 1	A
	84	2	2	6	- 1	9
	85	2	2	7	- 1	8
	86	2	2	8	- 1	7
	87	2	2	9	- 1	6
	88	2	2	10	- 1	5
	89	2	2	11	- 1	4
	90	2	2	12	- 1	3
	91	2	2	13	- 1	2
	92	2	2	14	- 1	1
	93	2	2	15	- 1	0
INT PLC	94	3	1 MPC LINE 1 CONNECTOR X111 OR X121	1	64	E
	95	3	1	2	- 1	D
	96	3	1	3	- 1	C
	97	3	1	4	- 1	B
	98	3	1	5	- 1	A
	99	3	1	6	- 1	9
	100	3	1	7	- 1	8
	101	3	1	8	- 1	7
	102	3	1	9	- 1	6
	103	3	1	10	- 1	5
	104	3	1	11	- 1	4
	105	3	1	12	- 1	3
	106	3	1	13	- 1	2
	107	3	1	14	- 1	1
	108	3	1	15	- 1	0

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124	Byte no. of 1st alarm byte		DB 60 DW 124
125	Byte no. of 2nd alarm byte		DB 60 DW 125
126	Byte no. of 3rd alarm byte		DB 60 DW 126
127	Byte no. of 4th alarm byte		DB 60 DW 127
Default value	Lower input limit	Upper input limit	Units
- 1	**- 1**	**127 (SW 4 and higher)**	**–**

This PLC MD can be used to define as many as 4 input bytes as alarm bytes. The PLC software scans these bytes for changes every 10 ms. Enter - 1 for input bytes that are not to serve as alarm bytes.

The PLC outputs an error message and goes to STOP if illegal values are detected on a cold restart.

If enabled in PLC MD 6050, bit 3 (bit 3 = 0), OB 3 is invoked when an alarm is generated.

128	Address 1st machine control panel		DB 60 DW 128
Default value	Lower input limit	Upper input limit	Units
64	**0**	**127 (SW 4 and higher)**	**–**

129	Address 2nd machine control panel		DB 60 DW 129
Default value	Lower input limit	Upper input limit	Units
72	**0**	**127 (SW 4 and higher)**	**–**

These PLC MD specify the start address (byte) for the machine control panels.

Eight bytes are required for each control panel. The inputs and outputs for each control panel have the same address numbers.

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Machine data words for PLC operating system (DB 60)				
DW No. PLC MD No.	High byte (DL)		Low byte (DR)	
DW 130 MD 130	Address interrupt byte Default setting=–1		–1 ... 254	
DW 131 MD 131	Address interrupt byte Default setting=–1		–1 ... 254	
DW 132 MD 132	Address interrupt byte Default setting=–1		–1 ... 254	
DW 133 MD 133	Address interrupt byte Default setting=–1		–1 ... 254	
DW 134 MD 134	Address interrupt byte of interface PLC/PLC 135 WD Default setting=–1		–1 ... 254	
DW 135 MD 135	Spare Default setting=–1		–1 ... 254	
DW 136 MD 136	Free configuring data block Default setting=0 (no DB)	DB 1 - 255 DX 0 - 255	1 ... 255 1000 ... 1255	
DW 137 MD 137	OEM information bits FW (MMC PLC IF) 1) 2)			

Note:

For configuration see Interface Description, Part 1, Signals, Section 2.11, Configuration of the distributed machine peripherals (DMP).

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* *Not software version 1*

1) *As from SW 3*

2) *Description in OEM package*

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8.3 PLC MD for function blocks (FB data)

2000 to 2077	PLC MD values for tool management package		DB 61 DW 0 - 77
Default value	Lower input limit	Upper input limit	Units
0			–

For values and their meanings, refer to the Tool Management description.

2078 to 2089	PLC MD values for computer link package		DB 61 DW 78 - 89
Default value	Lower input limit	Upper input limit	Units
0			–

For values and their meanings, see the Computer Link description.

2090	PLC MD values for load package		DB 61 DW 90
Default value	Lower input limit	Upper input limit	Units
0			–

For values and their meanings, see the Package 0 description.

2096 to 2119	PLC MD values for computer link package		DB 61 DW 96 - 119
Default value	Lower input limit	Upper input limit	Units
0			–

2120 to 2139	PLC MD values for tool management package		DB 61 DW 120-139
Default value	Lower input limit	Upper input limit	Units
0			–

8.4 PLC MD for the user

4000 to 4255	PLC MD values for user		DB 62 DW 0 - 255
Default value	Lower input limit	Upper input limit	Units
0	0	65535	–

A special area comprising 50 PLC MD words is available to the user to do with it as he sees fit. This area can be used, for example, to match the user's machine program to the machine configuration (also see PLC MD 8000 to 8255).

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8.5 PLC MD for the operating system (system bits)

PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6000 1) DL 0					Signals from/to NC channel			
			6 2)	5 2)	4	3	2	1

Default value: 0000 1111

This MD is used to enable the interchange of channel signals between NC and PLC. Because the 840 system has a one-channel basic configuration, bit 0 must be "1". If there are several channels, you must set the bits corresponding to the channels in this MD.

The highest channel number is specified for the PLC software in PLC MD 8. Options D32, D33 and D34 enable the use of as many as 4 channels (as from SW 4: 6 channels).

PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6009 DR 4					M decoding with ext. address channel			
			6 2)	5 2)	4	3	2	1

Default value: All bits default to 0

M DECODING WITH EXTENDED ADDRESS FOR NC CHANNEL (1 TO 4)

Bit = 0 No M decoding with extended address

Bit = 1 M decoding with extended address

Note:

The relevant data block (DB 80 - DB 83) must be loaded to enable M decoding with extended address. If the bit is set but the DB has not been loaded, the PLC goes into the STOP loop (for a list of errors, see the Installation Lists).

After each restart, the PLC system obtains the information required from the relevant NC machine data and stores it in the data blocks DB60 and DB63, which means that

- the other PLC MD remain active
- the PLC processes only those channels, spindles and axes actually defined via NC MD
- any changes in the number of channels, spindles or axes will become effective only after a PLC restart.

1) As from software version 3, these PLC MD are irrelevant, they are only used for display purposes

2) SW 4 and higher

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PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6012 1) DL 6			Signals from/to spindle 6	5	4	3	2	1

Default value: 0000 0001

This MD enables the interchange of spindle signals between NC and PLC. As the basic configuration of the 840T includes only one spindle, bit 0 must be "1".

If more than one spindle is available, you must set the bits corresponding to the channels in this MD. The highest spindle number is entered in PLC MD 9. Options E41, F05 and F06 enable the use of as many as six spindles.

PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6016 1) DL 8	Signals from/to axis 8	7	6	5	4	3	2	1
6017 1) DR 8	Signals from/to axis 16	15	14	13	12	11	10	9
6018 1) DL 9	Signals from/to axis 24	23	22	21	20	19	18	17
6019 1) DR 9	Signals from/to axis		30	29	28	27	26	25

Default value: MD 6016 0000 0111
MD 6017 0000 0000

Use this MD to enable the signals of the axes between the NC and the PLC. As the basic configuration of the 840T includes two axes, bits 0 and 1 in MD 6016 must be set to "1".

If there are more than two axes, the corresponding bits must be set in this MD.
The highest axis number is specified in PLC MD 10.

Fictitious axes for transformation (option 6FC5 150-0AD04-0AA0) must also be declared in the PLC MDs. Options A01 to A06 provide for more than two real axes.

After each restart, the PLC system obtains the information required from the relevant NC machine data and stores it in the data blocks DB60 and DB63, which means that

- the other PLC MD remain active
- the PLC processes only those channels, spindles and axes actually defined via NC MD
- any changes in the number of channels, spindles or axes will become effective only after a PLC restart.

1) As from software version 3, these PLC MD are irrelevant, they are only used for display purposes

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PLC MD DB63 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
6026 DL 13	Enable serial interface DB37	Enable init in same channel	Deselect autom. NC START INHIBIT with MDA		Save flag area	Access to PLC data inhibited with @	Command channel enabled	

Default value: 1000 000

Bit 7 When bit 7 is set, data can be read in and out via the computer link interface with DB 37.

Bit 6 = 1: Funktion Init im eigenen Kanal wird freigegeben.

Bit 5 = 1: NC start is issued to all channels (even if ”NC start inhibit” is active). It is up to the passed to make sure that NC start is not passed to the NC (DB 10-13, D 20).

Bit 3 = 0: Save flags 224 - 255 (default setting) when changing processing level

Bit 3 = 1: Save flags 200 - 255 when changing processing level

Bit 5 = 0: On MDA mode, NC start is only passed to the selected channel. NC start is **not** passed to those channels signalling ”NC start inhibit” (DBs 10-13, D 16-15).

Note:

The MD is **not** active when using the ”Overstore” function. With ”Overstore”, NC start is **always** prevented from becoming active in a non-selected channel.

Bit 2 Access to PLC data over @ commands is disabled.

Bit 1 The command channel function is enabled. The number of user interfaces is specified in PLC MD 33. See PLC MD 33.

PLC MD DB63 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
6029 DR 14					Signal T/H word routing target channel suppressed			T/H word routing active

Default value: 0

Bit 0 **Bit = 0** T and H words are output to the programmed channel DB only. Also see the Interface Description.

Bit = 1 T/H words can be routed to different channel DBs over the extended T/H address.

Bit 3 As long as interface signal DB 10 to 13, DR 63.6 is set to "1", machine data bit 6029.3 has the following effect:

Bit = 0 The signal "Route T/H word" from the source channel to the programmed target channel is suppressed.

Bit = 1 The signal "T/H word routing" is suppressed in the target channel.

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PLC MD DB63 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
6030 DL 15					Error/operational messages on inactive channels [1]			
					4	3	2	1

Default value: All bits default to 0

0 signal: Corresponding **inactive** channel DB is not used to activate error/operational messages.

1 signal: The inactive channel DB is used to activate error/operational messages.

Example:

0	0	0	0	0	0	1	1	PLC MD 6000

Only the error bits in the active channel DBs (DB10, DB11) for channels 1 and 2 are evaluated.

0	0	0	0	1	1	0	0	PLC MD 6030

The error bits in the inactive channel DBs (DB12, DB13) for channels 3 and 4 are also evaluated.

Note:

If an error bit is set in an inactive channel DB that is used for the extended display of error and operational messages, then the corresponding errors are **not** included in the message group displays.

You are not permitted to assign PLC channels (MD 6000) while the display of error and operational messages for **unused** channels (MD 6030) is active, as it would result in corruption and falsification of the displays. Also refer to the PLC Installation Section.

Example: MD 6000.0 = 1 and
MD 6030.0 = 1

---

1) No longer exists from SW 4 onwards, new alarm concept

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PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6032 DL 16	Alarm channel DB DR 9	DL 9	DR 8	DL 8	DR 7	DL 7	DR 6	DL 6
6033 DR 16	Alarm channel DB				DR 11	DL 11	DR 10	DL 10

Default value: All bits default to 0

Bit = 0 The system software does not evaluate the bits in the corresponding interface byte for error messages.

Bit = 1 The system software evaluates the bits in the corresponding interface byte for error messages.

Note:

The bit applies to all channels. If the **corresponding** bit is also set for operational messages (PLC MD 6040/6041), the PLC goes into the stop loop in the startup routine.

Sample application:

Error message evaluation when a DR8 bit is "1": PLC MD 6032.5=1
Bit 9.5 in channel 2 (DB 11) results in output of error message number 6145 (see PLC Installation Section).

PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6034 DL 17	Alarm DB 31						DR k+3	DL k+3

Default value: All bits default to 0

K = 0, 4, 8, 12, 16, 20 (1st to 6th spindle)

Bit = 0 The system software does not evaluate the bits in the corresponding interface byte for error messages.

Bit = 1 The system software evaluates the bits in the corresponding interface byte for error messages.

Notes:

1) The bit applies to **all** spindles.

2) If the **corresponding** bit is also set for operational messages (PLC MD 6042), the PLC goes into the stop loop in the startup routine.

Sample application:

DB 31 D 7.9 1 signal error message 8021;
PLC MD 6034.0= 1 (See PLC Installation Section)

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PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6035 DR 17	Alarm DB 32						DR k+3	DL k+3

Default value: All bits default to 0

K = 0, 4, 8, 12, ... 116 (1st to 30th axis)

Bit = 0 The system software does not evaluate the bits in the corresponding interface byte for error messages.

Bit = 1 The system software evaluates the bits in the corresponding interface byte for error messages.

Notes:

1) The bit applies to **all** axes.
2) If the identical bit is also set for operational messages (PLC MD 6043), the PLC goes into the Stop loop.

Sample application:

DB 32 D 3.3 1 signal error message 8211;
PLC MD 6035.1= 1

See PLC Installation Section.

PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6036 DL 18	Alarm DB 58 DR 4	DL 4	DR 3	DL 3	DR 2	DL 2	DR 1	DL 1
6037 DR 18	Alarm DB 58 DR 8	DL 8	DR 7	DL 7	DR 6	DL 6	DR 5	DL 5
6038 DL 19	Alarm DB 58 DR 12	DL 12	DR 11	DL 11	DR 10	DL 10	DR 9	DL 9
6039 DR 19	Alarm DB 58	DL 16	DR 15	DL 15	DR 14	DL 14	DR 13	DL 13

Default value: All bits default to 0

Bit = 0 The system software does not evaluate the bits in the corresponding interface byte for error messages.

Bit = 1 The system software evaluates the bits in the corresponding interface byte for error messages.

Note:

If the identical bit is also set for operational messages (PLC MD 6044-6047), the PLC goes into the Stop loop.

Sample application:

DB 58 D 3.10 1 signal error message 9034;
PLC MD 6039.4 = 1

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PLC MD DB63 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
6040 DL 20	Signal channel DB							
	DR 9	DL 9	DR 8	DL 8	DR7	DL 7	DR 6	DL 6
6041 DR 20	Signal channel DB							
					DR 11	DL 11	DR 10	DL 10

Default value: All bits default to 0

Bit = 0 The system software does not evaluate the bits in the corresponding interface byte for operational messages.

Bit = 1 The system software evaluates the bits in the corresponding interface byte for operational messages.

Notes:

1) The bit applies to **all** NC channels.
2) If the same bit is also set for error messages (PLC MD 6032, 6033), the PLC goes into the Stop loop.

Sample application:

DB 10 D 6.8 1 signal operational message 6000;
PLC MD 6040.0= 1
See PLC Installation Section.

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PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6042 DL 21	Signal DB 31							
							DR k+3	DL k+3

Default value: All bits default to 0

K = 0, 4, 8, 12, 16, 20 (1st to 6th spindle)

Bit = 0 The system software does not evaluate the bits in the corresponding interface byte for operational messages.

Bit = 1 The system software evaluates the bits in the corresponding interface byte for operational messages.

Notes:

1) The bit applies to **all** spindles.
2) If the same bit is also set for error messages (PLC MD 6034), the PLC goes into the Stop loop.

Sample application:

DB 31 D 7.1 1 signal operational message 8029;
PLC MD 6042.1= 1
See PLC Installation Section.

PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6043 DR 21	Signal DB 32							
							DR k+3	DL k+3

Default value: All bits default to 0

K = 0, 4, 8, 12, ... 116 (1st to 30th axis)

Bit = 0 The system software does not evaluate the bits in the corresponding interface byte for operational messages.

Bit = 1 The system software evaluates the bits in the corresponding interface byte for operational messages.

Notes:

1) The bit applies to **all** axes.
2) If the same bit is also set for error messages (PLC MD 6035), the PLC goes into the Stop loop.

Sample application:

DB 31 D 7.1 1 signal operational message 8029;
PLC MD 6042.1= 1
See PLC Installation Section.

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PLC MD DB63 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
6044 DL 22	Signal DB 58							
	DR 4	DL 4	DR 3	DL 3	DR 2	DL 2	DR 1	DL 1
6045 DR 22	Signal DB 58							
	DR 8	DL 8	DR 7	DL 7	DR 6	DL 6	DR 5	DL 5
6046 DL 23	Signal DB 58							
	DR 12	DL 12	DR 11	DL 11	DR 10	DL 10	DR 9	DL 9
6047 DR 23	Signal DB 58							
		DL 16	DR 15	DL 15	DR 14	DL 14	DR 13	DL 13

Default value: All bits default to 0

Bit = 0 The system software does not evaluate the bits in the corresponding interface byte for operational messages.

Bit = 1 The system software evaluates the bits in the corresponding interface byte for operational messages.

Note:

If the same bit is also set for error messages (PLC MD 6036 to 6039), the PLC goes into the Stop loop.

Sample application:

DB 58 D 5.1 1 signal operational message 9073;
PLC MD 6045.1 = 1

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PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6048 DL 24	Stop during processing delay by							
	OB 7	OB 6	OB 5	OB 4	OB 3	OB 2		

Default value: 1111 1100

Bit = 0 A delay in the relevant OB does not force the programmable controller to STOP.

Bit = 1 A delay in the relevant OB forces the programmable controller to STOP.

Note:

If you do not want the programmable controller to go to STOP when there is a processing delay in an OB, you must make use of a bit in flag byte 6 which is set when such a delay occurs. The user program can scan this bit and take any appropriate measures.

PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6049 DR 24						OB1 without minimum cycle time	Cold restart on RESET	Access to link bus

Default value: 0

Bit 0 For installation and for testing the STEP 5 program.

Bit = 0 No precise cause for a time-out during bus access can be displayed. In standard operations, this bit must be 0.

Bit = 1 The exact cause of a time-out (QVZ) is displayed as one item of precision error detection data (135 WB PLC). Bus access or the STEP 5 program is **slower**.

The bus interface executes a write access to the link or local bus while the processor receives an acknowledgement and continues operation (buffered access to local**/**link bus). Should a timeout occur during this type of write access, no deductions can be made regarding its cause by inspecting the state of to the processor and coprocessor registers.

The user can switch off buffered access to link and local bus via machine data (PLC operating system MD bits 6049.0 (e.g. if he wishes to test STEP 5 programs during start-up). However, this type of access operates is slower as the processor only receives an acknowledgement once the entire bus cycle is completed.

You must set machine data 6048.0 to be able to determine the exact cause of the timeout.

Bit 1 = 0 No IP**/**WF modules used (standard)

Bit 1 = 1 IP**/**WF modules inserted, a cold restart is enforced after every RESET.

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6049, **bit 2 = 0** PLC minimum cycle time switched on (default setting).

6049, **bit 2 = 1** PLC minimum cycle time switched off, i.e. the PLC cycle time is derived from the running time of the user program.

If the PLC minimum cycle time is switched off with PLC machine data 6049, bit 2, the user himself must maintain the VDI signals for at least twice the IPO sampling time.

PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6050 DL 25	Disable OB 7	OB 6	OB 5	OB 4	OB 3	OB 2		

Default value: 1111 1100

Bit 2-7 **Bit = 0** The OB referred to is enabled for processing.

Bit = 1 The OB is disabled for processing and is not invoked by the system program.

PLC MD DB63 DW No.	Bit No. 7	6	5	4	3	2	1	0
6051 DR 25							Program-mer mode	Special mode

Default value: 0000 0011

Bit 1 **Bit = 0** The programmer displays 155U as CPU identifier

Bit = 1 The programmer displays 135 WB as CPU identifier

See Section 3

For OB 5, also see PLC MD 2
For OB 2, also see PLC MD 30, 6032 and 6055

Bit 0 **Bit = 0** Level change possible after each STEP 5 statement (special mode).

Bit = 1 Level change (e.g. OB 6 interrupts OB 1) possible at block boundaries only (same performance as 130 WB PLC in normal mode).

Note:

You must set the bit for "PLC mode" to 0 if OB 2 and OB 5 are to be invoked. If this bit is "1", the OBs are not processed even if they have been loaded into the programmable controller.

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PLC MD DB63 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
6052 DL 26	Enable central interrupt byte IF PLC/PLC 135 WD							
	7	6	5	4	3	2	1	0
6053 DR 26	Reserved							
	7	6	5	4	3	2	1	0

Default value: 0

An EU interface module's eight interrupt inputs can be enabled separately.

Bit = 0 Input is disabled

Bit = 1 Input is enabled for OB 2 call

Also see PLC MD 30.

PLC MD DB63 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
6055 DR 27	Edge central interrupt byte IF PLC/PLC 135 WD							
	7	6	5	4	3	2	1	0
6056 DL 28	Reserved							
	7	6	5	4	3	2	1	0

Default value: 0

A signal change at an EU IM interrupt input triggers the interrupt that invokes OB 2 (enable via PLC MD 6052). The signal edge (i.e. positive or negative edge) that is to trigger the interrupt can be specified separately for each interrupt input.

Bit = 0 Positive edge triggers interrupt

Bit = 1 Negative edge triggers interrupt

The system program checks the machine data for the interrupt-generating I/Os for validity on cold restart. The PLC issues an error message and goes to STOP when illegal machine data are encountered. Also see PLC MD 30.

PLC MD DB63 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
6061 DR 30								

Default value: All bits default to 0

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PLC MD DB63 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
6064 DL 32								High-level language PLM

Default value: All bits default to 0

Bit 0 **Bit = 0** PL/M programming not possible

Bit = 1 PL/M programming
Permits function blocks written in the higher-level programming language PL/M to be processed in the 135 WB.

PLC MD DB63 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
6065 DR 32								Travel-key display for both MCPs

Default value: All bits default to 0

Bit 0 Travel-key LEDs on the machine control panel

Bit = 0 The user can control the travel-key LEDs

Bit = 1 The PLC operating system controls the travel-key LEDs

PLC MD DB63 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
6066 DL 33			Processing of direction keys for user	1st machine control panel configuration TT machine				1st MCP present
6067 DR 33			Processing of direction keys for user	2nd machine control panel configuration TT machine				2nd MCP present

Bit 0 **Bit = 1** Machine control panel (MCP) available

Bit = 0 Machine control panel (MCP) not available

Bit 4 Only on T machines:

Bit = 0 T machine

Bit = 1 TT machine

Bit 5 **Bit = 0** Direction key module processing by PLC operating system

Bit = 1 Direction key module processing by user program

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PLC MD	Default values
6400 - 6431	0000 0001
6480 - 6511	0000 0001
6560 - 6563	1111 1111
6572 - 6575	1111 1111

These PLC MDs are internal system bits. The default values must not be changed.

PLC performance (IA)								
Byte No. DB63 PLC MD	15	14	13	12	11	10	9	8
	Bit No.							
	7	6	5	4	3	2	1	0
6068 DL 34	Edge for interrupt byte 1st DMP interface module					1st line, bits 0...7		
6069 DR 34	Edge for interrupt byte 1st DMP interface module					2nd line, bits 0...7		
6070 DL 35	Edge for interrupt byte 2nd DMP interface module 1)					1st line, bits 0...7		
6071 DR 35	Edge for interrupt byte 2nd DMP interface module 1)					2nd line, bits 0...7		
6072 DL 36	Edge for distributed interrupt byte interface PLC/PLC 135WD					Bits 0...7		
6073 DR 36	Reserved					Bits 0...7		
6074 DL 37	Enable for interrupt byte 1st DMP interface module					1st line, bits 0...7		
6075 DR 37	Enable for interrupt byte 1st DMP interface module					2nd line, bits 0...7		
6076 DL 38	Enable for interrupt byte 2nd DMP interface module 1)					1st line, bits 0...7		
6077 DR 38	Enable for interrupt byte 2nd DMP interface module 1)					2nd line, bits 0...7		
6078 DL 39	Enable for distributed interrupt byte interface PLC/PLC 135WD					Bits 0...7		
6079 DR 39	Reserved					Bits 0...7		

1) SW 3 and higher

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Processing of operational messages (IA)								
Byte No. DB63 PLC MD	15	14	13	12	11	10	9	8
	Bit No.							
	7	6	5	4	3	2	1	0
6080 DL 40	Alarm DB 58							
	DR 20	DL 20	DR 19	DL 19	DR 18	DL 18	DR 17	DL 17
6081 DR 40	Alarm DB 58							
	DR 24	DL 24	DR 23	DL 23	DR 22	DL 22	DR 21	DL 21
6082 DL 41	Alarm DB 58							
	DR 28	DL 28	DR 27	DL 27	DR 26	DL 26	DR 25	DL 25
6083 DR 41	Alarm DB 58							
		DL 32	DR 31	DL 31	DR 30	DL 30	DR 29	DL 29
6084 DL 42	Signal DB 58							
	DR 20	DL 20	DR 19	DL 19	DR 18	DL 18	DR 17	DL 17
6085 DR 42	Signal DB 58							
	DR 24	DL 24	DR 23	DL 23	DR 22	DL 22	DR 21	DL 21
6086 DL 43	Signal DB 58							
	DR 28	DL 28	DR 27	DL 27	DR 26	DL 26	DR 25	DL 25
6087 DR 43	Signal DB 58							
		DL 32	DR 31	DL 31	DR 30	DL 30	DR 29	DL 29
6088 DL 44					Baudrate for RS232 C (V.24) interface on interface PLC/PLC 135WD			
6089 DR 44	Reserved							
6090 DL 45	Reserved							
6091 DR 45	Reserved							
6092 DL 46	Reserved							
6093 DR 46	Reserved							
6094 DL 47	Reserved							
6095 DR 47	Reserved							

MD 6088: Baud rate for RS232C (V.24) interface on the interface PLC
Machine data 6088

Bit 3 - 0	Baud rate	
0000	110	baud
0001	150	baud
0010	300	baud
0011	600	baud (up to SW 4)
0100	1200	baud
0101	2400	baud
0111	9600	baud Default value: 0111
1000	19200	baud

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PLC performance (IA)								
PLC MD No. DW No.	15	14	13	12	11	10	9	8
	Bit No.							
	7	6	5	4	3	2	1	0
6096 DL 48	Reserved							
6097 DR 48	Reserved							
6098 DL 49	Reserved							
6099 DR 49	Reserved							

MD No.	Bit No.							
	7	6	5	4	3	2	1	0
6400 : 6419	Internal system bits Bit 0 must be set to 1							
6480 : 6499	Internal system bits Bit 0 must be set to 1							

MD 6400 to 6574 without DB.

8.6 PLC MD bits for function blocks (FB bits)

PLC MD DB64 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
7000 to 7049 DW 0 - DW 24								

Default value: All bits default to 0

Refer to the Tool Management and Computer Link literature for details.

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8.7 PLC MD bits for the user (user bits)

PLC MD DB65 DW No.	Bit No.							
	7	6	5	4	3	2	1	0
8000 to 8049 DW 0 - DW 24								

Default value: 0

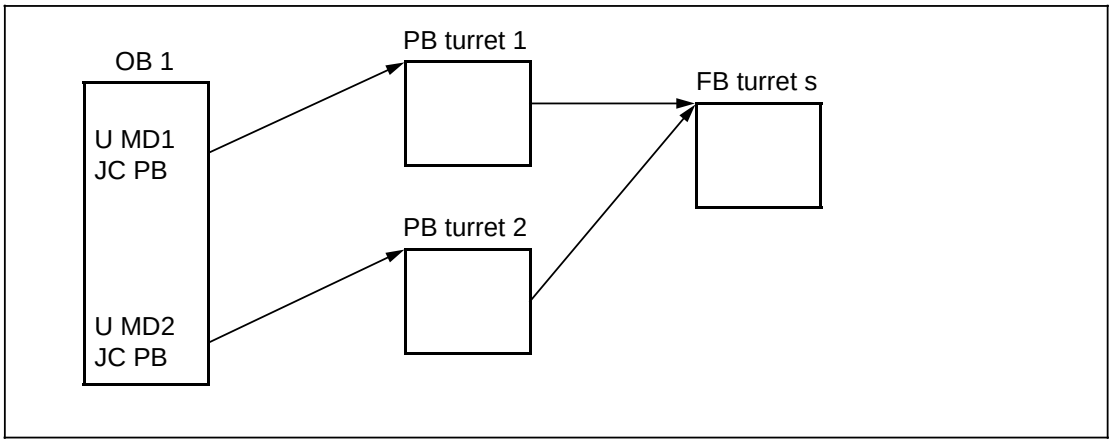
In addition to PLC MD words, PLC MD bits are also available to the user to do with as he sees fit. The available bit area comprises 25 words (400 bits).

The PLC machine data enables the machine manufacturer to process program blocks, function blocks or sections of a program conditionally on the basis of the bits set, and to allocate machine-specific option bits. The user can then specify additional machine-specific values.

Sample application:

A user builds machines with different turrets, but wants to be able to provide a single program for all machines. The turrets differ in the number of tool locations, e.g. turret 1 has 6, turret 2 has 8 locations.

The program for each type of turret (in this case a program block) is invoked via a corresponding PLC machine data bit. In the program, the number of tool locations is specified in PLC MD words.



END OF SECTION

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9 Drive Servo Start-Up Application (as from SW 3)

Introduction

SW 3 / SW 4 provides support for drive start-up and diagnostics by means of the following functions:

	Description in section
Measurement of drive control loops (current, speed, position)	9.2
Function generator	9.3
DAC output Mixed I/O output	9.4
Circularity test (SW 4 and higher) Conventional quadrant error compensation (SW 2 and higher) Neuronal quadrant error compensation (SW 4 and higher)	9.5
Trace function (user-parameterizable oscilloscope function – SW 4	9.6

9.1 General Comments

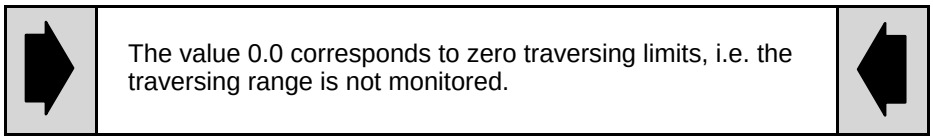
Safety measures

All measuring functions initiate traversing motions. It is therefore important to ensure that

- the **EMERGENCY STOP** switch is within reach
- the traversing range is free of obstacles.

Always enter the lowest possible **traversing range limits**. The measuring function is aborted if the specified traversing range is exceeded.

For axes with an endless traversing range, the traversing range monitoring function can be deactivated by entering “0” for the **traversing range upper and lower limits**.



The value 0.0 corresponds to zero traversing limits, i.e. the traversing range is not monitored.

You can also end the movement by means of the

- **NC STOP** key
- **STOP** softkey
- **RESET** key

or by cancelling the

- controller enabling command,
- drive enabling commands or
- traverse enabling command
- feed or spindle enabling command

or by setting the **OVERRIDE** switch to 0/50 for feed/main spindle drives.

Enabling commands

There are three possible methods of enabling traversing motions; these can be selected in the **Enables** toggle field:

- internally
- PLC
- PLC or NC (SW 4 and higher)

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Internal

The following conditions must be fulfilled before the traversing motion can be started:

- NC operating mode “JOG”
- No traversing command for axis/spindle
- No follow-up mode (for axes)
- No parking
- No axis/spindle disable
- No alarms
- No EMERGENCY STOP
- No warm restart
- Channel in reset
- Controller enabling command
- Drive enabling commands
- Feed/spindle enabling command
- No HW limit switch (for axes)
- Feed override $\neq$ 0 (for axes)
- No PLC spindle control
- No violation of working area limits (for axes)

The traversing motion is initiated through actuation of the **NC start** hardkey.

PLC

Axes with a mechanical brake also require a brake activation function. Select the “PLC” enables for this purpose. In this enable mode, the PLC signal “Motion enable drive test” acts in addition to the traverse enabling commands listed above. The traversing motion is likewise initiated through actuation of the **NC start** hardkey.

Use the request signal “Traverse request drive test” which is generated with selection of the measuring function in the PLC user program and the acknowledgement signal “Motion enable drive test” (see Interface Description – DB29 and DB31).

- On “Traverse request drive test”, switch on the control and enable the brake.
- Acknowledge the enabling of the control and brake with “Motion enable drive test”, following expiry of a delay timer if appropriate.
- The measuring function can only start when this sequence is complete.
- On completion of the measurements – when “Traverse request drive test” disappears, disable the brake and control again.

PLC without NC (as from SW 4)

In this enable mode, a positive edge of the PLC signal “Motion enable drive test” is required to start the traversing motion.
NC start is not necessary. In this mode, the number of internal enable monitoring functions is reduced to axial signals

- Controller enable
- Follow-up
- Parking
- Pulse enable
- Motion enable drive test

and to the general signals

- Key reset
- NCK mode switchover
- EMERGENCY STOP
- Warm restart.

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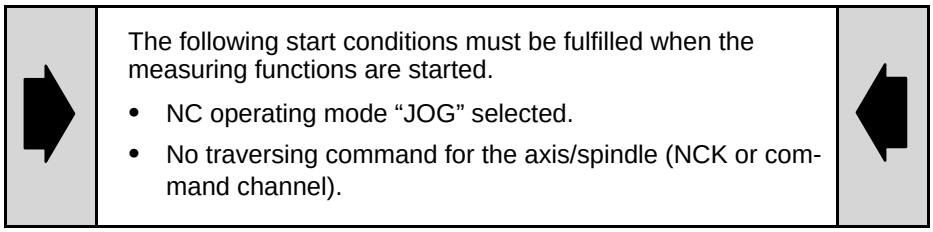
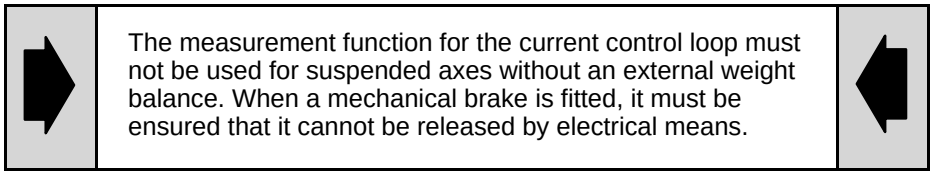


The following start conditions must be fulfilled when the measuring functions are started.

- NC operating mode “JOG” selected.
- No traversing command for the axis/spindle (NCK or command channel).

The “Overstore” function is disabled while the measurement is in progress. The axis or spindle interface is operated depending on which interface (spindle or (C) axis) is active when test mode is selected.

Operating mode on selection	**Active interface**	**DB number**
C-axis mode	Axis interface	DB 29/32
Spindle operating mode	Spindle interface	DB 31
Axis mode (feed axis)	Axis interface	DB 29/32



The measurement function for the current control loop must not be used for suspended axes without an external weight balance. When a mechanical brake is fitted, it must be ensured that it cannot be released by electrical means.

Automatic quadrant error compensation with integrated circularity test (option – SW 4)

The purpose of the quadrant error compensation function is to minimize contour errors resulting from friction, backlash and torsional strain during reversal.The following functions are provided with **SW 4** to allow the detection and compensation of quadrant errors:

- Automatic setting of quadrant error compensation to facilitate start-up.
- Integrated circularity test to provide visual display of axis performance and for diagnostic purposes.

Trace function (user-parameterizable oscilloscope function – SW 4)

A storage oscilloscope function with 4 user-parameterizable channels has been introduced as a supplement to the start-up functions implemented in SW 3 to date. This oscilloscope function makes it possible to record important signals for optimization and diagnostic purposes during start-up and in operation.

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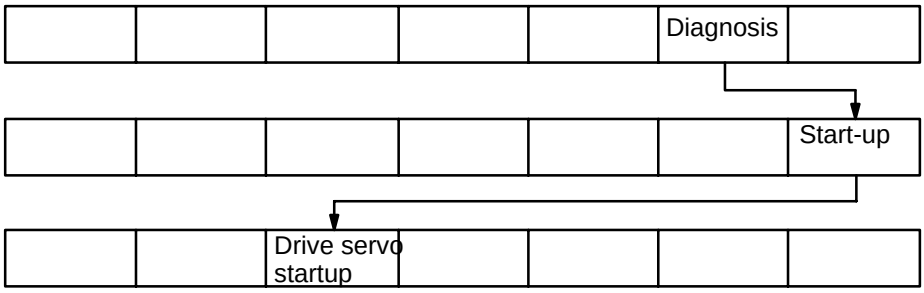
9.1.1 Selection of/menu trees of drive servo start-up application



Explanation

The drive servo start-up display (identical to the machine configuration display MDD) is called by means of the “Diagnosis”, “Start-up” and “Drive servo startup” softkeys.

Note

The **Drive servo startup** function takes approximately 30 s to load and is commented with the flashing text “Wait” during loading.

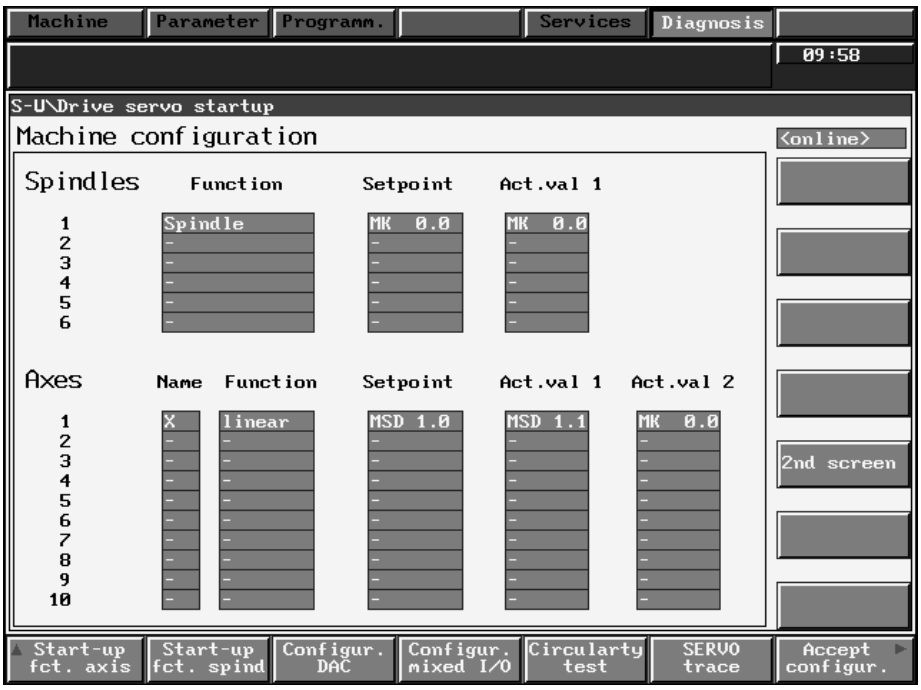


Fig. 9.1

Explanation

The drive servo start-up display (= machine configuration display) provides an overview of the current axis/spindle configuration and functions purely as a display (see also description of machine configuration in machine data dialog).

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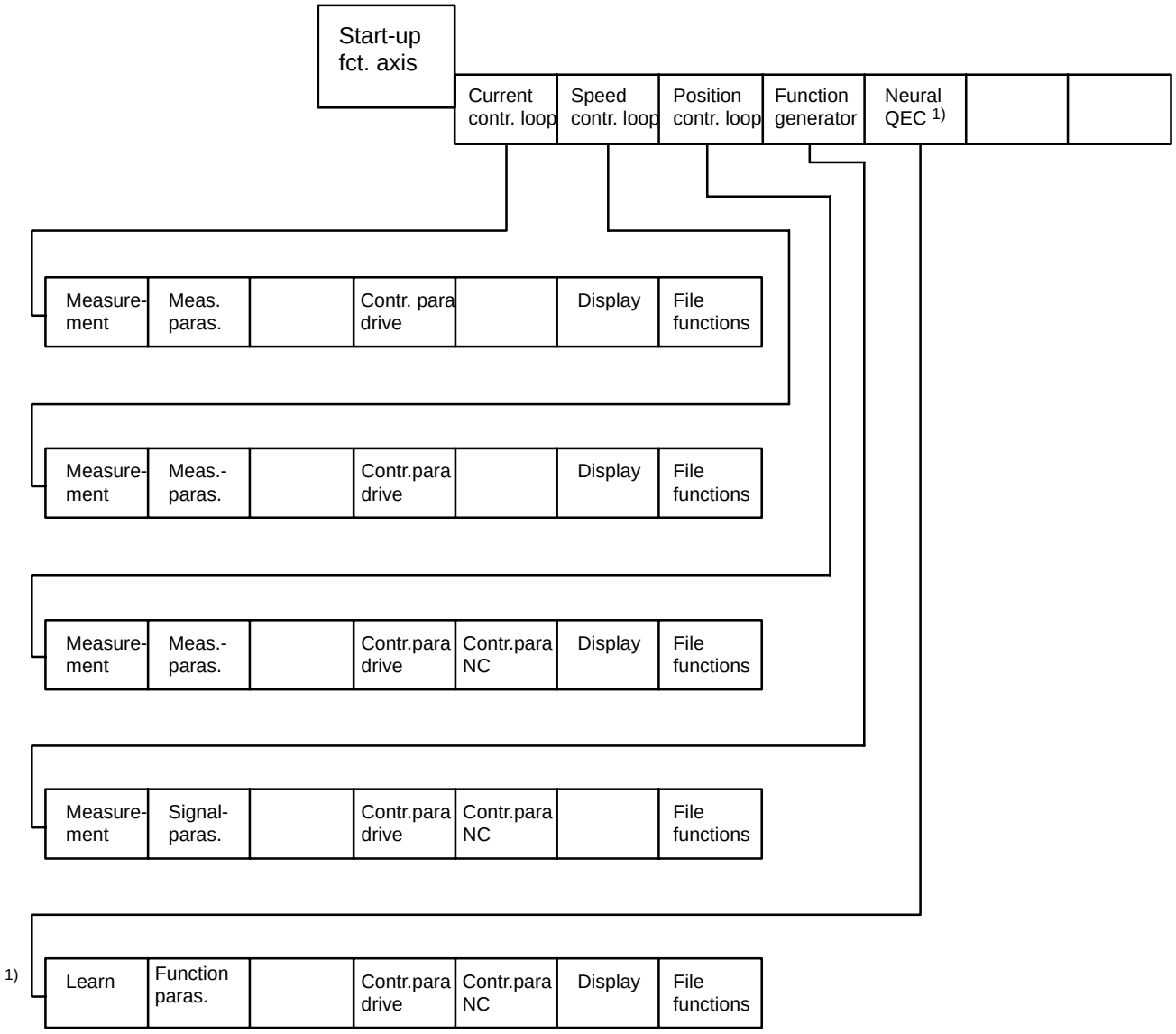
- **Menu tree: Axis start-up function**



1) as from SW 4

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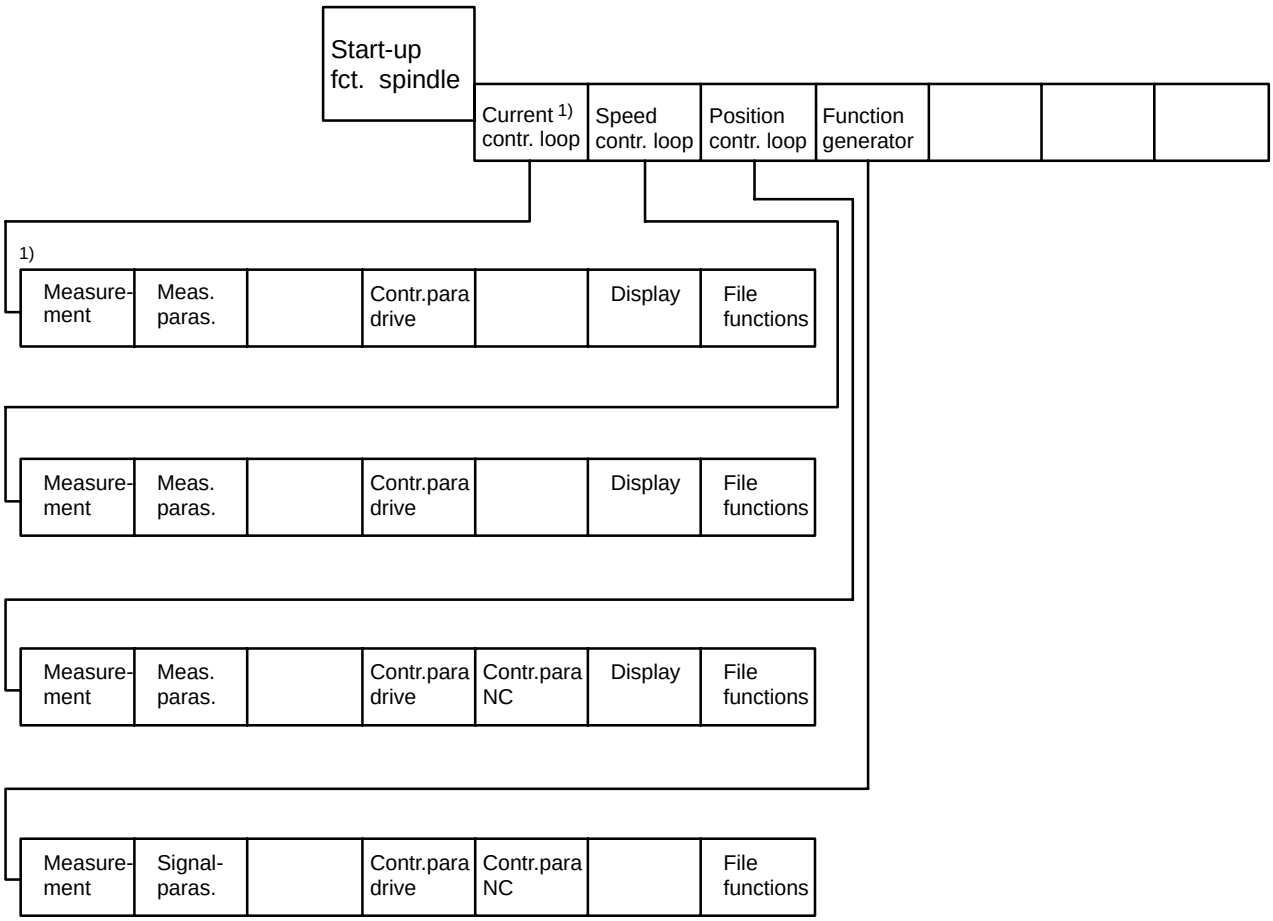
- **Menu tree: Spindle start-up function**



9.1.2 Softkeys

Start

This softkey enables the measurement or the DAC output. In order to start a measurement with traversing operation, the traverse enabling commands set by means of toggle field from the PLC/NC must be available. This operator action is acknowledged by an appropriate message.

The measurement or the DAC output is enabled by selecting the **Start** softkey, but can be disabled again with the **Stop** softkey. The function is aborted if the **Recall** hardkey is pressed without a preceding NC start command.

Stop

This softkey aborts the measurement, DAC output or traversing operation (function generator, QEC learning process) which is in progress.

1) as from SW 4

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- **Copying / pasting measuring parameter files into / from the clipboard**

Copy to clipboard

Paste from clipboard

With these softkeys you can re-use measuring parameter files that have been stored for the axis X, for example, for other axes as well (e.g. for axis Y). The same function can also be used for spindles.

Note:

- It is not possible to copy measuring parameter files from axes to spindles and vice versa.
- Measuring parameter files that have been backed up to measure in a current control loop, for example, cannot be copied to other measuring functions such as measuring in a speed control loop.
- A copy of a measuring parameter file in the clipboard is invalid as soon as the corresponding display is exited.

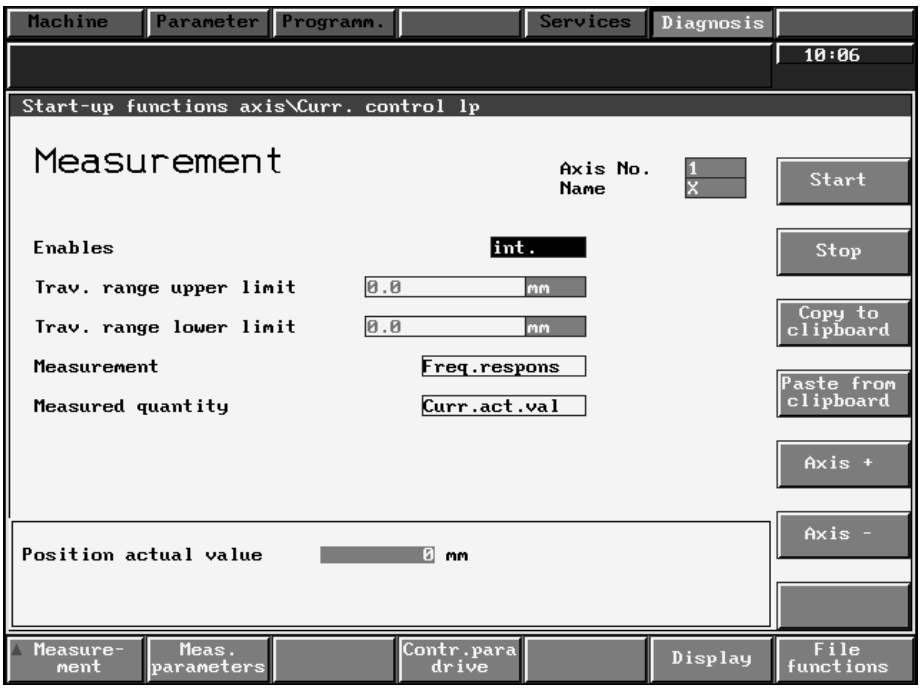

Fig. 9.2 Measuring in a current control loop for axes

Note

The File functions softkey can be used to read in a measuring parameter file with the softkey “Load from disk”. In the basic display assigned to the measuring function in question and under the softkey “Measuring parameters” it is possible to change values before accepting them for another axis. With the softkey “Copy to clipboard”, the measuring parameters are copied into the clipboard for the currently selected axis. To accept the values for another axis, you can select another axis with the softkeys “Axis+” and “Axis–”. The softkey “Paste from clipboard” is used to insert the measuring parameters of the old axis from the clipboard for the newly selected axis.

The procedure is the same for the measuring functions for spindles except that the softkeys “Spindle+” and “Spindle–” are used in the initial display.

Explanation

The results of the drive servo start-up functions: **Measurement current control loop, Measurement speed control loop and Measurement position control loop** are displayed.

Note

The value specification e.g. **–2.08 e+02** is equivalent to :

$-2.08 \times 10^2 = -208$

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X marker	This softkey activates or deactivates the marker with the horizontal direction of movement. This marker is displayed as a vertical line which can be moved along the displayed curve by the cursor control keys on the operator panel (shift + cursor= fast movement). The X and Y coordinates corresponding to the present position of the marker are displayed. The marker always appears in the active display; the active display can be switched over by means of the **Home key**.
Y marker	This softkey activates or deactivates the marker with the horizontal direction of movement. This marker is displayed as a vertical line which can be moved along the displayed curve by the cursor control keys on the operator panel. The X and Y coordinates corresponding to the present position of the marker are displayed. The marker always appears in the active display; the active display can be switched over by means of the **Home key**.
Expand	This softkey is used to expand a diagram window horizontally. The window is marked first with the X marker softkey and the **Expand** softkey then selected. The display can be returned to its original form by selecting the **Expand** softkey again.
Picture 1 Picture 2	These softkeys can be used to display each of the diagrams as a full-frame.
Picture 1 + Picture 2	This softkey is used to return the display to its original form.
X lin/log	You can alter the raster grid in the diagram along the horizontal axis with this softkey. You have the choice between a linear and a logarithmic raster grid.
Correct display	With this softkey, it is possible to change the scaling of the Y coordinates manually in both displays (see Fig. 9.3). Operation is identical to servo trace display. See description Section 9.6.
Axis +/– Spindle +/–	These softkeys are used to select the axes or spindles which must be started up.
Contr.para. FDD Contr.para. MSD Contr.para. drive Contr.para. NC	By selecting these softkeys, you can initiate the machine data dialog for the drive controller machine data for feed (FDD) and main spindle drives (MSD) or for the NC controller machine data. Changes which you need to make for the drive servo start-up process can be entered immediately in this dialog.

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Note

With **SW 4** and higher, the **Contr.para FDD** and **Contr.para MSD** softkeys have been combined under the **Contr.para drive** softkey with one exception: Under the circularity test function, the softkeys have remained as they were in **SW 3**.

Display

You can call up the graphic display of measurement results with this softkey.

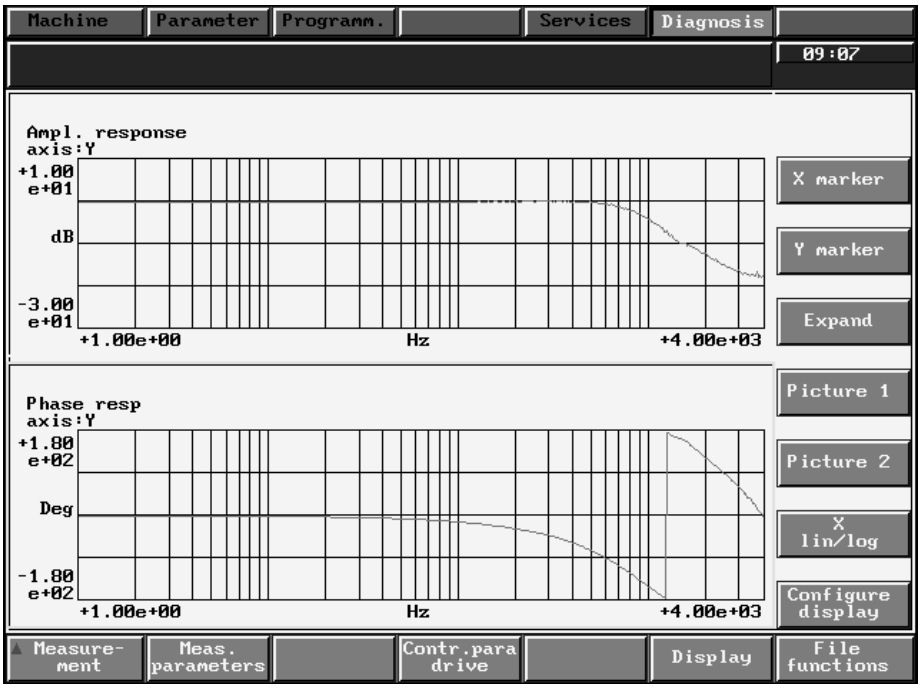

Fig. 9.3

File functions

You can enter the file function area by selecting this softkey.

Example for position control loop

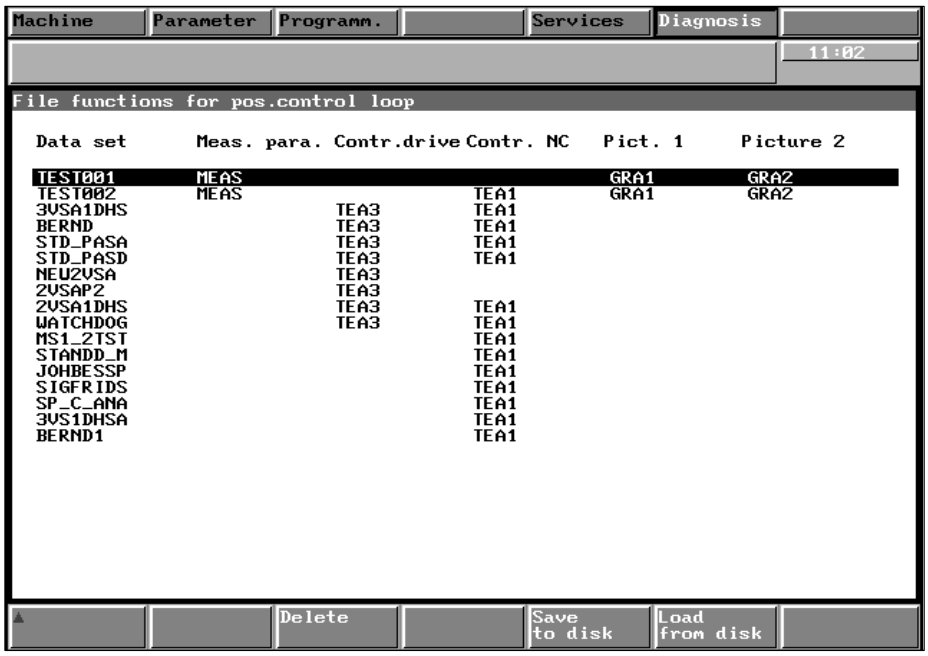

Fig. 9.4

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Explanation

This softkey gives you access to the control functions **Load**, **Save** and **Delete** with which you can load, save or delete a special measurement setting (configuration).
Displays/measurement results can likewise be loaded, saved or deleted.

After you have selected the desired file, a selection field appears in which you can choose the following functions with either “Yes” or “No” via the toggle key:
Measurement parameters
Controller parameters drive
Controller parameters NC
Picture 1
Picture 2
This means that you can reproduce settings and displays as you require.

Accept configur.

You can select the “Accept configuration” function with this softkey.

Explanation

On pressing this softkey, changes to the Power On data relevant for start-up (e.g. position/speed controller cycle time) are transferred.

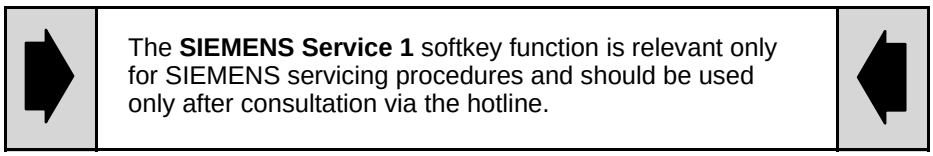
Notes

This softkey function must be activated after NCK reset (Power On) or after Drive Off/On when the start-up application is active (acceptance of the configuration is also requested).The configuration need not be accepted if an NCK reset is carried out when the machine data have not been changed.

If an NCK reset is performed without changing any machine data, it is possible to renounce to assume the configurations.

SIEMENS Service 1

You can select the SIEMENS Service 1 function with this softkey.



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9.2 Measuring the drive servo loops (current, speed, position)

Note

When measuring the spindle it is important not to enter the weak field range as this produces an incorrect display.

Measurements in the time range

The integrated time-range measuring functions of the drive servo start-up application enable you to assess the significant quantities of the speed and position control loops on the NC screen without external measuring equipment.

You can input a step or ramp function with adjustable **amplitude** and, if required, **ramp time** as a test signal for a parameterizable **measurement time**; a constant **offset** can also be superimposed on the test signal. By entering a **settling time**, you can determine the instant at which data recording begins.

The specified **traversing path** is monitored during the measurement. On completion of the measurement, you can assess the result on the screen by selecting the **Display** softkey.

Special test sockets on the drive modules of 611D drives allow all important control loop signals (setpoints, actual values, control deviations) to be output (DAC configuration) on external instruments (oscilloscope or signal recorder). You can also output these signals if you use a mixed I/O module (mixed I/O configuration).

There are always exactly three DAC channels for every 611D feed drive and main spindle module, even in multi-axis versions. A total of four position controller signals can be output simultaneously via the 611D DAC channels or the mixed I/O.

An integrated function generator supplies periodic test signals (square-wave and triangular signals, staircase function) to stimulate the control loops as well as noise signals for spectral analysis using external equipment.

The parameters of drives or position control can be accessed at any time, the application need not be terminated for this purpose.

Frequency response measurement

In addition to the usual method of optimizing control loop parameters which is based on the transient response, i.e. time characteristics, the Fourier analysis function integrated in the 840 C provides you with a powerful tool for assessing control loop settings and analyzing the given mechanical characteristics.

You should use this function whenever

- unsteady current, speed or position signal forms give you reason to suspect stability problems
- you can obtain only slow rise times in the speed loop
- the contour quality at high machining speeds is inadequate
- you require documentation of settings.

This optimization procedure is identical to that for the time range, i.e. you must optimize “from the inside outwards”, starting with the current control. The frequency response measurement method used in the SIN 840 C supplies precise and reproducible results even at very low test signal amplitudes; the **measurement parameters** can be matched to the application in question.

All measurements are carried out in the course of an **offset** movement of a few (approximately 1–5) revolutions per minute; a test signal **amplitude** (noise) of one to two revolutions is superimposed on the offset. The accuracy increases with the number of **averaging operations** (selectable); a value of 20 is normally sufficient. The **bandwidth**, which is likewise adjustable, is normally selected to correspond to half the sampling frequency.

$$\text{max. bandwidth} = \frac{f_{sampl.}}{2} = \frac{1}{2 \times t_{sampl.}} \doteq 4000\ \text{Hz}$$

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e.g. for 125 µs sampling time (cycle)
Owing to the short measuring times, **traversing paths** of a few revolutions are sufficient for the frequency response measurement. The measurement time is calculated as follows:

$$\text{Meas. time [s]} = \frac{512 \text{ x No. of averaging ops}}{\text{Bandwidth [Hz]}} + \text{Setting time}$$

The frequency response measurement on a drive with a sampling time of 125 µs and 20 averaging operations therefore takes approximately 2.5 s; given an offset of 5 rev/min, a **traversing path** of less than 0.3 revolutions is required for the measurement.

Always begin measurements with the lowest possible values for **offset** and **amplitude**. Do not increase the number of **averaging operations** or the **amplitude** unless you obtain extremely noisy results. Excessively high amplitude values lead to incorrect results and may cause mechanical damage.

The **offset** should always be higher than the **amplitude**. The measuring results at very low values may differ from those obtained at higher traversing speeds owing to backlash or static friction.
By decreasing the **bandwidth**, you can increase the frequency resolution, particularly at low frequencies.
After evaluating the measurement series – which takes between 5 and 20 s depending on the MMC-CPU, you can call up the result as a Bode diagram under the “Display” softkey.

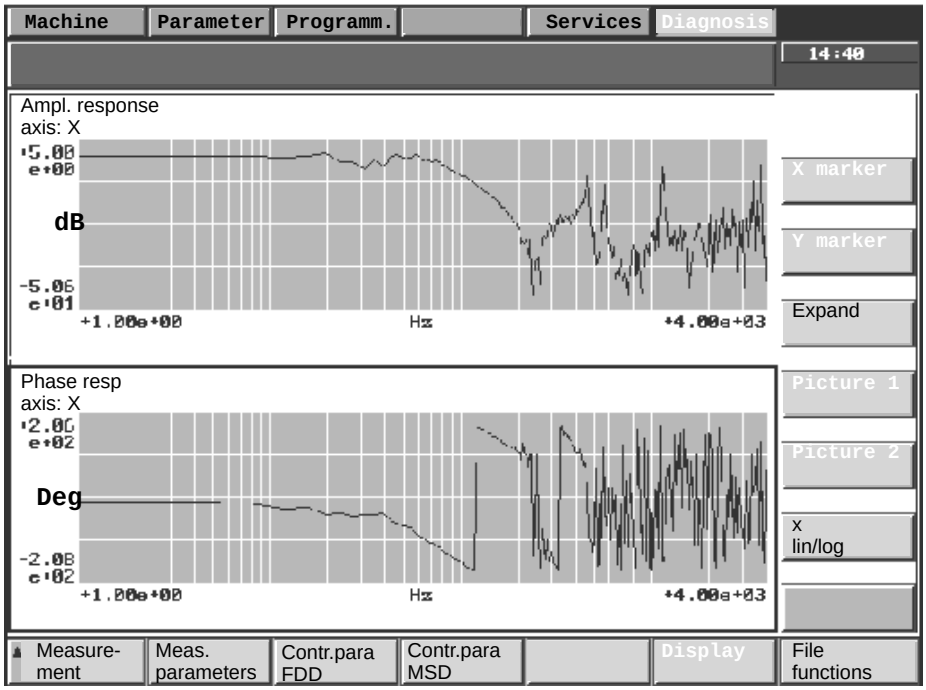

Fig. 9.5 New softkey bar as from SW 5: See Fig. 9.3

You can identify the position and intensity of any critical mechanical resonant points in the frequency response diagram – in the above diagram, you can see resonant points at 450 Hz, 600 Hz and 1200 Hz. Increasing the P gain of the speed controller would cause instability if filters were not used.

611D offers low-pass or bandstop filters as standard; the parameters of these filters – stop frequency, bandwidth or limit frequency – can be estimated using the Bode diagram.

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You can set the filters or controller parameters as required by means of “Contr.para FDD” or “Contr.para MSD”. You should check their effect immediately after a further measurement. You can also determine from the Bode diagram whether the available high dynamic response of the SIMODRIVE drives is being fully utilized. You should measure values of between 1 and 2 kHz in the current controller frequency response; the speed control loop reaches several hundred Hertz in feed drives and at least 100 Hz in main spindle drives.

Optimum setting of the current controller can be ensured when a standard motor/power section combination is input; the control need therefore only be measured when motors or power sections are used which are not contained in the standard lists or for servicing purposes.

The speed controller parameters are roughly preset for standard motor/power sections based on the motor moment of inertia. You must optimize the speed control loop according to the mechanical properties of the axis during start-up.

The response of the position control which has a decisive effect on the contour should be as linear as possible, particularly in the range up to 10 Hz. Resonance in the position controller frequency response always causes overshoots on the contour.

9.2.1 Current control loop (axis and spindle – as from SW 3)

Current control loop

You can select the measuring function for the current control loop with this softkey.

Note

Test measurements on the current control loop can be performed on digital feed and main spindle drives with **SW 4** and higher. With **SW 3**, this function can still only be applied to digital feed drives.

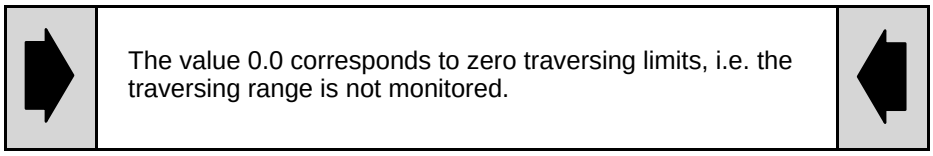
Explanation

Test measurements on the current control loop are based purely on the reference frequency response **measurement = frequency response**. The torque-producing current actual value **measured quantity = current actual value** is always measured.

The **enable commands** must be implemented either **internally** or with **PLC** or with **PLC without NC** (SW 4 and higher).

The following applies to the **upper and lower traversing range limits:**

The specified limit values define the permissible traversing range during start-up. With a referenced axis/positioned spindle, the limit applies to the axis position/spindle position at the start of the movement and, with a non-referenced axis/positioned spindle, to the axis/spindle position at the start of the first test movement after the machine is switched on.



The value 0.0 corresponds to zero traversing limits, i.e. the traversing range is not monitored.

The current axis/spindle position is displayed in the “Position actual value/absolute position” field.

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9.2.2 Current control loop – measurement parameters (as from SW 3)

Default settings

Measurement = **frequency response** and measured quantity = **current actual value**.

Meas. parameter

You can select the menu with the measurement parameters for the current control loop with this softkey.

Note

You enter the measurement parameters in the selected display. These parameters are managed internally as configuration data rather than machine data, i.e. the data are not initialized when the machine runs up.

Measurement parameter settings (see Section "Signal waveforms of function generator")

- **Amplitude**
  Input of maximum amplitude of test signals. Values corresponding to approximately 5% of power section current are suitable.

- **Bandwidth**
  Input of maximum amplitude of test signal. Values corresponding to approximately 5% of power section current are suitable.

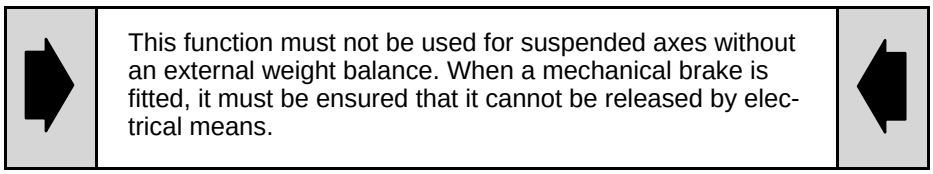
  $$\text{max. band width} = \frac{f_{sampl.}}{2} = \frac{1}{2 \times t_{sampl.}} \text{ e.g.}$$

  – 4 KHz for 2-axis modules (125 µs current controller sampling time).

  – 8 KHz/4 KHz for single-axis module (62.5 µs/125 µs depending on current controller sampling time).

- **Averaging operations**
  The normal value used is 20.
  The higher the value, the more accurate the measurement.

- **Settling time**
  The measurement is delayed with respect to the instant of injection of the test signal by the value entered here. Use a value of approximately 10 ms in normal cases.



This function must not be used for suspended axes without an external weight balance. When a mechanical brake is fitted, it must be ensured that it cannot be released by electrical means.

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9.2.3 Speed control loop (axis and spindle – as from SW 3)

Speed control loop

You can select the measuring function for the speed control loop with this softkey.

Notes

Test measurements on the speed control loop (axis and spindle) can be performed on both **analog** and **digital** drives.

Applic. to analog: The speed is sensed by the same measuring system with which the position control (SERVO) operates.

Applic. to digital: The motor speed is always measured.

The spindle measuring system (spindle encoder) must be defined or declared (NC-MD 5200.2) for the spindle.

Explanation

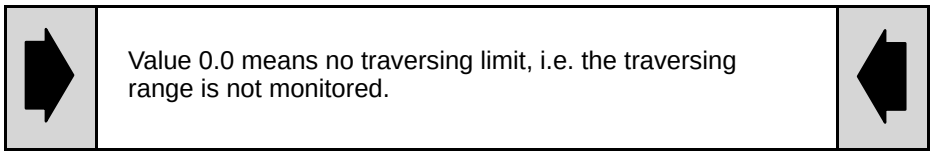
Different types of measurement are available for testing the speed control loop:

Reference frequency response
Interference frequency response (up to SW 4.4)
Mechanical frequency response n_{act}/Iq_{act} (as from SW 5)
Setpoint step change
Disturbance step change

The actual speed value of the active measuring system is the measured quantity.

The enable commands must be implemented **internally** or with **PLC** or with **PLC without NC** (as from SW 4).

The following applies to the **upper and lower traversing range limits**:
The specified limit values define the permissible traversing range during start-up. In the case of a referenced axis/positioned spindle, the limit refers to the axis/spindle position at the start of the movement and, with a **non**-referenced axis/**non**-positioned spindle, to the axis/spindle position at the start of the first test movement after the machine is switched on.



Value 0.0 means no traversing limit, i.e. the traversing range is not monitored.

The current axis/spindle position is displayed in the position actual value/absolute position field.

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9.2.4 Speed control loop (axis and spindle) – measurement parameters (4 basic settings – as from SW 3)

Overview of measurement types

The types of measurement available depend on the type of drive used. Various variables can be measured depending on the type of measurement selected.

Type of measurement	Measured quantity Speed actual value
Reference frequency response	analog / 611D
Interference frequency response (up to SW 4 **Mechanical frequency response n_{act}/Iq_{act} (as from SW 5)**	611D FDD (SW 3)/ 611D (SW 4)
Setpoint step change	analog / 611D
Disturbance step change	611D FDD (SW 3)/ 611D (SW 4)

Note

If the selected measurement cannot be carried out with the installed drive, the dialog box **160007 Measurement/drive-type combination not allowed** appears when the Start softkey is selected.

- **1st measurement type: Reference frequency response**

The reference frequency response measurement determines the transient response of the speed control loop. The response range should be as wide as possible and without resonance. It may be necessary to install stop or low-pass (611D) filters. Particular care must be taken to prevent resonance within the speed controller limit frequency range.

Meas. parameters

You can select the menu with the parameters for measuring the speed control loop with this softkey.

Notes

You enter the measurement parameters in the selected display. These parameters are managed internally as configuration data rather than machine data, i.e. they initialized when the machine runs up. Data can be input in two different ways:

- Manual input
- Input by loading of an existing, complete data set with the aid of file functions

The measurement of the MSD speed control loop frequency response is carried out with respect to the position control only with **SW 3** and therefore makes allowance for system-related transfer times between the position and speed control loops.

Measurement parameter settings (see Section "Signal waveforms of function generator")

- **Amplitude**
  This parameter determines the magnitude of the test signal amplitude.
  It should not be more than a few (approx. 1–2) motor rpm for the 1st basic setting (frequency reference response).

- **Offset**
  The measurement requires a small speed offset of a few motor revolutions per minute. The offset value must be set higher than the **amplitude** value.

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As from SW 6:

- The offset is reached along an acceleration ramp.
- The acceleration value is defined for an
  axis: MD 276*: Acceleration
  spindle: MD 419* –
  MD 426*: Acceleration constant for 8 gear stages
- The following applies: Acceleration value=0, no ramp
  Acceleration value ≧ 0, ramp active
- The actual measuring function is not activated until the offset value is reached.
- **Bandwidth**
  Setting of frequency range to be analyzed (must not exceed a value corresponding to half the speed controller sampling frequency). The lower this value, the finer the frequency resolution will be and the longer the measurement time.

  $$\text{max.band width} = \frac{f_{sampl.}}{2} = \frac{1}{2 \times t_{sampl.}}$$

  e.g. 4 kHz with 1 or 2 drive modules (for 125 μs speed controller sampling time)
- **Averaging operations**
  The higher this value is set, the more accurate the measurement and the longer the measurement time. You should normally enter a value of 20.
- **Settling time**
  This value represents the delay between the start of measured data recording and injection of the test signal and offset. A settling time of more than zero (0.1–2 s) should be entered for frequency response measurements in order to take measurements under steady-state conditions – interference in the amplitude and phase response may otherwise occur as a result of transient behaviour.

- **2nd measurement type: Interference frequency response (up to SW 4.4) Mechanical frequency response n_{act}/Iq_{act} (as from SW 5)**

To evaluate the noise suppressions by the control (only 611 D–FDD), the interference frequency response can be entered. With SW4, this measurement can also be performed for 611 D_MSD.

Meas. parameter

You can select the menu Meas. parameters for measuring the speed control loop with this softkey.

Note

You enter the measurement parameters in the selected display. These parameters are managed internally as configuration data rather than machine data, i.e. they are not initialized when the machine runs up. Data can be input in two different ways:

- Manual input
- Input by loading of an existing, complete data set with the aid of file functions

Measurement parameter setting (see Section on Signal waveforms of the function generator)

as for measurement type reference frequency response

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• 3rd measurement type: Setpoint step change

The transient response of the speed control in the time range can be assessed with the step stimulation function for setpoint or disturbance variables. If an **offset** value other than zero is input, the step change is stimulated during transition.

Meas. parameter

You can select the menu with the parameters for measuring the speed control loop with this softkey.

Notes

You enter the measurement parameters in the selected display. These parameters are managed internally as configuration data rather than machine data, i.e. they are not initialized when the machine runs up. Data can be input in two different ways:

- Manual input
- Input by loading of an existing, complete data set with the aid of file functions

The recording starts with the output of the setpoint step, i.e. the step is not visible in the setpoint signal display. This does **not** apply to analog drives because a fixed pre-trigger time corresponding to 10 % of the measurement time is set for them. If the settling time setting is lower than this 10 % value, then the pre-trigger time is limited to the settling time.

Measurement parameter settings

- **Amplitude**
  This parameter determines the magnitude of the specified disturbance step change.
- **Offset**
  The step is stimulated from standstill or starting from the constant traverse speed set in this parameter.

As from SW 6:

- The offset is reached along an acceleration ramp.
- The acceleration value is defined for an
  axis: MD 276*: Acceleration
  spindle: MD 419* –
  MD 426*: Acceleration constant for 8 gear stages
- The following applies: Acceleration value=0, no ramp
  Acceleration value ≧ 0, ramp active
- The actual measuring function is not activated until the offset value is reached.
- **Measurement time**
  This parameter determines the period of time to be recorded.
- **Settling time**
  This value represents the delay between the start of measured data recording and injection of the test signal and offset (not relevant for 611D).

Notes

The recording starts with the output of the setpoint step, i.e. the step is not visible in the setpoint signal display.

If the selected measurement cannot be carried out with the installed drive, the dialog box **160007 Measurement/drive-type combination not allowed** appears when the Start softkey is selected.

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- **4th Measurement type: Disturbance step change**

The transient response of the speed control in the time range can be assessed with the step stimulation function for setpoint or disturbance variables. If an **offset** value other than zero is input, the step change is stimulated during transition.

Meas. parameter

You can select the menu with the parameters for measuring the speed control loop with this softkey.

Notes

The test signal can also be connected to the speed controller output to allow assessment of the control response to disturbances (611D FDD only). This function is also available for 611D MSD when **SW 4** is installed.

You enter the measurement parameters in the selected display. These parameters are managed internally as configuration data rather than machine data, i.e. they are not initialized when the machine runs up. Data can be input in two different ways:

- Manual input
- Input by loading of an existing, complete data set with the aid of file functions

Measurement parameter settings

as for measurement type setpoint step change

Notes

as for measurement type setpoint step change

9.2.5 Position control loop (axis and spindle – as from SW 3)

Position contr. loop

You can select the measuring function for the position control loop with this softkey.

Notes

Test measurements on the position control loop (axis and spindle) can be performed on both **analog** and **digital** drives.

The spindle measuring system (spindle encoder) must be defined or declared (NC-MD 5200.2) for the spindle.

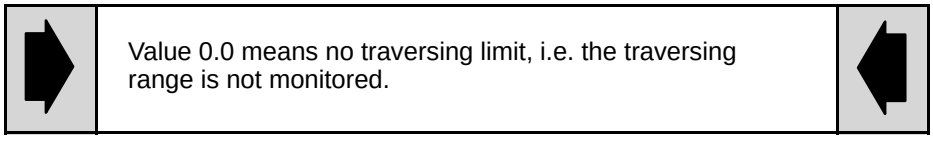
Explanation

Three different types of measurement are available for testing the speed control loop:

Frequency response
Setpoint step change
Setpoint ramp

The **position actual value**, **following error** or **speed actual value** of the active measuring system are acquired depending on the type of measurement selected. The enable commands must be implemented **internally** or with **PLC** or with **PLC without NC** (SW 4 and higher)

The following applies to the **upper and lower traversing range limits**:
The specified limit values define the permissible traversing range during start-up. In the case of a referenced axis/positioned spindle, the limit refers to the axis/spindle position at the start of the movement and, with a **non**-referenced axis/**non**-positioned spindle, to the axis/spindle position at the start of the first test movement after the machine is switched on.



Value 0.0 means no traversing limit, i.e. the traversing range is not monitored.

The current axis/spindle position is displayed in the position actual value/absolute position field.

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9.2.6 Position control loop (axis and spindle) – measurement parameters (9 basic settings – as from SW 3)

Overview of types of measurement

The types of measurement listed below are not dependent on the drive used. Various variables can be measured depending on the measurement type selected.

	Type of measurement	Measured quantity Position actual value	Measured quantity Following error	Measured quantity Speed actual value
1.)	Frequency response	analog / 611D	–	–
2.)	Setpoint step change	analog / 611D	analog / 611D	analog / 611D
3.)	Setpoint ramp	analog / 611D	analog / 611D	analog / 611D

- **1st measured type: Frequency response**

The frequency response measurement determines the response of the position control loop in the frequency range. The balancing filter, KV value and feedforward control must be parameterized such that resonance is avoided wherever possible over the entire frequency range. Excessive resonance requires

- increase in balancing filter
- decrease in KV value

In the case of dips in the frequency response, the setting of the feedforward balancing filter should be reduced. If these measures do not lead to an improvement, then the setpoint can be rounded by means of a smoothing filter. The effects of this filter can be checked in the test functions in the time range (step and ramp stimulation).

Meas. parameter

You can select the menu with the parameters for measuring the position control loop with this softkey.

Note

You enter the measurement parameters in the selected display. These parameters are managed internally as configuration data rather than machine data, i.e. they are not initialized when the machine runs up. Data can be input in two different ways:

- Manual input
- Input by loading of an existing, complete data set with the aid of file functions

Measurement parameter settings

- **Amplitude**
  This parameter determines the magnitude of the test signal amplitude.
- **Offset**
  The measurement requires a small speed offset of a few motor revolutions per minute. The offset value must be set higher than the **amplitude** value.
- **Bandwidth**
  Setting of frequency range to be analyzed (must not exceed a value corresponding to half the speed controller sampling frequency). The lower this value, the finer the frequency resolution will be and the longer the measurement time.

$$\text{max.band width} = \frac{f_{sampl.}}{2} = \frac{1}{2 \times t_{sampl.}}$$

e.g. 0.5 kHz with position controller sampling time of 2 ms.

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- **Averaging operations**
  The higher this value is set, the more accurate the measurement and the longer the measurement time. You should normally enter a value of 20.
- **Settling time**
  This value represents the delay between the start of measured data recording and injection of the test signal and offset. Set the value to between 0.2 and 1 s.

Notes

In order to ensure a more gentle machine setting, the lowest possible values should be set for **amplitude** and **offset**. Excessively high input values result in the output of alarm messages such as “1560 Speed setpoint alarm limit violated”.

The only quantity which can be measured is the **position actual value** from the active (current) measuring system.

When speed actual value or following error is selected, the dialog box **160043 Measurement/measured-qty combin. not allowed** appears when the Start softkey is selected.

• 2nd measurement type: Setpoint step change

The transient or positioning response of the position control in the time range can be assessed with the step stimulation function.
If an **offset** value other than zero is input, the step change is stimulated during traversal. The displayed position actual value does not include this speed offset. The effect of the setpoint smoothing filter can be checked on the basis of the position setpoint characteristic.

Meas. parameter

You can select the menu with the parameters for measuring the speed control loop with this softkey.

Notes

You enter the measurement parameters in the selected display. These parameters are managed internally as configuration data rather than machine data, i.e. they are not initialized when the machine runs up. Data can be input in two different ways:

- Manual input
- Input by loading of an existing, complete data set with the aid of file functions.

A fixed pre-trigger time corresponding to 10 % of the measurement time is set for the recording, i.e. the setpoint step change is also visible in the setpoint signal display. If the settling time setting is lower than this 10 % value, then the pre-trigger time is limited to the settling time.

Measurement parameter settings

- **Amplitude**
  This parameter determines the magnitude of the specified setpoint step change.
- **Offset**
  The step is stimulated from standstill or starting from the constant traverse speed set in this parameter.
- **Measurement time**
  This parameter determines the period of time to be recorded.
- **Settling time**
  This value represents the delay between the start of measured data recording and the injection of the test signal and the offset.
- **Ramp time**
  When the basic setting “Setpoint ramp” is selected, the position setpoint is changed according to the set ramp time. In this case, the acceleration is specified in accordance with the acceleration limits which currently apply for the axis or spindle
  These limits must be set in “Controller parameters NC”
  Spindle: NC MD 4780–4850
  Axis: NC MD 2760

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Notes

In order to ensure a more gentle machine setting, the lowest possible values should be set for **amplitude** and **offset**. Excessively high input values result in the output of alarm messages such as “1560 Speed setpoint alarm limit violated”.

Following error, **speed actual value** or **position actual value** are the quantities which can be measured. The position setpoint and the active measuring system are recorded in each case.

- **3rd measuring type: Setpoint ramp**

The transient or positioning of the position control in the time range can be assessed with the ramp stimulation function. If an **offset** value other than zero is input, the step change is stimulated during traversal. The displayed position actual value does not include this speed offset. The effect of the setpoint smoothing filter can be checked on the basis of the position setpoint characteristic.

Meas. parameter

You can select the menu with the parameters for measuring the position control loop with this softkey.

Note

You enter the measurement parameters in the selected display. These parameters are managed internally as configuration data rather than machine data, i.e. they are not initialized when the machine runs up. Data can be input in two different ways:

- Manual input
- Input by loading of an existing, complete data set with the aid of file functions

Measurement parameter settings

as for measurement type setpoint step change

Note

as for measurement type setpoint step change

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9.3 Function generator (axis and spindle – as from SW 3)

Function generator

You can select the function generator with this softkey.

Note

Axes and spindles can be traversed with the function generator in both **analog** and **digital** drives.

Explanation

The function generator can operate in the following five different **modes**:

Current setpoint (SW 3: 611D FDD/SW 4: 611D)
Disturbing torque (SW 3: 611D FDD/SW 4: 611D)
Speed setpoint speed loop (speed controller SW 3: 611D FDD/SW 4: 611D)
Speed setpoint position loop (position controller)
Position setpoint

The signal types **square-wave**, **noise signal**, **sawtooth** and **staircase function** can be used within the framework of these operating modes.

The following applies to the **upper and lower traversing range limits**:
The specified limit values define the permissible traversing range during start-up. In the case of a referenced axis/positioned spindle, the limit refers to the axis/spindle position at the start of the test movement and, with a **non**-referenced axis/**non**-positioned spindle, to the axis/spindle position at the start of the first movement after the machine is switched on.

The current axis/spindle position is displayed in the position actual value/absolute position field.

The **scaling** can also be altered when the function generator is in operation. This is done by entering the normalization factor and confirming the input with the **Start** softkey bar. When a normalization value of 100 is entered, the function generator generates precisely the amplitude set by the signal parameters. The value can be varied to obtain a fine setting.

Overview of operating modes

The type of drive used determines which operating modes are available. Various signal forms are available depending on the selected operating mode.

Operating mode	Signal type “Squarewave”	Signal type “Sawtooth”	Signal type “Staircase”	Signal type “Noise signal”
Current setpoint	611D	–	–	611D
Disturbing torque	611D	–	–	611D
Speed setpoint (speed controller cycle)	611D	–	–	611D
Speed setpoint (position controller cycle)	analog/611D	analog/611D	analog/611D	analog/611D
Position setpoint	analog/611D	analog/611D	analog/611D	analog/611D

Note

If combinations other than those specified above are selected, the dialog boxes **160008 Mode/drive type combination not allowed** or **160009 Mode/signal type combination not allowed** appear when the Start softkey is selected.

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- **Selection of function generator parameterization “Signal types with operating modes”**

Signal parameters

You can select the menu with the signal parameters for the function generator in the five operating modes with this softkey.

Note

You enter the signal parameters in the selected displays. These parameters are managed internally as configuration data rather than machine data, i.e. they are not initialized when the machine runs up. Data can be input in two different ways:

- Manual input
- Input by loading of an existing, complete data set with the aid of file functions

9.3.1 Function generator (axis and spindle) – signal parameters (as from SW 3)

Measurement parameter settings

With a scaling value of 100 %, the function generator output signal is determined by the following signal parameters:

- **Amplitude/Amplitude 1**
  This parameter determines the magnitude of the specified setpoint step change.
- **Amplitude 2**
  This parameter is significant only for the staircase signal form. It determines the maximum signal amplitude (see waveforms of signal types).
- **Offset**
  In the disturbing torque, speed setpoint speed loop, speed setpoint position loop and position setpoint operating modes, stimulation takes place from standstill or starting at the constant reverse speed set in this parameter.

  In the current setpoint operating mode, stimulation takes place from standstill or starting at the current offset set in this parameter.
- **Limitation**
  The output signal is limited to this value prior to normalization.
- **Period**
  This parameter specifies the fundamental frequency of the function generator.
- **Pulse width**
  See Section “Waveforms of signal types”.
- **Bandwidth**
  See Section “Frequency response measurement”.

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9.3.2 Additional information (notes) on measurement and signal parameters (as from SW 3)

Overrange

The maximum values which may be set for amplitudes, offset and acceleration are dependent upon (see also corresponding NC and drive machine data):

- Drive type
- Selected operating mode
- Position controller resolution
- Axis or spindle-specific current and velocity limitations

Note

Monitoring takes place in operation or when the function is started.

Interdependencies

The following parameters are also mutually interdependent:

- **Band width** [Hz]

  $$\text{Band width} = \frac{1}{2 \times \text{sampling time [s]}}$$

- **Period** [ms]

  Period $\geq$ 6 x sampling time [ms]

- **Pulse width** [ms]

  0 < pulse width < period (with function generator)

Note

The user should generally apply the input values which are recommended for these functions. He must, however, make allowance for any machine-related restrictions by setting the appropriate parameter values (e.g. signal amplitudes).

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9.3.3 Signal waveforms of function generator (as from SW 3)

- **Square-wave** (speed setpoint)

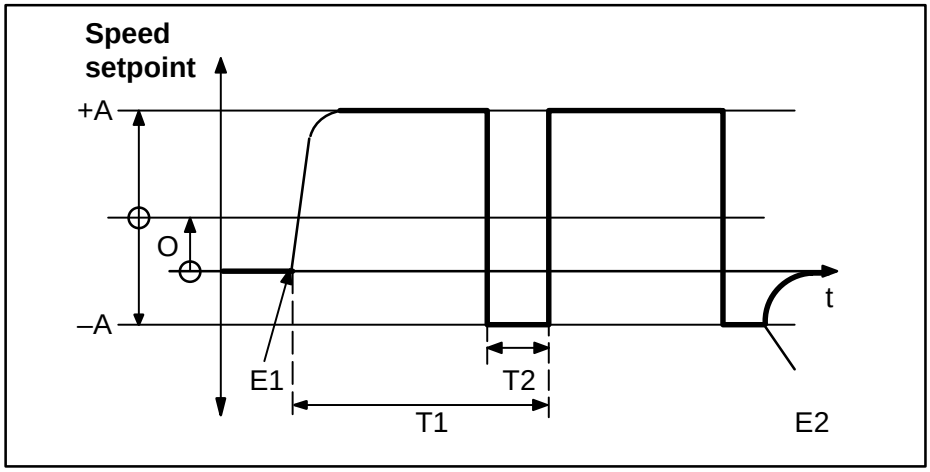

Fig. 9.6

Conditions

Operating mode	: Speed setpoint (position controller cycle)
Signal type	: Square-wave
E1	: Switch-on instant (NC Start hardkey)
E2	: Switch-off instant (e.g. NC Reset)
T1	: Period
T2	: Pulse width
A	: Amplitude (+/–)
O	: Speed offset

Explanation

While starting and braking is in progress, the speed setpoint is output with a delay via a filter. The speed setpoint amplitude acts in relation to the set speed offset.
The axis/spindle is traversed at the set amplitude during period T1 (Period). The amplitude is output with the opposite sign during period T2 (pulse width).

- **Sawtooth** (speed setpoint)

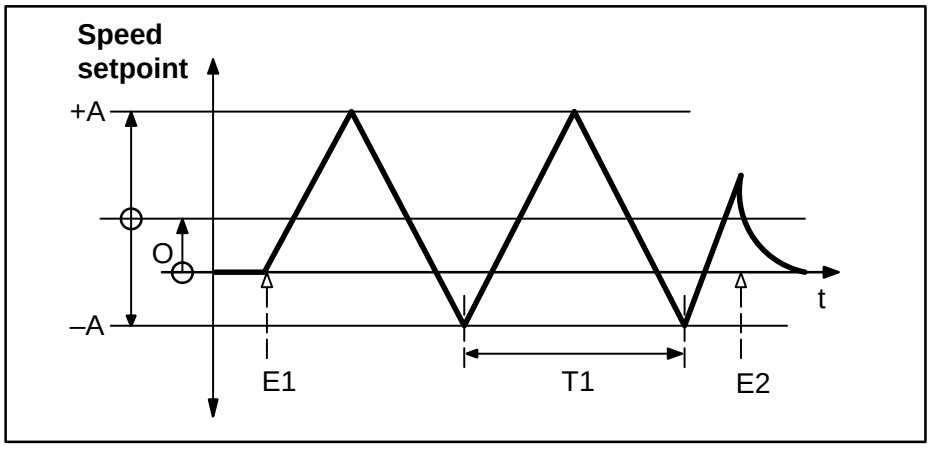

Fig. 9.7

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Conditions

Operating mode	: Speed setpoint (position controller cycle)
Signal type	: Sawtooth
E1	: Switch-on instant (NC Start hardkey)
E2	: Switch-off instant (e.g. NC Reset)
T1	: Period
A	: Amplitude (+/–)
O	: Speed offset

Explanation

The speed setpoint is output with a delay via a filter during braking.

The speed setpoint amplitude acts in relation to the speed offset.

- **Staircase** (speed setpoint)

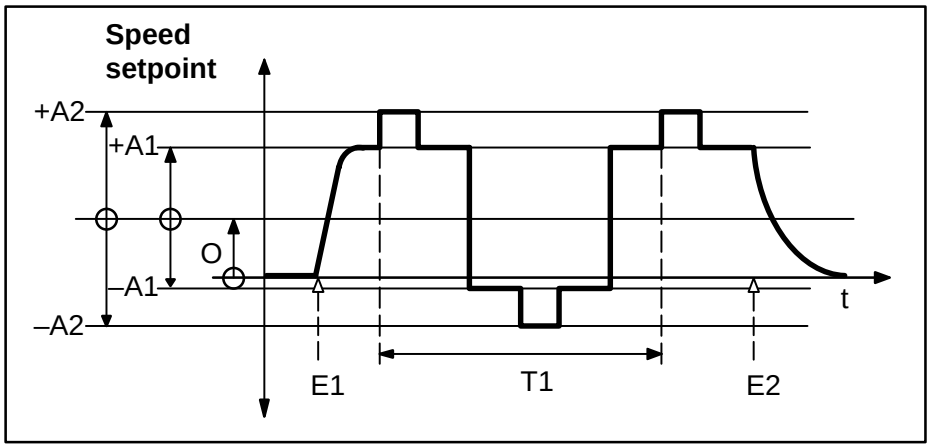

Fig. 9.8

Conditions

Operating mode	: Speed setpoint (position controller cycle)
Signal type	: Staircase
E1	: Switch-on instant (NC Start hardkey)
E2	: Switch-off instant (e.g. NC Reset)
T1	: Period
A1	: Amplitude 1 (+/–)
A2	: Amplitude 2 (+/–)
O	: Speed offset

Explanation

Starting and braking are implemented with a delay via a filter. The amplitude changes in cyclical operation are output in step form.
Amplitudes A1 and A2 are calculated symmetrically to the offset line.

- **Noise signal**

Note

This waveform corresponds to that of a square-wave signal, but with statistically varying pulse width and period.

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- **Ramp 1** (position setpoint)

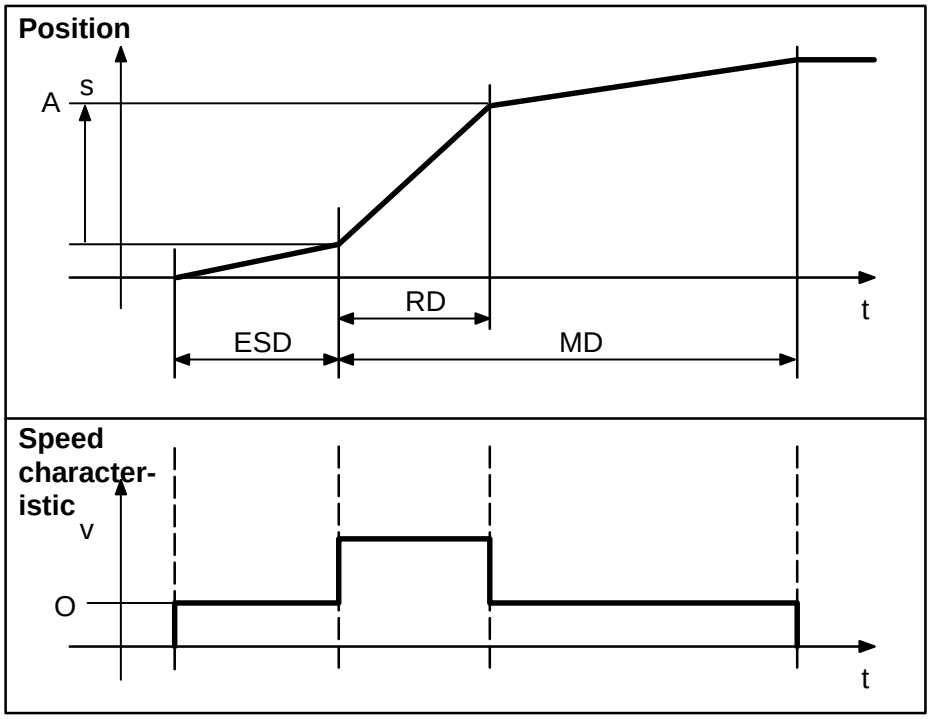

Fig. 9.9

Conditions

Operating mode	: Position setpoint
Signal type	: Ramp
ESD	: Settling time
RD	: Ramp time
MD	: Measuring time
A	: Amplitude
O	: Speed offset

Note

Set acceleration is very high (speed characteristic).

Erläuterung

The axis/spindle is traversed at the constant speed offset during the setting time and after ramping according to the position ramp. The speed setpoint increases during the position ramp time.

The acceleration set in the NC MD generally applies to the signal waveform of the speed characteristic. To obtain the above signal waveform, a very high value must be set in this NC-MD to ensure step changes in the speed.

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- **Ramp 2** (position setpoint with reduced acceleration value)

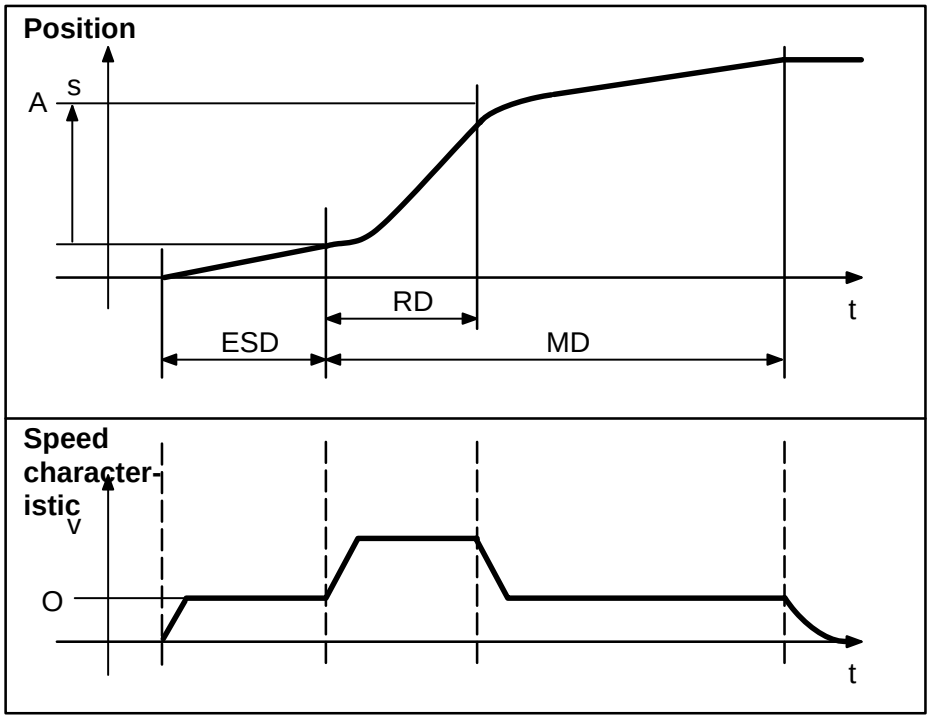

Fig. 9.10

Conditions

Operating mode	: Position setpoint
Signal type	: Ramp
ESD	: Settling time
RD	: Ramp time
MD	: Measurement time
A	: Amplitude
O	: Speed offset

Note

Set acceleration is lower (speed characteristic).

Explanation

The setpoint characteristic is the same as that in the ramp 1 diagram except that the drive acceleration has been reduced. The position setpoint transitions during speed changes are therefore softer. The speed is influenced by the values set in the NC-MD:

- Spindle : MD 4780 – MD 4850
- Axis : MD 2760

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- **Step change** (speed setpoint)

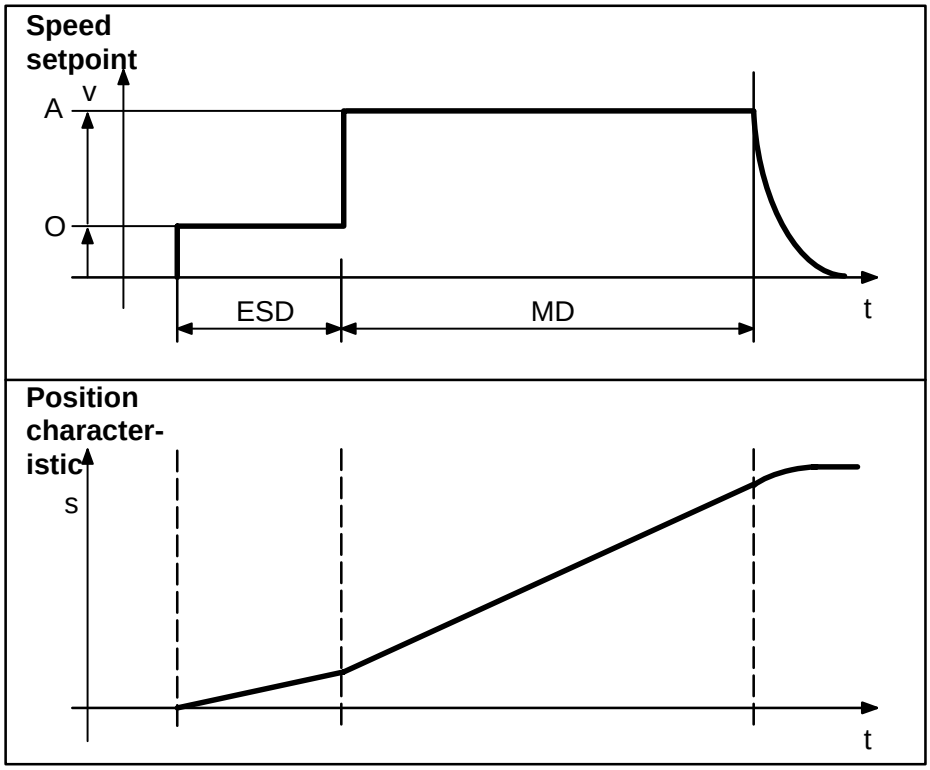

Fig. 9.11

Conditions

Operating mode	: Speed setpoint (position controller cycle)
Signal type	: Step change
ESD	: Settling time
MD	: Measurement time
A	: Amplitude
O	: Speed offset

Explanation

On expiry of the settling time the speed setpoint is increased abruptly by the amplitude value from the offset.

On expiry of the measurement time, the setpoint signal is removed and the speed setpoint reduced to zero with a delay via a filter.

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- **Step change** (position setpoint)

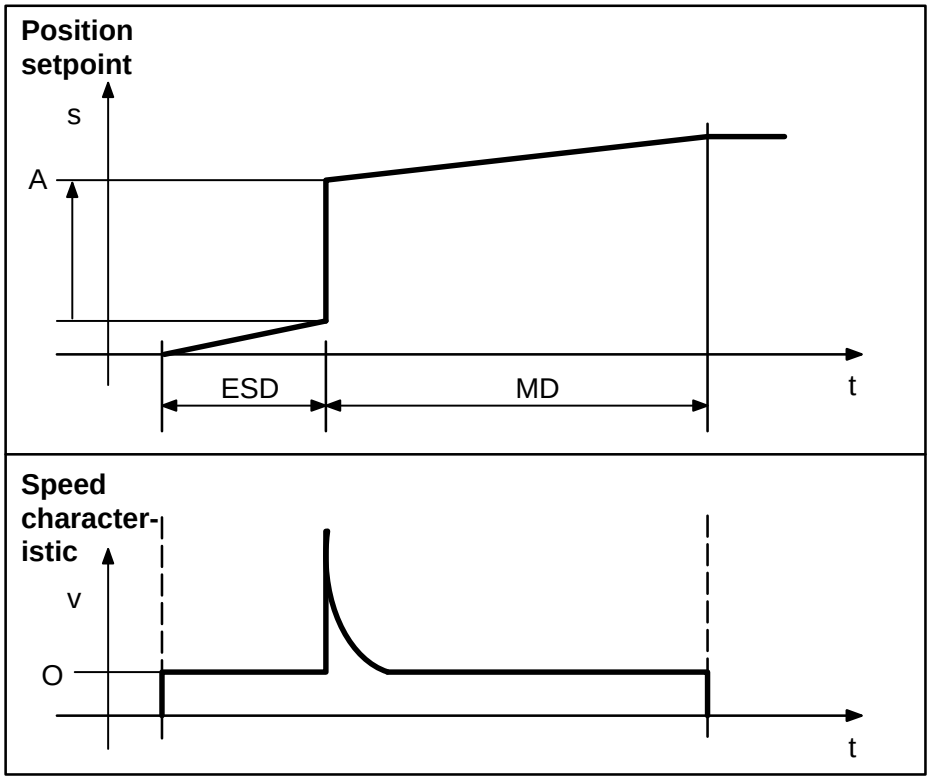

Fig. 9.12

Conditions

Operating mode	: Position setpoint
Signal type	: Step change
ESD	: Settling time
MD	: Measurement time
A	: Amplitude
O	: Speed offset

Explanation

During the settling period and on completion of the position step change, the drive is operated with the specified speed offset.
On expiry of the settling time, the position amplitude is switched through to the position controller input within one cycle.

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- **Effect of scaling on the signal waveform**

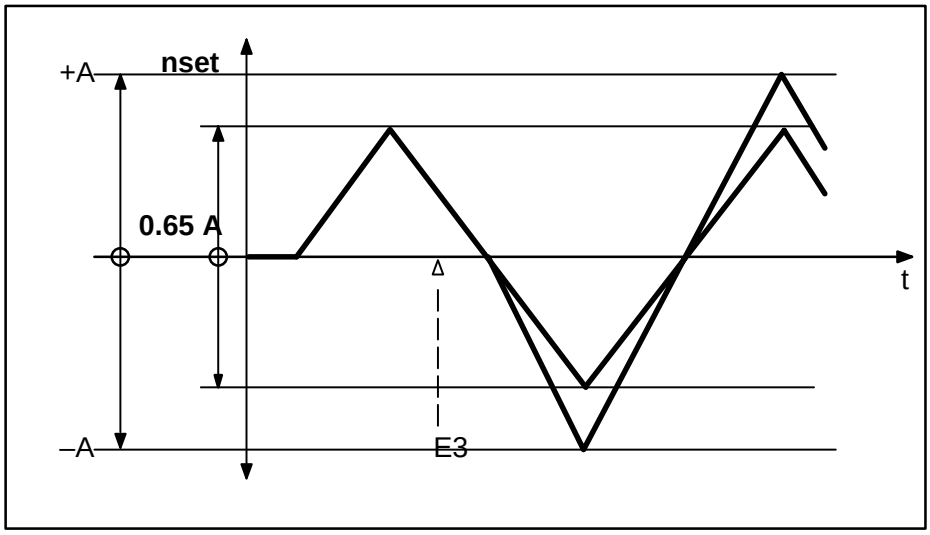

Fig. 9.13

Conditions

Operating mode	: Speed setpoint (position controller cycle)
Signal type	: Sawtooth
E3	: Change in scaling value by user (e.g. from 65% to 100%)
A	: Amplitude (+/–)

Explanation

A new scaling value is input via the Start softkey at instant in time E3. The resultant increase in amplitude is not input as a sudden step change, but is delayed via a filter.

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9.4 Mixed I/O configuration and digital-analog converter, DAC (as from SW 3)

General notes on mixed I/O

The possible applications for digital-analog converters described in this Section are used to conduct test measurements on digital signals from the drive or position control. These signals can be output as analog voltages for diagnostic purposes on an oscilloscope or a recorder.

The 4 DAC channels of the MIXED I/O module with the order no. 6FX1138–4BA01 (16-bit resolution) are used for this purpose.

The DAC signals are output at connector X111.

General notes on DAC, 611D drives

Max. 4 DAC channels are supported for output of SERVO quantities.

The DACs on the 611D feed and main spindle drives have the following features:

SW 3:

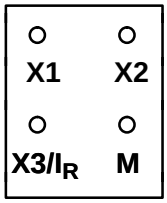
- 8-bit resolution
- 3 DACs on each feed drive module (single and two-axis module).
- Each main spindle module is provided with 2 DACs and a special-purpose test socket. This test socket outputs a voltage which is proportional to the current actual value of phase R (see Table).

Module	Scaling Test socket I_R
8/10/16 A	25 A ≙ 8.25 V
24/32/32 A	50 A ≙ 8.25 V
30/40/51 A	75 A ≙ 8.25 V
45/60/76 A	150 A ≙ 8.25 V
60/80/102 A	150 A ≙ 8.25 V
85/110/127 A	200 A ≙ 8.25 V

SW 4/SW 5:

- 8-bit resolution
- 3 DACs are installed on each MSD and FDD module

Arrangement of DACs/sockets:



X1 : Test socket DAC1
X2 : Test socket DAC2
X3 : Test socket DAC3
I_R : Test socket current actual value phase R (MSD module) – **SW 3 only**
M : Reference earth for test sockets

With **SW 3** only, the scaling of the voltage output with test socket I_R is dependent on the MSD module used:

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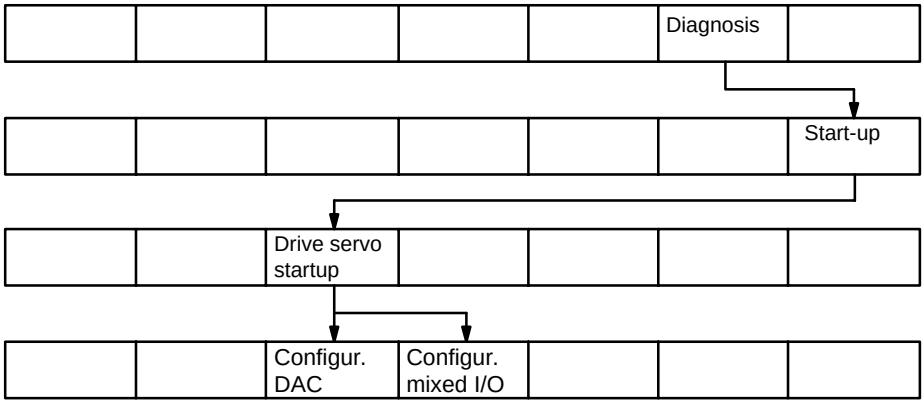
Note

The test sockets on 611D modules have an output voltage of between 0 and 5 V; 611A modules have a +/–10 V output. The test sockets can be evaluated in the usual way. These sockets are not intended for use in **normal operation**.

Anwahl



Configur. DAC

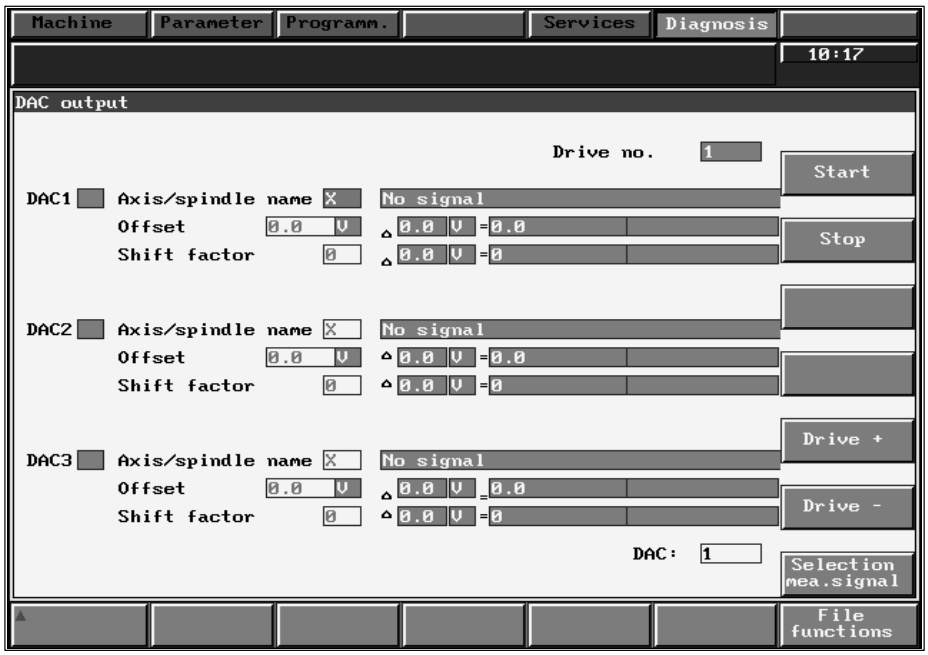


Fig. 9.14

Explanation

In this display, the output DACs are assigned via **drive selection** (+/–) and specification of the **axis/spindle name**.

The **offset** input values must make allowance for the output range of the analog voltage signal. The 611D drive module DACs have an output range of –2.5 V to 2.5 V.

Since the DAC resolution is limited (8 bits), a window can be placed over the output value by means of the **shift factor**, i.e. the signal output is decreased (normalization) when a negative shift factor is input and is increased (normalization) with a positive shift factor. The input limits for the shift factor vary for SERVO, FDD and MSD:

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	Lower input limit	Upper input limit
SERVO (SW 3 SW 4)	–7	31
FDD (SW 3/SW 4)	–7	23
MSD (SW 3)	0	15
MSD (SW 4)	–7	23

Notes

Make sure that the selected drive (display) corresponds to the connected test sockets (DACs) of the appropriate drive (module) in the case of 611D signals. Servo signals (max. 4) can be output by every module – however, the axis name must also be input.

The analog output must be set again after power on reset.

When 611D signals are output from an

- FDD (speed/current controller signals) or an
- MSD (speed SW 4: current controller/signals)

the drive (drive number) which is to be measured must be selected for the output.

The “Axis/spindle” input field has no function in this case.

Note

- It is not possible to save the DAC configuration with “Load/save all” for complete backup, nor is it possible to load a boot file via the File function.
- The DAC boot file should be deleted if the DACs are not longer required, in order to reduce the load on the processor.
- It is no longer possible to reinstall the analog output after Power On as these DACs are active again after Power On.

Configur. mixed I/O

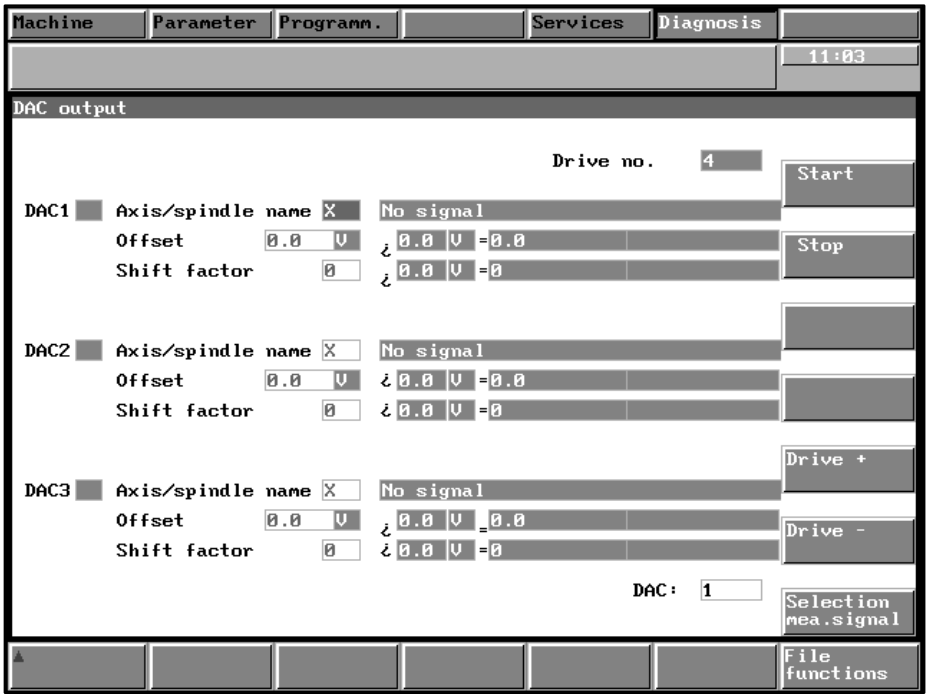

Fig. 9.15

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Explanation

In this display, the output DACs are assigned via **drive selection** (+/–) and specification of the **axis/spindle name**.

The **offset** input values must make allowance for the output range of the analog voltage signal. The 611D drive module DACs have an output range of –2.5 V to 2.5 V.

Since the DAC resolution is limited (8 bits), a window can be placed over the output value by means of the **shift factor**, i.e. the signal output is decreased (scaling) when a negative shift factor is input and is increased (scaling) with a positive shift factor. The input limits for the shift factor vary for SERVO, FDD and MSD:

Note

The analog output must be set again after Power On Reset.

Selection meas. signal

SW 3
You can select lists containing a selection of signals with this softkey:

Explanation

Signals are selected with the cursor hardkeys and softkey **Selection End**. The page-up and page-down hardkeys can be used to scroll in this list.

Selection list for axes (SERVO)

Following error
Absolute setpoint (IPO)
Speed setpoint
Part actual value
Part setpoint (IPO cycle)
Contour deviation
Following error (IPO cycle)
Absolut value modulo
Part setpoint FIPO input
Absolute setpoint (LR)
Part setpoint FIPO output

Selection list for axes and spindles (SERVO)

Part actual value 2nd MS/spindle encoder
Part actual value 1st MS/C-axis encoder

Selection list for spindles (SERVO)

Speed actual value
Speed setpoint (actual)

Selection list for gearbox interpolation (SERVO)

Synchronism deviation
Delay compensation value abs.
Delay compensation value inc.
Part compensation value FIPO output
Limiting memory
Part compensation value FIPO input
Leading axis total actual value link
Leading axis total all leading axes
Leading axis total active
Part compensation value (IPO cycle)
GI additional setpoint

Selection list for 611D FDD (feed) only

Current i(R)
Current i(S)
Current i(d)
Current i(q)
Current setpoint (limited)
Current setpoint (controller output)
Speed actual value motor
Speed setpoint
Speed setpoint reference model

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Selection list for 611D MSD (spindle) only	Speed setpoint low Speed setpoint high Speed actual value low Speed actual value high Speed actual value amount Rated power as percentage Motor rated torque as percentage Torque setpoint Active current setpoint Magnetization current setpoint Slip frequency setpoint Stator temperature smoothed

Selection meas. signal

SW 4 and 5
You can select lists containing a selection of signals with this softkey:

Explanation	Signals are selected or deselected with the cursor hardkeys and softkeys **ok** and **Abort**. The page-up and page-down hardkeys can be used to scroll in this list.
SERVO signals for axes/spindles	Following error as from SW 6 position control difference (following error) Absolute setpoint Absolute actual value Speed setpoint (0.01 %) Part actual value (active) Part setpoint Synchronism error
SERVO signals for axes	Contour deviation Abs. compensation value
SERVO signals for spindles	Speed setpoint (present) Speed setpoint (RFG output) Speed actual value
Special SERVO signals	Part actual value 1st MS Part actual value 2nd MS Following error (IPO cycle) Position control difference (IPO cycle) Absolute value modulo Part setpoint (IPO cycle) Part setpoint (FIPO input) Absolute position setpoint (PC) Part setpoint (FIPO output) Part compensation value FIPO output Part compensation value FIPO input Leading axis total actual value link Leading axis total all leading axes Leading axis total active Part compensation value (IPO cycle) Angular offset (mech. coupling) Learn criterion (QEC) Quadrant error Output torque compensatory controller Setpoint torque compensatory controller, as from SW 6 modulo position
Signals for 611D only	Speed actual value motor Speed setpoint Speed setpoint reference model Torque setpoint (controller output) Current i_q (before filter) Current setpoint i_q (limit)

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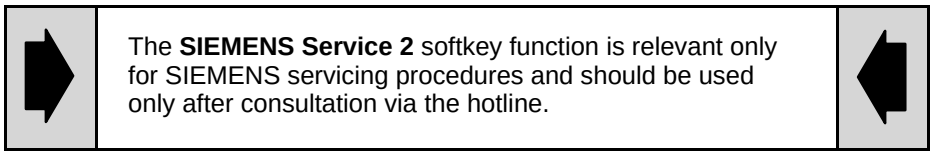
Current actual value i_q (torque-producing)
Rotor flux setpoint
Rotor flux actual value (MSD only)
Current setpoint i_d
Current actual value i_d
Cross voltage U (q)
Longitudinal voltage U (d)
Current actual value i_r (Phase R)
Current actual value i_s (Phase S)
Torque setpoint limit
Active power
Capacity utilization M/M_{max}
Motor temperature
Zero mark signal motor measuring system Shift factor 16
Bero signal
DC-link voltage
Rotor position signal (in $10 000 format with extrapolation; as from SW 6)
Voltage setpoint (as from SW 6)
Current setpoint (as from SW 6)

Notes

The zero mark signal is connected to bit 7.
The cam bero signal is connected to bit 11 (for a 24-bit data word width this means a shift factor of 11)

SIEMENS Service 2

You can select the SIEMENS Service 2 function with this softkey



The **SIEMENS Service 2** softkey function is relevant only for SIEMENS servicing procedures and should be used only after consultation via the hotline.

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9.5 Quadrant error compensation

9.5.1 General comments

Technical reasons why quadrant error compensation is necessary

If an axis is accelerated from a negative to a positive velocity (or vice versa), it sticks when passing through zero speed because of the changing friction conditions. this action causes contour errors with interpolating axes. This action seriously effects machining of circular contours, where one axis moves at the maximum path velocity whereas the second axis is still at the quadrant transition point. Measurements on machines have shown that this disturbing friction moment can be compensated for by applying an additional speed setpoint impulse (with a high enough amplitude and correct sign).

Other measurements shows that the compensating amplitude of the friction feedforward value does not remain constant across the whole acceleration range. Where the acceleration is higher, feedforward control must be applied with a smaller compensation value than for smaller acceleration. For this reason, a friction compensation with adapted amplitude has been developed.

Installation

The compensation value for the quadrant error compensation essentially depends on the machine configuration.

The easiest way to install the quadrant error compensation is to carry out a circularity test. With a circularity test, deviations from the programmed radius when a circle is described can be measured and displayed graphically, must especially at the quadrant transition points. To obtain an optimum compensation in the whole working range of the friction feedforward control, the compensation dependancy on the acceleration must also be considered. This is done by measuring this dependancy at various points in the range between acceleration 0 and set maximum acceleration.

9.5.2 Circularity test (option – SW 4)

Explanation

The circularity test is provided as a means of testing the contour accuracy achieved. It is implemented on a level above axial start-up since the functions involved are applied generally rather than to one specific axis.

This circularity test can be used to check the **neuronal** as well as the **conventional** quadrant error compensation. Since this test function displays a number of important guide quantities, it also facilitates setting of the conventional QEC.

Notes

At least 2 axes must be defined or else activation of the circularity test function is disabled with error message 160107 “Axes not configured”.

The circle must be specified by means of an NC part program, i.e. the circularity test is a pure measurement function.

Selection

The circularity test display can be called by means of softkeys **Diagnosis**, **Start-up and Drive servo startup**.

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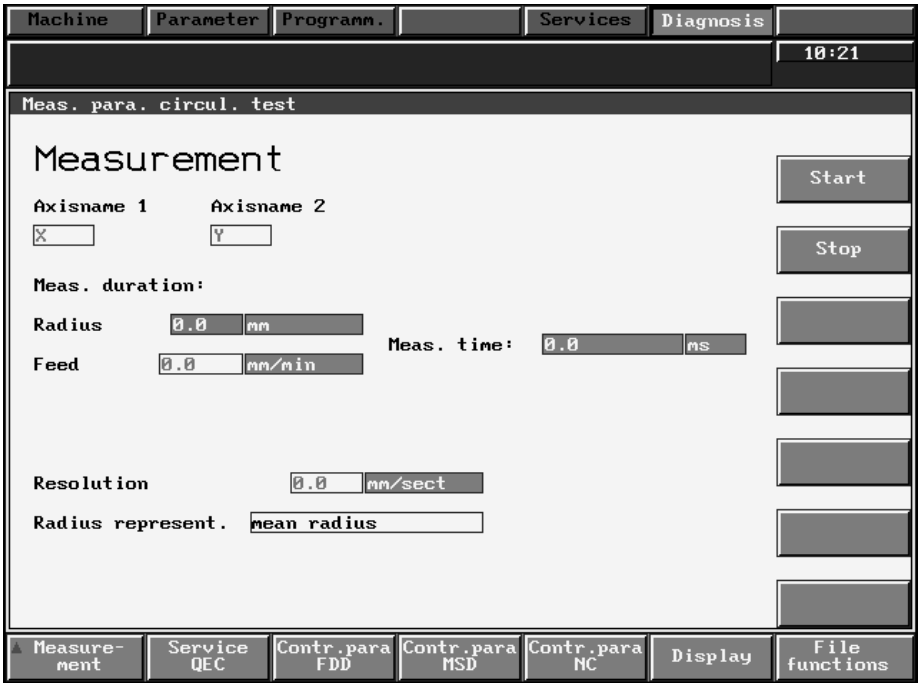

Fig. 9.16

Explanation

The axis names with which the circle is to be traversed are selected in this display. No check is made to ascertain whether the selected axes correspond to those programmed in the part program.

Measurement

The measurement time for the circularity test can be parameterized only by means of radius and feedrate and is displayed when the measurement commences or when softkey **Measurement** is selected again.

The values entered in input fields “Radius” and “Feed” must correspond to those entered in the part program controlling the circular motion of the axes, with allowance made for the override switch. No check is made to ascertain whether the values in the part program (including override) correspond to those entered in the display.

Display field “Meas. time” displays the measurement time required to record the position actual values during traversal of the circle; this time is calculated on the basis of the radius and feed values.

It is also possible to parameterize the mode in which measurement results are represented (via programmed radius or mean radius) and the resolution (scaling of diagram axes). These inputs are used by the MMC to prepare representation of the measured values in the form of a circle diagram.

If the measurement time exceeds the time range which can be represented by the trace buffers (measurement time position controller cycle x 2048), then an appropriate sub-scanning process is executed for the recording.

Start

The user must start the test program chosen to control the traversing motion (circular) for the selected axes by means of “NC start” to ensure that the program receives the values required to perform the measurement function. “NC start” can be executed from standard operating modes such as MDA or AUTOMATIC.

- The measurement function is initiated by selecting the vertical **Start** softkey.

Stop

- The measurement can be terminated at any time by selecting the vertical **Stop** softkey.

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Display

Any measurements which may not be complete at the point of interruption are displayed as well as possible under the **Display** softkey. No monitoring functions are activated in this case.

The part program (for circle traversal) and the measurement function are not synchronized. The user can freely select the order in which he starts the part program (via NC start) and starts the measurement depending on the application in question. The standard displays (machine display) can be used to test and check the traversing motion (e.g. to trace traversal path).

Softkeys **Contr.para FDD**, **Contr.para MSD** and **Contr.para NC** are made available to allow direct access to the controller parameters required.

Axis +, –

These softkeys lead to the list input displays for the NC and drive controller machine data. The appropriate axes must be selected in these displays by means of vertical softkeys **Axis +** and **Axis –** or **Drive +** and **Drive –.**

The machine data required for the conventional quadrant error compensation are also contained in the list input display **Contr.para NC**. Only a small number of operator inputs are therefore required to start up the conventional QEC.

Service QEC

You can select the service QEC display with this softkey.

Explanation

Important guide quantities relating to the quadrant error compensation of the two relevant axes are displayed under softkey **Service QEC** to assist the user further in starting up the conventional QEC.

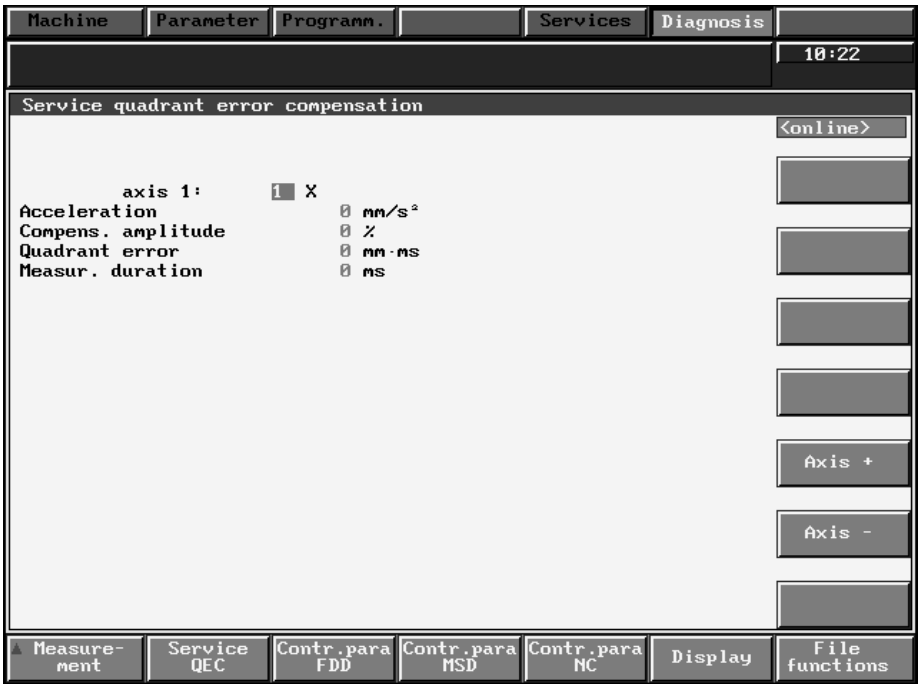

Fig. 9.17

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Explanation

The following service data are output cyclically in the above display:

- The following service data are output cyclically in the above display:
- The axial acceleration at the instant of the last speed zero crossing
- The compensation amplitude on the last speed zero crossing
- The axis quadrant error (error criterion) of the neuronal QEC in cases where an error measuring time is parameterized (see section “Further optimization and intervention options”).

Note

The characteristic for the quadrant error compensation function in use to date can be determined directly on the basis of the quantities acceleration and compensation amplitude. Using the quadrant error (error criterion) as a basis, the setting can be assessed (this value should be as low as possible).

Display

SW 4
You can call the graphic representation of the circularity test by means of this softkey.

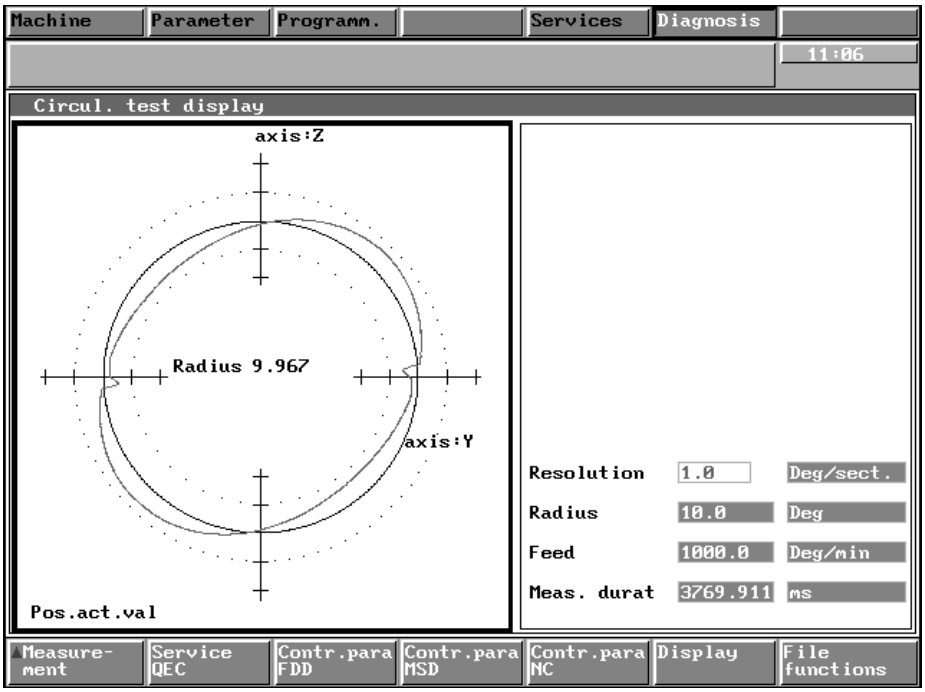

Fig. 9.18

Explanation

This display shows the measured characteristic of the two axis position actual values in the form of a circle with the resolution selected by the user. The mean radius (or the programmed radius), the programmed feedrate and the circle measurement time derived from these values are then displayed for documentation purposes (i.e. for subsequent storage of the measured circle characteristic as a file).

In order to accentuate the transitions on the quadrants, for example, the user can set a finer scale for the diagram axes in the input field/selection with position frame to the right. Softkey **Display** must then be selected again in order to display the entire circle diagram with the new resolution setting.

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Note

The displayed measurement results can be stored as a file on the MMC by selecting softkey **File functions**.

Data output of circularity test measurement results

Data can be output on an external PC via the V24 interface and by means of commands in the “Services” menu. The extensions for “Services” required for this purpose are listed in the requirements to other areas. Data can therefore be output in **PC format** with the aid of the “PC-IN” program. Within this program, it is possible to re-convert the data back to the original ASCII format with software version 3.0 and higher.

Note

Measurement results can also be written to a file using the hardcopy function and output by means of “Services” functions.

Display

SW 5
You can switch to graphic representation of the contour with this softkey.

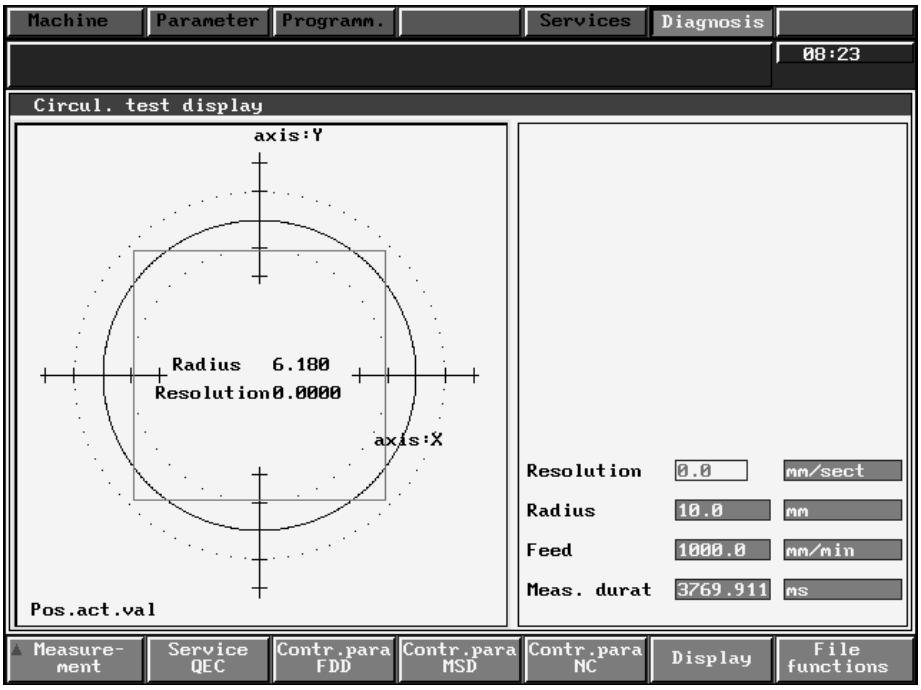

Fig. 9.19

Explanation

The contour is shown without any distortion if the value 0 is entered in the field “Resolution”. If suitable radius and feedrate values are entered, other contours can also be displayed.

Radius and feedrate represent the input parameters required for setting the measuring duration and the radius is used to define the form of graphic representation.

Note

Storage and output of the measuring results are the same as described for the circularity test display in Section 9.5.2.

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9.5.3 Conventional quadrant error compensation (as from SW 2)

Corresponding data

- MD 1332*
  1236*
  1240*
  1244*
  1248*
  1252*
  1256*
- MD 1804*, bit 6
  1804*, bit 7
  1824*, bit 0

Parameterization

The friction feedforward control is activated axis-specifically via MD 1804*, bit 6. If MD 1804*, bit 7 is set, the adaptation characteristic also becomes active.

The following machine data area available for parameterization:

MD 1232*	Compensation value in range 2	[0.1 mV] [0.01 %] 1)
MD 1236*	Compensation time constant	[0.1 ms]
MD 1240*	Compensation value in range 4	[0.1 mV] [0.01 %] 1)
MD 1244*	Upper limit range 1 (a_1)	[100 units MS/s^2]
MD 1248*	Upper limit range 2 (a_2)	[100 units MS/s^2]
MD 1252*	Upper limit range 3 (a_3)	[10000 units MS/s^2]

9.5.3.1 Installation without adaptation characteristic

The installation is carried out in two stages. In stage one, the friction feedforward control without adaptation (MD 1804*, bit 6=1) is derived.

Two parameters (compensating amplitude and compensation time constant) can be altered. These two parameters are each increased or decreased until the deviations from the programmed radius become minimal or have completely disappeared in the circularity test at the quadrant transition point (Figs. 9.20 to 9.24).

A starting value of a relatively small compensating amplitude (e.g. MD 1232* = 100) and a time constant of a few position controller cycles (e.g. MD 1236* = 80) should be defined at the beginning of the measurement.

Changes can most clearly be seen when the circularity test is first carried without friction feedforward control (MD 1804*, bit 6 = 0).

Fig. 9.20 shows typical quadrant transition points without friction feedforward control.

1) 100% in the two compensation values from MD 1232* and 1240* correspond to a speed setpoint of 1 V on analog drives and 10% of the maximum speed set on the drive side on digital drives.

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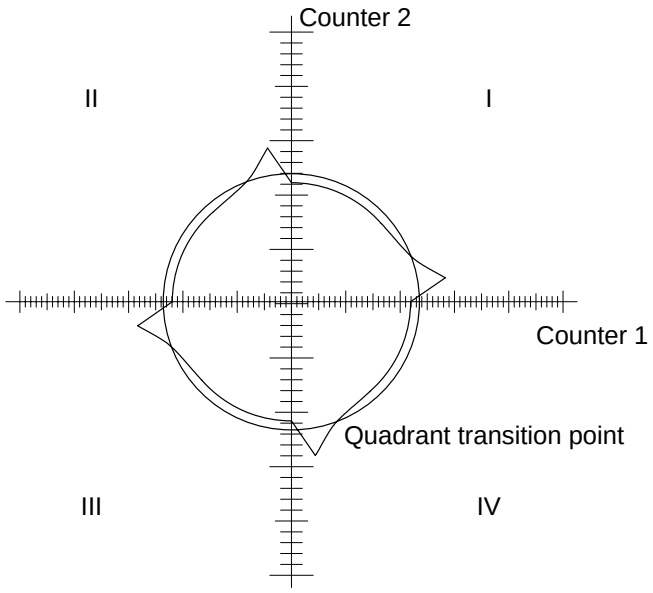

Fig. 9.20 Radius deviations at the quadrant transition points without compensation

Setting the compensating amplitude

If the compensating amplitude is too small, the circularity test shows that the radius deviations from the programmed radius at the quadrant crossover points have insufficient compensation (see Fig. 9.21).

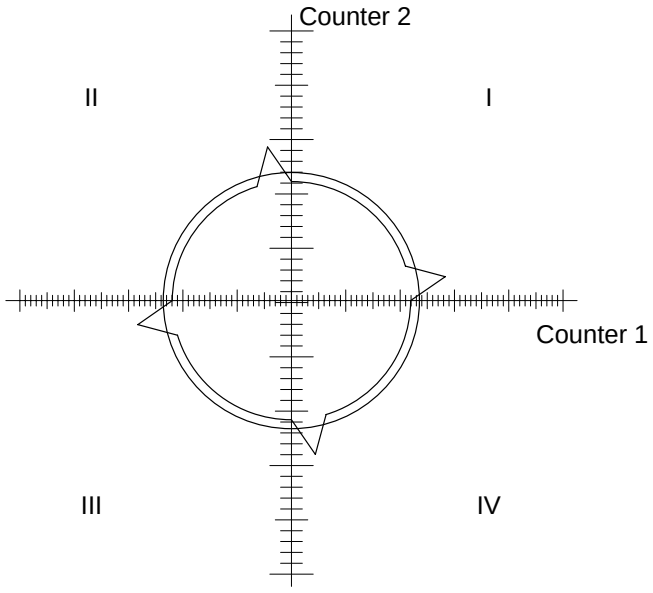

Fig. 9.21 Radius deviations at the quadrant crossover points with insufficient compensation

If the compensating amplitude is too high, the circularity test clearly shows the overcompensation of the radius deviations at the quadrant crossover points (see Fig. 9.22).

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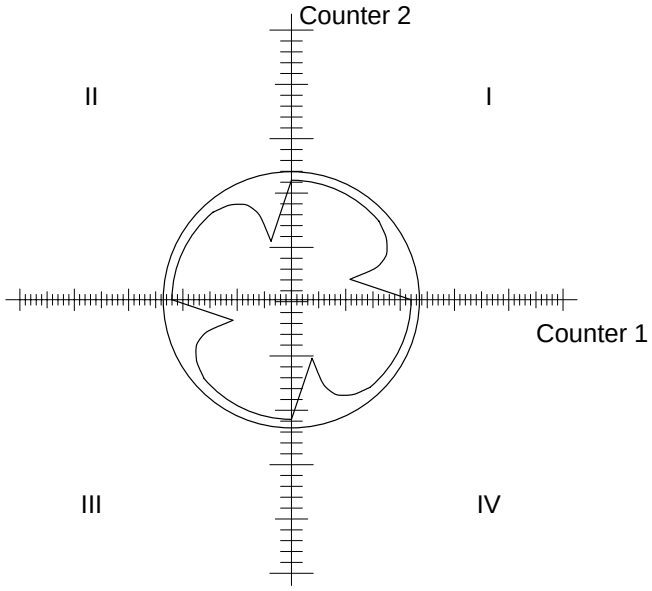

Fig. 9.22 Compensating amplitude too high

Setting the compensation time constant

If the compensation time constant used in the circularity test is too small, the test shows that the radius deviation is compensated for, for a short time at the quadrant transition points, but that larger radius deviations from the programmed radius again occur immediately after (see Fig. 9.23).

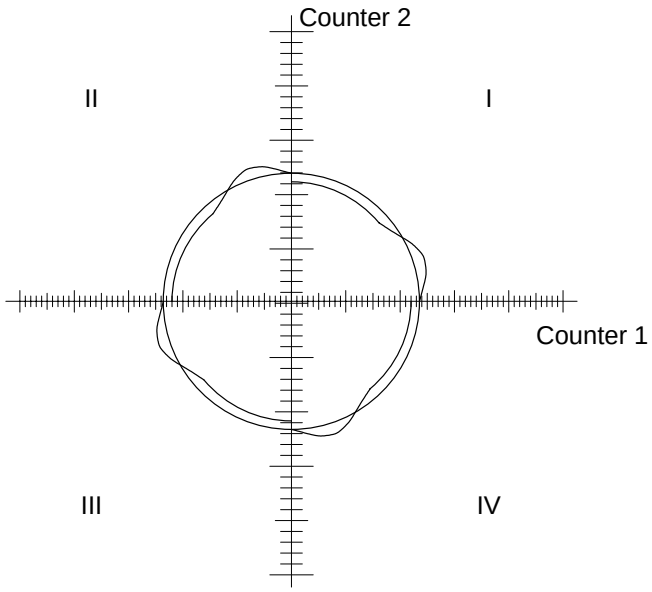

Fig. 9.23 Compensation time constant too small

If the value for the compensation time constant chosen for the circularity test is too high, we see that the radius deviation at the quadrant transition points is compensated for (it is assumed that the optimum compensating amplitude has been found), but that after the quadrant transition point the radius deviation is less than the programmed radius (see Fig. 9.24).

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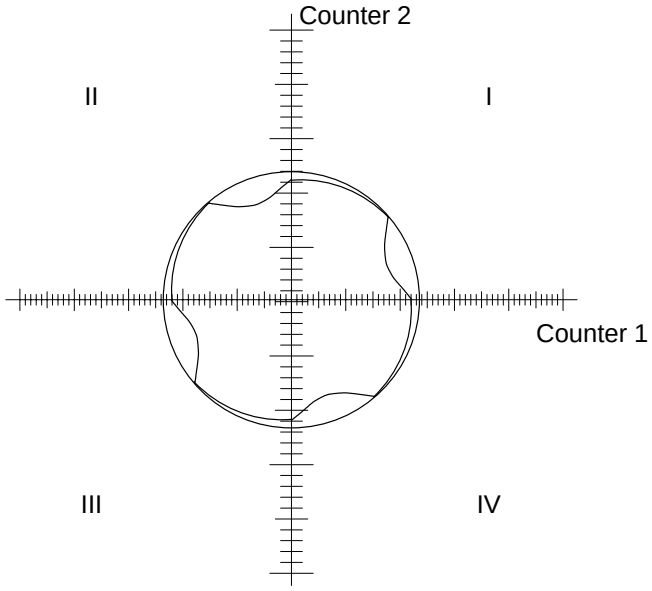

Fig. 9.24 Compensation time constant too large

If it is not possible to find a uniform compensation time constant for the various radii and velocities, the average value of the derived time constants is used.

If it has been possible to achieve a good result with these time constants and the constant compensating amplitude across the whole working range, i.e. for all required radii and velocities and for positioning, characteristic adaptation (MD 1804*, bit 7) is no longer needed.

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9.5.3.2 Installation with adaptation characteristic

If the compensation is acceleration dependant, a characteristic must be determined in a second stage.

The required compensation amplitudes for different radii and velocities are determined, the effect of the compensating amplitudes checked in a circularity test and the optimum compensation amplitudes logged.

The following characteristic is used for the adaptation:

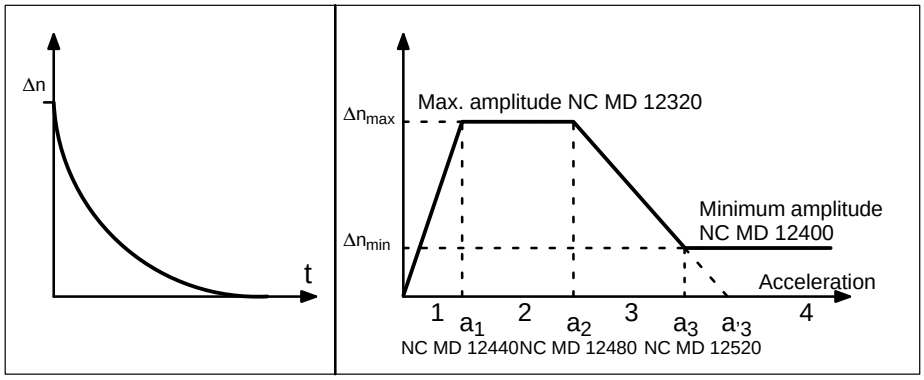

Fig. 9.25

A distinction is made between four ranges in the characteristics:

$$\Delta n = \begin{cases} \Delta n_{max} \times \frac{a}{a_1} & \text{for } a < a_1 \\ \Delta n_{max} & \text{for } a_1 \leq a \leq a_2 \\ \Delta n_{max} \left(1 - \frac{a - a_2}{a_3 - a_2}\right) & \text{for } a_2 < a < a_3 \\ \Delta n_{min} & \text{for } a_3 \leq a \end{cases}$$

The characteristics in Fig. 9.25 are used for the following examples. It is defined by the values “Maximum compensating amplitude”, “Minimum compensating amplitude” and the three acceleration values a_3, a_2 and a_1. Considerably more measured values should be determined as a control, must importantly there should be a sufficient number of points for high velocities with small radii. The characteristic values are most easily derived from a graphic representation.

The acceleration values are derived from $|a| = v^2/r$ from the radius and travel velocity. The acceleration value can easily be varied using the override switch.

Before entering these acceleration values a_3, a_2 and a_1 in machine data 1244*, 1248* and 1252*, it may be necessary to convert to the input format of the machine data ([mm/s^2] → [100 units MS/s^2] or [10000 units MS/s^2]).

A monitoring function in the control ensures that incorrect parameterization of the characteristics for the friction feedforward control are avoided.

The following conditions must be met when entering accelerations a_3, a_2 and a_1 for the characteristic.

$a_1 < a_2 < a_3$

If this condition is not met, parameter error 328 is output. The user should therefore follow the input sequence a_3, a_2 and then a_1 when entering the acceleration values. Parameter error 328 is also output if internal formats are exceeded as a result of calculation errors when determining the accelerations from inputs a_3, a_2 and a_1 . If this happens, the user must check whether the break points in the

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curve have been correctly calculated and/or have been entered in the correct input format (caution: MD 1252* uses a format factor 100 larger than MDs 1244* and 1248*!)

Example for setting the characteristic

a. To derive the actual acceleration
The acceleration when passing through zero speed in a circular path is calculated as follows:

$a = v^2/r$

A radius of 10 mm and a circular velocity of 1 m/min = 16.7 mm/s produces an acceleration $a = 16.7^2/10$ [mm/s^2] = 27.78 mm/s^2.

b. Entering the characteristic break points

The following accelerations were determined as the characteristic break point:

a_1 = 1.11 mm/s^2, a_2 = 27.78 mm/s^2, a_3 = 695 mm/s^2

The position control resolution 0.5 $\times$ 10 – 4 mm was selected, resulting in: 1000 units [MS] = 1 mm

The characteristic break points are therefore:

a_1 = 11100 units/s^2, a_2 = 277800 units/s^2, a_3 = 6950000 units/s^2

The following values must therefore be entered in the machine data in the given order:

MD 1252* = 695, MD 1248* = 2778, MD 1244* = 111

If unsatisfactory results are obtained for very low speed values,
a. increase the position control resolution
b. raise the smoothing time constant (MD 1256*), values $\leq$ 100 ms are recommended.
c. set MD 1824* bit 0 to 1. However, it must be remembered that compensation if performed on small traversing movements (e.g. with µ incremental mode) with this parameterization.

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9.5.4 Neural quadrant error compensation (QEC – SW 4)

Explanation/basic principles

The quadrant error compensation function reduces the contour errors resulting from friction, backlash or torsional stresses during reversal. Errors are compensated through the injection of an additional speed setpoint pulse at the instant of zero crossing of the speed setpoint (see diagram below on left).

With software versions up to and including SW 3, the intensity of the compensation pulse can be set according to a characteristic as a function of acceleration. This characteristic must be determined and parameterized during start-up using external measuring instruments (see diagram below on right), i.e. it is a relatively complicated process requiring a certain amount of experience.

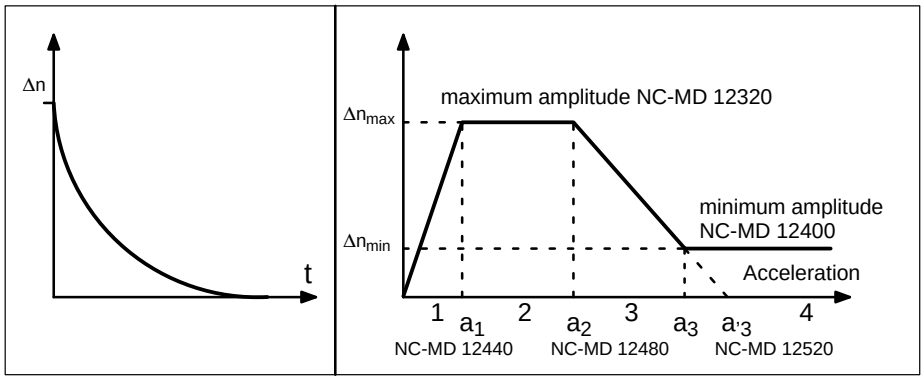

Fig. 9.26

With **SW 4** and higher, the manually parameterized characteristic block used to date can be replaced by a neural network of type CMAC which offers the following advantages:

- To **facilitate start-up**, the characteristic need no longer be set by the start-up engineer. Instead, it is automatically calculated during a learning phase. However, the characteristic can be calculated correctly only if errors occurring on the workpiece during quadrant transition are actually detected by the measuring system. This means that a direct measuring system, an indirect measuring system with distinct load reactions on the motor (rigid mechanical construction, low backlash) or appropriate compensation systems must be available. In the case of indirect measuring systems, the backlash compensation function should be applied to compensate any backlash.
- With the conventional QEC, the characteristic is approximated by means of a polygon with 4 straight lines. The neural network can simulate the actual characteristic shape considerably better, ensuring a **greater degree of accuracy**. The characteristic resolution can be adjusted to achieve the required accuracy and a directional dependency of the compensation amplitude can be taken into account. Apart from the compensation amplitude, the decay time can also be adapted to the acceleration rate in special cases.

During the **learning phase**, the neural network acquires a certain operating response, i.e. it learns a certain correlation between its input and output quantities. In the **working phase**, however, no further changes whatsoever are made to the stored characteristic.

During the learning phase, the neuronal quadrant error compensation requires a speed feedforward control of 100 %; a setpoint filter may be required for adaptation of the dynamic response.

Notes

The learning and working phases as well as the resultant neural quadrant error compensation have a purely axis-specific action, i.e. there is no mutual influence between axes.

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The operating procedure from **SW 3** can still be used if, for example, the conditions listed under **facilitation of start-up** cannot be met or if there is insufficient computing time available for the neuronal network.

Quantization of tof operating range

The input quantity (setpoint acceleration) is quantized before it is processed by the CMAC network. The entire operating range is broken down into intervals, the output value remaining constant in each interval (see diagram below). A memory location is assigned to each interval. The interval width increases with the acceleration rate in order to optimize memory requirement and learning period.

Finer quantization – involving higher memory space requirements – allows the resolution of the characteristic to be increased (see diagram below). However, this also prolongs the learning phase, i.e. start-up takes longer.

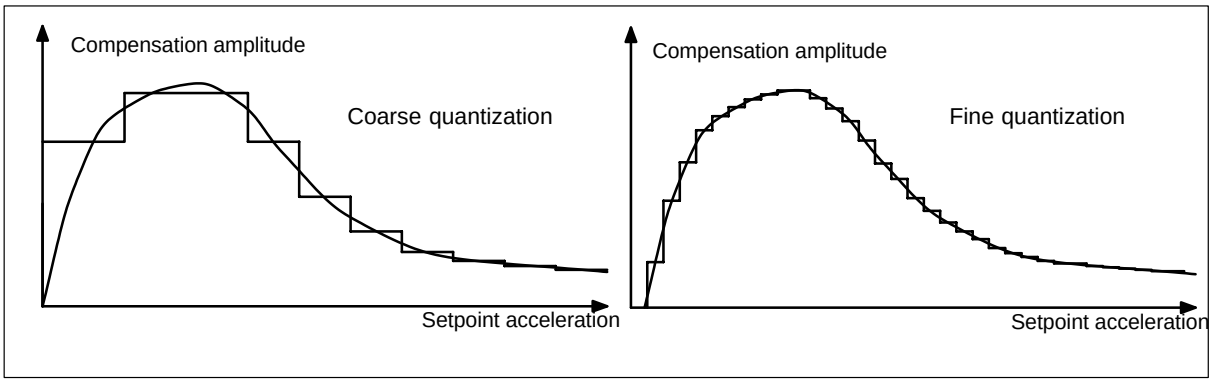

Fig. 9.27

Quantization of the input quantity is set by means of the two variables **fine quantization c** and **coarse quantization q**. The amount of memory space required or the total number of quantization intervals is calculated according to the following formula:

Amount of memory space = c x (q + 1)

A maximum of 1000 memory locations are reserved for each axis, affording sufficient resolution even when a high degree of accuracy is required.

Two quantities are used to determine quantization since fine quantization c has a further function in addition to its role in determining the interval sizes. A high fine quantization setting results in a “similar” output value being calculated for adjacent intervals of the input quantity, making it possible to identify, for example, measuring errors which only occur at a certain acceleration rate. In contrast, a low fine quantization setting allows characteristics with sharp changes in shape to be simulated better. For the purpose of neuronal friction compensation, the greater error tolerance afforded by a high fine quantization setting (c setting in the range of approx. 10) should be used. Only when the coarse quantization value is no longer significantly higher than the fine quantization value may the latter be reduced.

The lower the acceleration rate, the finer the quantization of the input quantity. In the low acceleration range, a particularly high resolution is required to ensure that the widely varying compensation values in this range can be simulated.

The following diagram shows the correlation between the quantization interval width and the setpoint acceleration (storage utilization by means of variable node distance).

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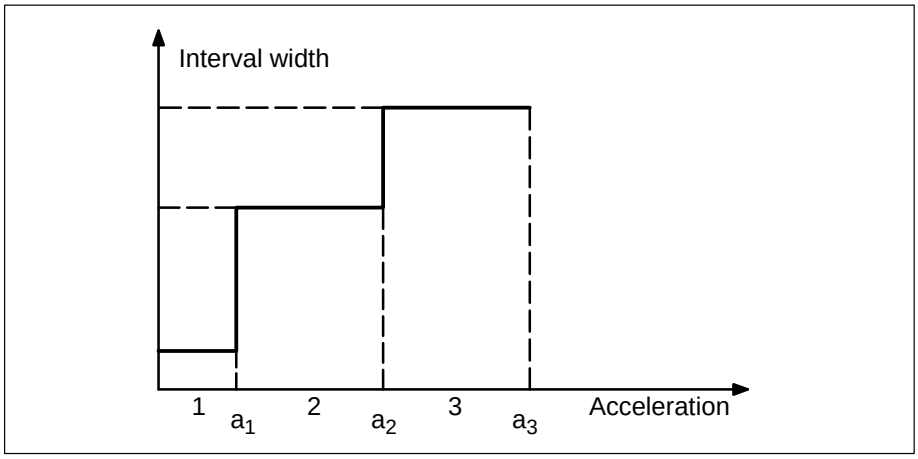

Fig. 9.28

Values a1 (lower range limit) and a2 (medium range limit) can be parameterized (see **Function parameters** softkey), a3 (max. acceleration) is the upper limit of the parameterized operating range. The standard settings for the limits of the operating range are as follows:

a1 = 2 %
a2 = 60 % of parameterized maximum acceleration

The parameter settings of a1 and a2 should only be changed if the compensatory effect in certain acceleration ranges is insufficient.

This can be assumed to be the case if the learned characteristic in one of the 3 ranges, 1, 2 or 3, deviates sharply from the diagram shown above while having a very uniform shape in one or both of the other ranges. The characteristic can be checked by selecting the **Display** softkey.

- **Saving and loading NQEC data**

  The MDD functions “Save all” and “Load all” have been extended to include the NQEC functions.

  With “Save all”, the NQEC parameterization including the measured values are read from the NCK/servo and stored in the ASCII files under the selected name.

  With “Load all”, the selected NQEC ASCII files are read in and stored as boot files. Using a method similar to TEA3-Load all, a back-up mechanism is implemented which is able to regenerate the original NQEC boot files automatically on power loss, emergency stop, disk full, abort key or similar occurrences.

  New alarms for this function: 165051 to 165054.

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• Standard start-up QEC

Explanation

The start-up process is semi-automatic and does not involve any external equipment. The contour accuracy achieved can be checked by means of the circularity test implemented internally in the control or with the aid of external measuring equipment. The standard start-up procedure is described and explained below. The functions provided to assist start-up as well as additional parameterization options in the event of unsatisfactory results are also given.

Decay time setting

The optimum decay time (NC-MD 12360) is determined manually at an operating point; the procedure to follow is described in section “Friction compensation”. The integrated circularity test is provided to assist calculation of this setting (see section headed “Circularity test”). The default settings of NC-MD 12360 (15 ms) ensure good results. The decay time is generally constant over the entire operating range. In special cases, however, it may be advantageous to raise the setting in the very low acceleration range or vice versa, to reduce the setting for very high acceleration rates (see section headed “Further optimization and intervention options”).

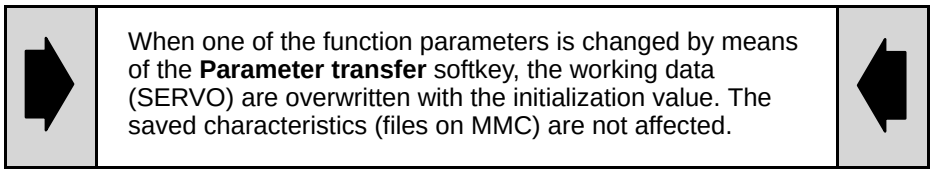
Loading of standard parameters

A file (STANDD_Q) containing standard data is available on the MMC for the parameters described under the **Function parameters** softkey; its purpose is to facilitate the start-up procedure. The start-up engineer can load these data by selecting softkey **File functions** or he can, as an alternative, enter the parameters individually.

The value for parameter “Max. acceleration” must be entered according to requirements, i.e. the neuronal network works and learns optimally only in the operating range with this maximum acceleration value.

Note:

When these parameters are entered manually, they do not become operative as working data until the **Parameter transfer** softkey has been selected.



When one of the function parameters is changed by means of the **Parameter transfer** softkey, the working data (SERVO) are overwritten with the initialization value. The saved characteristics (files on MMC) are not affected.

Activation of neural quadrant error compensation

The neural QEC is activated for the desired axis by setting bit 0 of NC-MD 18120. If the function parameters in the working data are not meaningfully assigned at the instant of activation, then service number 328 is set (see start-up lists).

Learning process

This process trains the network. For this purpose, a test signal is generated on the basis of which the network learns the optimum compensation amplitude over the entire parameterized operating range.

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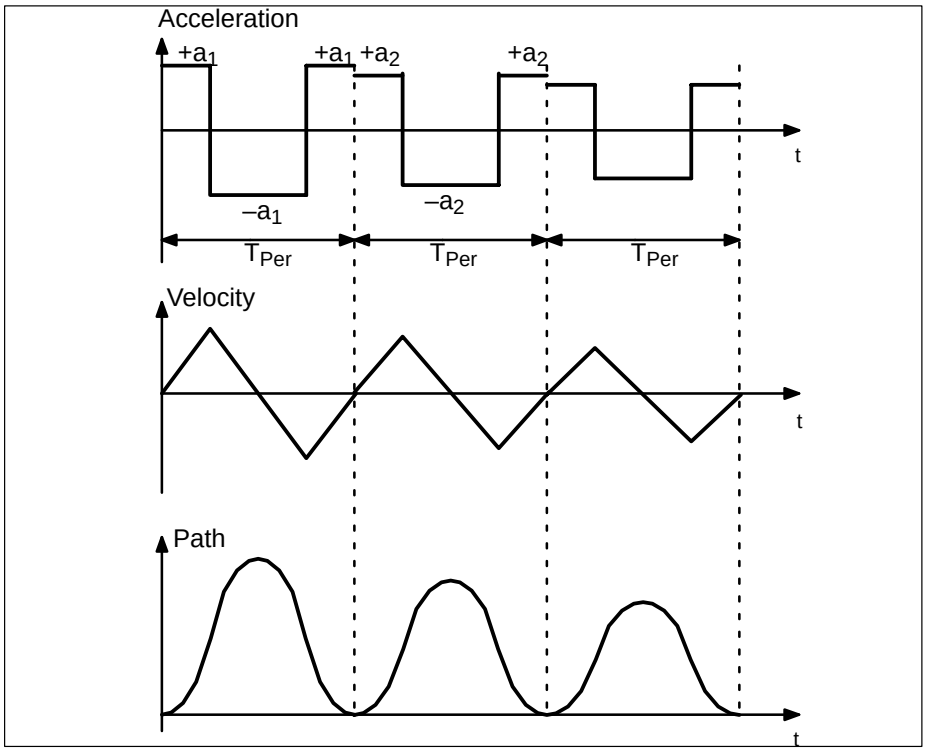

Fig. 9.29

The test signal generates successive reversing processes which are executed at an acceleration rate which slowly decreases over the three sections of the operating range.

The individual sections with time TPer are repeated according to a parameterizable number of learn process runs (default setting: 15). Estimate values for the required learning period are given under section heading “Further optimization and intervention options”.

The learning process is started on a menu-assisted basis (sequence of operations as for function generator). The end of the traversing motion is indicated by the message “Learning process complete”. The training result can be checked immediately by means of a circularity test.

Storage of information learned

On completion of the learning process, the compensation data must be saved in a boot file by means of file functions. This file is loaded after power ON by means of a file transfer from the MMC to the neuronal network. The file functions also allow the data to be stored in user files which can also be loaded to the neural network, thus making it possible to store several learned “characteristics” for one axis (e.g. for test purposes).

Notes

After power OFF/ON, however, the characteristic from the boot file is always active.

After data have been saved in the boot file, it is advisable to store them again in a user file for two reasons. Firstly, data can be loaded from a boot file only through the execution of an NCK reset and secondly, a back-up copy will then be available in the event of the boot file being accidentally erased or overwritten.

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9.5.4.1 Start-up of neural QEC

Neural QEC

You can select the “Neural quadrant error compensation” function for axes with this softkey.

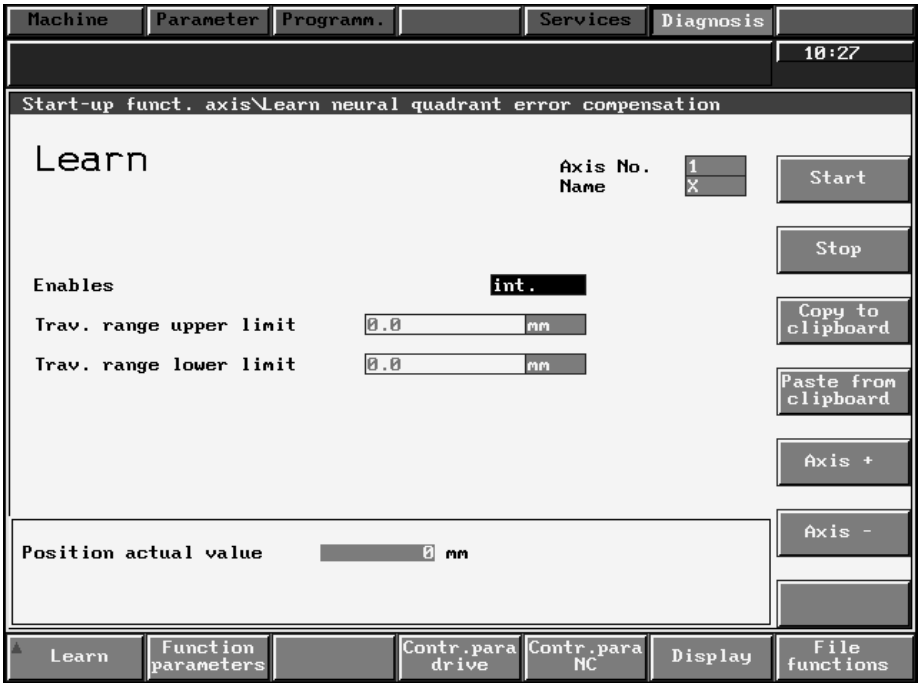

Fig. 9.30

Explanation/Notes

The input/information output display **Learn** has the same structure as the **Measurement** displays in the other axial start-up functions. The inputs in this display determine in which way the traverse enabling commands for the function generator are generated (internally PLC). In addition, the monitored traversing range limits can be parameterized. The present position actual value (cyclically updated) is displayed.

The learning process takes place on an axial basis; there is no mutual influence between axes.

The **Start** softkey initiates the automatic learning process by the neuronal network provided the QEC function is activated by means of bit 0, NC-MD 18120 (bit can be set under the **Contr.para NC** softkey). If this sequence is not observed, then error message “QEC bits not set” is output.

When the automatic learning process is started, a check is also made whether the speed feedforward control is parameterized and activated. If this is not the case, the function is aborted with error message 160106 “Feedforward control not activated”.

For safety reasons, the user must still select the enabling commands set in the toggle field after he has actuated softkey **Start** since traversing motions must not be started through the selection of softkeys alone.

The traversing motions determined by the test signal (see learning process) are executed during the learning process. At this point in time, the learning phase of the neuronal network is automatically activated, i.e. the learning phase activation bit (NC-MD 18120, bit 1) is not taken into account.

After the function generator has stopped, the setting selected beforehand via the NC-MD activation bit becomes effective again.

The traversing motion can be interrupted by means of the **Stop** softkey and with the other start-up functions (e.g. NC stop, Reset key, etc.).

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• Neural QEC parameterization

Function parameters

You can select the menu with the function parameters for the neural QEC function with this softkey.

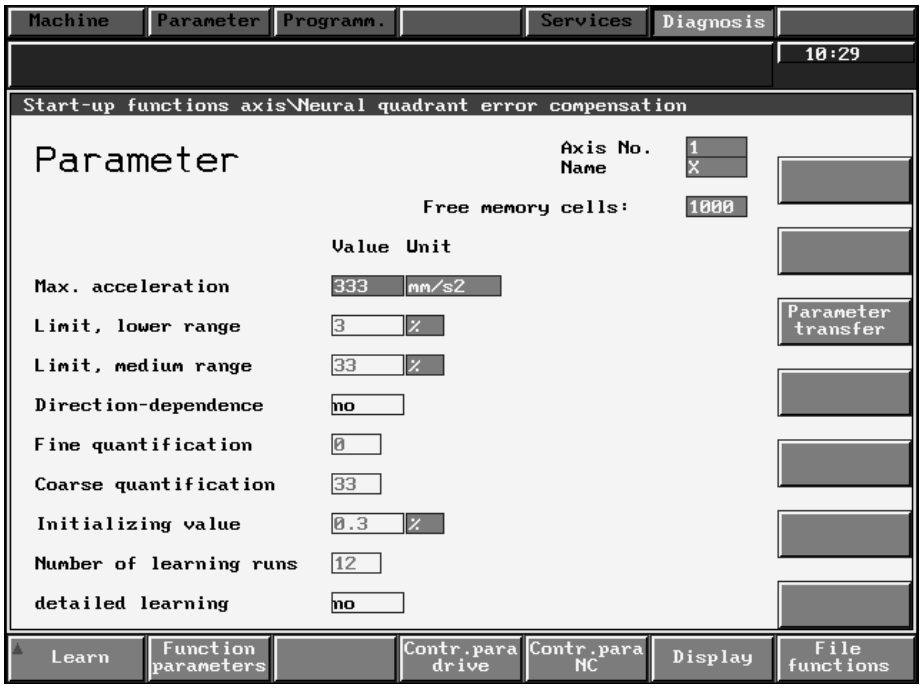

Fig. 9.31

Notes

You enter the function parameters in this display. If the neural QEC has not yet been started up for this axis, all parameters are set to 0. Meaningful standard parameter settings can be assigned by means of the file functions with “Load file: STANDD_Q”. The current parameter settings are displayed if a data block is already stored in the boot file or if the neuronal network has been activated since the last power ON for the axis displayed.

Function parameter settings

- **Max. acceleration (a_3)**
  This parameter defines the upper limit of the operating range. Values of > 0 may be entered. The default setting after “Load default” is 500 mm/s^2.
- **Lower range limit (a1)**
  This parameter defines the limit of the lower acceleration range. Values of >0 and <100 may be entered. The default setting after “Load default” is 2 %.
- **Medium range limit (a2)**
  This parameter defines the limit of the medium acceleration range. Values of >0 and <100 may be entered. The default setting after “Load default” is 60 %.
- **Direction dependence**
  This parameter determines the direction-specific compensation. The states “yes” or “no” may be selected. The default setting after “Load default” is “no”.
- **Fine quantization**
  This parameter defines the fine quantization of the input quantity. Values of

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between 4 and 32 may be entered. The default setting after “Load default” is 8.

- **Coarse quantization**
  This parameter defines the coarse quantization of the input quantity. Values of >1 and <250 may be entered. The default setting after “Load default” is 49.
- **Initialization value**
  This parameter determines the initialization value of the compensation amplitude. Values between 0 and 1 may be entered. The default setting after “Load default” corresponds to 0 % of the maximum speed.
- **Number of learn process runs**
  This parameter determines the number of learn process runs. Values of between >1 and <41 may be entered. The default setting after “Load default” is 15.
- **Detailed learning**
  This parameter determines whether the detailed learning function is selected or not. The states “yes” or “no” may be selected. The default setting after “Load default” is “no”.

- **Parameter transfer**

Parameter transfer	This softkey is required to transfer manually changed data.
Additional information	All NC machine data of the selected axis required to parameterize the neural QEC are available under the **Contr.para NC** softkey. Most importantly, the activation bits are stored under this key. In cases where the activation bit of the conventional QEC (NC-MD 18040, bit 6) is set at the same time, the neural QEC has priority.
Display	If you need to check the neuronal QEC characteristic, it can be selected with this softkey.

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9.5.4.2 Further optimization and intervention options

Checking methods

1st method: Circularity test

2nd method: Display of characteristic – in this display, the compensation amplitude is output as a % of the maximum speed as a function of the set memory partitioning.

3rd method: Record the learning process for a difficult acceleration (derived from the SERVICE quadrant error compensation display) with SERVO trace. The following SERVO trace parameterization is recommended:

Measuring times, trigger conditions:
Trace 2, 3, 4 with start trigger Trace 1, measuring time 200 ms, triggering time–50 ms
Trace 1: Edge signal $\geq$ threshold for positive passage through zero, edge signal $\leq$ threshold for negative passage through zero at threshold = 0.

Trace signals:
Trace 1: Partial setpoint FIPO output (for triggering only)
Trace 2: Following error
Trace 3: Learning criterion QEC
Trace 4: Quadrant error

Examination of Trace 2 and 3:

- If the bump can be seen in following error and not in learning criterion QEC, the measuring time in the area examined must be increased.
- If the bump can be clearly seen in learning criterion QEC and a later fault is also included, the measuring time must be reduced.
- If vibrations are contained in the following error at the time of the passage through zero, they must be eliminated by trying other control settings. A very high position setpoint smoothing can only be considered a solution during the automatic learning stage. Conditions can also be improved by reducing the measuring time.

Table: Possible errors and how they can be eliminated

Error:	Recognized by:	Remedial action:
Compensation not adequate	Circularity test	Increase the learning rate or increase number of learning passes
Overcompensation in the lower and middle range	• Circularity test • Display of the characteristic: Overshooting in this range	Increase measuring time in this range (MD 1372*, MD 1376*)
Over compensation in the upper range	• Circularity test • Display of the characteristic: Overshooting in this range • Check with SERVO Trace	Check the following error and learning criteria QEC with SERVO Trace or DAC output and adapt the measuring time in this range on the basis of that information (MD 1380*)
Large fluctuations in compensation: sometimes overcompensation, sometimes undercompensation	• Circularity test • Display of the characteristic: Large fluctuations	Decrease learning rate, restart learning process (with fewer learning passes)

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Direction-specific compensation

Direction-specific injection can be selected via a function parameter under the **Function parameters** softkey. This is necessary in cases where the compensation is not equally effective in opposing quadrants when the injection is not direction-specific (see diagram below).

However, the following points must be noted in this respect:

- Twice the number of quantization intervals or memory locations must be provided for the characteristic, e.g. by doubling the coarse quantization.
- The number of learning process runs with the test signal (see “Learning processes”) should likewise be increased because only every 2nd zero crossing is executed again on the same input quantity (this time +/– a, last time |a|)!
- If the resolution is not altered, the start-up process takes longer.
- Changes to this parameter setting cause a re-initialization of the weight factors already learned.

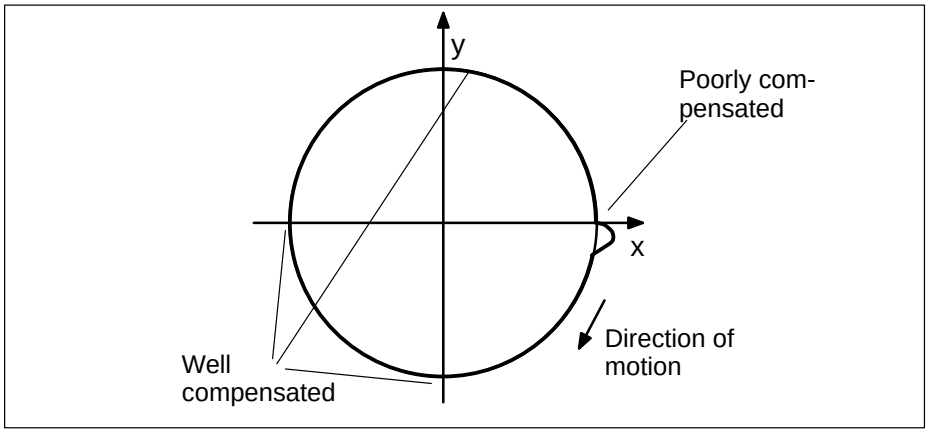

Fig. 9.32

It is often possible to decrease the resolution while maintaining the same degree of accuracy by reducing the maximum acceleration. If a higher acceleration rate than the parameterized operating range is detected, then the injection amplitude which was calculated for the parameterized maximum operating range is applied. At high acceleration rates, this injection value remains relatively constant.

Influencing the period of “Detailed learning”

As described under “Learning process”, the test signal for the learning phase is derived from the parameterized acceleration range of the neural QEC. In normal cases, the acceleration is varied in steps of approximately one coarse quantization step when “Detailed learning” is set to “no” (e.g. from a1 to a2 – see diagram under “Learning process”). The duration of the learning process is thus calculated from the function parameters according to the following formula:

Learning period = (coarse quantization + 1) x number of learning process runs x T_{Per}

The period T_{Per} (see diagram “Learning process”) is 1 s. With the default settings, therefore, the learning process period is approximately 12.5 min per axis.

As from SW4.4 the period of the learning signal can be parameterized (NC-MD 1296*).

The learning period can be reduced by specifying a higher fine quantization setting and a lower coarse quantization setting which will give rise to the effects of a high fine quantization setting described under “Quantization of operating range”.

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The number of learning process runs can be reduced particularly in cases where data blocks are already available for the machine type in question so that only minor optimization measures are required.

When “Detailed learning” is set to “yes”, the acceleration step changes in the test signal are varied in much smaller increments, leading to a considerable increase in the total time required for the learning process.

When “Detailed learning” is selected, the number of learning process runs can and should be reduced for this reason. The duration of the “Detailed learning” process is calculated as follows:

Learning period = (coarse quantization + 1) x fine quantization x number of learning process runs x T_{Per}

When default settings are used and the number of learning process runs reduced to 5, the learning process takes approximately 33 min (if the number were to remain at 15, the process would take 100 min!). When “Detailed learning” is selected and the resolution remains unchanged, the time required for the learning process cannot be reduced by changing the coarse and fine quantization settings.

“Detailed learning” should only be used in cases where extremely high accuracy is required.

Changing the variable node distance

The standard input for the variable node distance makes allowance for the fact that the characteristic requires a higher resolution at low acceleration rates. In the higher acceleration range, the compensation values vary only slightly so that a low resolution is quite sufficient.

This parameter setting is based on empirical values acquired on machines with a maximum acceleration (= operation range) of up to approximately 700 mm/s2.

If a significantly smaller operating range is selected, then limits a1 and a2 from the diagram “Storage utilization by means of variable node distance” will likewise be lower in absolute terms since they are parameterized as a % of the maximum acceleration. These parameters should then be set to slightly higher values. However, a1 should not exceed the range corresponding to approximately 5 % of the maximum acceleration. 40% to 75% of the maximum acceleration are meaningful limits for a2.

If ranges with widely varying amplitudes are discovered when the characteristic is checked (**Display** softkey), then it is advisable to increase the resolution in these ranges to satisfy more stringent requirements. The inputs for a1 and a2 must be altered appropriately for this purpose.

Please note, however, that this will cause a change in the memory partitioning, resulting in re-initialization (see “Loading of standard parameters”). The currently valid working data are overwritten.

Adaptation of decay time

It has already been mentioned under the heading “Basic principles” that the decay time can be adapted by means of parameterization. However, this option should only be used to a limited extent; significant improvements can normally be achieved by selecting a finer position control and input resolution.

An increase in the decay time, e.g. by a factor of 5 or higher, produces better results only in the very low acceleration range; a relatively constant value is desirable over the remaining operating range.

The adaptation of the speed setpoint pulse decay time according to the characteristic in the following diagram is parameterized by means of a 2nd compensation time constant in NC-MD 13640 and activated via bit 2 in NC-MD 18120.

The time constant which is effective without adaptation (NC-MD 12360) applies in the medium acceleration range (50 %). The adaptation characteristic is produced according to an e^{-x} function through these two points.

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The decay time is not adapted when a value of 0 or of less than or equal to the value in NC-MD 12360 is entered in NC-MD 13640.

Monitoring of the decay time continues to ensure that it cannot become a negative value at maximum acceleration (100 % of acceleration in diagram below). In this case, the characteristic is positioned such that a decay time of 0 is calculated at maximum acceleration.

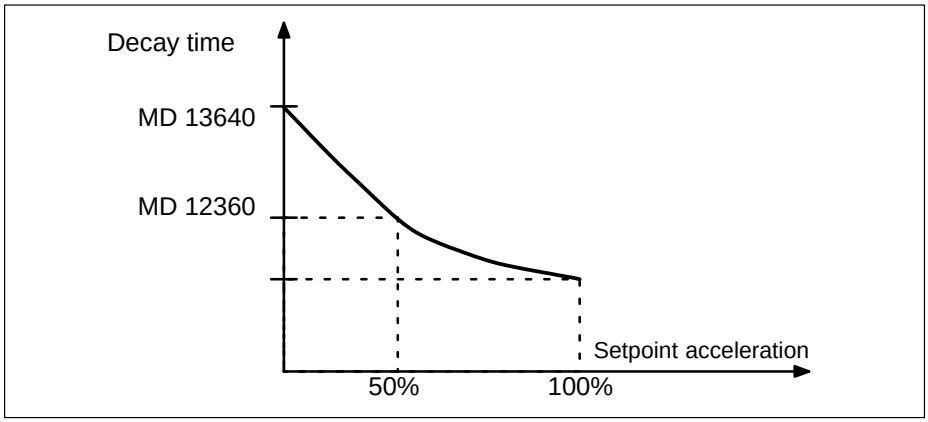

Fig. 9.33

Parameterizing the error measuring time

While the neuronal network is in its learning phase, the error measuring time determines the time window during which the contour error is monitored after the speed zero crossing.

Experience shows that the error measuring time for medium-range acceleration rates (approx. 2 – 50 mm/s^2) must be set to a value corresponding to three times the decay time.

The error measuring time must be adapted for the very high or very low acceleration ranges. The time is adapted automatically according to the characteristic in the diagram below. In this case, a value corresponding to 6 times the decay time is set for the error measuring time at low acceleration rates tM1 while double the decay time is set for high acceleration rates tM3 (default setting by the appropriate machine data).

In order to maintain these relationships when the decay time is changed, the error measuring times (e.g. 1st axis: NC-MD 13720, NC-MD 13760 and NC-MD 13800) are specified as a %age of the compensation time constant (NC-MD 12360).

If **NC-MD 12360** is set to **0**, then the percentages specified in NC-MDs 13720, 13760 and 13800 are referred to a time of 10 ms.

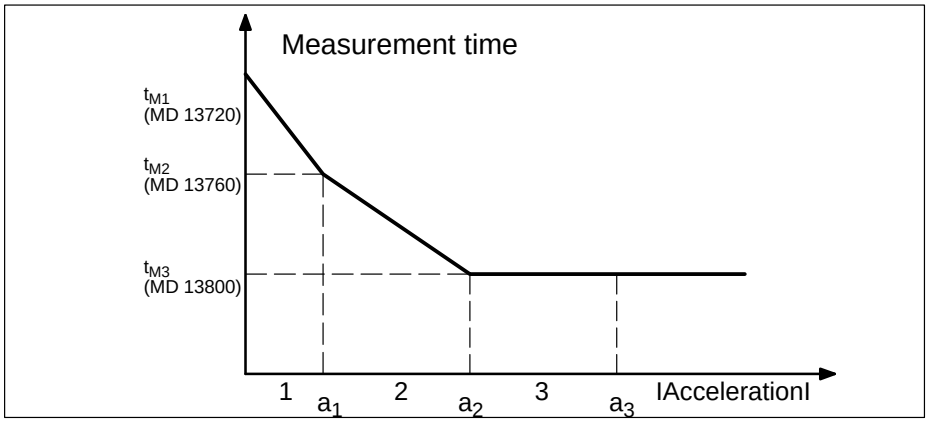

Fig. 9.34

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In special cases, however, it may still be necessary to re-parameterize the error measuring times:

- Setting of very extreme values for the compensation time constant (NC-MD 12360).
  Experience shows that error measuring times of <10 ms and >200 ms are not effective.
  If a value of more than approximately 30 ms is set in NC-MD 12360, then the setting in NC-MD 13700 (t_{M1}) should be reduced in any case, and possibly also the other error measuring times if appropriate.
  If a value of less than approximately 5 ms (but not 0, see above) is set in NC-MD 12360, then the setting in NC-MD 13800 (t_{M1}), and possibly the other error measuring times as well, should be increased.
- Parameterization of measuring times when DT1 time constant is adapted (NC-MD 18120, bit 2 = 1).
  If the adaptation function for the DT1 time constant is used, then the following rule of thumb applies to the parameter settings of error measuring time t_{M1}:
  t_{M1} must be set to approximately 3 times the value in **NC-MD 13640**.

Example

A value of 10 ms is parameterized in NC-MD 12360 and a value of 30 ms in NC-MD 13640. With the default value from NC-MD 13720 of 600 %, an error measuring time tM1 of 60 ms is thus calculated. However, the rule of thumb dictates that a t_{M1} of 90 ms must be applied and NC-MD 13720 must therefore be set to 900 %.

Notes

The error measuring time is required to produce the error criterion of the neural quadrant error compensation function. This error criterion is also made available under the Circularity Test in display Service QEC in order to facilitate parameterization of the conventional quadrant error compensation function.

To ensure that the error criterion produces useful results, the error measuring time should be parameterized even when the neuronal QEC is deselected (NC-MD 18120, bit 0 = 0). NC-MD 13760 is provided for this purpose. NC-MD 13760 need only be re-parameterized for the decay time parameter settings (NC-MD 12360) described under the compensation time constant.

These 3 machine data are monitored or limited as follows:

- Service number 328 is output if NC-MD 13760 is set to 0 when the neural QEC is activated via its machine data bits. This does not result in an error message output with the conventional QEC.
- If the setting in NC-MD 13700 is lower or equal to the value in NC-MD 13760, then the error measuring time in range 1 (in diagram above: a < a1) remains constant at the error measuring time value from NC-MD 13760.
- If the setting in NC-MD 13800 is higher or equal to the value in NC-MD 13760, then the error measuring time in range 3 (in diagram above: a > a2) remains constant at the error measuring time value from NC-MD 13760.

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9.5.4.3 Power ON/OFF – monitoring functions – special functions (SW 4)

Power ON procedure

After power ON, the boot file stored for the neuronal QEC must be transferred from the MMC to the SERVO. These data are transferred in the same way as 611D drive machine data are booted.

Service number 328 is output if bit 0 in NC-MD 18120 is set at the instant of power ON for an axis which does not have an axial boot file.

Please note that no compensation is applied to the axis concerned in this case. This alarm is output on **Power ON** only if the neuronal QEC is activated via bit 0 in NC-MD 18120 at that instant.

Incorrect parameterization of machine data

As with the previous software version, service number 328 is output in response to incorrect/illegal parameter settings caused by changes to machine data. Possible causes for this error message are:

- Activation of neuronal QEC (NC-MD 18120, bit 0) without valid parameter settings for function parameters. This parameterization error is also indicated on power ON if the start-up results have not been saved in the boot file.
- Activation of neuronal QEC (NC-MD 18120, bit 0) with learning rate setting of 0 or learning rate parameterized as 0 (NC-MD 13680) when neuronal QEC is active.
- Activation of neuronal QEC (NC-MD 18120, bit 0) with error measuring time tM2 set to 0 or error measuring time tM2 parameterized to 0 (NC-MD 13760) when neuronal QEC is active.
- Previously detected incorrect/illegal QEC parameter settings when the neuronal QEC is not activated.

Incorrect parameter iinputs for start-up function

Incorrect inputs for the function parameter settings trigger a start-up application error message. Possible causes and remedies can be found under section headings “Neuronal QEC parameterization” and “Alarm description”.

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9.6 SERVO trace (SW 4)

Explanation

To supplement the start-up functions “DAC output” and “Measurement function” implemented in SW 3, SW 4 includes a trace function with the following functionality:

- 4 trace buffers with 2048 values
- Output of SERVO signals with symbolic signal selection
- Graphic representation of recorded signal waveforms
- Various trigger conditions for starting recording
- Pre-trigger and post-trigger settings possible
- File functions for storing and loading trace settings and measurement curves

The SERVO trace function is integrated on the highest menu tree level of the drive servo start-up application since the 4 trace buffers offer 4 global resources which can be applied to any NC axis or spindle (comparable to the 4 DAC channels of the mixed I/O module).

Selection

The SERVO trace display can be called by means of softkeys **Diagnosis**, **Start-up** and **Drive servo startup**.

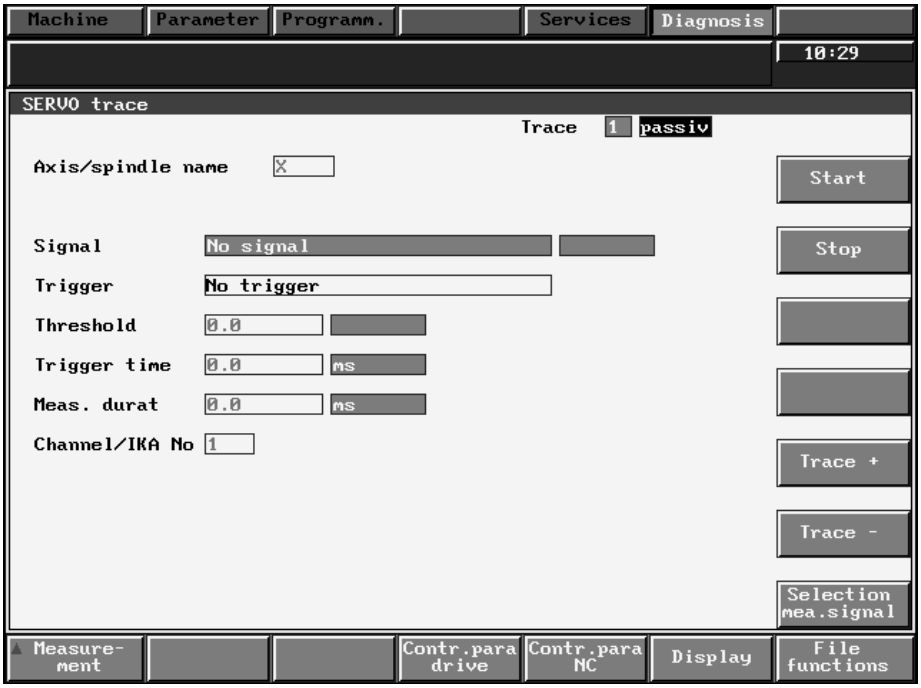

Fig. 9.35

Explanation

The measurement parameters relevant to the trace function can be set in this display.

The field marked “Signal” is a pure output field which indicates the measured signal selected under softkey **Selection meas.signal**. The text “No signal” is the default setting.

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Trigger conditions for starting the recording can be set in the field marked “Trigger”. The following settings are provided:

- No trigger ≙ default setting for trace 1
- Edge signal ≥ threshold ≙ Recording starts if selected signal is greater than set “threshold” (edge transition)
- Edge signal ≤ threshold ≙ Recording starts if selected signal is smaller than set “threshold” (edge transition)
- PLC trigger ≙ Recording starts if PLC trigger signal (1 to 4) switches from 0 to 1 (the 4 trigger signal are preassigned to the 4 trace buffers).
  DB48 DR2 bit 0 ... 3
- Startt rigger trace 1 ≙ The start trigger of trace 1 is used

  (default setting for as the start trigger condition. Traces 2-4)

The start of recording can be set in the field marked “Trigger time”. Pre-trigger (“Trigger time” < 0) and post-trigger (“Trigger time” ≥ 0) settings can be entered here. If the measurement has commenced and the trigger condition is fulfilled before the set pre-trigger time has elapsed, then the pre-trigger range is displayed in an appropriately shortened form in the measurement curve.

The trace functions are initiated through selection of softkey **Start**. This key starts all trace functions with valid signal selection. When the function is activated, the recording is started internally in a ring buffer store. The relevant trace buffers are then filled when the trigger condition is fulfilled with allowance made for the trigger time (pre-/post-trigger times).

The trace function is terminated if

- the trace buffer is full (allowing for pre-/post-trigger) or
- the measurement time has elapsed or
- the **Stop** softkey is actuated.

Note

“Trigger time” and “Measurement time” of traces 2 – 4 (applies **only** when “No trigger” setting is selected) are linked to the start trigger of trace 1.

A new input parameter has been integrated from SW 5 for selecting channel and IKA number (see Fig. 9.35).

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9.6.1 Selection of measured signal

Selection meas. signal	You can select lists containing a selection of signals with this vertical softkey (see Fig. 9.35).
Explanation	Signals are selected or deselected with the cursor hardkeys and softkeys **ok** and **Abort**. The page-up and page-down hardkeys can be used to scroll in this list.
SERVO signals for axes/spindles	Following error Absolute setpoint Absolute actual value Speed setpoint (0.01 %) Part actual value (active) Part setpoint Synchronism error
SERVO signals for axes	Contour deviation Abs. compensation value
SERVO signals for spindles	Speed setpoint (present) Speed setpoint (RFG output) Speed actual value
Special SERVO signals	Part actual value 1st MS Part actual value 2nd MS Following error (IPO cycle) Absolute value modulo Part setpoint (FIPO input) Absolute position setpoint (PC) Part setpoint (FIPO output) Part compensation value FIPO output Part compensation value FIPO input Leading axis total actual value link Leading axis total all leading axes Leading axis total active Angular offset (mech. coupling) Position setpoint (PC cycle) Absolute actual value (PC cycle) Quadrant error Quadrant error plane Torque compensation controller output (SW 5) Setpoint torque compensation control (SW 5)
611D signals in position controller cycle	Current actual value Power Torque Torque (delta) Speed actual value Capacity utilization in %
NCK signals (as from SW 5)	Axial feedrate Path feedrate Distance-to-go path Distance-to-go axis Number of predecoded blocks Capacity utilization Set position before transformation Path feedrate before transformation IKA input A IKA input B IKA output

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SIEMENS Service 3

You can select the SIEMENS Service 3 function with this vertical softkey.

The displayed signals are not explained here.
The **SIEMENS Service 3** softkey function is relevant only for SIEMENS servicing procedures and should be used only after consultation via the hotline.

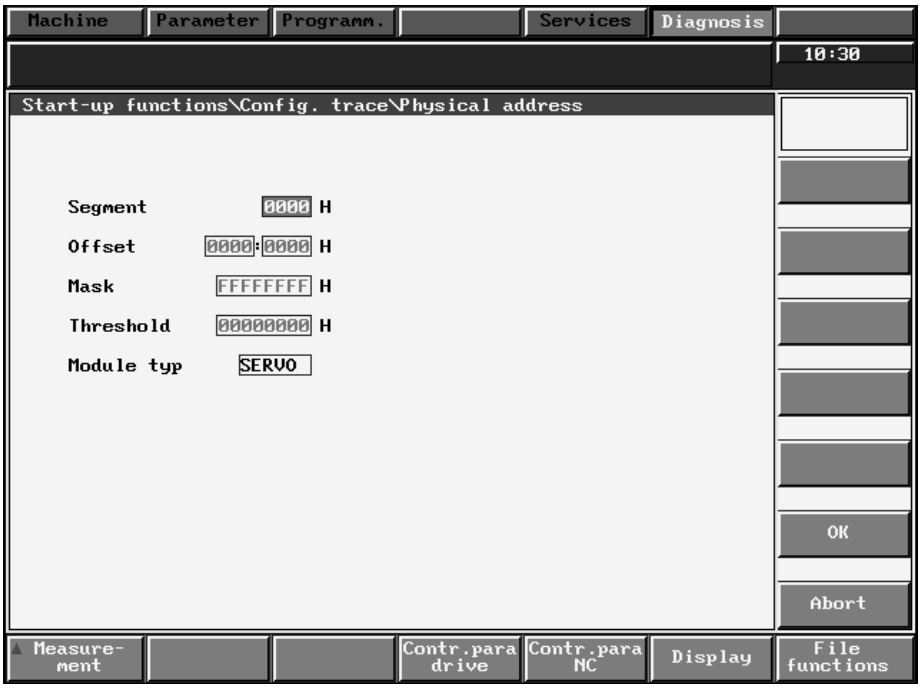

Fig. 9.36

Physical addresses can be defined in this display. The toggle field “Module type” has been extended to include “NCK” (from SW 5).

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9.6.2 SERVO trace display

Display

You can call the graphic representation of the SERVO trace function by selecting this softkey.

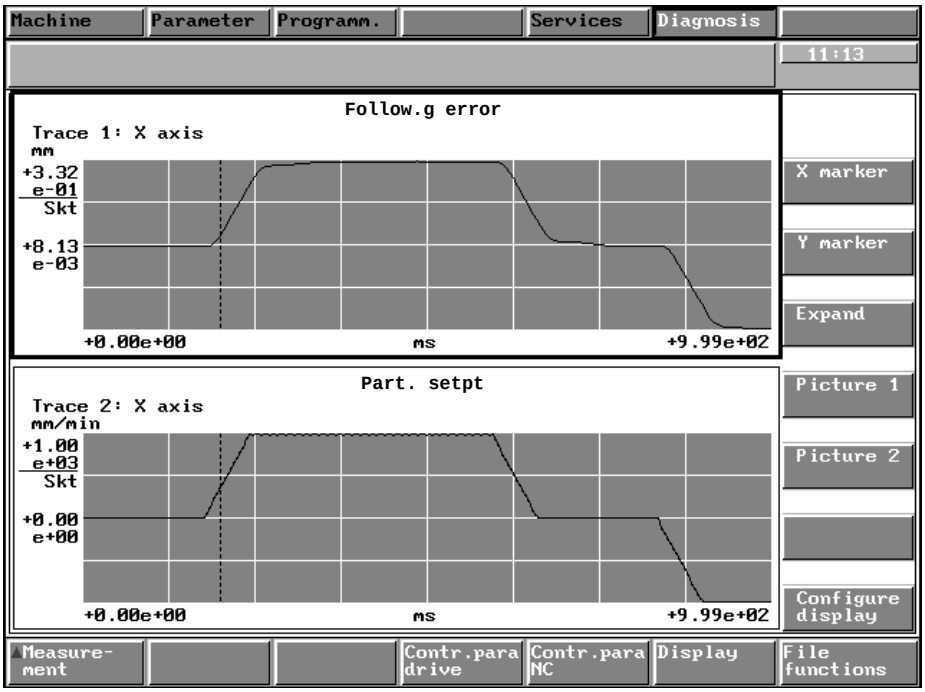

Fig. 9.37

Explanation

Two SERVO trace signals are output in this display. The trigger is shown as a vertical, broken line.

Note

The displayed measurement results can be transferred to the MMC for storage as a file by means of softkey **File functions**.

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Configure display

The two displays (Picture 1/Picture 2) can be set by means of this softkey.

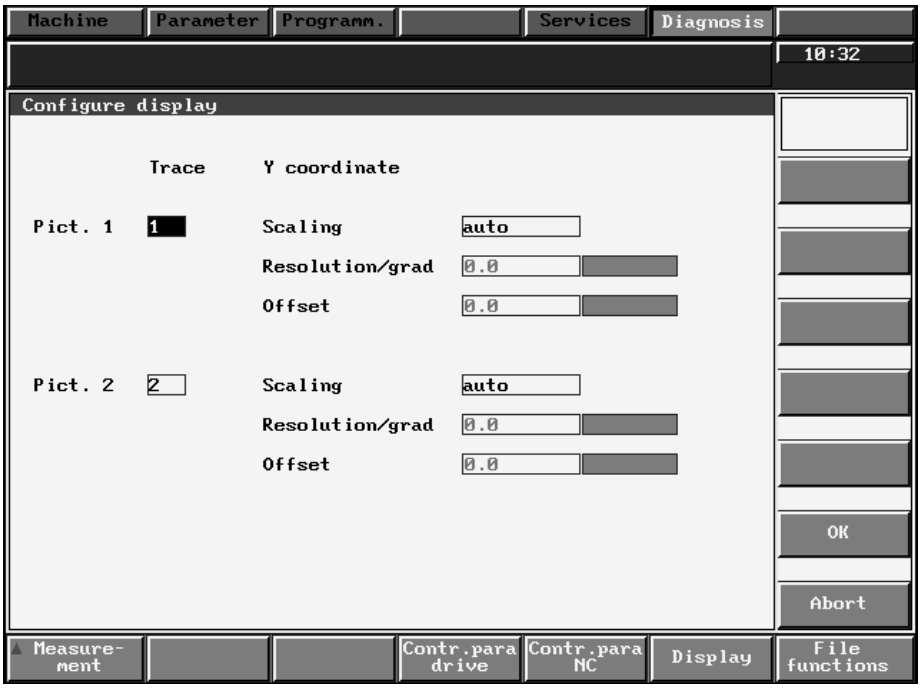

Fig. 9.38

Explanation

The displays called by means of softkey **Display** (Picture 1/Picture 2) can be set in the above display. The displays can be allocated to trace buffers 1 to 4 in the input fields marked “Picture 1” and “Picture 2”. The scaling can be set separately for each display to “automatic” (display format is automatically scaled by value range in trace buffer) or to “manual”. When “manual” is selected, the required resolution and the offset must be entered in the appropriate input fields. The automatic setting provides an optimum visual display of the measured characteristic between the maximum and minimum values of the measured curve. The “manual” setting allows the resolution to be altered as required in order, for example, to zoom part of the displayed range.

END OF SECTION

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10 Axis and Spindle Installation

10.1 Determining sampling interval and interpolation time

Corresponding data

MD 155	NC MD Position controller basic clock frequency
MD 160	Ratio of interpolation to position control
MD 168	Drive basic cycle time
MD 1396*/MD 466*	Position control clock frequency increase axis/spindle

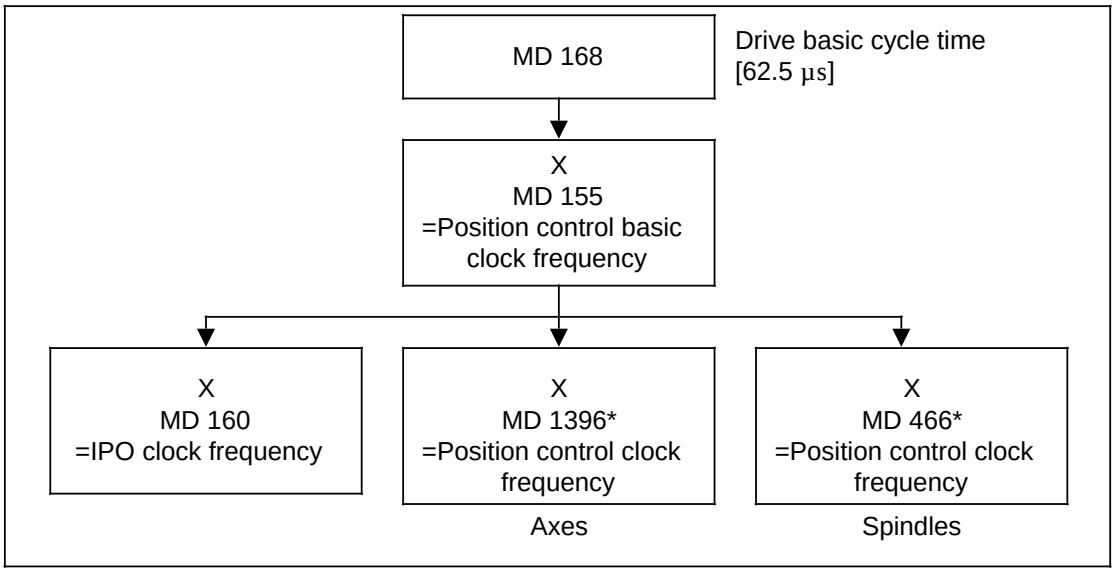
Functional description

MD 155 and MD 168 are used to set the position control basic clock frequency, and MD 160 to set the ratio of the interpolation time to the sampling interval. The objective is to keep both these times to a minimum.

In order to off-load the CPU as much as possible, axes that are not used for workpiece machining (auxiliary axes, loader axes) can be controlled at longer intervals. MD 1396* is used to increase the sampling interval.

The sampling interval is the interval at which the control forwards a new setpoint to the axes and computes the actual value.

MD466* is valid for the spindle rather than MD1396*.



Determination of sampling interval and interpolation time

From software version 3 onwards, the machine data dialog handels the standard start-up.
See Section entitled Machine Data Dialog (MDD).

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Setting

- Enter drive basic cycle time in MD 168 (in 62.5 µs).
- Enter position control basic clock frequency in MD 155 (multiplier MD 168).
- Enter ratio to interpolation time in MD 160.
- If MD is incorrect, alarm 1012* ”Parameterization error” drive MD is output.
- Set increase of position control basic clock frequency for each axis in MD 1396*

Relationship between interpolation time and position control sampling time must be integral and larger than 1

$$\frac{\text{IPO time}}{\text{Position control time}} > 1$$

Example for setting the sampling interval

Available: 2 machining axes (X, Z)
2 auxiliary axes (Q1, Q2)

Desired sampling interval for machining axis	1 ms
Desired interpolation cycle time	4 ms

Possible sampling intervals for auxiliary axis:

1 ms, 2 ms. The selected interval is 2 ms.

MD values:

MD 168	=	8 (0.5 ms)
MD 155	=	2 (1 ms)
MD 160	=	4 (4 ms)
MD 1396*	=	2 (4 ms)

Display of the NC CPU utilization (SW 5 and higher)

The SINUMERIK 840C control has a real-time operating system that ensures that the moving axes and spindles are supplied with setpoints in a defined timebase (position control and interpolation cycles). All other control activities (display, input etc.) are dealt with a lower priority by the operating system.

The value displayed for the NC CPU utilization when the control is in the reset state and no operator actions are being performed is the basic CPU utilization.

The user can influence this basic utilization of the NC CPU by setting the position control and interpolation cycles. It also depends on the number of channels, axes and spindles.

The interpolation cycle is the basic cycle in the control. Within the IPO cycle, all control activities (calculation of the next partial setpoint, processing of keystrokes, refreshing the active display etc.) must be terminated. If time is left at the end of a cycle, the control is idle. The shorter the position control or interpolation cycles, the shorter the control idling time will be.

The NC CPU utilization is the ratio of the idling time to the set IPO cycle. The NC CPU is considered fully utilized if there is no more idling time within a cycle.

The value of the CPU utilization indicates to what extent the interpolation and position control cycles can be set for the NC CPU used for a certain control configuration.

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Notes:

- The maximum value of the basic utilization should be approx. 70%.
- Evaluation of the CPU utilization is performed in a 960 ms timebase in order to be able to display a "stable" mean value.

How the NC CPU utilization is displayed

The value calculated for the NC CPU utilization is entered in machine data 60012. This value is displayed in the MDD under Machine data**/**NC MD**/**General NC MD**/**General basic MD (for original display see also Section 5, Section "User displays"):

Start-up**/**Machine data**/**NC MD**/**General NC MD	
General basic MD	
Measuring units	
5002.4 System of units	Metric
5005.4-7 Input resolution	1E-3 mm
Utilization	
60012 NC CPU utilization	70%
System cycles	
168 Basic drive cycle	1.00 ms
155 Position control cycle	4.00 ms
160 Interpolation cycle	16.00 ms
General basic data	
5197.0 Display M active	yes
... etc.	

Optimization of the CPU use	
On start-up of the control, it is possible to proceed as follows:	
1.	Perform control configuration, i.e. definition of the number channels, axes and spindles. The MD set are activated after Power On.
2.	Observe the basic NC CPU utilization in the MDD display during cyclic operation.
3.	Change the values for the position control and interpolation cycles: If the basic use is small, the above cycle values can be made shorter, and vice versa.
After Power On, continue with point 2 until the optimum has been found.	
Comment: On starting a part program, additional modules are active that perform the decoding of the part program blocks. The blocks are entered in the block buffer of each channel. Depending on the number of block buffers set (flexible memory configuration function) it takes a while until all block buffers are full. During this time, CPU utilization is 100%. After all block buffers have been filled, the value settles at a lower value.	

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10.2 Axis-specific resolutions

Corresponding data

MD 5002	bit 4-7	Input resolution
MD 564*	bit 5	Rotary axis
MD 1800*	bit 0-3	Position control resolution
MD 1800*	bit 4-7	Display resolution

Indirectly related:

MD 155	Position controller's sampling interval
MD 160	Ratio of interpolation to position control
MD 168	Basic cycle time of drive

10.2.1 General remarks on the axis-specific resolutions

The axes can be matched to the controls via MD. It must be remembered that only specific combinations are permissible, and care must be taken that the boundaries, maximum axis speed and range limits are not exceeded.

The following types of resolution can be specified for axes:

- Input resolution: Set via MD for all axes
- Geometry resolution: Input resolution x 0.5
- Position control resolution: Set via MD for each axis
- Display resolution: Set via MD for each axis
- Measuring system resolution: Set via MD for each axis

The measuring system resolution is used for adapting the axes to the measuring system.

10.2.2 Input, display and position control resolution

The input resolution for the entire control is defined in MD 5002, bits 4 to 7. The input resolution defines the geometry resolution for linear and rotary axes. Rotary axes have the same input resolution as linear axes. The geometry resolution determines the interpolation accuracy.

The input resolution also defines the number of maximum programmed decimal places after the decimal point for positional values in the part program as well as the number of decimal places after the decimal point for TO, ZO, SD etc. (and therefore also the maximum achievable degree of precision).

The input resolution defines the units system (inch - metric - degrees).

The input resolution must be taken into account when entering machine data that must be stored in the input system. The default value for linear axes is 10^{-3} and for rotary axes 10^{-3} degrees.

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Display resolution

In addition to the input resolution, the user must also define the display resolution. In contrast to the input resolution, the display resolution is defined separately for each axis. NC MD 1800*, bits 4-7, are provided for this purpose. The display resolution defines the number of decimal places that are to be displayed. The default value for all axes is 10^{-3} mm or degrees.

The display resolution must have the same input system (inch - metric - degrees) as the input resolution. Alarm 4 (Power on Alarm) is issued to flag "Illegal input system" if this is not the case.

A display resolution < 10^{-3} degrees is only possible for rotary axes if the option is available.

Position control resolution (Measuring System - MS)

Like the display resolution, the position control resolution is defined on an axis-specific basis. This must be taken into account when entering machine data stored in the measuring system. MD 1800*, bits 0-3, are used to define the position control resolution.

The unit system must be the same for each position control resolution.

The unit system (inch - metric - degrees) used for the position control resolution need not necessarily be identical to the one used for the input resolution.

Note:

A position control resolution < 10^{-3} degrees is only possible for rotary axes if the option is available.

Position control, input and measuring system resolutions

On the SINUMERIK 840C, position control resolution and input resolution can be entered separately. In order to obtain a closed position control loop, the pulses arriving from the digital measuring system and the control accuracy must be matched.

The units ”unit (MS)” for the position control resolution and ”unit (IS)” for input resolution are used as new units of measurement.

The following applies:
1 unit (MS) = 2 units of position control resolution
1 unit (IS) = 1 unit of input resolution

Example:

Assuming a position control resolution of 0.0005 mm and an input resolution of 0.001 mm the following applies:

1 unit (IS) = 1 unit (MS) = 1 µm

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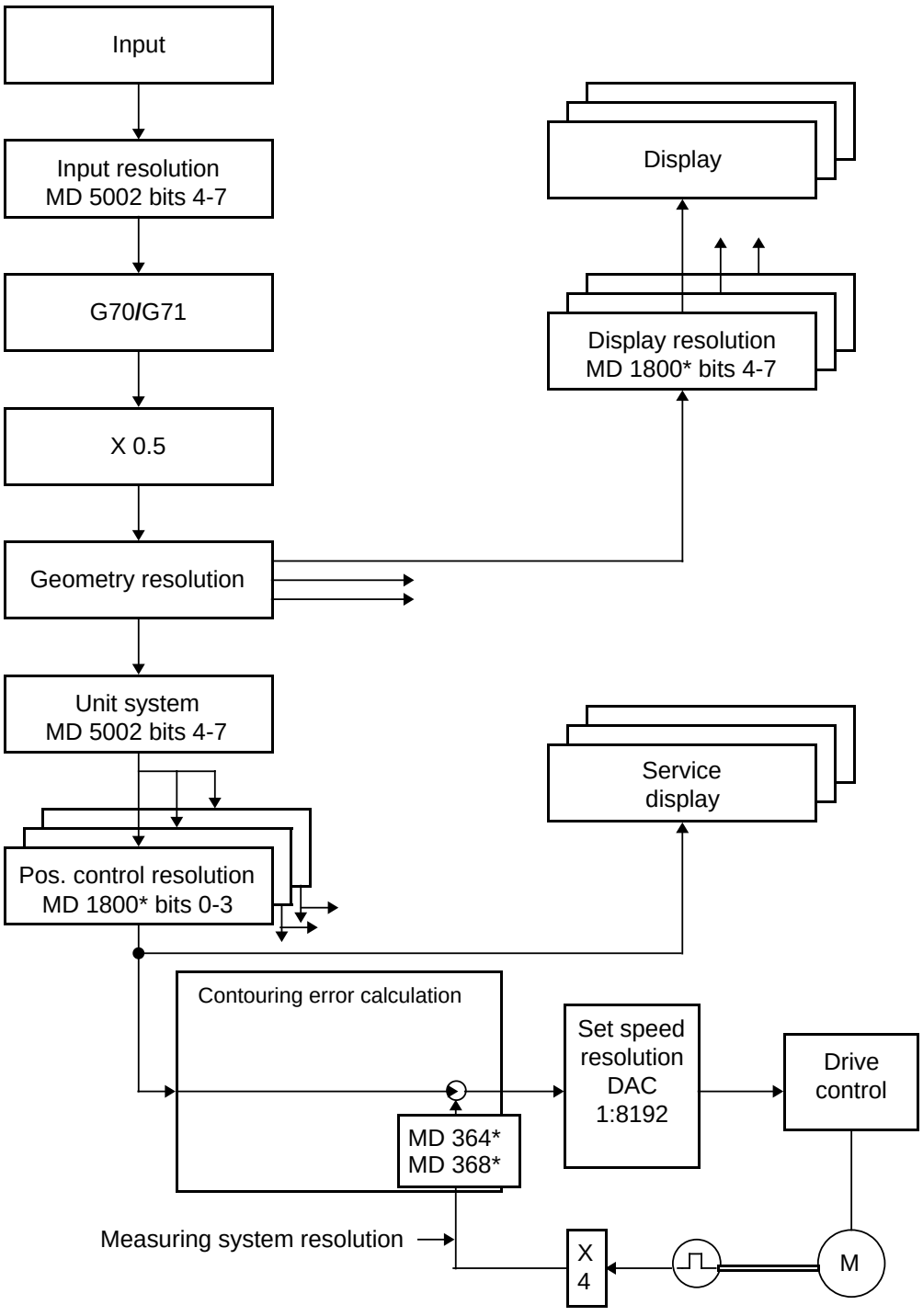
10.2.3 Resolution block diagram



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10.2.4 Resolution codes

The following Table shows the codes for the various types of resolution.
Alarm 4 ("Illegal input system") is issued when illegal values are entered as machine data. NC MD 5002, bit 4 is used to identify the units system. Metric input system G71 (bit 4 = 0) is the reset state.

Table of resolution codes

Bit 7	Bit 6	Bit 5	Bit 4	Input resolution			NC MD 5002
Bit 7	Bit 6	Bit 5	Bit 4		Display resolution		NC MD 1800*
Bit 3	Bit 2	Bit 1	Bit 0			Pos. contr. resol.	NC MD 1800*
0	0	0	0	———	10^{-1} [mm] [degr.]	0.5 x 10^{-1} [degr.]	Metric (degrees)
1	0	0	0	10^{-2} [mm] [degr.]	10^{-2} [mm] [degr.]	0.5 x 10^{-2} [mm] [degr.]	
0	1	0	0	10^{-3} [mm] [degr.]	10^{-3} [mm] [degr.]	0.5 x 10^{-3} [mm] [degr.]	
1	1	0	0	———	———	2 x 10^{-4} [mm] [degr.]	
0	0	1	0	10^{-4} [mm] [degr.]	10^{-4} [mm] [degr.]	0.5 x 10^{-4} [mm] [degr.]	
1	0	1	0	10^{-5} [mm] [degr.]	10^{-5} [mm] [degr.]	0.5 x 10^{-5} [mm] [degr.]	
0	1	1	0	———	———	———	
1	1	1	0	———	———	———	
0	0	0	1	———	10^{-1} [degr.]	0.5 x 10^{-1} [degr.]	Inches (degrees)
1	0	0	1	———	10^{-2} [degr.]	0.5 x 10^{-2} [degr.]	
0	1	0	1	10^{-3} [inch] [degr.]	10^{-3} [inch] [degr.]	0.5 x 10^{-3} [inch] [degr.]	
1	1	0	1	10^{-4} [inch] [degr.]	10^{-4} [inch] [degr.]	0..5 x 10^{-4} [inch] [degr.]	
0	0	1	1	———	———	2 x 10^{-5} [inch]	
1	0	1	1	10^{-5} [inch] [degr.]	10^{-5} [inch] [degr.]	0.5 x 10^{-5} [inch] [degr.]	
0	1	1	1	10^{-6} [inch] [degr.]	———	———	
1	1	1	1	———	———	———	

0 1 0 0 = standard machine data

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10.2.5 Permissible resolution combinations

Permissible resolution combinations

Input resolution, display resolution and position control resolution can be defined in any combination within certain limits (see the following two tables). Please note that a factor of max. 200 between input resolution and position control resolution for all axes together is possible.

Example:

Input resolution	10^{-4} mm or degrees
Position control resolution rotary axis	0.5 . 10^{-4} degrees
Position control resolution machining axes	0.5 . 10^{-3} mm
Position control resolution loader axes	0.5 . 10^{-2} mm

Permissible combinations of position control resolution and input resolution

Unit system	Position control resolution	Input resolution							
		10^{-2} [mm] [degr.]	10^{-3} [mm] [degr.]	10^{-4} [mm] [degr.]	10^{-5} [mm] [degr.]	10^{-3} [inch] [degr.]	10^{-4} [inch] [degr.]	10^{-5} [inch] [degr.]	10^{-6} [inch] [degr.]
mm	0.5 x 10^{-2} [mm][degr.]	xy	x	x	-	x	x	x	-
mm	0.5 x 10^{-3} [mm][degr.]	xy	xy 2)	x	-	x	x	x	-
mm	2 x 10^{-4} [mm]	x	x	x	x	-	-	x	x
mm	0.5 x 10^{-4} [mm][degr.]	xy	xy	xy	x	-	-	x	x
mm	0.5 x 10^{-5} [degr.]	y	y	y	y	-	-	-	-
inch	0.5 x 10^{-3} [inch][degr.]	x	x	-	-	xy	x	x	-
inch	0.5 x 10^{-4} [inch][degr.]	x	x	-	-	xy	xy	x	-
inch	2 x 10^{-5} [inch]	x	x	x	x	x	x	x	x
inch	0.5 x 10^{-5} [inch][degr.]	x	x	x	x	xy	xy	xy	x

x ... linear axes only
y ... rotary axes only
xy ... linear and rotary axes
– ... linear and rotary axes illegal
2) standard machine data

Note:

Excessive differences between position control resolution and input resolution ought to be avoided. For example, an input resolution of 10^{-2} mm together with a position control resolution of 0.5 - 10^{-5} mm does not make sense since one geometry resolution unit equals 1000 position control resolution units.

If the units of both position control and input resolution belong to the same unit system (metric, inches, degrees), the display resolution and the position control resolution must be equal (see table above).

If the units of the position control and input resolution do not belong to the same unit system, the display resolution must be set according to the table above.

As a matter of principle, the same unit system must be used for the display resolution and the input resolution.

Note:

As from SW 4, the position control and display resolution for the rotary axes must not exceed the input resolution.

---

1) Bit "High-resolution rotary axis" must be set for rotary axes. For input resolution 10^{-4}, otherwise alarm message 4 "System of units illegal" is output.

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Valid combinations of position control resolution and input resolution

Unit system	Position control resolution	Input resolution									
		mm					inch				
		10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}
mm	0.5 x 10^{-1} [degr.]	xy	-	-	-	-	-	-	-	-	-
mm	0.5 x 10^{-2} [mm][degr.]	-	xy	-	-	-	-	-	x	-	-
mm	0.5 x 10^{-3} [mm][degr.]	-	-	xy	-	-	-	-	-	x	-
mm	2 x 10^{-4} [mm]	-	-	xy	xy	-	-	-	-	-	x
mm	0.5 x 10^{-4} [mm][degr.]	-	-	-	xy	-	-	-	-	-	x
mm	0.5 x 10^{-5} [degr.]	-	-	-	-	xy	-	-	-	-	-
inch	0.5 x 10^{-1} [degr.]	-	-	-	-	-	xy	-	-	-	-
inch	0.5 x 10^{-2} [degr.]	-	-	-	-	-	-	xy	-	-	-
inch	0.5 x 10^{-3} [inch][degr.]	-	x	-	-	-	-	-	xy	-	-
inch	0.5 x 10^{-4} [inch][degr.]	-	x	-	-	-	-	-	-	xy	-
inch	2 x 10^{-5} [inch]	-	-	x	-	-	-	-	-	xy	xy
inch	0.5 x 10^{-5} [inch][degr.]	-	-	x	-	-	-	-	-	-	xy

xy ... permissible for both linear and rotary axes
x ... permissible for linear axes only
– ... linear axes and rotary axes illegal

Caution:

The display resolution must use the same unit system (inches - metric - degrees) as the input resolution.

10.2.6 The influence of resolution on velocity

The input resolution determines not only the path resolution, but also the lowest programmable velocity. The lowest programmable velocity is always 10 times greater than the path resolution. For example, if the input resolution is 10^{-4}, the lowest programmable velocity is then 10^{-3} mm/min. Depending on the unit system used, the feedrate is interpreted either in mm**/**min or in inches/min. **If one of the interpolating axes is a rotary axis, the corresponding axial feedrate is interpreted as degrees/min.**

When rotational feedrate G95 is used, the feedrate is interpreted in either mm**/**revolution, inches/revolution or degrees**/**revolution.

When the feedrate is rotational, the lowest programmable velocity is identical to the path resolution (for instance, for an input resolution of 10^{-4}, the lowest programmable velocity for G95 would be 10^{-4} mm**/**revolution).

The limiting value based on the position control resolution can be taken from the table above. At no time may the limiting values be exceeded.

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Input resolution	Smallest programmable path velocity
10^{-2} mm, degrees	0.1 mm/min, degrees/min
10^{-3} mm, degrees	0.01 mm/min, degrees/min
10^{-4} mm, degrees	0.001 mm/min, degrees/min
10^{-5} mm, degrees	0.0001 mm/min, degrees/min
10^{-3} inch, degrees	0.01 inch/min, degrees/min
10^{-4} inch, degrees	0.001 inch/min, degrees/min
10^{-5} inch, degrees	0.0001 inch/min, degrees/min
10^{-6} inch, degrees	0.00001 inch/min, degrees/min

The maximum axis velocity is only dependent on the input resolution with the SINUMERIK 840C:

Input resolution	Maximum axis velocity (NC MD 540*.6 = 0 mm/min)
10^{-2} mm, degrees	99 999 000 mm/min, degrees/min
10^{-3} mm, degrees	10 737 400 mm/min, degrees/min
10^{-4} mm, degrees	1 073 740 mm/min, degrees/min
10^{-5} mm, degrees	107 300 mm/min, degrees/min
10^{-3} inch, degrees	99 999 000 inch/min, degrees/min
10^{-4} inch, degrees	27 273 000 inch/min, degrees/min
10^{-5} inch, degrees	2 727 300 inch/min, degrees/min
10^{-6} inch, degrees	272 700 inch/min, degrees/min

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The maximum path velocity (defined with the input resolution) and the maximum axis velocity together define the maximum velocities.

The interpolator breaks down the path velocity into its axis specific velocity components (axis velocities). Then these values are converted to position control resolution. This conversion is only possible if the relevant maximum velocities and their correlation to interpolation are observed during programming. Alarm 2038, ”Path feed too high” (reset alarm) is output if the velocity is not possible. The alarm disables processing and NC Start.

Setting data item in ”Dry-run feedrate” is still entered in 1000 IS units/mm. A maximum of 5 places can be displayed or entered via the keyboard (e.g. input resolution of 10^{-4} mm max. dry-run feedrate 9.999 m/min).

If more than 5 places are programmed using the CL 800 command in ”SEN” or the command @ 410, alarm 3040 ”Field**/**variable cannot be displayed” is issued.

10.2.7 Maximum velocity for thread cutting

In the case of threading blocks G33, G34 and G35, the feedrate is calculated from the spindle speed and the pitch rather than being based on the programmed (linear) feedrate. This feedrate determines the tool path feedrate for the threading block.

Constant pitch thread cutting (G33)

For this type of threading, the tool path feedrate must not exceed the following limiting values.

Input resolution:	10^{-2} mm	:	<	1000	m**/**min
	10^{-3} mm	:	<	1000	m**/**min
	10^{-4} mm	:	<	1000	m**/**min
	10^{-5} mm	:	<	100	m**/**min

When programming thread cutting blocks, not only the maximum path velocity but also the maximum axis velocity must be taken into consideration (see tables in Axis installation Section).

Thread cutting with variable pitch (G34/G35)

Please follow the permissible limiting values for this type of thread cutting. This applies to path velocity, axis velocity, pitch and spindle speed (see NC Programming Guide).

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10.2.8 Maximum traversing range

The set combination of input resolution and axis-specific position control resolution determines the maximum traversing range (separate for each axis). This maximum traversing range applies to the maximum path between the two axis limitations as well as to the maximum programmable value for axis positions, interpolation parameters, chamfer, radius etc.

Only values which are within the range limits are permitted for the working area limitation (setting data: 300*, 304*). If an illegal value is entered for the working area limitation, alarm 3084 ”Wrong working area limitation” is issued. In addition, the maximum permissible maximum or minimum value is entered by the control into the setting data ”Working area limitation”.

In addition to the working area limitation, the control also checks that the software limit switch (machine data: 224*, 228*, 232*, 236*) and the prelimit switch (machine data: 1100*) are valid. Alarm 87 ”Wrong software end switch” is output if the values are illegal. This check is carried out independently of machine data 556* bit 5 ”Working area limitation, software limit switch active”.

To avoid exceeding the working area, the absolute position is compared with the range limits. This comparison only has to be carried out if the software limit switch/working area limitation are not active, because when they are, the traversing range is not exceeded. This check is not carried out on rotary axes.

If the range limits are exceeded, alarm 1204* ”Traversing range limit” (reset alarm) is issued. The alarm is output if the traversing range is exceeded in a positive or a negative direction. The same procedures are introduced when the working area limitation is violated, i.e. retreat from the area limits is only possible in the opposite direction. The alarm is only issued once the traversing area has been left. The axes concerned are braked abruptly (no deceleration ramp).

In the case of endlessly rotating rotary axes the traversing ranges shown below can be exceeded if the permitted combination of input and position control resolution has been configured. If illegal input resolution and position control resolutions are entered, incorrect operation results (when the traversing range is overshot).

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Unit system	Position control resolution	Input resolution			
		10^{-2} [mm] [degrees]	10^{-3} [mm] [degrees]	10^{-4} [mm] [degrees]	10^{-5} [mm] [degrees]
inches	$0.5*10^{-1}$ [degrees]	-- -- --	-- -- --	-- -- --	-- -- --
inches	$0.5*10^{-2}$ [degrees]	-- -- --	-- -- --	-- -- --	-- -- --
inches	$0.5*10^{-3}$ [inches] [degrees]	±99999.99 mm ±3937.007 inches --	±99999.999 mm ±3937.0078 inches --	-- -- --	-- -- --
inches	$0.5*10^{-4}$ [inches] [degrees]	±9999.99 mm ±393.700 inches --	±99999.999 mm ±3937.0078 inches --	-- -- --	-- -- --
inches	$2*10^{-5}$ [inches]	±25399.99 mm ±999.999 inches --	±25399.999 mm ±999.99999 inches --	±25399.999 mm ±999.9999 inches --	±9999.9999 mm ±421.99999 inches --
inches	$0.5*10^{-5}$ [inches] [degrees]	±25399.99 mm ±999.999 inches --	±25399.999 mm ±999.9999 inches --	±25399.999 mm ±999.99999 inches --	±9999.9999 mm ±421.99999 inches --

Unit system	Position control resolution	Input resolution			
		10^{-3} [inches] [degrees]	10^{-4} [inches] [degrees]	10^{-5} [inches] [degrees]	10^{-6} [inches] [degrees]
inches	$0.5*10^{-1}$ [degrees]	-- -- ±99999.9 degrees	-- -- --	-- -- --	-- -- --
inches	$0.5*10^{-2}$ [degrees]	-- -- ±999999.99 degrees	-- -- ±99999.99 degrees	-- -- --	-- -- --
inches	$0.5*10^{-3}$ [inches] [degrees]	±253999.99 mm ±9999.999 inches ±99999.999 degrees	±253999.99 mm ±9999.999 inches ±99999.999 degrees	±107374.18 mm ±9999.999 inches --	-- -- --
inches	$0.5*10^{-4}$ [inches] [degrees]	±253999.99 mm ±9999.999 inches ±9999.999 degrees	±253999.99 mm ±9999.9999 inches ±9999.9999 degrees	±107374.18 mm ±9999.9999 inches ±9999.9999 inches	-- -- --
inches	$2*10^{-5}$ [inches]	±25399.99 mm ±999.999 inches --	±25399.9999 mm ±999.9999 inches --	±25399.99 mm ±999.99999 inches --	±10737.418 mm ±999.99999 inches --
inches	$0.5*10^{-5}$ [inches] [degrees]	±25399.99 mm ±999.999 inches ±999.999 degrees	±25399.999 mm ±999.9999 inches ±999.9999 degrees	±25399.999 mm ±999.99999 inches ±999.99999 degrees	±10737.418 mm ±999.99999 inches ±999.99999 degrees

± 99999.999 mm	max. traversing range for linear axes in [mm]
± 3837.0078 inches	max. traversing range for linear axes in [inches]
± 99999.999 degrees	max. traversing range for rotary axes in [degrees] (when NC MD 572* bit 2=0)

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Unit system	Position control resolution	Input resolution			
		10^{-2} [mm] [degrees]	10^{-3} [mm] [degrees]	10^{-4} [mm] [degrees]	10^{-5} [mm] [degrees]
mm	$0.5*10^{-1}$ [degrees]	-- -- ±999999.9 degrees	-- -- ±999999.9 degrees	-- -- --	-- -- --
mm	$0.5*10^{-2}$ [mm] [degrees]	±99999.99 mm ±3937.007 inches ±999999.99 degrees	±99999.99 mm ±3937.007 inches ±999999.99 degrees	±99999.99 mm ±3937.007 inches ±99999.99 degrees	-- -- --
mm	$0.5*10^{-3}$ [mm] [degrees]	±99999.99 mm ±3937.007 inches ±99999.99 degrees	±99999.999 mm ±3937.0078 inches ±99999.999 degrees	±99999.999 mm ±3937.0078 inches ±99999.999 degrees	-- -- --
mm	$2*10^{-4}$ [mm]	±9999.99 mm ±393.700 inches --	±9999.999 mm ±393.7007 inches --	±9999.9999 mm ±393.70078 inches --	±9999.9999 mm ±393.70078 inches --
mm	$0.5*10^{-4}$ [mm] [degrees]	±9999.99 mm ±393.700 inches ±9999.99 degrees	±9999.999 mm ±393.7007 inches ±9999.999 degrees	±9999.9999 mm ±393.70078 inches ±9999.9999 degrees	±9999.9999 mm ±393.70078 inches ±9999.9999 degrees
mm	$0.5*10^{-5}$ [degrees]	-- -- ±999. 99 degrees	-- -- ±999.999 degrees	-- -- ±999.9999 degrees	-- -- ±999.99999 degrees

Unit system	Position control resolution	Input resolution			
		10^{-3} [inches] [degrees]	10^{-4} [inches] [degrees]	10^{-5} [inches] [degrees]	10^{-6} [inches] [degrees]
mm	$0.5*10^{-1}$ [degrees]	-- -- --	-- -- --	-- -- --	-- -- --
mm	$0.5*10^{-2}$ [mm] [degrees]	±99999.99 mm ±3937.007 inches --	±99999.99 mm ±3937.007 inches --	±99999.99 mm ±3937.007 inches --	-- -- --
mm	$0.5*10^{-3}$ [mm] [degrees]	±99999.999 mm ±3937.0078 inches	±99999.999 mm ±3937.0078 inches	±99999.999 mm ±3937.0078 inches --	-- -- --
mm	$2*10^{-4}$ [mm]	-- -- --	-- -- --	±9999.9999 mm ±393.70078 inches --	±9999.9999 mm ±393.70078 inches --
mm	$0.5*10^{-4}$ [mm] [degrees]	-- -- --	-- -- --	±9999.9999 mm ±393.70078 inches --	±9999.9999 mm ±393.70078 inches --
mm	$0.5*10^{-5}$ [degrees]	-- -- --	-- -- --	-- -- --	-- -- --

± 99999.999 mm	max. traversing range for linear axes in [mm]
± 3837.0078 inches	max. traversing range for linear axes in [inches]
± 99999.999 degrees	max. traversing range for rotary axes in [degrees] (when NC MD 572* bit 2=0)

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10.2.9 Influence on the display

The axis position is displayed with the relevant axis-specific number of decimal places. No distinction is made between linear and rotary axes when defining the number of decimal places.

The values for zero offset, working area limitation and scale are displayed in the input resolution. If this is not possible, decimal places are truncated in order to enable the display of the entire integer portion of the value.

Rotary axis values can be displayed as absolute or modulo values (depending on NC MD 560* bit 7).

Service display

The service display shows the absolute position in the units of position control resolution. When viewing this display, it must be noted that the significance of the last decade depends on the axis-specific position control resolution.

In the case of endlessly rotating rotary axes (NC MD 572* bit 2=0) the control automatically switches the service display from the maximum positive value to the maximum negative value plus compensation factor when the 32 bit limit (1073741.824 degrees $\hat{=}$ 2982.61 revolutions at a resolution of 10^{-3} degrees) is reached.

10.2.10 Influence on the modes/function

"Increment" mode

In "Increment" mode, the machine travels at the specified incremental speed. The feedrate is specified via machine data. The increment is derived from the mode (NC 1, 10, 100, 1000, 10000) and from the display resolution of the relevant axis.

The table below shows the traverse path in mm, inches or degrees in dependence on the display resolution and the mode.

Display res. / Increment	Millimeters / Degrees / Inches				
	10^{-1} [degr.]	10^{-2} [mm] [degr.]	10^{-3} [mm] [degr.] [inch]	10^{-4} [mm] [degr.] [inch]	10^{-5} [degr.] [inch]
INC 1	0.1	0.01	0.001	0.0001	0.00001
INC 10	1	0.1	0.01	0.001	0.0001
INC 100	10	1	0.1	0.01	0.001
INC 1000	100	10	1	0.1	0.01
INC 10000	1000	100	10	1	0.1

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”DRF” function

In "DRF" mode, the handwheel pulses are also weighted with the display resolution of the selected axis. If the input resolution is greater than the display resolution (e.g. input resolution 10^{-2} mm, position control resolution $0.5 \cdot 10^{-3}$), no DRF is possible.

Input resolution		Display resolution		
10^{-2}	1000	10^{-4}	0010	Increments 1 and 10 no function
10^{-3}	0100	10^{-4}	0010	Increment 1 no function
10^{-2}	1000	10^{-3}	0100	Increment 1 no function
10^{-2}	1000	10^{-4}	0010	Increments 1 and 10 no function
10^{-3}	0100	10^{-4}	0011	Increment 1 no function
10^{-2}	1000	10^{-5}	1010	Without function handwheel not possible
10^{-3}	0100	10^{-5}	1010	Increments 1 and 10 no function
10^{-4}	0010	10^{-5}	1010	Increment 1 no function

”Preset” function

The "Preset" mode can be used to shift control zero to an arbitrary point in the machine coordinate system. The Preset offset may comprise no more than 8 decades (plus sign). An alarm is issued if more than 8 decades are entered.

The following value ranges must be observed when specifying a preset value for rotary axes.

Input resolution	Value range
10^{-2} degr.	0 ... 359.99
10^{-3} degr.	0 ... 359.999
10^{-4} degr.	0 ... 359.9999
10^{-5} degr.	0 ... 359.99999
10^{-6} degr.	0 ... 359.999999

”Play back” function

In this mode, position values approached in jog mode are transferred to the part program. The input resolution determines the number of decimal places with which the coordinate values are transferred to the part program. The number of decimal places is identical for all axes, and is independent of the display or position control resolution. A maximum of 8 decades can be transferred as position value to the part program. Where applicable, decimal places are not transferred to the part program.

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Maximum pitch for threads

The maximum pitch that can be defined for threads depends on the IPO time and the input resolution. The table shows the maximum product that can be defined for spindle speed · pitch:

IPO [ms]	Maximum product with IR ... [mm/inches] 10 **-3	10 **-4	10 **-5
8	120000	12000	1200
10	100000	10000	1000
12	85000	8500	850
14	75000	7500	750
16	65000	6500	650
18	55000	5500	550
20	52000	5200	520

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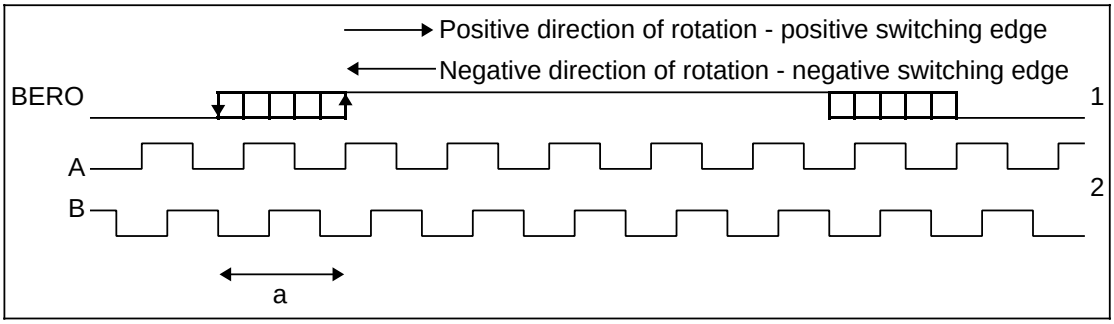
10.3 BERO (SW 4 and higher)

The zero mark can be synchronized to a BERO switch with SW 4 by means of a PCA measuring circuit or with SW 3 by means of actual value acquisition via 611D-PCU. The following machine data are used for switching over from encoder zero mark to BERO synchronization:

MD 522*, bit 0	"external zero mark"	(spindle) and
MD 1820*, bit 2	"external zero mark 1:MS"	(axis)
MD 1820*, bit 4	"external zero mark 2:MS"	(axis)

The switching edge of the BERO signal causes the actual value system to be updated.



Synchronization with BERO switch

Uncertainty range of BERO switching edge

In this range, the actual value register of the measuring circuit is deleted depending on the position of the switching edge of the BERO switch.

The following machine data have been introduced in order to compensate for a switching hysteresis:

MD 3096* - 3124*	"Zero mark compensation positive"	(axis),
MD 2416* - 2433*	"Zero mark compensation positive"	(spindle) and
MD 3128* - 3156*	"Zero mark compensation negative"	(axis),
MD 2434* - 2441*	"Zero mark compensation negative"	(spindle)

These MDs are stored in the ”Speed ratios” parameter set group, which means that they can be set for each gear ratio (Description of Functions Section).

The control is unable to detect effects of external influences (speed, temperature, etc.) on this switching hysteresis. Basically, the different parameter sets permit, however, to parameterize different zero mark offsets.

The existing MDs (also) remain active:

MD 240*	"Reference point offset"	(axis)
MD 459*	"Zero mark offset"	(spindle)

The system does not verify whether the external hardware required for the external zero mark hardware is actually available (BERO and cabling).

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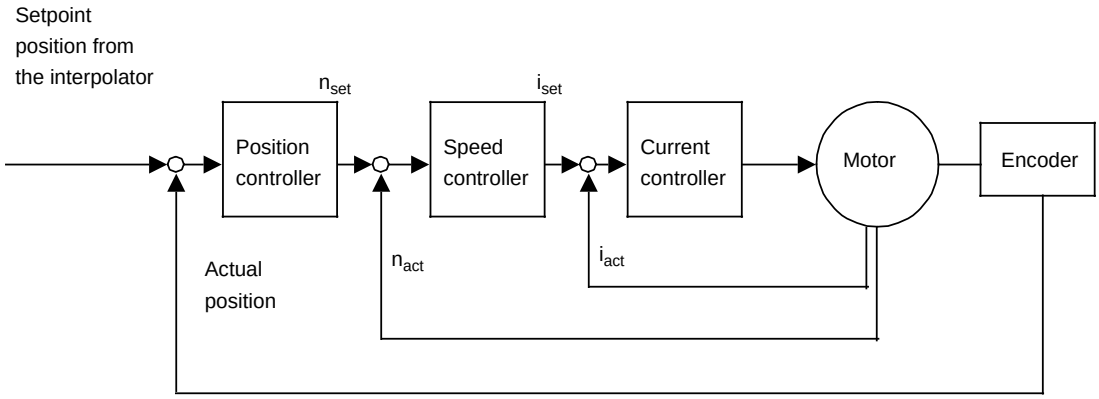
10.4 Axis installation

10.4.1 Drive optimization

10.4.1.1 Checking and setting the control direction of the feed axes

Simplified block diagram of the drive control system



Before the position control system is put into operation, the speed controller and the current controller for the drive must be installed and optimized. When the position control system is installed, the actual position must be checked before the setpoint position is optimized.

The following must be clarified before beginning work:

- Travel direction of the feed axis (as per customer specification or in accordance with the ISO standard)
- Polarity of the set speed voltage on the control unit for axis movements in a positive direction (as per customer specification or ascertained by performing a test using a battery box)

The control direction of the position control system can be influenced via bit 1 of NC MD 564* (which changes the sign of the setpoint position) and bit 2 of NC MD 564* (which changes the sign of the actual position) - see flowchart.

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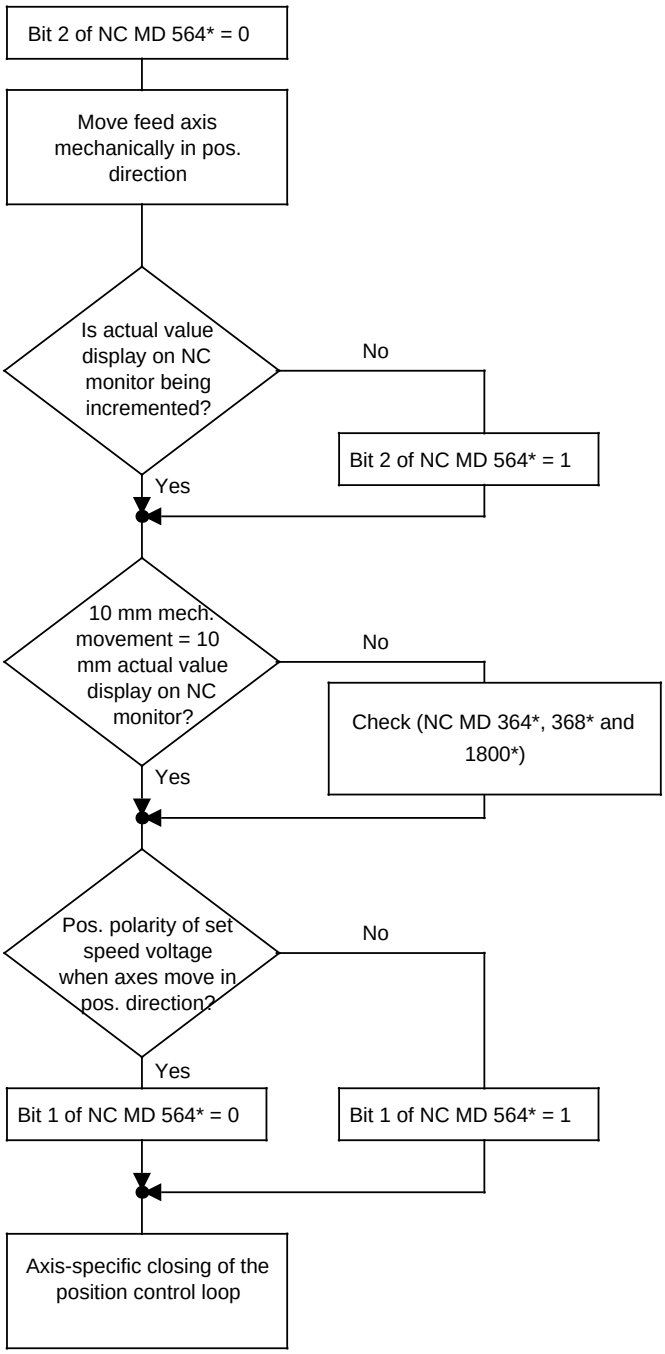

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10.4.1.2 Speed setpoint matching / tacho compensation

NC MD 256*	Scaling factor maximum velocity	[mm/min] [inches/min] [degrees/min]
NC MD 260*	Scaling factor maximum speed setpoint	[mV] (up to SW 2) [0.01 % of max. setpoint speed] (as from SW 3)

The quotient of MD 256* and MD 260* is used to match the controlled system to the servo gain factor defined in MD 252*. The quotient serves as the multiplier for the entered servo gain factor.

Procedure for standard installation

Basic setting: The maximum speed of the axis is entered in MD 256*. The unit is always mm/min or inches/min for linear axes depending on the position control basic system (1800*) (mm or inches). The unit for rotary axes is always degrees/min. The input value depends on the resolution of the basic system.

The speed setpoint which will produce the maximum traversing velocity is entered in MD 260* (the unit of the MD is mV). For analog drives a maximum speed setpoint voltage of 9V is usually selected, i.e. 9000 is input.

On digital drives 100% is set, i.e. 10 000 is entered. The control margin is taken into account in the drive machine data.

Tacho compensation (analog only)
This compensation is carried out in the tacho potentiometer in the drive. A traversing velocity of 10% of the maximum velocity can be defined via the control. The speed setpoint service display must be watched during the traversing operation. The tacho compensation at the drive must be continued until the speed setpoint is approx. 0.9 V. The voltage 0.9 V corresponds to a speed setpoint display of 737 VELOS or 900 [0.01 %].

Fine tacho compensation (analog only)
The axis must then be traversed at maximum velocity. A speed setpoint of approx. 9 V or 7373 VELOS or 900 [0.01 %] results. This displayed value must be converted and entered in MD 260*.

Conversion (analog only)

$$\text{MD 260*} = \frac{\text{Speed setpoint VELO}}{0.8192\left(\frac{\text{VELO}}{\text{mV}}\right)} \quad \text{(until SW2)}$$

”In the service display”...
After the compensation, the contour deviation at constant velocity must be nearly zero. The following error value must correspond to the theoretical value which results from the defined servo gain factor and the velocity.

Precision enhancement

For even more precision of the setpoint matching, MD 256* and MD 260* can be increased by the same factor.

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Example (for analog):

"V_{max}" = 300 mm/min MD 256* = 3000 or 6000 with SW 3
"U_{max}" = 9000 mV MD 260* = 90000 or 18000 with SW 3

Example of a linear axis

	for analog	for digital
Input/display resolution	IS = 10^{-4} inch	as for analog
Position control resolution	MS = $0.5 \cdot 10^{-3}$ mm	
Rated motor speed or FDD MD 1400	n = 3000 $^{rev}/_{min}$	
Spindle pitch	s = 10 $^{mm}/_{rev}$	
Gear (spindle motor)	r = 1 : 2 = 0.5	
Required max. setpoint	U = 9.5 V	
Max. velocity	V_{max}[mm] = n · S · r V_{max}[mm] = 3000 $^{rev}/_{min}$ · 10 $^{mm}/_{rev}$ · 0,5 V_{max}[mm] = 15000 $^{mm}/_{min}$ V_{max}[inch] = 15000 $^{mm}/_{min}$: 25.4 $^{mm}/_{inch}$ = 590.55 $^{inch}/_{min}$ 590 $^{inch}/_{min}$	as for analog
MD 256*, Scaling factor maximum velocity	15 000 [$^{mm}/_{min}$]	15 000 [$^{mm}/_{min}$]
MD 260*, Scaling factor maximum speed setpoint	9 500 [mV] or [0.01 %]	10 000 [mV] or [0.01 %]
MD 280*, Maximum velocity (progr. rapid traverse G00)	5 900 [1000 · 10-4 inch/min]	5 900 [1000 · 10^{-4} $^{inch}/_{min}$]
FDD MD 1147 speed limitation	—	3 300

A speed setpoint of 7730 VELOS or 9500 [0.01 %] results in rapid traverse. The converted value of 9436 or 9500 is entered in MD 260* (for analog only).

Maximum speed setpoint

The maximum value to be output as the speed setpoint is defined with MD 268*, maximum speed setpoint. If the limit is exceeded, alarm 104*, "DAC monitor has responded" is triggered.

The internal speed setpoint is also monitored. If the speed setpoint set is too high, alarm 156*, "Speed setpoint alarm limit activated", is triggered.

The alarms appear when the tacho compensation (for analog only) has not been carried out correctly or there is a measuring circuit or drive error.

For axes whose maximum velocity is reached at approx. 9 V, for analog, or 100%, for digital, the standard values can be used for the machine data.

Matching is necessary when the maximum velocity is reached at a low speed setpoint voltage. This applies to axes for which the theoretical maximum velocity has to be limited for mechanical reasons, e.g. pulse encoder.

The tacho compensation must be set to the desired maximum speed setpoint. This speed setpoint must be entered in MD 268* taking account of the control margin of 5 - 10%. For MD 264*, a value that is 20% higher than that for MD 268* is selected.

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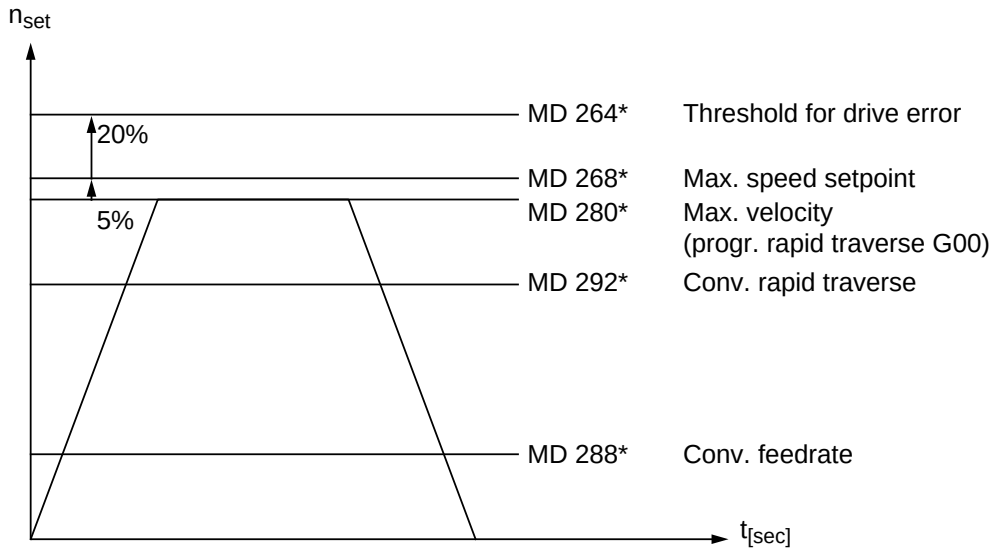
n_{set} = speed setpoint in [VELO], [0.01%] or [$^{mm}/_{min}$]



Example:

Overdimensioned drive for a rotary axis (analog)

Input resolution	:	IS	=	10^{-3} degrees
Position control resolution	:	MS	=	10^{-3} degrees
Motor speed	:	n	=	3000 $^{rev}/_{min}$
Gear (axis motor)	:	r	=	1 :10
Max. velocity	:	V_{max}	=	n · r · 360 [$^{degrees}/_{min}$]
			=	108000 $^{degrees}/_{min}$ = 300 $^{rev}/_{min}$
Set max. velocity for axis	:		=	54000 $^{degrees}/_{min}$ = 150 $^{rev}/_{min}$

The following machine data result

MD 256*, scaling factor maximum velocity:	54000	[$^{degrees}/_{min}$]
MD 260*, scaling factor maximum speed setpoint:	5000	[mV] [0.01%]
MD 280*, maximum velocity (progr. rapid traverse G00):	54000	[1000 · 10^{-3} $^{degr.}/_{min}$]
MD 268*, maximum speed setpoint:		
MD 268*, MD 260* · 0.8192 + 5% =	4300	[VELO] or 5250 [0.01%]
MD 264*, threshold for drive errors:		
MD 264*, MD 268* + 20% =	5160	[VELO] or 6300 [0.01%]

Caution: The low speed setpoint has an adverse effect on the control behaviour of the axis.

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10.4.1.3 Servo gain factor K_V NC MD 252*

To achieve only negligible contour deviations with continuous path control, a high K_V (servo gain) factor (NC MD 252*) is required.

If the K_V factor is too high, however, instability, overshoots and possibly excessive machine loads result.

The maximum permissible K_V factor depends on:

- the drive configuration
  (rise time, acceleration and braking ability).
- the quality of the machine

The K_V factor is defined as

$$K_V = \frac{\text{Speed}}{\text{Following error}} \qquad \frac{[\text{m/min}]}{[\text{mm}]}$$

$\frac{\text{m/min}}{\text{mm}}$ is the unit of the K_V factor according to VDI standard

If an empirical value for the K_V factor is known for the machine, set this value and check for overshooting or instability.

Good speed controller optimization is a precondition for

a correct K_V factor setting.

K_V factor adjustment

Reduce the acceleration (NC MD 276*). The overshoot behaviour is decisive for evaluating the maximum K_V factor. The acceleration must therefore be set at an accordingly low level to ensure that the drive remains below its current threshold.

If the drive is intended to have acceleration of 1 m/s^2, adopt a cautious approach and reduce to one-half of the value

0.5 m/s^2 $\hat{=}$ input 50

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Enter the servo gain according to the following conversion formula in NC MD 252*:

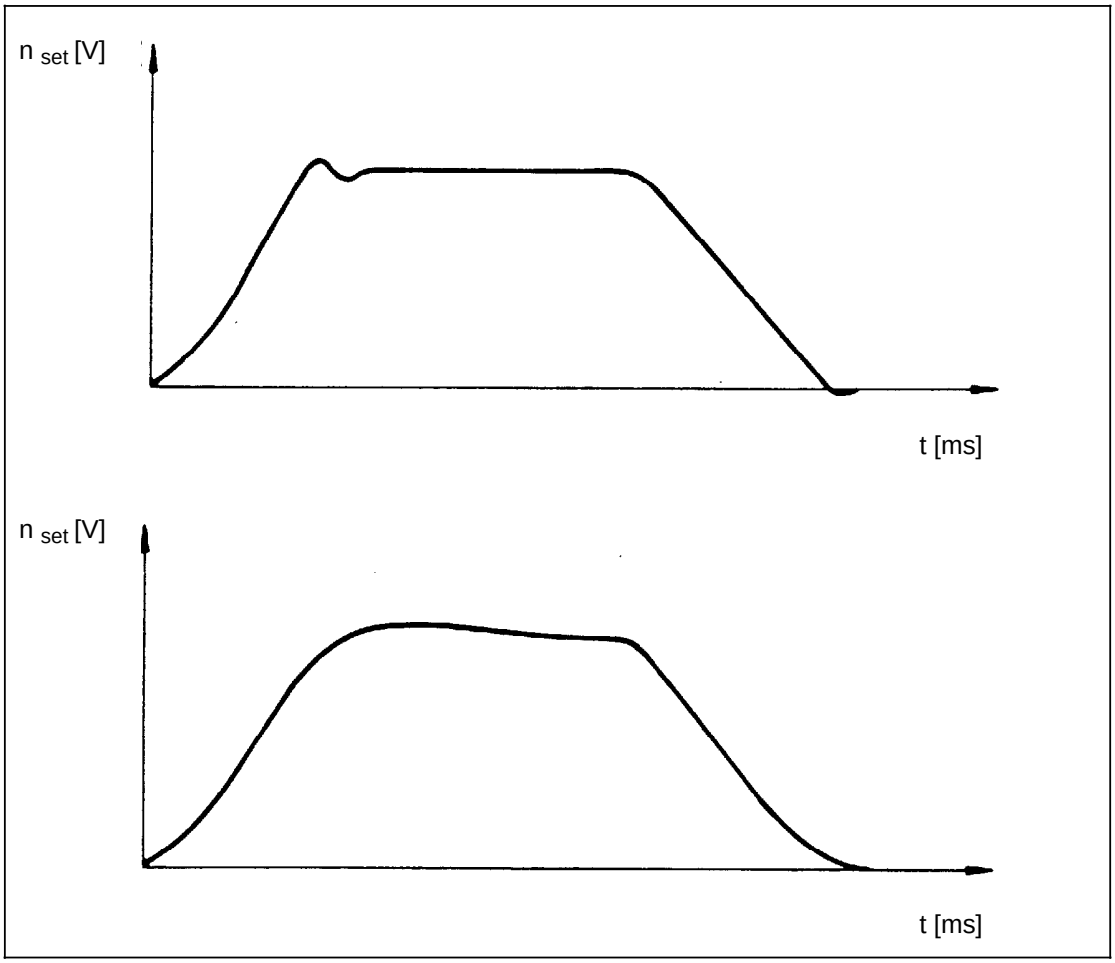
$$K_V\ (0.01\ s^{-1}) = \frac{5000}{3} \cdot K_V \left[\frac{m/min}{mm}\right]$$

$$= 1666 \cdot K_V \left[\frac{m/min}{mm}\right]$$

The numerical value 1666 is thus input for the K_V factor 1.

To evaluate the starting conditions and determine whether the set maximum value has been selected correctly, use the dynamically most unfavourable axis that contributes to continuous path control.

Measure the setpoint voltage n_{set} to the speed controller with an oscillomink ink jet plotter, storage oscilloscope or with the integrated servo start-up function (Section 9). Traverse at various feedrates.



Especially deceleration can be observed with high voltage gain on the screen.

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Overshooting may also have one of the following causes:

- Acceleration too great (current threshold is reached)
- Excessive rise time of speed circuit
- Fault in speed controller (re-optimization may be necessary)
- Mechanical backlash
- Displaced location of mechanical components
- Load fluctuations (vertical axis)

For safety reasons, select a K_V factor that is at least 10 % lower than the maximum possible factor.

Important:

Axes that operate together with continuous path control must have the same K_V factor.

K_V factor check

Refer to the service display for the individual axes (see diagnosis description for selection) to determine the size of the following error. The displayed value is the same with both positive and negative traverse directions if the drift is compensated.

Subsequently check the input K_V factor of all axes on traversing with reference to the following error display.

Exact continuous path control requires that the dynamic behaviour of the axes is the same, i.e. the same following error must occur at the same speed.

In the event of discrepancies, the differences must be compensated at the multgain or speed actual value potentiometer.

10.4.1.4 Acceleration NC MD 276*

The specified accelerations

$$b \times 10^{-2} \ [m/s^2]$$

are used to accelerate and decelerate the axes.

This enables the axes to accelerate to the relevant speed and assume position quickly, accurately and with the least possible wear and tear on the machine.

The customer must be questioned as to the machine's suitability for continuous deceleration/acceleration. This value (if it does not overtax the drive) is entered in NC MD 276*.

This value normally lies in the range from 0.3 m/s^2 to 2 m/s^2.

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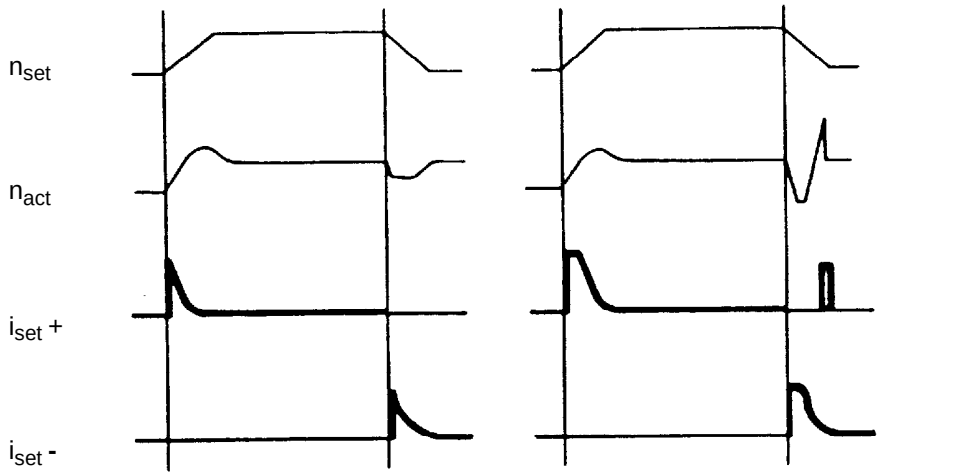
Checking/determining the acceleration values

Setting:	NC MD 276*
Criterion:	Overshoot-free acceleration or positioning at rapid traverse rate (acceleration stop limit). Under maximum load conditions (heavy workpieces on the machine table)
Measuring equipment:	Recorders, storage oscilloscopes or trace function (Section 9)
Measuring point:	Setpoint speed and possibly actual current and speed controller output. With digital drive DAC, mixed I/O (see Section 9).

Once acceleration has stopped, the axes travel at maximum speed (rapid traverse) and the actual current values and possibly the n-controller output are recorded. This makes it possible to ascertain whether or not the current limit was reached. The drive can reach the current limit briefly, but this must occur only in the rapid traverse range. Speed control and current control must be back within the normal range (current limit not attained!) before the rapid traverse rate or position has been reached.



Example of a well-chosen acceleration value

In this example, the current limit is reached (recognizable by the fact that the actual current retains its maximum value over a period of time). A **lower acceleration** must be chosen in this case.

Relation between acceleration and actual current

Minor changes in the load (such as sluggishness or the effects of lubrication) must not cause immediate reaching of the current limit. A 10 % lower acceleration value should therefore be specified.

If the customer wishes it, the acceleration can be further reduced to protect the machine against excessive wear and tear. The various axes, including interpolating axes, may be assigned different accelerations.

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10.4.1.5 Jerk limitation (as from SW 6)

Definition of term:

By jerk we mean the change in acceleration per unit of time.

Previous behavior (up to SW 5)

In the velocity control function used until now, the acceleration changes over time in steps. The aim of this velocity control is to accelerate to the programmed feedrate at the maximum permissible acceleration at the beginning of a block and then to decelerate at maximum permissible acceleration at the end of the block. Jerk-free approach and deceleration of the axes is not possible with this discontinuous, stepped acceleration behavior but a contour is followed faster than it would be with jerk limitation at the same acceleration.

New behavior (as from SW 6):

Unlike stepped acceleration, in jerk-limited acceleration the axis setpoint adopts a jerk-limited course.

This is achieved by limiting the change in acceleration. However, a smoother acceleration curve results in a longer traversing time for the same path, velocity and acceleration than would result for a stepped acceleration. This loss in time can be partially compensated for by increasing the acceleration of the axes.

Jerk-limited acceleration offers the following advantages:

- Full exploitation of the acceleration possibilities of the machine
- Reduction in the mechanical load on the machine and drive
- Reduction in vibration of the machine system
- Improvement of the movement of machine parts with a high breakdown torque

Description of function

With a jerk-controlled interpolator the velocity is increased and reduced by a constantly changing acceleration. At the beginning of the acceleration and braking phase the acceleration value is increased from zero to the maximum value by a constant amount (jerk) and then reduced in the same way at the end of the phase. The axis is traversed at constant acceleration in the intermediate time. A steady change in the acceleration and a smooth velocity curve are the result.

User interface

The function ”Jerk-controlled interpolation” is a function activated via NC MD 5198 bit 2. The jerk value is stored axis-specifically and parameter-set-specifically in machine data 3332* to 3360*. The default for the jerk values is 0, i.e. jerk limitation is not active and acceleration-controlled interpolation is used.
A path jerk is calculated from the axial jerk and path data as for velocity and acceleration.

– Jerk limitation is active in all operating modes.

Exceptions:

– Jerk limitation is not active:
  - In emergency retraction blocks:
  - In thread blocks with G33 (with and without ram), G34 and G35;
– The function ”Look Ahead” is not implemented. It is therefore the responsibility of the programmer to program the path feedrate at a knee in the contour in such a way that the axes involved move with as little jerk as possible.

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Example:

Maximum jerk (r):	50 m/s^3
Maximum acceleration (a):	4 m/s^2
Programmed velocity (v)	24 m/min
Interpolation cycle (TIPO):	10 ms

A jerk of 50 m/s3 results in a change in acceleration per IPO cycle of 0.5 ms/2.
This is calculated as follows:

$$r=50\ \frac{m}{s^3}=\ \frac{50\ m}{100\cdot TIPO\cdot s^2}=0.5\ \frac{m}{s^2}/TIPO$$

With jerk limitation the maximum acceleration of 4 m/s2 is not reached until 8 IPO cycles have elapsed.
In addition, the change in acceleration of 0.5 m/s2 per IPO cycle results in a change of velocity of 0.005 m/s (corresponds to 0.3 m/min) per IPO cycle.
This is calculated as follows:

$$a=0.5\ \frac{m}{s^2}=\ \frac{0.5\ m}{100\cdot TIPO\cdot s}=0.005\ \frac{m}{s}/TIPO=0.3\ \frac{m}{min}/TIPO$$

In the table below a movement from zero speed is assumed:
Constant, maximum acceleration takes place In the 8th to 10th IPO cycle. Then, the acceleration is reduced to zero again with jerk limitation. After 17 IPO cycles a velocity of 24 m/min is reached and a ”constant travel phase” follows.

Time [ms]	10	20	30	40	50	60	70	80	90	100
r [m/s^3]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0
a [m/s^2]	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.0	4.0
v [m/min]	0.3	0.9	1.8	3.0	4.5	6.3	84	10.8	13.2	15.6
Time [ms]	110	120	130	140	150	160	170	180	190	200
r [m/s^3]	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	0	0
a [m/s^2]	3.5	3.0	2.5	2.0	1.5	1.0	0.5	0	0	0
v [m/min]	17.7	19.5	21.0	22.2	23.1	23.7	24.0	24.0	24.0	24.0

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10.4.1.6 Position monitoring

Coarse exact stop and fine exact stop tolerance ranges (NC MD 204* and 208*)

The approached position is checked. In automatic mode, the next block is not started if the following error exceeds the value entered in NC MD 204* to 208*.

Setting

The positioning accuracy depends on the quality of the position control and speed control loops.

The normal deviation is ascertained by observing the following error at zero speed (i.e. in the "at rest" state).

Depending on the customer's requirements and the positioning accuracy attained, the specified value should lie in the range from 10 µm to 50 µm, but should be at least double the maximum following error deviation at zero speed.

Zero-speed monitoring (NC MD 212*)

The machine manufacturer must try to keep the position deviation to a minimum, i.e. under the exact stop tolerance range set in NC MD 204* to 208*. The value specified for zero-speed monitoring (NC MD 212*) should be approximately double that entered in NC MD 204* to 208*. Alarm 112* is triggered if one of the axes is forced out of position (clamping active and cancellation of the servo enable signal) at zero speed (after the time set in NC MD 372* has elapsed).

Positioning is monitored in order to ensure that an axis reaches its position within the specified time period (in dependence on K_V factor, acceleration, ...). The monitoring data are set in NC MD 212* and NC MD 372*. A detailed description is given under NC MD 372*.

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10.4.1.7 Dynamic contour monitoring

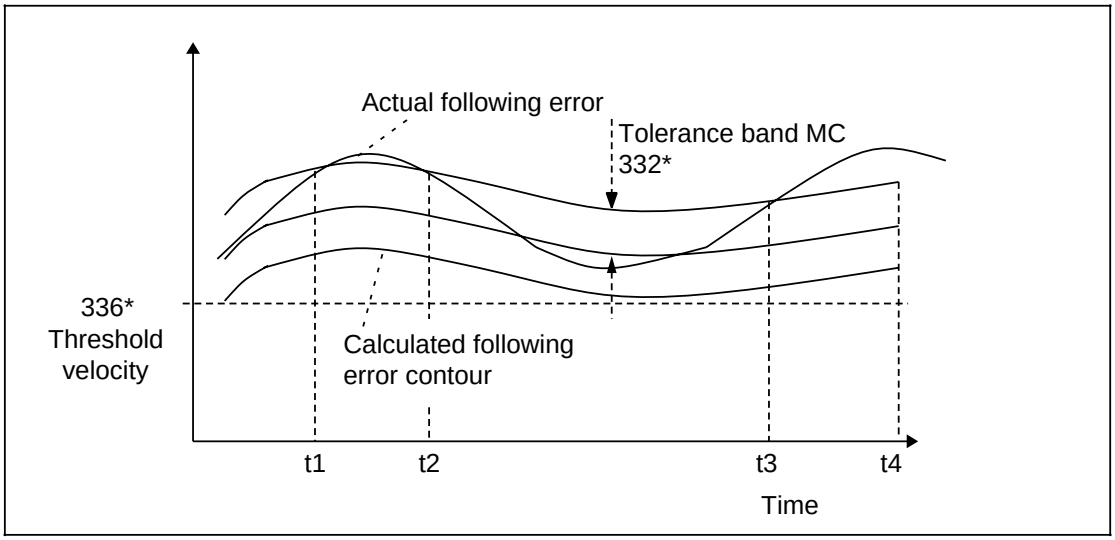
Operational faults resulting from the mechanical jamming of axes or drive faults can be detected with the help of dynamic contour monitoring and an incorrect parameterization of the machine data setting for drift and multgain rectified. The contour monitoring works by continuously comparing the measured following error and the following error calculated from the NC position partial setpoint. A model which reproduces the dynamics of the position control including the feedforward control is used to calculate the following error.

The contour monitoring tolerance band (MD 332*) is defined as the difference between the actual and the calculated following error and is input in the format "units (MS)".

A tolerance band is entered to avoid triggering the contour monitoring unnecessarily when slight speed fluctuations resulting from operational control processes occur.

In addition to the velocity at which the contour monitoring responds (MD 336*), it is also possible to define the response time (MD 1200*) during which the contour monitoring response threshold can be exceeded.

The contour monitoring can be switched off with MD 1820*, bit 7 (1 = contour monitoring off) (e.g. during installation, before MD 256*/ 260* have been set exactly).



Activating contour monitoring at constant setpoint velocity

t2-t1 < MD 1200* : Monitoring not switched off
t4-t3 > MD 1200* : Monitoring switched off and alarm output at t4

If the velocity exceeds the response threshold (MD 336*) and the difference between the measured and calculated following error lies outside the tolerance band (MD 332*) for longer than the defined response time (MD 1200*), the mode group concerned is switched off and the alarm message "Contour monitoring" is output for the axis concerned. The illustration above shows how the contour monitoring works.

Machining true to contour is only possible if all the axes that interpolate with each other are set to the same servo gain (also applies to rotary axes).

The servo gain factor should be as high as possible.

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In addition to the values set in machine data NC MD 252* (servo gain) and NC MD 260*, 1200* (multgain), the servo gain is also influenced by the tachogenerator compensation in the speed controller (for analog), by the variable increment weighting and by gear ratios etc.

NC MD 332*, MD 256* and 336* are used to influence the contour monitoring.

The tolerance band defining the range of activity of the contour monitoring is specified in NC MD 332*.

The speed from which the contour monitoring is to take effect is entered in NC MD 336* in 1000 units**/**min (IS). If the value 0 is entered, the contour monitoring is also active when the axis is at zero speed. The zero-speed monitoring also checks for excessive axis movement when the axes are at zero speed.

Deviations from the contour at any one time can be displayed for the individual axes in the diagnostics menu under softkey "SERVICE DISPLAY".

When the monitoring is triggered, alarm 116* is output and the drives are decelerated at the current limit with the output of setpoint value "0". The speed controllers are also disabled and switched to follow-up mode. The alarms can only be cleared with "RESET" (MD/M30).

If alarm 116* is output it can be assumed that either the speed control loop has been poorly optimized, the servo gain factor is too large for the machine or the tolerance band is too small.

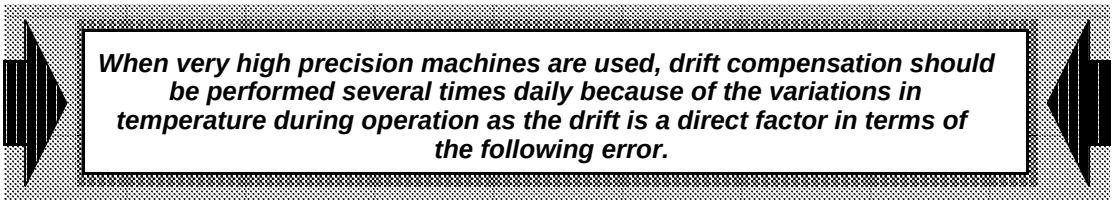
10.4.2 Drift compensation

Drift compensation is semi-automatic on the SINUMERIK 840C, as it must be initiated by the operator. Drift compensation can be performed when the axes (of the NC) and the drives are operating in closed-loop control mode and the axes are at rest.

Drift compensation has to be carried out if the drift has exceeded the permitted values defined in MD 204* and 208*.

Drift compensation must be carried out for all axes individually.

Drift compensation can also be carried out manually by changing the value in MD 272* until the following error at zero speed has reached zero (check service data for axes).



Selection of drift compensation (up to SW 2)

Use the DIAGNOSIS**/**NC DIAGNOSIS**/**SERVICE DISPLAY softkeys.

Selection as from SW 3

Use the DIAGNOSIS**/**SERVICE DISPLAY**/**NC DIAGNOSIS softkeys.

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10.4.3 Axis traversing

10.4.3.1 Traversing in jog mode

Prerequisites

- All axis setpoint cables inserted.
- Control direction correct.
- Position control loops closed.
- All gain values correct.
- Safety signals active (EMERGENCY STOP, HARDWARE LIMIT SWITCH).

The following alarms can prevent axis traversing:

Alarm No.	Description
2000	”EMERGENCY STOP"
148*	Software limit switch approached (triggered by MD224*, 228*, 232*, 236*)
152*	Software limit switch approached (triggered by MD224*, 228*, 232*, 236*)
188*	Hardware limit switch approached
192*	Hardware limit switch approached
168*	Interface unit revoked servo enable for traversing axis
156*	Set speed too high. Triggered by NC MD 264*.
112*	Zero-speed monitor Axis is not in position. Triggered by NC MD 372*
116*	Contour monitor (triggered by NC MD 332*, 336*)
132*	Hardware measuring-circuit monitor
136*	Measuring system dirty

The following additional signals (which do not trigger an alarm) are required for traversing in jog mode:

No feed disable	X, Y, Z, 4 - 9	Interface test
No feed disable all		
No axis disable	X, Y, Z, 4 - 9	
Servo enable	X, Y, Z, 4 - 9	
No follow-up mode	X, Y, Z, 4 - 9	
No parking axis	X, Y, Z, 4 - 9	
Pulse enable with digital drive		

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In the absence of feed enable and servo enable signals, an indication showing that the axis is not in position (" > ") is screened when the direction key is pressed. The following signals must not be present if the axis is to traverse at the specified speed (with consideration given to the feedrate/rapid traverse override switch):

- External F (feedrate from PLC)
- Feedrate reduction ratio 1:100
- Testing of all jog mode functions:
  - Limit switches
  - External deceleration (reference point cam)
  - Feedrate override
  - Incremental feed mode
  - Reference point approach

10.4.3.2 Program-controlled traversing

Only the main function should be tested to enable the use of programs as optimization aid.

The following data and signals can prevent program-controlled traversing:

- Read-in inhibited (DL 7 to DR 10)
- NC START = 1 **/** NC STOP = 0 (DR 2)
- NC START inhibited (DW 11)
- NC MD 106*
- Reference point not approached or bit 3 set in NC MD 5004
- NC MD 548*, 550*, 552*
- NC START ineffective (DL 16)
- Feed disable all

Check to see if axis traversing is possible via program memory.

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10.4.4 Reference point approach

Corresponding data

- MD 240* (reference point value)
- MD 244* (reference point offset)
- MD 284* (reference point cutoff speed)
- MD 296* (reference point approach speed)
- MD 5008 bit 5 (setting up in jogging mode)
- MD 560* bit 6 (reference point approach with automatic direction recognition)
- MD 564* bit 0 (direction of reference point approach)
- "Ref. point reached" signal (DB 32 DL_K bit 4)
- "Decelerate reference point approach" signal (DB 32 DL_{K+1} bit 4)

Indirectly related:

- MD 5004 Bit 3 (NC START without reference point)
- MD 560* bit 4 (no start inhibit for reference point)

The control provides options for two different types of reference point approach, i.e. with and without automatic direction finding. The relevant option is selected via MD 560* bit 6.

Note:

From SW 5, simultaneous referencing of several axes in one channel is possible.

10.4.4.1 Reference point approach without automatic direction recognition

Prerequisites

- MD 560* bit 6 = 0
- Axis-specific feed enable set
- Collective feed enable set
- Reference point between reference point cam and limit switch.

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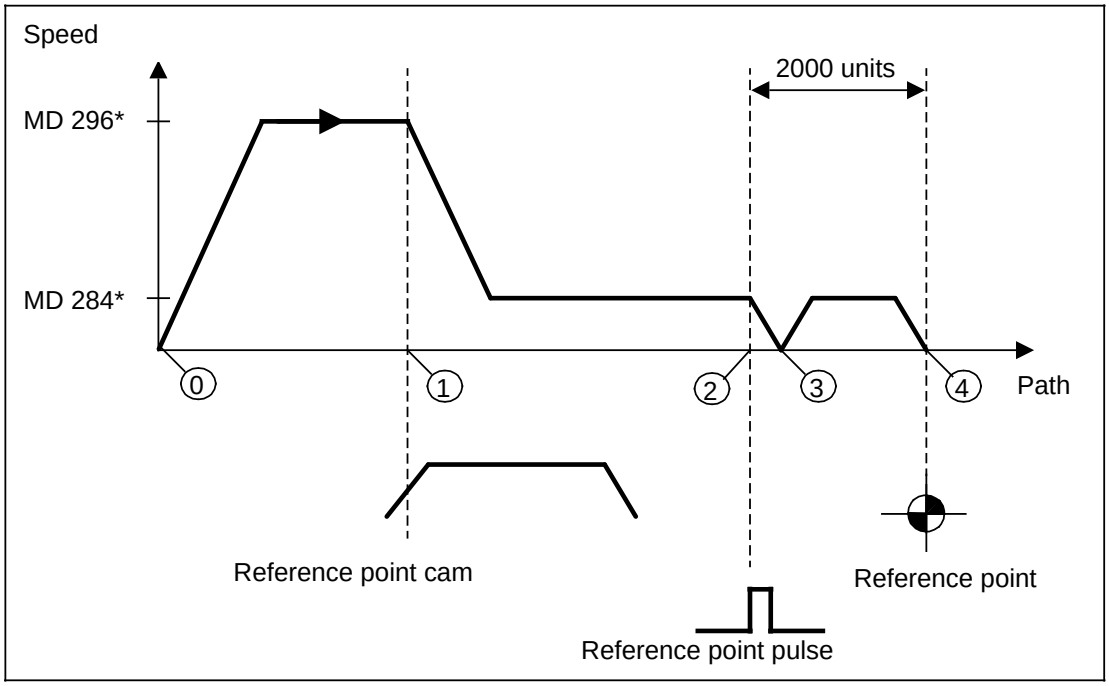
1st case: Axis is ahead of the reference point cam



Axis is ahead of reference point cam

⓪ When the direction key is pressed, the reference point for the axis is approached in the specified direction (MD 564* bit 0) at the speed defined in MD 296*.

① When the reference point cam is reached, the "Deceleration" interface signal reduces the axis speed to the value defined in MD 284*.

② After the axis has left the reference point cam, the next reference point pulse is evaluated and the axis decelerated.

③ To prevent backlash on the machine during reference point approach, an additional path of 2000 units is travelled from the reference point pulse to the actual reference point.

Because point is in different places for different speeds, the distance still to be traversed ( ) must be determined before the actual reference point is approached. The axis decelerates down to zero speed.

④ Reference point reached.

Note:

The NC's approach path from to after reaching the zero mark depends on the position control resolution entered in NC MD 18000. If the specified position control resolution is 1/2 - 10^{-3} mm, the NC will travel another 2 mm after reaching the zero mark, whereas it will travel 20 mm if the position control resolution is 1/2 x 10^{-2}. This could be compensated with the aid of NC MD 244* ("Reference point offset") by entering 2000 in NC MD 244* and a position control resolution of 1/2 x 10^{-3}.

During reference point approach, the axis would then travel to and then back to .

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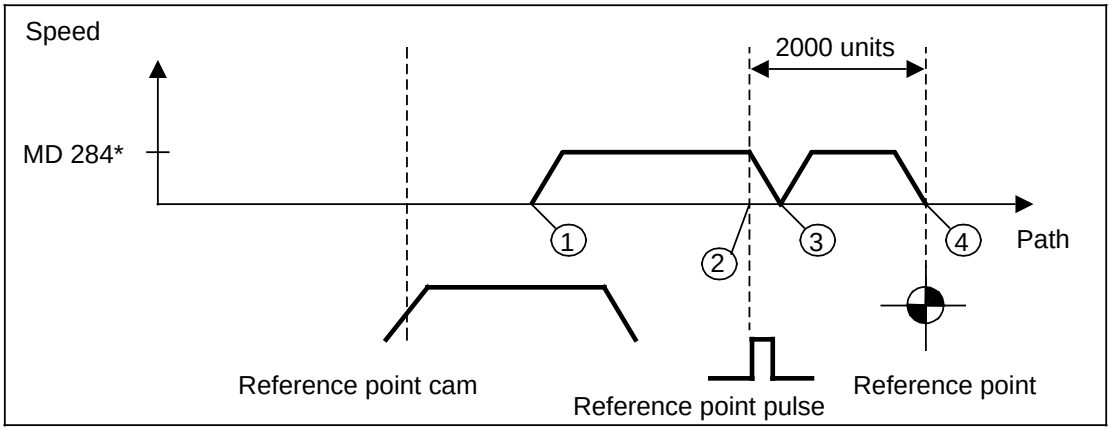
2nd case: Axis is at the reference point cam

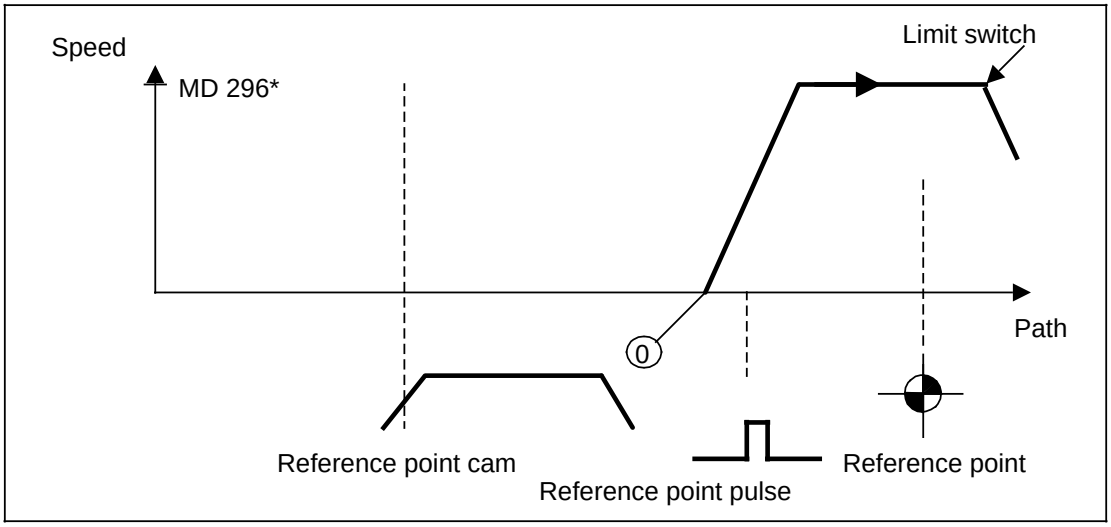
Rather than accelerate to the reference speed, the axis accelerates immediately to the reference point cutoff speed (MD 284*).



Axis is at reference point cam

3rd case: Axis is behind the reference point cam

Since the signal state of the "Deceleration" signal is the same after the reference point as it was before, the control assumes that the axis is still ahead of the reference point cam and therefore accelerates to the reference approach speed (MD 296*), i.e. the axis travels at high speed toward the limit switch (EMERGENCY STOP), as the software limit switches are not in force prior to or during reference point approach.



Axis is behind reference point cam

If referencing is repeated several times, the software limit switches are exceeded by the following error if the cam is not reached. The automatic direction recognition function is used to remedy this.

In order to circumvent the problems posed by case 3, it was necessary to integrate a complex system of travel interlocks in the PLC. It was therefore decided that the SINUMERIK System 800 should provide an option which would solve the problem without additional PLC support during reference point approach. This option is referred to as automatic reference point approach, i.e. reference point approach with automatic direction recognition.

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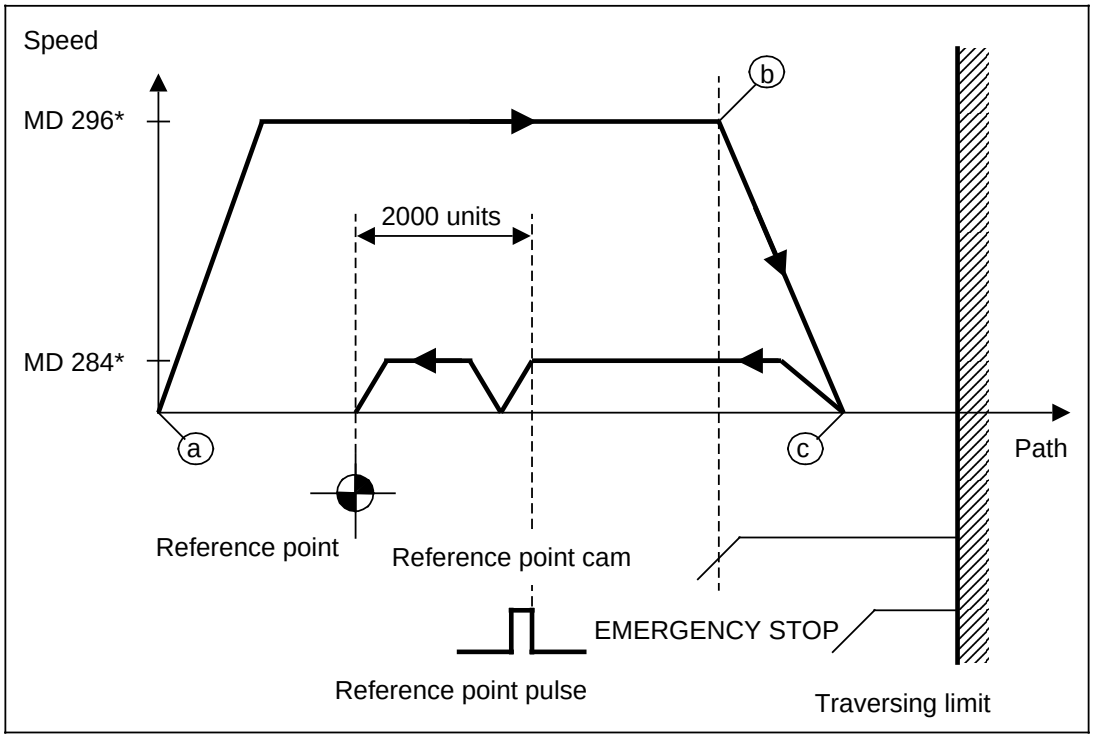
10.4.4.2 Reference point approach with automatic direction recognition

Prerequisites

- MD 560* Bit 6 = 1
- Feed enables set
- Reference point cam extends as far as the traversing limit
- Reference point is ahead of reference point cam

The purpose of automatic direction recognition is to eliminate the problems caused by reference point approach without automatic direction recognition in situations such as those presented in case 3.

1st case: Axis is ahead of the reference point cam



Axis is ahead of reference point cam

ⓐ When the direction key is pressed, the axis approaches the reference point in the specified direction (MD 564* bit 0) at the speed defined in MC 296*.

ⓑ Upon reaching the reference point cam, the axis is decelerated to zero speed with the "Deceleration" signal.

ⓒ The axis then moves away from the reference point cam at reverse speed (MD 284*) and the next reference pulse is evaluated (refer to Section REFERENCE POINT APPROACH WITHOUT AUTOMATIC DIRECTION RECOGNITION for a detailed description of the remaining part of the sequence).

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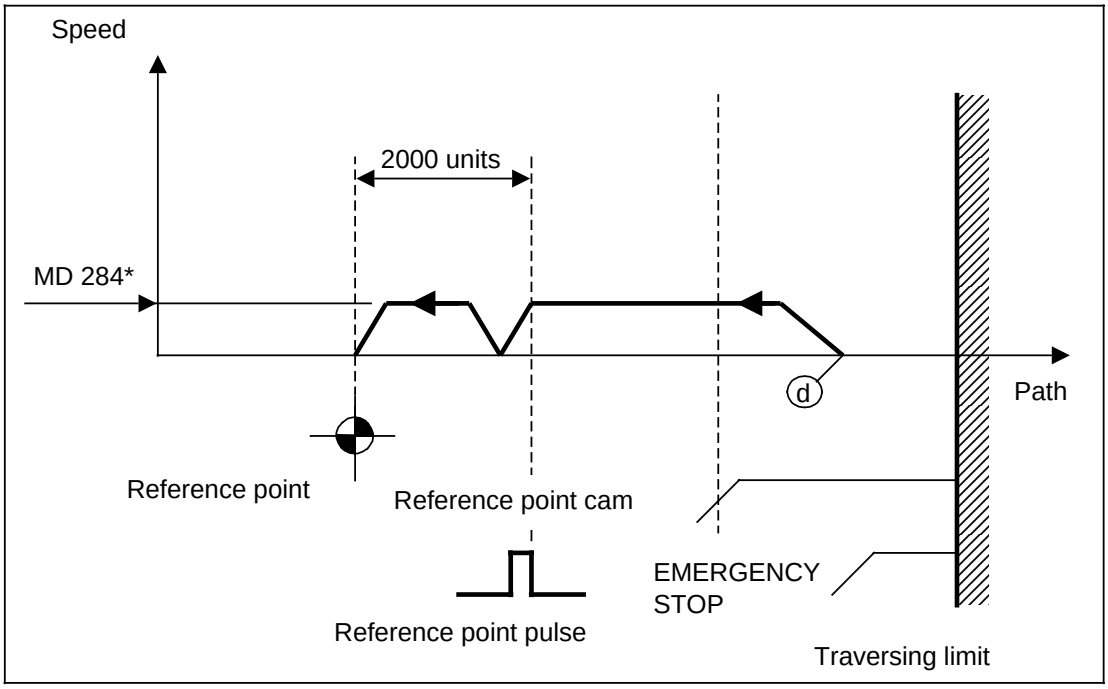
2nd case: Axis is at the reference point cam



Axis is at reference point cam

ⓓ When the Direction key is pressed, the PLC's "Deceleration" signal enables the NC to establish with absolute accuracy that the axis is already located at the reference point cam. The axis therefore accelerates in the reverse direction (MD 564* bit 0) to the speed defined in MD 284* (refer to Section REFERENCE POINT APPROACH WITHOUT AUTOMATIC DIRECTION RECOGNITION for a detailed description of the remaining portion of the sequence).

10.4.4.3 Program-controlled reference point approach

Reference point approach can be executed in a part program with G74. When MD 1808*, bit 4, is set, reference point approach to the coded reference marks is executed automatically. The direction is defined in MD 564*, bit 0, and not with the direction keys.

Example:

AUTOMATIC or MDA mode

```
N10  G74  X  LF
```

Note:

From SW 5, simultaneous referencing of up to 5 axes is possible.

Example:

```
N10  G74  X  Y  Z  U  V  LF
```

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Remarks:

- Only one axis per NC block can be programmed (e.g. **G74 C L_F**)
- From SW 5 up to 5 axes can be programmed in one NC block.
- TRANSMIT or coupled motion must not be selected
- G74 is non modal
- Tool offset and zero offset, PRESET + DRF are suppressed internally with G74 and automatically become active again after ”Reference point reached”. This also applies to G functions such as e.g. G01, G90, G94 etc.
- After the function "Program-controlled reference point approach with synchronization" has been initiated, the "actual position" continues to be updated. The distance to go is displayed as zero because no proper differential values are produced while this function is active.

10.4.4.4 Referencing without programmed motion (with SW 4 and higher)

Corresponding data

- NC MD 240* (Reference point value)
- NC MD 244* (Reference point offset)
- NC MD 296* (Absolute encoder offset)
- NC MD 564* bit 0 (Reference point direction, negative)
- Signal DB 32 DW K+2 bit 13 (Referencing without programmed motion)
- Signal DB 32 DW K+2 bit 12 (Delay reference point approach)

General

With SW 4, referencing without programmed travel movement (without NC setpoint assignment, referencing in follow up mode) is possible. This function is required for axes, for example, that cannot be operated in position-controlled operation.

Function description

MD 560*, bit 6 ("Automatic reference point approach") is not evaluated, i.e. the user must defined the approach direction himself with MD 564*, bit 0).

Reference point offset is then calculated for the selected direction. If reference point approach is performed in different directions, different machine positions also result if the reference point offset is not equal to zero.

Linear and rotary incremental encoders as well as distance-coded measuring systems can be used. Absolute encoders (e.g. SIPOS encoders) can also be used.

The interface signal "Delay reference point approach" in DB 32 DW k + 1, bit 12 is evaluated as for normal reference point approach.

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This function is started by

- G74 from the part program (with internal triggering of G200 for this axis at the end of referencing) or
- pressing of the direction key enabled for referencing by the user in the reference point approach mode.

The block-stepping conditions with G74 are the same as with conventional referencing. As soon as the function has been initiated, either the axis or the measuring system must be moved, for example by hand or by an auxiliary drive, so that the reference cam and the zero mark are passed.

When the zero mark is reached, the absolute system is set according to MD 240*, 244* and the constant offset of 2000 position control increments (not with C axes to spindles). A conventional NC-controlled reference operation provides the same result.

In order to be able to execute the function, servo enable must also be set for an axis in follow-up mode.

10.4.4.5 Setting reference dimension by a PLC request (SW 4 and higher)

The PLC request ”Set reference dimension” permits to bring an axis to the ”Axis referenced” state at any position without explicit referencing operation:

This function cannot be executed unless the axis is at standstill.

Corresponding data:

NC MD 1824*, bit 5 ”Setting reference dimension allowed”
NC MD 1824*, bit 3 ”Set absolute system to reference dimension”
NC MD 240*, ”Reference point value”
NC MD 244*, ”Reference point offset”
NC MD 396*, ”Absolute encoder offset”
NC MD 564*, Bit 1 ”Reference point offset negative”

Signal: ”Set reference dimension”, (DB 32, DW K+2, bit 14)
Signal: ”Reference point reached”, (DB 32, DW K+0, bit 12)

Significance of this function:

- Set absolute system to MD 240* (depending on MD 1824*, bit 3)
- Enable leadscrew error compensation, IKA compensation
- Enable SW limit switch monitoring
- Set "Reference point reached" bit, (DB 32, DW K+0, bit 12)

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MD 1824* bit 5 enables this function. By means of MD 1824* bit 3 the user can define whether only the "Reference point reached" signal is set with "Set reference dimension" or whether the absolute system is also set to the value specified in MD 240*. MD 1824* bit 3 is active only with the "Set reference dimension" function and has no effect on normal reference point approach (default: setting of absolute system MD 240* active).

The request is triggered by an edge change of the axis-specific control signal DB 32, DW K+2, bit 14 "Set reference dimension".

When the edge is positive, the "Reference point reached" status signal is first deleted (DB 32, DW K+0, bit 12).

If the actual value system of the NC has been updated according to the the new reference dimension (only if MD 1824*, bit 3 = 1) after subsequent deletion of the "Set reference dimension" control signal (negative edge), the status signal "Reference point reached" is set again as positive acknowledgement of the function. If the function could not be executed (axis not at standstill), the "Reference point reached" signal is not set and, in addition, the axis-specific RESET alarm 1028* "Setting reference dimension not possible" is triggered. This monitoring function is not performed unless the axis is in position-controlled operation when ”Set reference dimension” is requested.

If position control is not active, two different cases are possible:

a) Follow-up operation**/**parking active:
Equal values for setpoint and actual value are set in this state. No following error is stored. If "Set reference dimension" is requested, setpoint and actual value are set to the new value (depending on MD 1824*, bit 3).

b) Controller enable missing:
In this state, the following error is stored. If "Set reference dimension" is requested, an active following error is deleted (depending on MD 1824*, bit 3) and setpoint and actual value are set to the reference dimension value (depending on MD 1824*, bit 3).

General conditions for using leadscrew error compensation, IKA:

Leadscrew error compensation**/**IKA does not make sense and operate properly unless ”Set reference dimension” is performed in the reference point of the axis. Otherwise, leadscrew error compensation**/**IKA looses its reference to the existing machine system since leadscrew error compensation**/**IKA uses the position at the moment when ”Set reference dimension” is requested as reference position.

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10.4.5 Distance-coded reference marks

Corresponding data

NC MD 240*		Reference point value, reference point for leadscrew error compensation
NC MD 284*		Reference point creep speed
NC MD 396*		Absolute encoder offset
NC MD 564*	bit 0	Reference point approach direction (only required for G74)
NC MD 1300*		Basic distance between coded reference point marks
NC MD 1304*		External pulse multiplication
NC MD 1808*	bit 2	Encoder absolute system opposite to machine system
NC MD 1808*	bit 3	Absolute offset valid
NC MD 1808*	bit 4	Measuring system 1 distance coded
DB32 DW (K)	bit 12	Signal "REFERENCE POINT REACHED"

Machine data 240* (reference point value) is of no significance to the referencing movement, but continues to described the reference point for the leadscrew error compensation table (= position to which no offset is applied).

Description of function

In the case of linear scales with distance coded reference marks which have a reference mark track and an incremental track running parallel to each other, neither a cam play has to be evaluated, nor a certain point (reference point) approached when referencing the axes. The distance between any two reference points is always different. The absolute position of the axis in the machine system can thus be determined by crossing two reference marks and measuring the distance between those two marks. The absolute position is sent to the NC: the actual position has now been determined.

The direction and position from which the reference marks are crossed is of no significance. A reference point cam is no longer necessary.

In operating mode REFPOINT, the travel direction (referred to the machine system) is determined by the direction key (+/-) which is pressed on start.

In operating modes AUTOMATIC and MDI AUTOMATIC, a reference point can be taken from a part program with the G74 command. As the G74 command contains no information regarding direction, the reference point approach direction defined in machine data MD 564*, bit 0, is taken (see also FUNCTIONAL DESCRIPTIONS Section).

Reference point approach is executed at creep speed (MD 284*).

If the reference point approach does not produce successful results within double the "Basic distance between reference marks" (MD 1300*), because, for example, the zero mark tracks are faulty, the axis is brought to a halt with alarm 132* ("Control loop hardware").

The function "Distance coded reference marks" does not affect the reference point approach with position encoders already in use.

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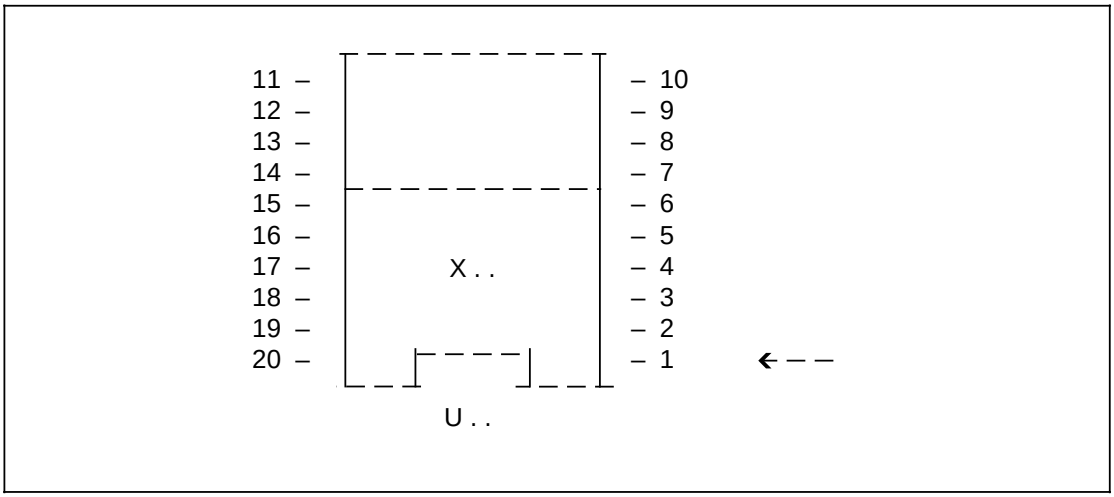
The following control loops must be used for processing distance coded reference marks:

- SPC control loop.
  Measuring systems with rectangular and sinusoidal output signals (currents) can be connected to a SPC.
  Where measuring systems have sinusoidal output signals, EXE submodules **must be** inserted into the module.
- HMS control loop.
  As standard, this board is only used for encoders producing unconditioned voltage signals. Encoders producing unconditioned current signals can also be connected if, instead of the shorting plug, an I/V hybrid is inserted in the relevant jumper sockets (U23, U17, U12 for axes 1,2 and 3). (no EXE submodules).
  For reasons of interference immunity and precision, the unconditioned current signal encoder can only be connected directly if the cable is no longer than 18 m. If the cable is longer, the unconditioned current signals must be converted to unconditioned voltage signals of specifed amplitude in an external converter positioned close to the encoder.

	Encoder with voltage signals (800mV to 180 ohms)	Encoder with current signals (5.5 µA)
Axis 1	Shorting plug (X23)	I/V hybrid (U23)
Axis 2	Shorting plug (X17)	I/V hybrid (U17)
Axis 3	Shorting plug (X12)	I/V hybrid (U12)

The shorting plug (minimum 12-pin) and the I/V hybrid (20-way) are both connected to start at pin 1.



Note:

During reference point approach, the axis must be brought to rest **within** the range covered by the (linear) scale after crossing two adjoining reference marks.

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10.4.5.1 Initial installation of distance-coded reference marks

The following steps must be followed when installing the distance coded reference marks for the first time:

1. Selecting the measuring system

MD 1808*, bit 4, must be set for distance coded reference point approach.

2. Calculating the maximum permissible velocity for reference point approach

(Creep speed MD 284*)

The velocity used for reference point approach (creep speed) must not exceed a maximum value. The velocity must be so slow that the time taken to cross the smallest possible reference mark distance on the scale is always longer than one cycle of the position controller (PCC).

The smallest possible distance between two adjoining reference marks on the scale is calculated as follows:

$$Xmin = \frac{a}{2} \cdot k - \frac{\text{Measured length on scale}}{a}$$

a: Basic distance (in multiples of the scale division)
b: Scale division (grid spacing [in µm])

The maximum possible creep speed for the reference point approach is calculated as follows:

$$Vmax <= \frac{Xmin}{PCC}$$

Xmin: Smallest possible reference mark distance
PCC: Set position controller cycle

A value which is smaller than or equal to Vmax must be entered in MD 284*.

Example:

Calculating the maximum possible velocity for one **linear scale** with the following data:

Measured length: 3040 mm
Scale division k: 20 µm = 0.02 mm
Basic distance a: 1000 1000*k = 20 mm
Max. servo cycle time (PCC) 8 ms

$$Xmin = \frac{a}{2} \cdot k - \frac{\text{Measured length}}{a} = \frac{1000}{2} \cdot 0.02\ mm - \frac{3040\ mm}{1000} = 6.96\ mm$$

Vmax <= Xmin **/** PCC = 6.96 mm **/** 8msec = 52.2 m**/**min

The maximum possible value which can be entered for the creep speed is therefore:
MD 284* (axis) = 50 m**/**min.

Machine data MD 296* (reference point approach speed) is not evaluated.

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3. Direction of linear scale as compared with the machine system

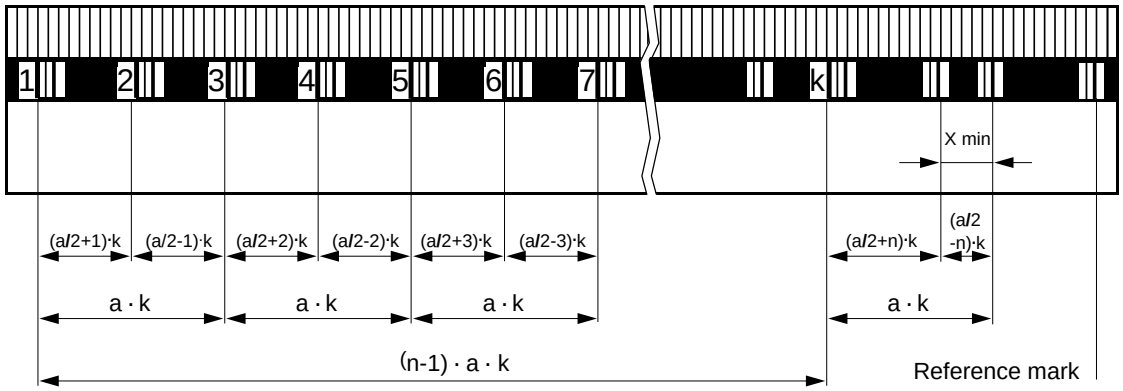
It should be made clear how the linear scale is applied to the machine system. Whether the direction is positive or negative is defined in MD 1808*.

- NC MD 1808*, bit 2 = 0 Linear scale same direction as machine system
- NC MD 1808*, bit 2 = 1 Linear scale opposite direction to machine system

4. Determining the offset of (linear) scale and machine system

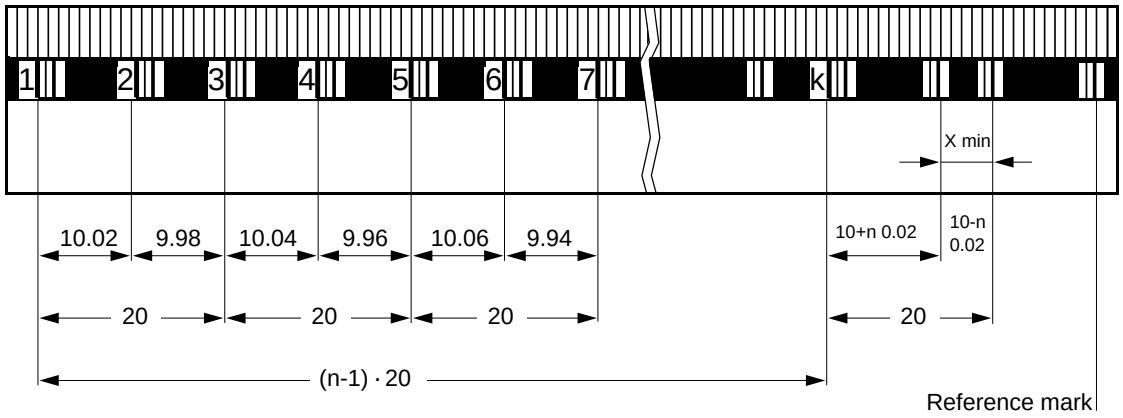
(Absolute offset)

Structure of the linear scale with coded reference marks:



$$\text{with } n = \frac{\text{Measured length on scale}}{a \cdot k}$$

Using the above example:



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$$n = \frac{3040\ mm}{1000 \cdot 0.02\ mm} = 152$$

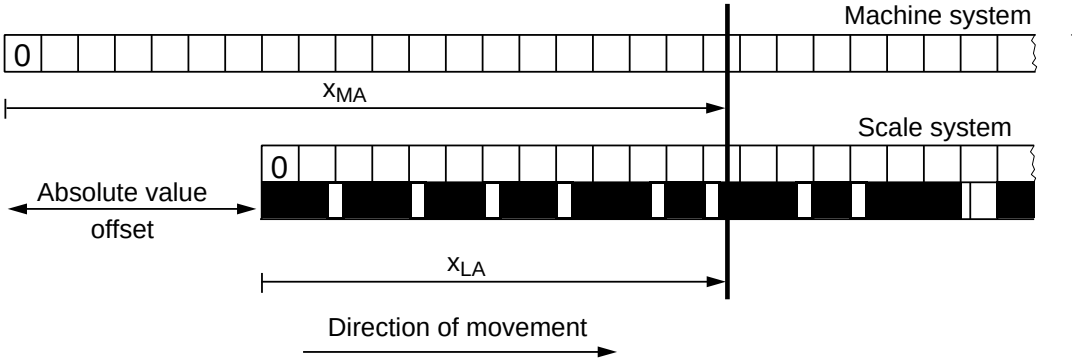
The following correlation is used for calculating the absolute offset:

Position in machine system = Absolute offset +/- absolute position in scale system
(x_{MA}) (x_{LA})

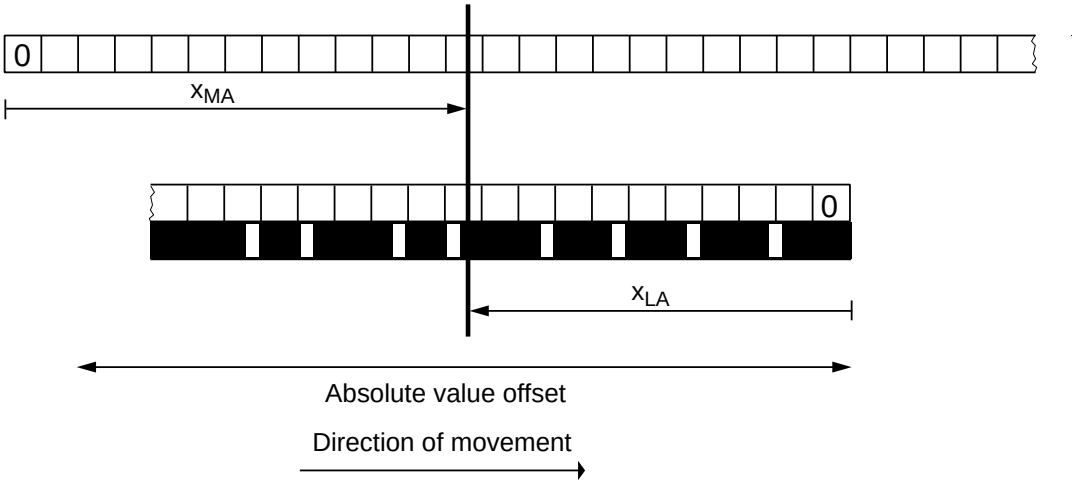
or

Absolute offset = Position in machine system -/+ absolute position in scale system
(x_{MA}) (x_{LA})

+: Machine scale and linear scale in same direction
(MD 1808*, bit 2=0)



-: Machine and linear scale in opposite directions
(MD 1808*, bit 2=1)



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The absolute offset is the offset between machine zero and the 1st reference mark on the linear scale; at any one point (any axis position) the absolute offset corresponds to the difference between the position to be measured in the machine system (e.g. measured with a laser interferometer) and the current position on the linear scale (1st actual value display when MD 396* = 0).

The absolute offset (MD 396*) is derived as follows:

- Machine data MD 396* for the absolute offset must be set to 0.
- Reference point approach (manually in REFPOINT mode)
  When two reference marks have been crossed, the axis is decelerated to rest.
  The absolute position in the reference system on the linear scale (scale system) is now available as the "actual value".
- By deriving the current axis position relative to the machine system, i.e. the offset relative to the machine zero or another known accessible point in the machine system (e.g. by measuring it with a laser interferometer).
- By calculating the absolute offset from the measured positional value in the machine system and the value shown as the actual value in the scale system (acc. to the formula).
- The calculated absolute offset must be entered in MD 396* and declared as valid with "Absolute offset valid", MD 1808*, bit 3.

Now the axis can be referenced in the usual way (manually or automatically).

If the absolute offset is not declared valid for the referencing, i.e. when "Absolute offset valid" (MD 1808*, bit 3) has not been set, the PLC interfacer interface signal, "Reference point reached" is **not** set and no part program can be started. The software limit switches are not enabled and no values are displayed in the reference point display.

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10.5 Spindle installation, spindle functions

Corresponding data

- MD 131 ... 146 (Spindle override)
- MD 4000 ... 499* (Spindle data)
- MD 540* bit 2
- MD 5200 bits 0 ... 7
- MD 524* bits 0 ... 3
- MD 521* bit 1 and bit 7
- Interface DB 31 (Spindle DB)
- Interface DB 10 ... 13 (Channel DB)

Note:

Additional information in Functional Descriptions Section.

Overview

In SINUMERIK 840C, output of the analog spindle speed is fully implemented in the NC, so that it can only be influenced from the PLC with special signals (see Interface Description, Part 1, Signals). Spindle data for max. 8 gear stages and additional monitoring functions are stored in the control.

The following spindle functions are available:

- Speed-controlled spindle
- Oriented spindle stop
- Position-controlled spindle (C axis)

The individual spindle functions are produced with the following **spindle modes**:

- **Control mode** Spindle rotates with constant speed or cutting rate (open-loop control of spindle speed)
- **Oscillation mode** Spindle rotates at constant motor speed setpoint (open-loop control of spindle speed)
- **Positioning mode** Spindle stops at a preset position (oriented spindle stop)
- **C axis mode** Spindle acts like a rotary axis (position-controlled spindle). See Section 12 for a description.
- **V/f operation** Voltage**/**frequency controlled operation for MSD**/**AM and FDD. See Section 12 for description.

- Following error compensation for thread cutting
- Multiple thread
- Thread recutting

The main characteristics are:

- Spindle speeds up to 99 999 rev**/**min without actual-value encoder
- Spindle speeds up to 30 000 rev**/**min with actual-value encoder
- Encoder-specific resolution
- Monitoring of encoder cutoff frequency
- Adjustable zero mark
- C axis mode
- Several positioning modes

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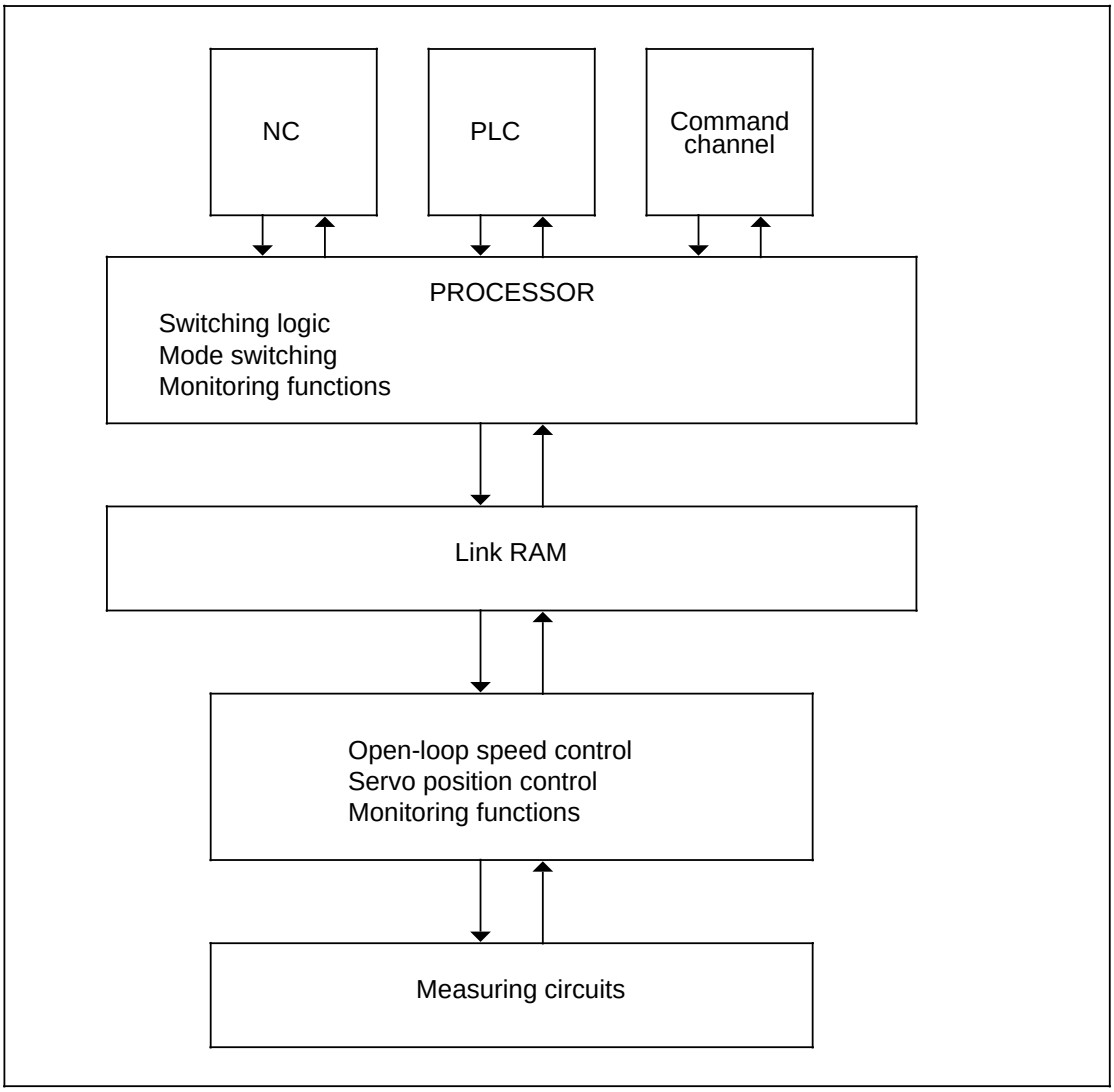
General notes:

- With a spindle speed of 0.1, the feed actual value indication in the basic display with functions G95/G96 is too low by a factor of 10.
- If the system includes several spindles, a function must always be assigned to the first spindle.

The diagram "Structure of spindle control" provides an overview of the functions available and also the flow of data and commands. Data flows in the direction indicated:

Setpoints and control data
Actual values and status data
Switching commands
Status



Structure of spindle control

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Description of the spindle modes

The following is a description of the various modes in which the spindle may be operated. The individual modes can be programmed by NC (part program MDA, overstore), PLC or command channel (CC). The functions that are then available are given in each case.

The various command sources (NC, PLC or CC) have different priorities, i.e. they can interrupt or interlock each other.

The various switching conditions and interlocks are dealt with in the section headed ”Switching logic”.

10.5.1 Open-loop control mode

General

In the open-loop control mode, the spindle is issued with a setpoint for speed (or cutting rate) and direction of rotation. The setpoint that has been input can be altered by "Speed override" when necessary.

Actual value acquisition

- The open-loop control mode normally requires no encoder for actual value acquisition except if the spindle is to be used for thread-cutting or the "Revolutional feedrate" function in which case an encoder must be mounted on the spindle.
- If an encoder is fitted, it is also used in the open-loop control mode for monitoring and displaying the actual values (of speed and position). The encoder must be mounted directly on the spindle so that the actual speed and position of the spindle can be measured.

Selecting the open-loop control mode

Open-loop control mode is selected by NC, PLC or command channel. The following functions are possible:

PLC: Request for open-loop control mode
- Constant speed and direction of rotation:
  - IS:INITIALIZE
  - set speed from MD 449*
  - set direction of rotation with IS:SET ROTATION CW

CC: Request for control mode
- Constant speed and direction of rotation:
  - ”S external” function
  - set S value (speed) and M3, M4 (rotation) or M5 (spindle stop) in user data of command channel

NC: Request for open-loop control mode
- Constant speed and direction of rotation
  - programming of S value, M3, M4, M5, G94, G95, G97
- Constant cutting rate
  - programming of S value, M3, M4, M5 and G96
- Thread-cutting
  - programming of S value, M3, M4, M5 and G33, G34, G35

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Gear ratio changing

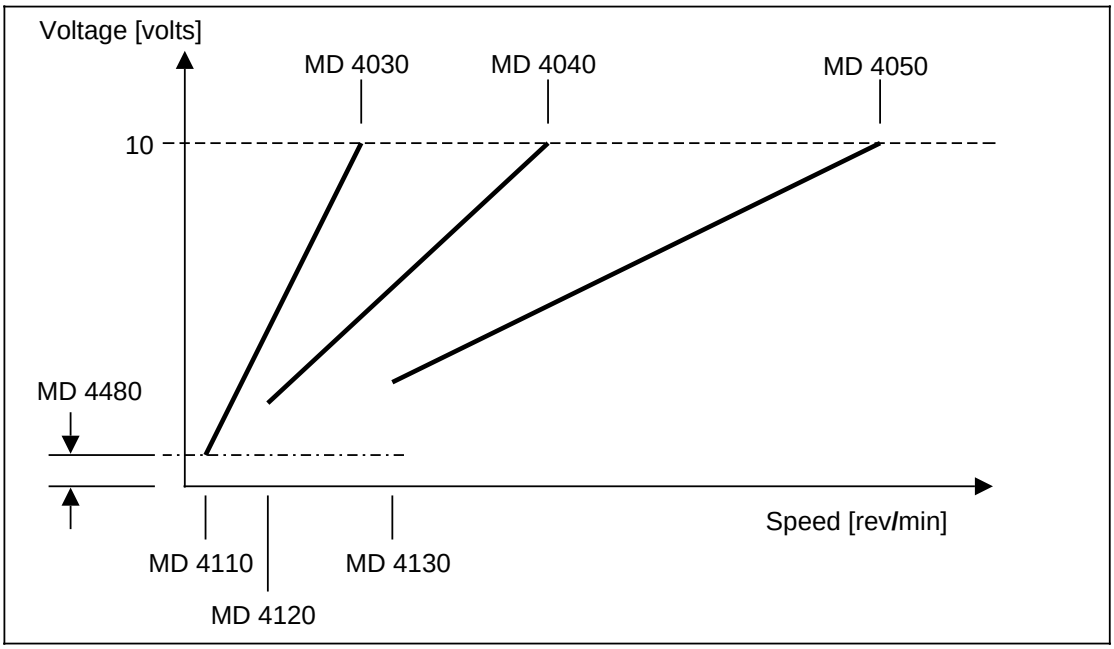
Gear ratio changing is only possible in the open-loop control mode. There can be up to eight different ratios between motor and spindle.

A permitted range of speed can be laid down for each gear ratio by defining maximum and minimum speed values. If the speed setpoint does not fall within the range of the gear ratio that is currently active, the number of the required gear ratio is ascertained automatically and entered into the interface to the PLC together with IS:CHANGE GEAR.

The PLC user program executes the gear change, acknowledges the request by resetting IS: CHANGE GEAR and enters the new gear ratio into the interface.

If no suitable gear ratio for the programmed speed exists, no request for gear changing is generated. The programmed speed is then transferred to the current gear ratio. So it is important to ensure that there is always a suitable gear ratio available.

The behaviour of the spindle during gear ratio changing can be influenced by MD 521*, bit 5 "New S value after PLC acknowledgement". If the bit is set, the programmed speed setpoint will only be accepted when the PLC has acknowledged gear ratio changing. This prevents an unwanted increase in speed while still in the old ratio before changeover.



The gear is output on the basis of the lowest switching frequency, i.e. if the speeds of the individual gears overlap, a new gear is output only when the programmed S value is no longer possible for the selected gear.

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In view of the fact that not all spindle drives are equipped with ramp-function generators, a ramp-function generator was integrated in the control (unit 1 ms). The following enable signals are required for spindle setpoint output:

DB 31 Spindle-specific signals

- DL_K+_1 bit 6= 1 "Servo enable"
- DL_K+_1 bit 5= 0 "Default setpoint is 0"
- DW_K+_3 all bits= 0 "Spindle disable"
- Setting data "Spindle speed limitation"

Note:

See also functional description ”Parameter set switchover” in Section 12.

Data required

This section describes the data that is of particular significance to the open-loop control mode.

- **Limiting the speed**

  Parameters for maximum and minimum speed limits can be assigned for each gear ratio. Parameter assignment is effected through the machine data:
  – MD 403* to 410* ”Max. speed” per gear ratio
  – MD 411* to 418* ”Min. speed” per gear ratio

  If a gear stage is not used, the value zero **must** be entered for the maximum speed of this gear stage and not the value in the standard machine data.

  Regardless of which gear ratio is active, the speed is limited by:
  – MD 451* ”Max. chuck speed”
  – MD 448* ”Min. motor speed”
  – SD 401* ”Programmable spindle speed limit for G96”; programmed with G92
  – SD 403* ”Programmable spindle speed limit”; programmed with G26

- **Limiting the acceleration**

  In order to avoid excessive acceleration when changing speeds, the setpoint is ramped up or down accordingly by means of a ramp-function generator. The maximum value of acceleration to be used is assigned by means of an acceleration time constant. A separate acceleration time constant must be specified for each gear ratio employed:

  – MD 419* to 426* ”Acceleration time constant without position control”

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10.5.2 Oscillation mode

The oscillation mode can be used with gear ratio changing to facilitate engagement of the gear by oscillating the spindle.

When switching from open-loop control to oscillation control, the speed setpoint is first reduced to zero at the deceleration ramp defined by the active acceleration time constant. The oscillation speed setpoint is then output.

Preconditions

The request for the oscillation mode comes from the PLC. The PLC user program sets the IS: OSCILLATION SPEED. The following conditions must be satisfied:

- IS:PLC SPINDLE CONTROL set

Parameter assignment

- The motor setpoint for oscillation speed is issued by MD 450*. The sign of the setpoint, and hence the direction of rotation, is determined by IS: SET ROTATION CW
- There is no acceleration or speed limitation in the oscillation mode.

Implementation

- The spindle is actually oscillated by the setpoint being output with an alternating sign. This has to be implemented in the PLC user program by inverting IS:SET ROTATION CW.

10.5.3 Positioning mode, M19, M19 through several revolutions

10.5.3.1 General

In the positioning mode, the spindle is driven to a preset position under position control and stopped there. The position is reached either directly (M19) or **through several revolutions** (M19tsr).

Position control and actual value acquisition

- Actual value acquisition is needed for position control. Therefore, an encoder must be mounted directly on the spindle.
- The reference point for the angle measuring system is the zero mark of the encoder. A permanent offset to the zero mark can be established by using the zero mark shift (MD 459*).

Position control polarity with M19

When the spindle is switched to closed-loop control with M19 by the control, the pulses from the ROD encoder must reach the control with the correct direction of rotation. Incorrect position control polarity can be recognized because the spindle spins fast and shuts down at the maximum setpoint with alarm "Alarm limit speed setpoint", cancelling the speed controller enable.

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Accuracy

- The position is entered with an accuracy of 0.01°. The positioning accuracy achieved by the spindle depends on a number of factors:
  – The resolution of the angle measuring system
  – The gain factor of the active gear ratio
  – The drift
  – The interfacing to the drive system.

Restrictions

- Gear ratio changing cannot be employed in the positioning mode.
- M19 must not be activated or programmed when the G96 function is active.

Selecting the positioning mode

A distinction must be made between absolute positioning (M19 from NC or PLC) and incremental positioning (M19 through several revolutions from the command channel).

Positioning mode can be selected by NC, PLC or command channel. The following functions are available:

PLC: Request for M19
- IS:POSITION SPINDLE
  – set position from MD 452*

CC: Request for M19tsr
- ”Incremental spindle positioning” function
  – set incremental traversing path in user data of command channel
  – spindle override remains active

NC: Request for M19
- M19 in part program or during overstore
  – set position as S value
  – set position from setting data (SD 402*) if no S value has been programmed.

Acknowledging M19

If the signal "Spindle position reached" (DB 31 DL k bit 4) is output during positioning by the NC, the PLC must then output the signal "Acknowledge M19" (DB 31 DR k + 2 bit 2) if function M19 is to be terminated. However, signal "Acknowledge M19" must not be output until the spindle has settled in position. If serious overshoot occurs (gain factor very large) , it is advisable to delay output of signal "Acknowledge M19" to the NC until signal "Spindle position reached" has been pending for a machine-specific time tv.

Signal "Acknowledge M19" not only cancels spindle positioning but it also stops the spindle (like M05) so that a new M03 or M04 has to be programmed in the part program to enable the spindle to accelerate to the S value previously programmed.

Signal "Acknowledge M19" is only active in combination with "PLC spindle control".

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Data required

This section describes the data that is of special significance to the positioning mode. A detailed description of the machine data and setting data will be found in the Section "NC Machine Data (NC MD)/NC Setting Data (NC SD)".

- **Position**

  An absolute position is given in response to a request from the NC or PLC. The position is specified by S value, machine data or setting data. The values must be within the range 0 to 359.99° and the entry must be to an accuracy of 0.01°.

- **Distance traversed**

  An incremental path is given in response to a request from the command channel. This path is specified in the user data of the command channel and can be more than one revolution. The size is only limited by the numerical format. The value must again be accurate to 0.01° and its mathematical sign determines the direction of rotation for positioning.

- **Override factor**

  The speed during positioning can be influenced by the spindle override factor.

- **Other data**

  Positioning is effected with interpolation guiding and under position control. The following data is needed:
  – Maximum permitted speed during positioning
  – Maximum permitted acceleration
  – Gain factor
  – Position window

  This information is transferred to the user data on request from the command channel.

  When there is a request from the NC or PLC, the corresponding machine data of the active gear ratio is used, which is:

  – MD 427* to 434* ”Creep speed for M19” as max. speed during positioning
  – MD 478* to 485* ”Acceleration time constant with position control” for limiting the acceleration rate during acceleration and deceleration
  – MD 435* to 442* ”Gain factor” for the position controller
  – MD 443* ”Position tolerance” for establishing the position window (regardless of the active gear ratio)

  If the gain factor is required to be changed in the positioning mode, the following will also be needed:

  – MD 469* ”Factor for gain changing”

  – Output of signal "Spindle position reached" (DB31 DLK bit 4) to the PLC if the current spindle position has not reached the tolerance range set in MD 4430.

  – M19 is completed when the PLC outputs signal "Acknowledge M19" (DB31 DRK + 2 bit 2), or with M3, M4. In this case the position control loop is opened but the spindle controller enable relay does not drop out (spindle can drift out of position).

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10.5.3.2 Absolute positioning sequence (M19)

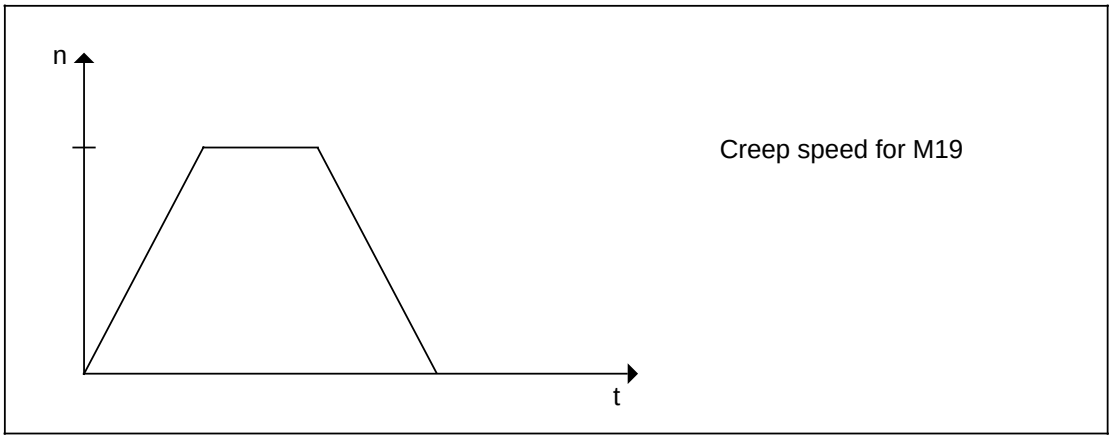
The spindle is to be brought to a preset angular position as quickly as possible and stopped there. Driving to a particular position is only possible if the spindle is synchronized with the encoder, i.e. if the zero mark has been overtravelled once. It is only then that the absolute position of the spindle can be defined.

1. Spindle synchronized with encoder

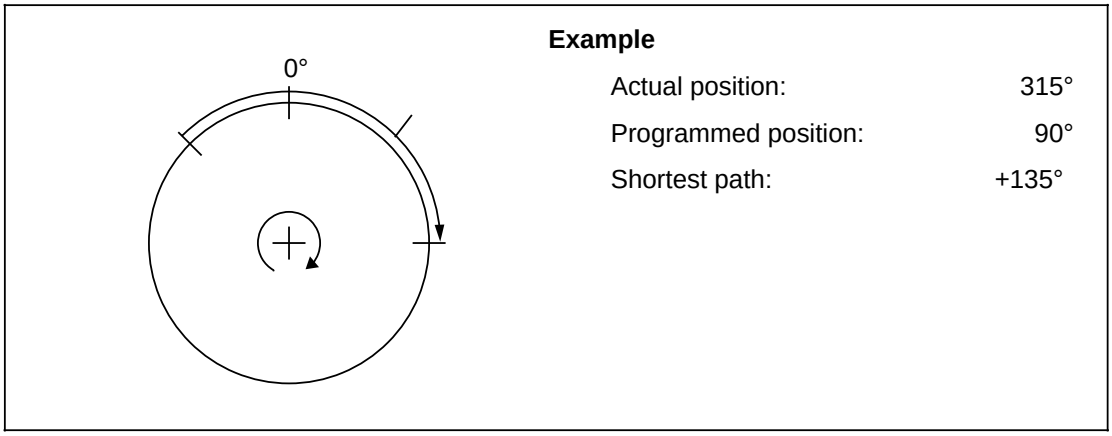
   a) Spindle stopped

   The spindle is driven to the preset position by the shortest path. This means that the path to be traversed is always within the range -180 to +180°. Determining the shortest path also determines the direction of rotation.

   The maximum speed attained during positioning is the creep speed.



Speed characteristic for case 1a



Example for case 1a

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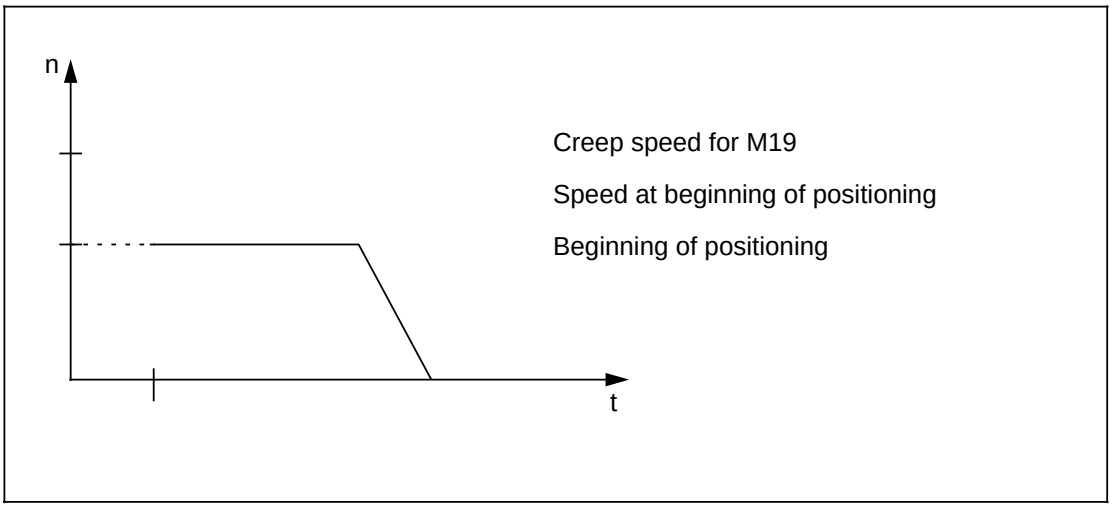
b) Spindle running

The spindle is driven to the specified position as quickly as possible, without changing the direction of rotation.

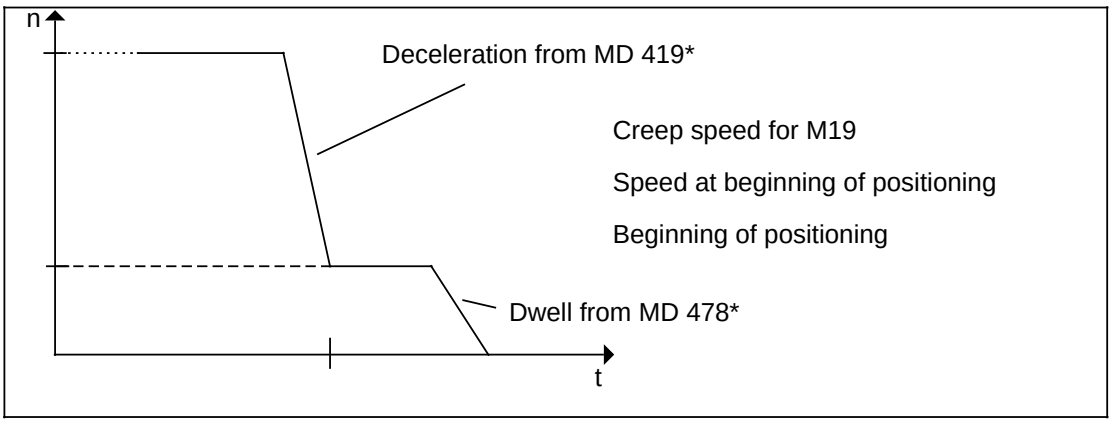
The nearest position at which the spindle can be stopped is calculated from the actual position and the deceleration distance based on the momentary speed. The spindle is driven to the specified position in the direction of travel. The sum of this required distance and the deceleration distance then gives the distance to be traversed, which is covered as quickly as possible.

If the actual speed is less than the creep speed, the spindle is accelerated up to and no further than the creep speed.

If the actual speed is greater than the creep speed, the spindle decelerated until the creep speed has been reached (MD 427*). Then the M19 position is approached with interpolation until the spindle can be stopped at the specified position utilizing maximum deceleration.



Speed characteristic for case 1b (actual speed < creep speed)



Speed characteristic for case 1b (actual speed creep speed)

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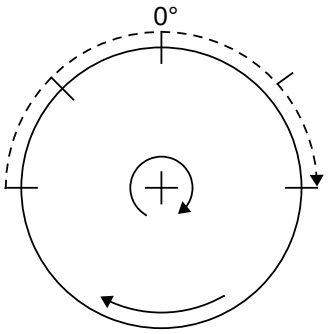


Example

Actual position:	315°
Actual rotation:	positive
Programmed position:	90°
Nearest position at which spindle can be stopped:	270°
Distance to be traversed in addition to the deceleration distance:	+180°
Total distance to be traversed:	+495°

Example for case 1b

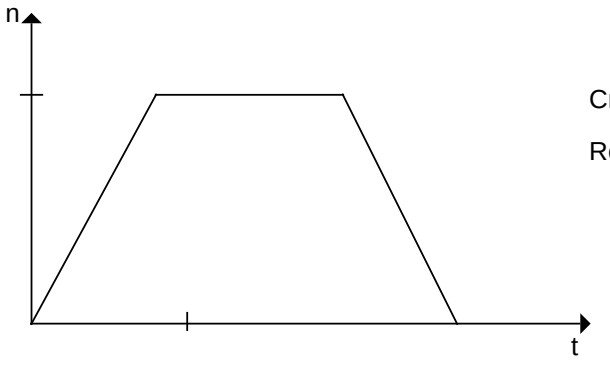
2. Spindle not in synchronism with zero mark

   In this case, neither the actual position nor the distance to be traversed can be ascertained correctly.

   Therefore, the spindle is first driven at creep speed (MD 427* to 434*) until the zero mark of the encoder is recognized.

   This allows the internal actual-value counter to be synchronized with the encoder. The remainder of the positioning sequence is identical to that of case 1b.

   If, when M19 is selected, the spindle rotates at a speed above the encoder cutoff frequency (MD 462*), the spindle is first decelerated under control to the creep speed. If the speed of the spindle is below the limit speed, it must be resynchronized. Continue then as in case 1b).



Speed characteristic for case 2

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The following applies when selecting the creep speed:

The drive must have sufficient acceleration reserves in the speed range below the creep speed, corresponding to the programmed acceleration for position-controlled spindle operation.

The values in the preset range (100 rev/min to 500 rev/min) are generally suitable.

If the spindle leaves the target position when function M19 is selected (e.g. by being pushed out of position when the closed loop control is switched off), it is returned to the target position using interpolation when the servo enable is reactivated.
If the closed loop control is disabled while the position is being approached, the positioning operation restarts when servo enable is restarted, if M19 is still selected.

10.5.3.3 Incremental positioning sequence (M19 through several revolutions)

There are two preconditions to be fulfilled in this case:

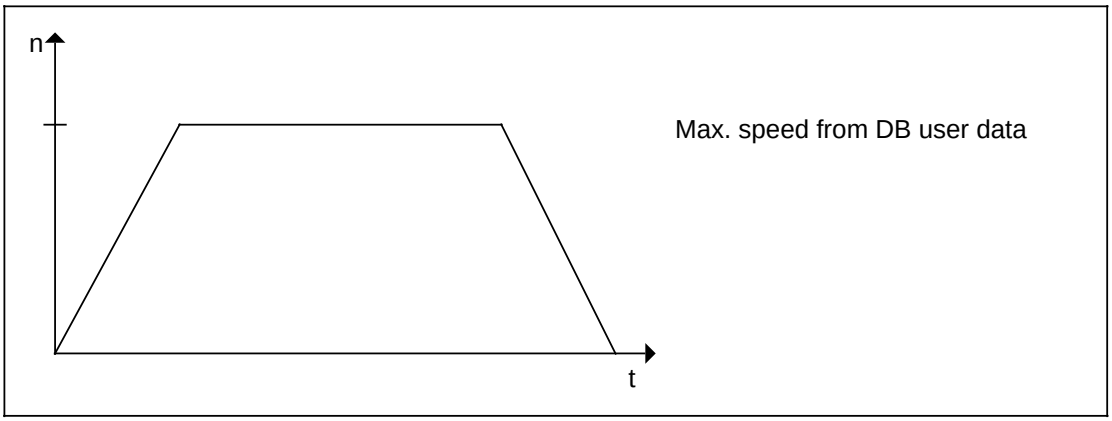
- spindle stopped
- spindle synchronized with encoder

The specified angle in this case is not the position to be reached but the distance to be traversed. The starting point for this distance is the last position to which the spindle was driven (last M19 position). The direction of rotation is determined by the sign of the programmed path.

If the spindle has not been driven to an absolute position before incremental positioning is carried out for the first time, the starting point is assumed to be 0°.

It is possible, e.g. due to drift, that the actual position does not agree with the last M19 position. In this case the discrepancy is included in the distance to be traversed.

The actual position can be uniquely defined only within one revolution (0 ... 360°). Since one assumes that the spindle has moved little since the last positioning, the difference is defined in the range -180 to +180°.



Speed characteristic for incremental positioning

Note:

If function M19 is interrupted during several revolutions via command channel (e.g. by reset), this may lead to incorrect positioning.

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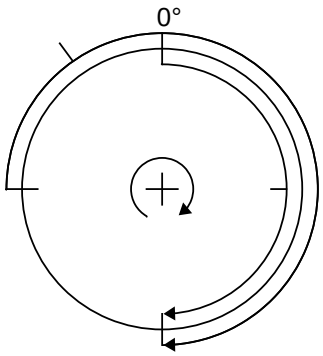
Examples

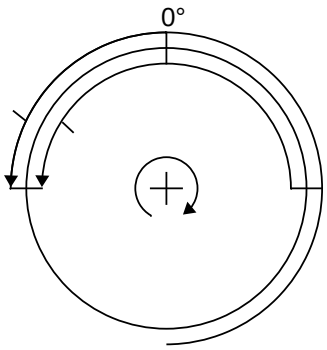


Last M19 position:	0°
Actual position:	270°
Specified travel:	+180°

This means that the spindle has moved 90° from the last M19 position in the opposite direction to the specified direction, so the total is:

Distance to be traversed:	+270°

Example 1



last M19 position:	90°
Actual position:	0°
Specified travel:	–180°

The spindle has thus moved 90° from the last M19 position in the specified direction, so the total is

Distance to be traversed:	–90°

Example 2

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10.5.3.4 Method A and B in the NC-internal solution

With the **NC-internal** solution there are two methods **(method A and method B)** by which the oriented spindle stop can be integrated into the block sequence of the NC program.

Method A (M19 without axis motion):

With **method A**, the spindle stop is handled in a separate part program block and a block change is only initiated after the function has terminated. Axis motions are not possible at the same time as spindle positioning.

Method B (M19 with axis motion):

In method B, M19 is modal even across several blocks. While the spindle is positioning or is held in the position control, it is possible to move the axes, continue the program or even perform a tool change (NC MD 520*, bit 5).

The following applies to both methods (A and B):

- M19 S... must be programmed in a separate block without axis motions.
- The orientation is performed in the specified direction of rotation (M03**/**M04)
- M19 is possible from rest (shortest path)
- The oriented spindle stop is started at the beginning of the block
- M19 is cancelled and terminated by
  - Emergency stop (alarm 2000)
  - Reset (machine data dependent)
  - End of program (M02**/**M30)(machine data dependent)
  - Spindle disable (DB 31 DW $_{K+3}$)
  - Servo loop error of spindle or axis
  - Error that causes all axes to stop
  - Cancellation of NCBB2
  - Acknowledge M19 + PLC spindle control (DB 31 DW $_{K+2}$)
- in "MDI AUTO", "jog" or "AUTOMATIC". M19 can also be selected by overstoring.
- M19 is output at the PLC interface as an auxiliary function.

Characteristics peculiar to method A (NC MD 520*, bit 5 = 0)

- Block change is only performed after the M19 function has terminated (acknowledge M19)
- Simultaneous traversing of the axes is not possible.

Characteristics peculiar to method B (NC MD 520*, bit 5 = 1)

- M19 is modal even across several blocks.
- The block change is performed after a delay of one PLC cycle.
- In the following blocks axes can be moved or a tool change performed parallel to positioning or position control.
- While positioning is running (M19) the direction of rotation must not be reversed (M03**/**M04). Otherwise positioning is performed in an undefined direction.
- During M19 it is possible to switch to jog, incremental or repositioning. The position control loop remains closed and the axes can be traversed.

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- If the PLC detects the auxiliary function M19 it can prevent the block change by cancellation of the READ-IN ENABLE.
- If M19 is reselected before a previous M19 has terminated with the signal "Acknowledge M19", the new spindle position is adopted by the function. The NC moves to the new position by the shortest path regardless of the set direction of rotation. The spindle path is smaller than 180° regardless of the closed-loop control characteristic.

10.5.3.5 Gain factor change

Gain factor change

In the positioning mode it must be possible to drive the spindle to a target position from full speed under position feedback control. The spindle must be held at the target position even when there is drift.

To ensure that the spindle is steady at rest, even in the presence of drift, very small set speeds with very high resolution must be given to the drive actuator via the analog interface.

The speed setpoints are transferred as voltage signals via the analog interface between control system and drive actuator. Under some circumstances the control behaviour can be improved by increasing the voltage level (relative to the set speed) because it enables a higher resolution to be achieved and the analog interference noise can be reduced.

Consequently, with some drive actuators, such as the SIMODRIVE 650, a different scaling for the set speeds (voltage levels) can be selected by applying a configurable terminal signal.

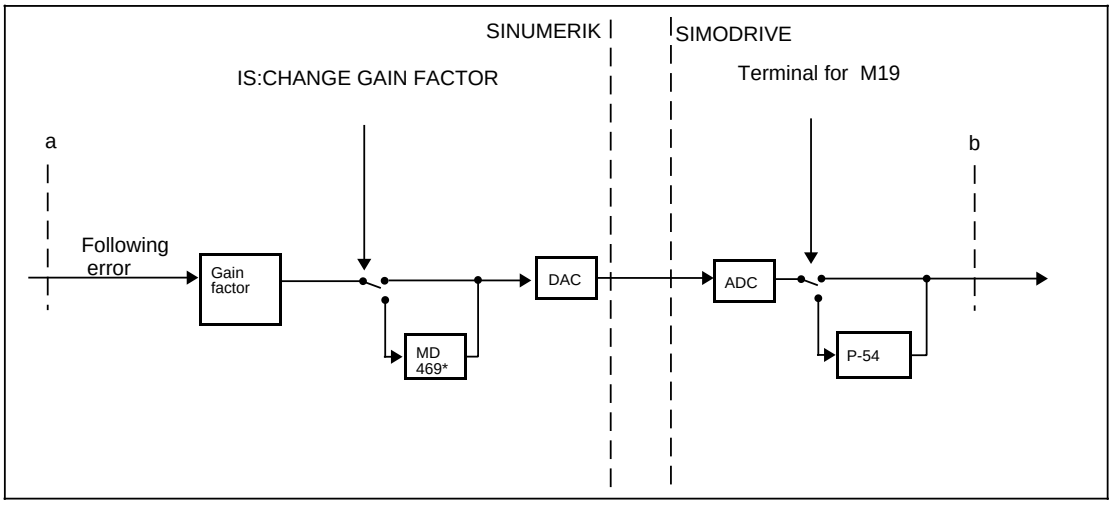
This changing of the scaling in the drive actuator must be allowed for in the control so that, overall, the effective gain factor remains the same. The gain factor (dependent on gear ratio, MD 435* to 442*) must be adapted to the new scaling.

The factor for gain changing is entered as machine data. The value is calculated from:

$$\text{MD } 469^* = \frac{1}{N} \qquad \text{where N = scaling factor in the drive actuator}$$

Changing of the gain factor must be initiated by the PLC user program with the interface signal CHANGE GAIN FACTOR (DW K + 1, bit 15).

The diagram below is intended to illustrate the changeover process using SIMODRIVE 650 as an example.



Simplified block diagram

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Referring to the SIMODRIVE 650 Operating Instructions will explain the following:

P-54:	Scaling factor for set speeds (M19 mode)
Terminal for M19:	Terminal configurable with P-83 to P-85

The block diagram shows that MD 469* and the SIMODRIVE parameter P-54 must add up to 1 in order to obtain the same effective gain factor between points a and b with or without changeover.

It is also apparent that, for stable control behaviour, the changeover of the gain factor and the speed normalization must always take place **simultaneously**. Only then will the effective gain factor remain the same.

Gain factor change in the positioning mode

In order to position the spindle from full speed, it must first be possible to transfer the maximum speed setpoints. Consequently, when the positioning mode is started, neither changeover of the drive actuator scaling nor changeover of the gain factor must be activated.

Changeover should only be effected when the spindle has come to rest. Therefore, it is sensible for it to be done when the interface signal SPINDLE STOPPED has been set by the NC system.

In all cases it is essential for the value of speed setpoint (voltage level) to be transferred to be less than 10 V after changeover.

If the spindle is to be positioned several times in succession, it can be convenient for changeover to remain activated at the start of the second positioning sequence and the subsequent ones. However, then it will be necessary to ensure that the maximum speed attained during positioning (see section headed "The positioning sequence") is less than the speed that can be transferred via the analog interface at a maximum of ± 10 V.

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10.5.3.6 Aborting the positioning mode

The specified position is regarded as having been reached (or the distance as having been traversed) when the spindle is within the position window. This is signalled to the PLC by setting IS:SPINDLE POSITION REACHED.

The position is held under position control until the M19 function is aborted. The conditions for aborting are as follows:

- IS ACKNOWLEDGE M19
- M3/M4 in part program or command channel
- Select C axis or synchronous mode
- Program end
- Reset

M19 and RESET

NC MD 520* bit 6 (no M19 abort on RESET) can be set to prevent function M19 aborting on program end (M30/M2) or RESET (key). In this case, M19 can only be aborted by signal "Acknowledge M19" from the PLC or by alarms ”Remove NCBB2” or ”EMERGENCY STOP”. Otherwise function M19 is only aborted on channel-specific reset if the channel is aborted for which the spindle is entered in the channel DB as the spindle of that channel.

Setting IS:SPINDLE DISABLE or resetting IS:SERVO ENABLE interrupts the positioning mode. If the signal is reset again or set again, positioning is continued, but with the following **exception**:

- If the positioning mode was selected from the command channel, it will be interrupted if IS:SERVO ENABLE is reset. An error message will be entered in the user interface. Positioning will **not** be continued, however, if the signal is set again.

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10.5.4 Curved acceleration characteristic (SW 4 and higher)

When induction motors are used (spindle operation), allowance must be made for their speed-dependent acceleration capability in position-controlled operation:

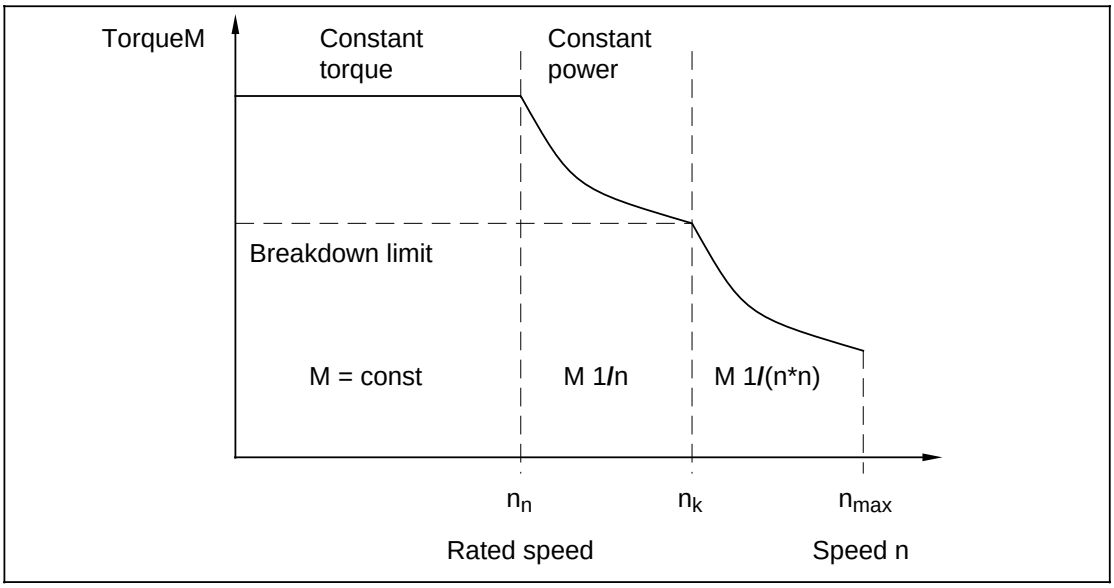

Fig. 1 Torque characteristic of induction motor

At speeds (n) above rated speed (n_n), the drive acceleration capability decreases in relation to the speed. Immediately above rated speed nn, there is a range of "constant power" in which the torque (and thus also the acceleration capability) drop in proportion to 1/n. When speed n increases further, there is a range ("breakdown limit") immediately above speed nk in which the torque decreases in proportion to 1/(n*n).

The required parameters are selected and set in the MSD drive unit.

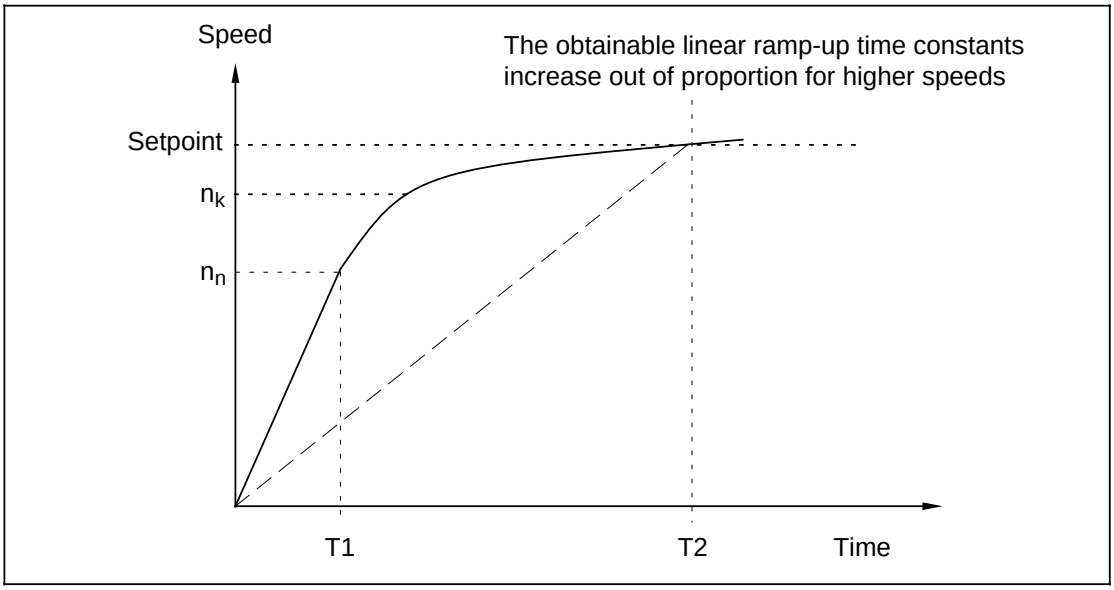

Fig. 2 Speed characteristic during acceleration (thick line)

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Figure 2 shows the speed characteristics which are obtained when the acceleration capability is fully utilized.

In **speed-controlled** operation, the drive accelerates either according to the acceleration rate (dashed line for T2 in Fig. 2) set in MD 419* (ramp-up time constant T in open-loop control mode) or, when the ramp-up time constant is shorter, optimally in terms of time along the current limit.

With software versions up to and including SW 3, the ramp-up time constant in MD 478* for **position-controlled** operation must be set such that the current limit must not be reached when the drive accelerates to maximum speed to avoid the risk of instability or overshoot on positioning. The maximum acceleration capability of the drive cannot be fully utilized.

In the new software version, a speed-dependent acceleration characteristic, which can be adapted according to the prevalent physical conditions (speed-dependent adaptation), is implemented for the position-controlled spindle operating modes (most important application: Open-loop controlled operation of a leading spindle in the synchronous spindle or ELG grouping).

In main spindle drives, the torque is limited as follows (cf. Fig. 1):

- Constant torque up to rated speed n_n: Torque = const
- Constant power above rated speed up to breakdown speed n_k: Torque 1 **/** n
- Power reduction at higher speeds up to n_{max}: Torque 1 **/** (n*n)

Allowance is made for these characteristics in the control in the form of an acceleration adaptation which is simple to parameterize:

- Constant acceleration (according to MD 478* as with previous SW) up to a freely settable speed limit n_x.

  The speed limit nx is entered via a new MD 2471* - MD 2478* which parameter-set-specific.

- Above speed limit nx, the acceleration rate is reduced according to the equation:

  Acceleration= MD 478* n_x **/** n

  n: Present speed

It may to be necessary to make allowance for the acceleration characteristic of the induction drive which drops in proportion to 1**/**(n*n) above the speed range of constant power. This can be achieved approximately by means of an additionally applied adaptation factor c (MD 2479* - MD 2486*):

Acceleration= (MD 478*) for n n_x
Acceleration= (MD 478*) * [n_x **/** (n * c)+(c - 1) **/** c] for n>n_x

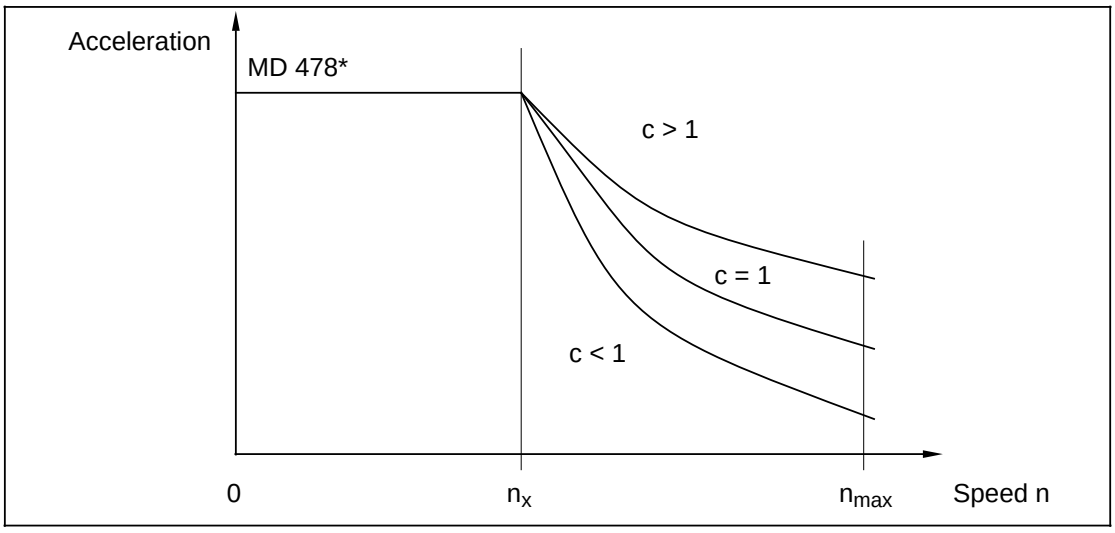

Fig. 3 Possible shapes of acceleration characteristic when adaptation factor is varied. For c = 1 (1 = 100 %), the acceleration above speed limit nx is reduced in inverse proportion to the speed.

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When speed n_x is set to the same value as limit speed n_{max} or when "0" (default setting) is input, the acceleration characteristic is the same as that obtained with previous software versions, i.e. without characteristic curvature (break point above maximum speed).

When "1" is entered for adaptation factor c, the acceleration rate is reduced according to the speed value reciprocal (1/n) above limit speed. This reduction rate can be increased ("steeper" acceleration characteristic) or decreased ("flatter" acceleration characteristic) as required by entering values lower or greater than "1" (i.e. 100 %).

In M19 operation, the search speed is limited internally to n_x.

With the exception of the parameter set extension, the acceleration response obtained with previous software versions is still only available in C-axis operation, i.e. it is not possible to adapt the acceleration rate to the speed value.

It is not necessary to parameterize the characteristic for spindles which are not operated in synchronous groupings or which are equipped with feed drives.

As with previous software versions, the acceleration characteristic is parameterized by the user according to technological requirements. In this case, analog and digital drives are treated in the same way. Automatic adjustment using drive data (e.g. breakdown limit) does not take place. It is thus possible to set the load side parameters (acceleration characteristic) and the drive side parameters (protection of motor and power section) independently.

The "Curved acceleration characteristic for spindles" is operative in the following spindle operating modes:

- Open-loop control mode (M3, M4, adjust PLC):
  The setpoint speed is specified according to the "Curved acceleration characteristic" when the position controller is active at the same time (main application: Leading spindle in synchronous spindle group).
- Positioning mode (M19, positioning from PLC or command channel):
  The maximum positioning speed is limited to nx ("Limit at which acceleration adaptation takes effect", MD 2471*).

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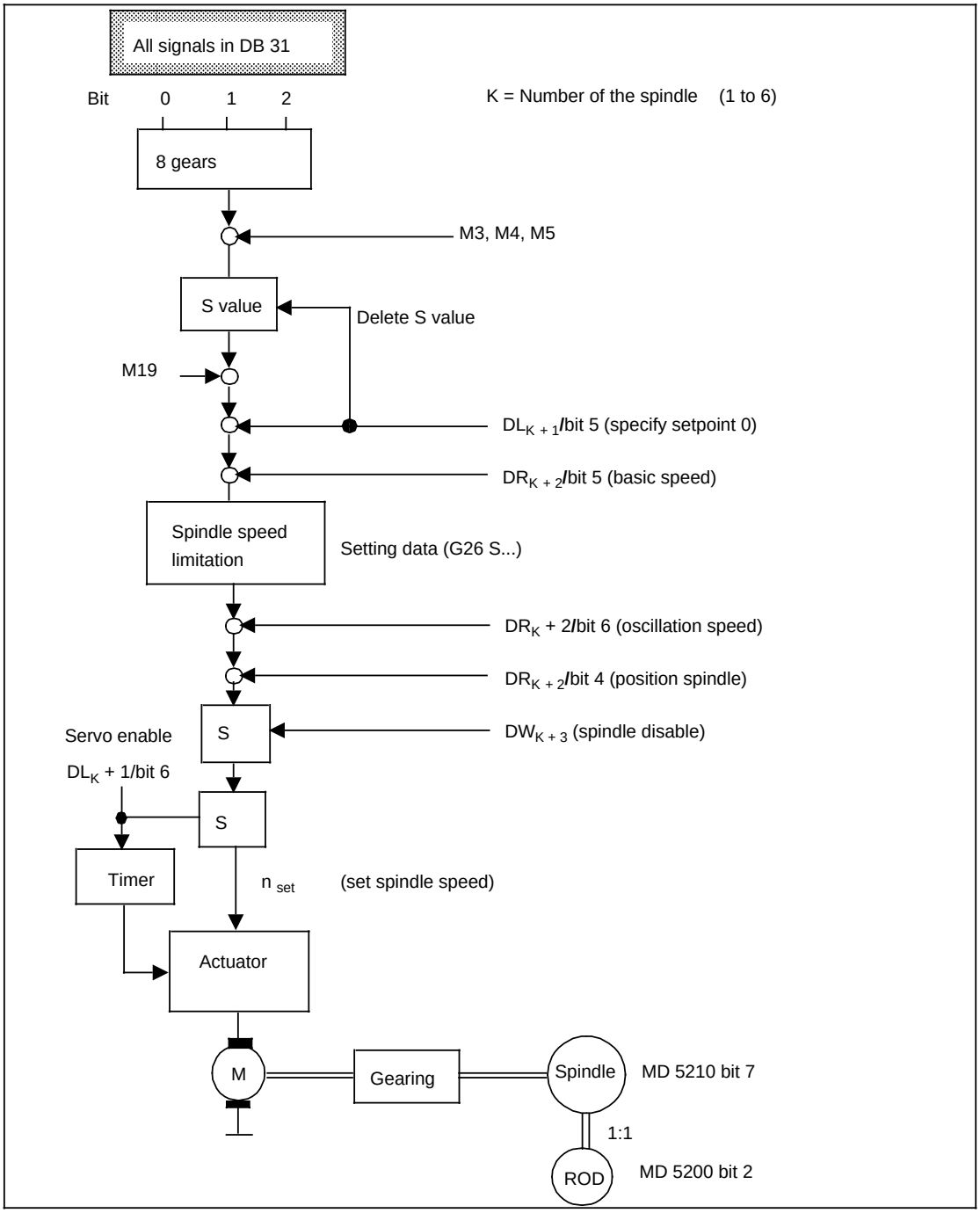
10.5.5 PLC intervention in spindle control

The flowchart on the next page shows the effects of the various PLC interface signals on the spindle. For the sake of clarity, the feedback pulses are not shown.

The "Set direction of rotation clockwise", "Oscillation speed", "Standard speed", "Spindle positioning", "Resynchronize spindle" and "Acknowledge M19" signals are effective only in conjunction with the "PLC spindle control" signal.



DRK + 1

END OF SECTION

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11 Data Backup/CPU Replacement

11.1 Data area

The following data areas are backed up by a battery on the CSB module:

NC data:

- NC machine data
- Cycle machine data
- Setting data
- Tool offsets
- Zero offset
- R parameters

PLC machine data

PLC data (RAM to PLC CPU, ...):

- Data blocks
- User program

The following might cause data loss:

- Failure or replacement of the battery while the control is switched off
- NC CPU defective or removed (NC data)
- MMC CPU defective or removed (PLC MD)
- PLC CPU defective or removed (PLC data)

- Main programs and subroutines are not battery-backed. If you edit part programs in the NCK memory (parameter area), you must save them to hard disk when you have finished editing them. Otherwise they will be lost when you switch off the control. The operating system offers you a workpiece called STANDARD. All data associated with the workpiece STANDARD are automatically loaded into the NCK memory when the control is powered up.
  With SW 2 and higher, you can use MD 5025 bit 7 to set whether the last active workpiece is to be loaded in the NCK at Power On.
  With SW 3 and higher, data (e.g. IKA data) can be loaded automatically in the NCK at Power On (similar to UMS) (see General Reset Section).
- When you have completed start-up you should save the data in the memory of the hard disk (MMC CPU).
- The SINUMERIK 840C provides the option of storing various data sets of the same type. To facilitate management of these files, the SINUMERIK 840C allows the use of directories like those used on PCs. If the MMC CPU is defective all data is lost even on the hard disk. So, it is advisable to back up user data on an external storage medium.

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11.1.1 Ways of backing up data

- **BACKUP function**

  On the MMC CPU you will find a Centronics parallel interface (X122) to which you can connect a VALITEK streamer. With a streamer you can make a backup copy of all files on the hard disk (including the operating system and user data). You cannot copy individual files with the BACKUP function. You can call the BACKUP function from within the DIAGNOSIS area[1]. The function is only designed to work with the VALITEK streamer. The VALITEK streamer is not included in the scope of supply but must be ordered as a hardware option. If you copy a hard disk copy from the streamer back onto the hard disk, all existing data on the hard disk is overwritten.

  See also Section 10, Subsection BACKUP, of the Operator's Guide.

  As from SW 6, data can be saved in an external PC using the help function of the "PC link" user interface. See Section 4.6 for a detailed description.

- **Data backup with V24/20mA interface from MMC CPU to external backup devices**

  On the MMC CPU you will find two serial interfaces, one for the operator panel (X141) and one for data exchange (X151). Via X151 you can only transfer the user data. You can connect various devices (e.g. programmer, PC, etc.).

  Under the softkey DATA INPUT/OUTPUT in the SERVICES area, you can also create archive lists of your user data files. An archive list is a list of files (directories, workpieces files and other files and even archive lists) that you can only read out via the V24/20mA interface. When you read out an archive list the files listed are read out. When you read an archive list in again the files are put back into their original directories and directories are put back into their original position in the directory tree. It only makes sense to output archive lists in PC format because only in this format is information on the original path of files and directories output.

  See the SINUMERIK 840C Operator's Guide for a detailed description.

  The interface is automatically switched between V24 and 20mA modes to match the cable used. Two additional V24 interfaces are available if the MMC interface is used. Floppy disk drive FD-E2 can be connected to the MMC interface.

- **Data backup with V24/20mA interface in the interface PLC or PLC CPU**

  This interface is only of interest for start-up and service.

  With it, you can read out the PLC program in S5 format onto a programmer and make an error diagnosis if PLC errors occur. It is not necessary to back up the PLC program because it is normally stored on an EPROM. As from SW 3, the PLC program is saved on hard disk. This serial interface is permanently active but you have to switch the programmer ON-LINE.

- **Data transfer with IBM compatible PCs**

  Program description PC IN V3.0 can be ordered at the Werkstatt Fürth.

---

1) As from SW 3, a system backup and a user backup can be called.

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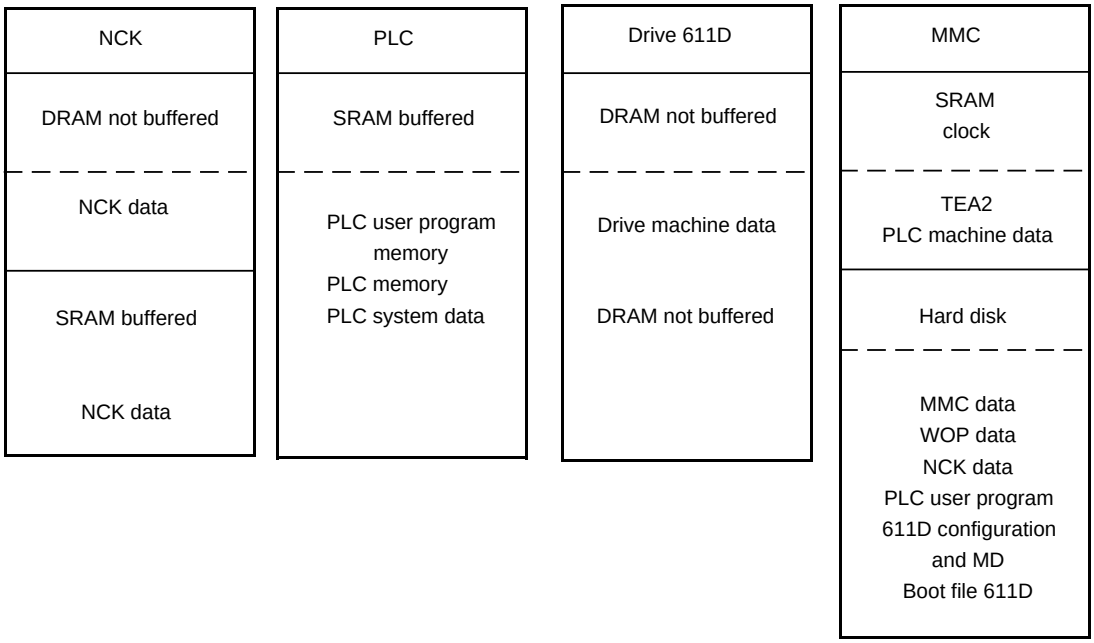
11.1.2 General notes on data backup

Loss of data occurs in case of

- hardware defect on the module
- hard disk defect
- backup battery failure (loss of SRAM data)
- withdrawal of modules CSB, NC CPU, MMC CPU
- EMC influence

Data range

Hardware overview



Note:

The CSB battery is used for SRAM data buffering.

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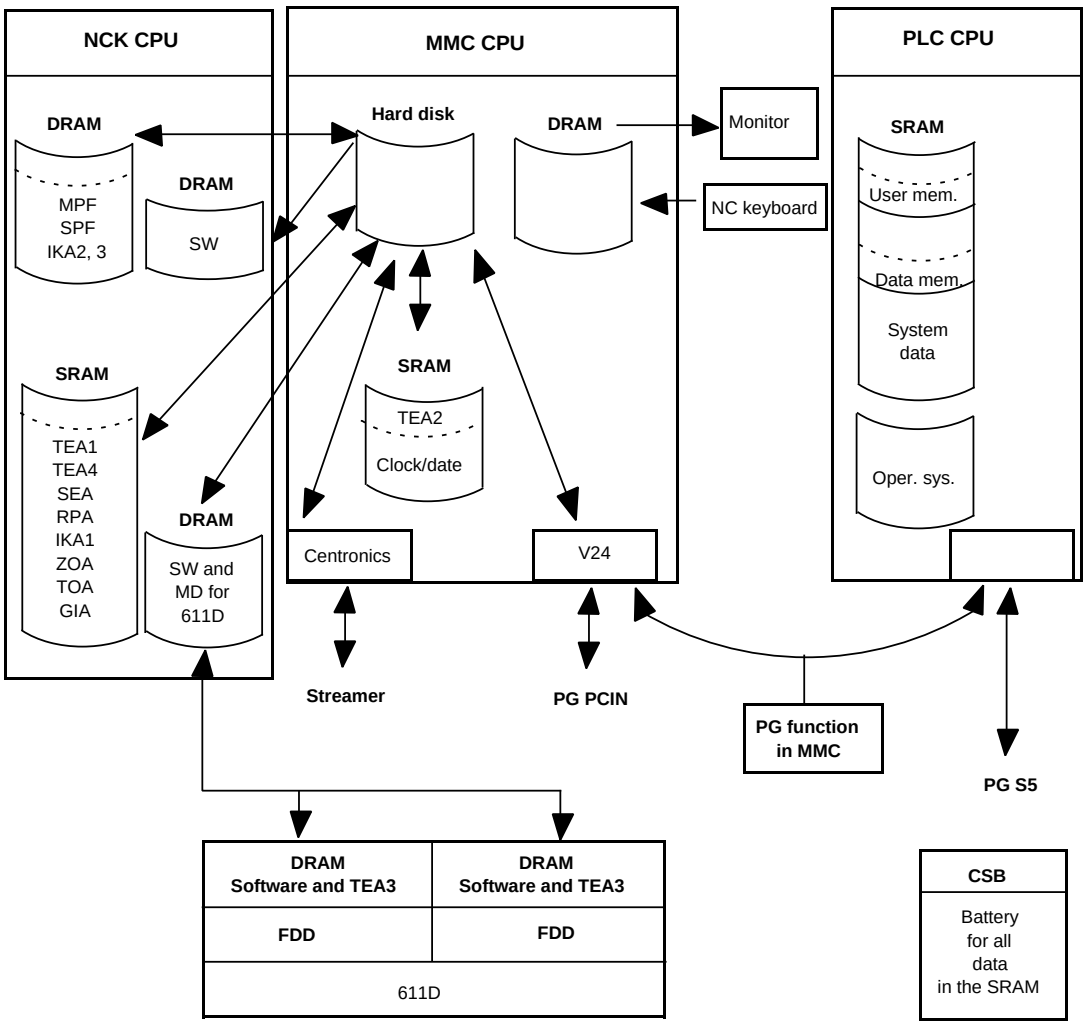
Overview of the data on the following modules:



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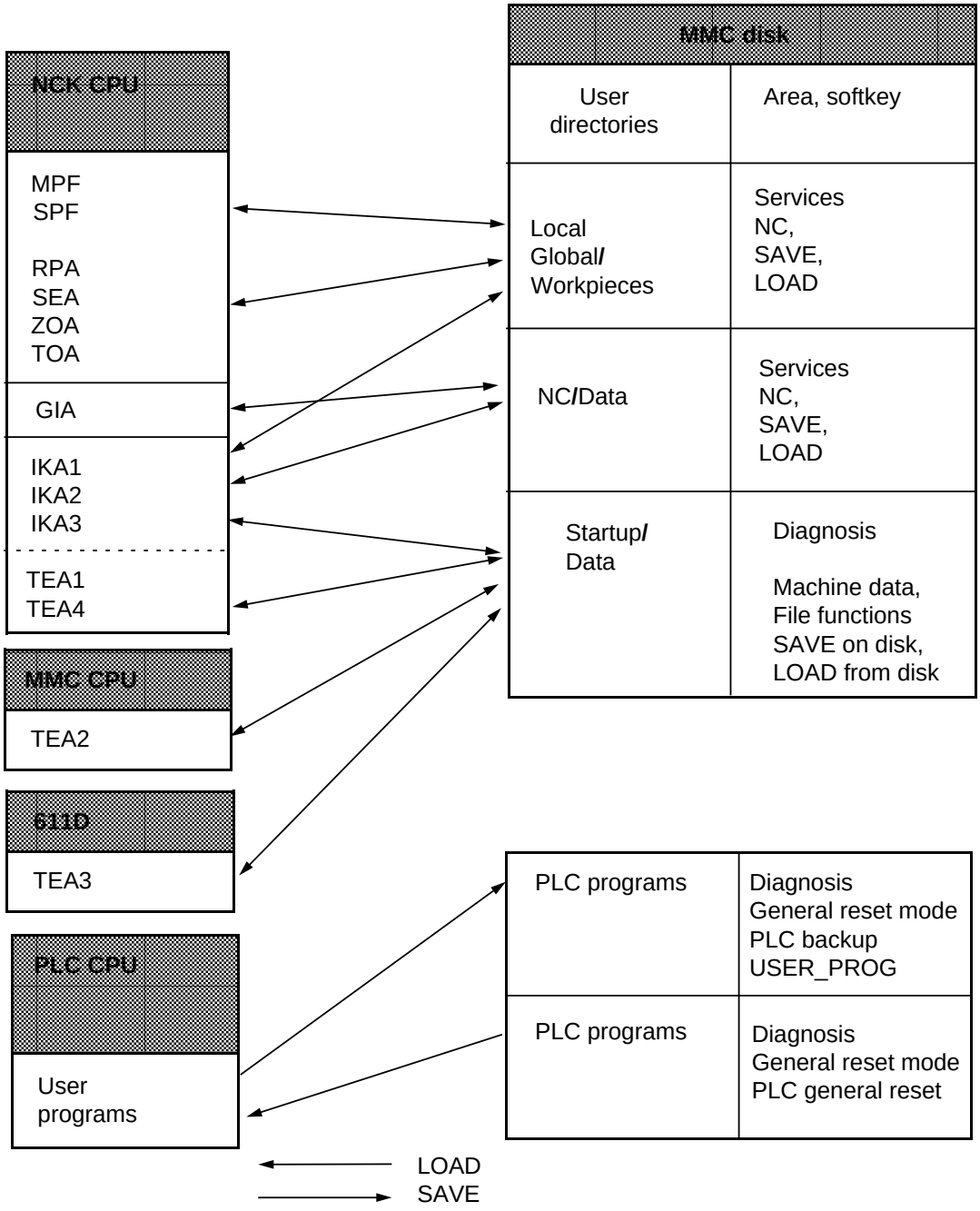
11.1.3 Saving/loading NCK data

Saving and loading RAM data from or to the hard disk



Notes:

- Workpieces can also be transferred from the ”Machine” area to the NCK while in the automatic operating mode.
- NC programs can be transferred from the ”Machine” area and ”Programming” areas (NC editing) to the disk.
- NC programs can also be saved and loaded in the ”Services” area.

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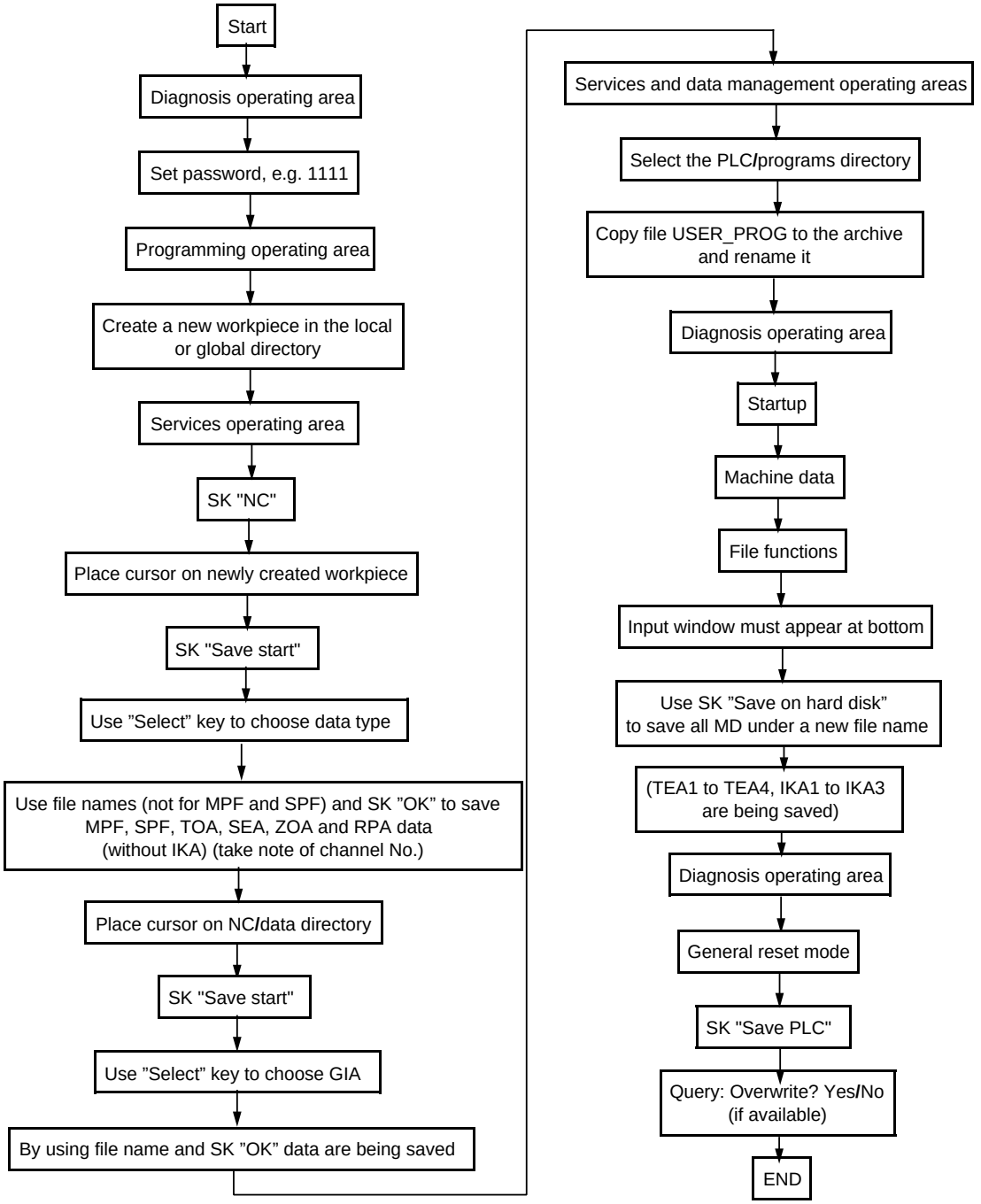
Procedure to save all RAM data on hard disk



Note:

When implementing tool management the data blocks used must be saved by PG.

Run a backup of customer-specific PLC data

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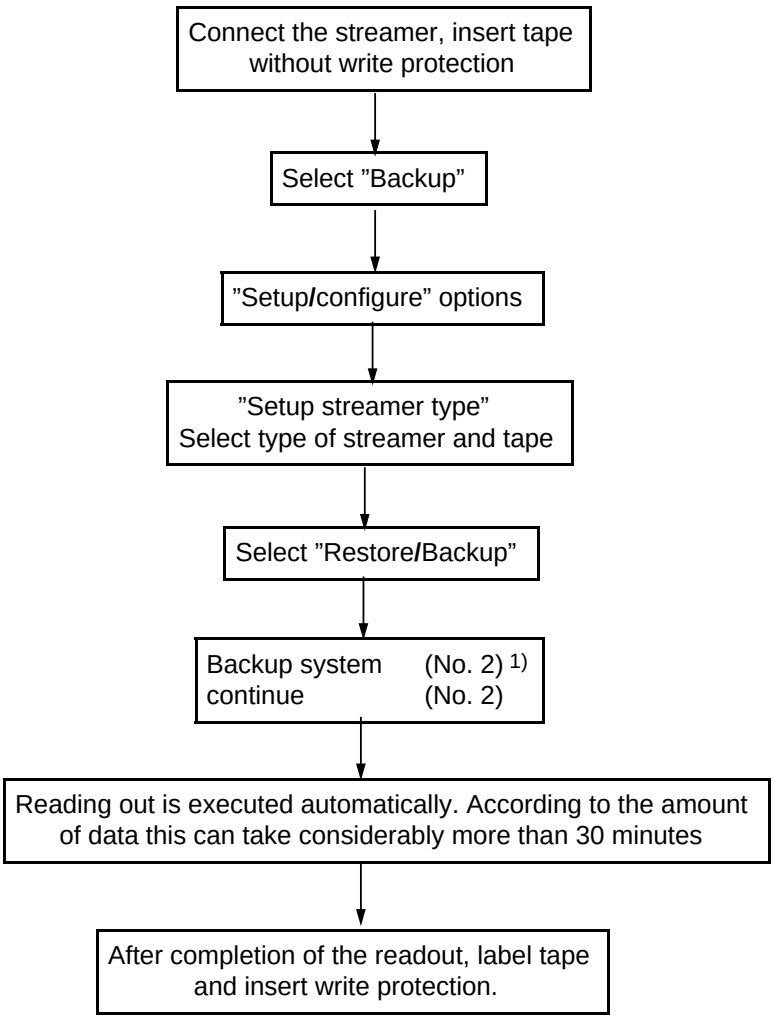
11.1.4 Data backup procedure via streamer



1) Remark: As opposed to ”Backup system” (No. 2), with ”Backup user data” (No. 4) only the user data can be saved.

Using the menu option ”Backup system” all data can be saved including additional options such as WOP.

With ”Backup user data” only user data are saved.

Note:

”User data” must be available when upgrading software.

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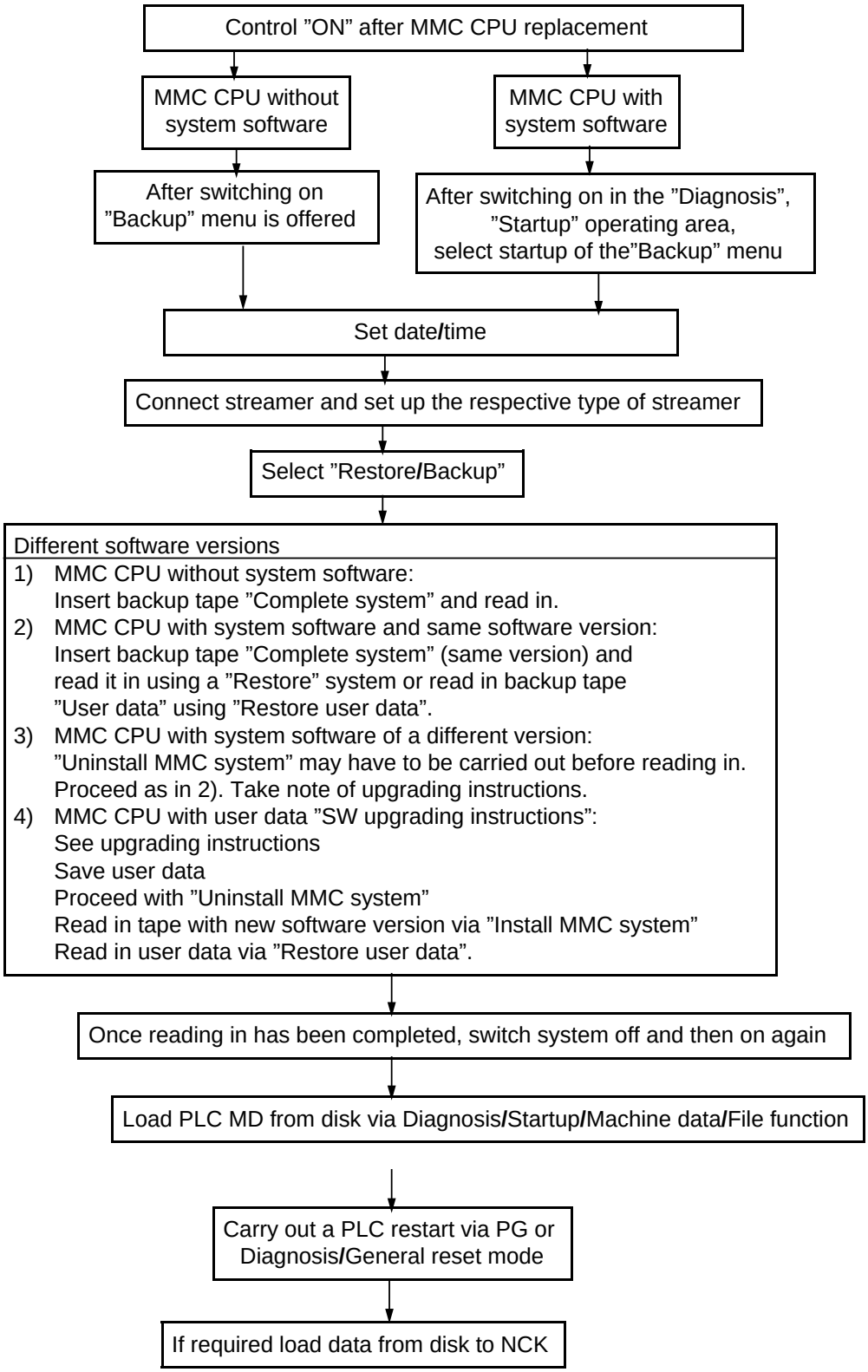
11.1.5 Restarting after MMC CPU replacement

Loading using the streamer (Restore)



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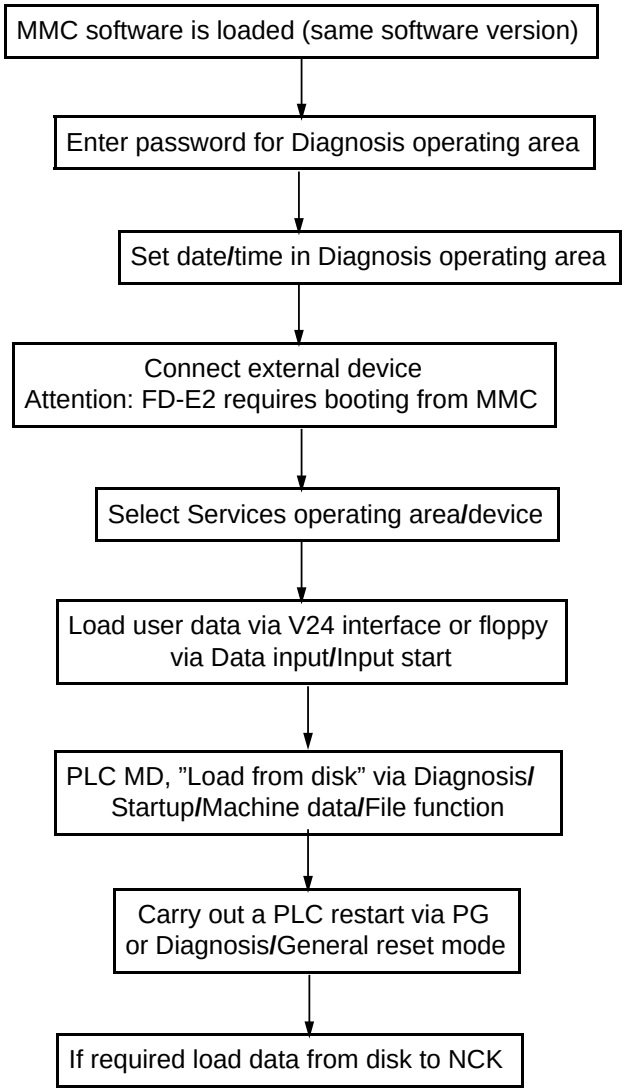
11.1.6 Loading via V24 interface or FD-E2

Example: Replacement of MMC CPU



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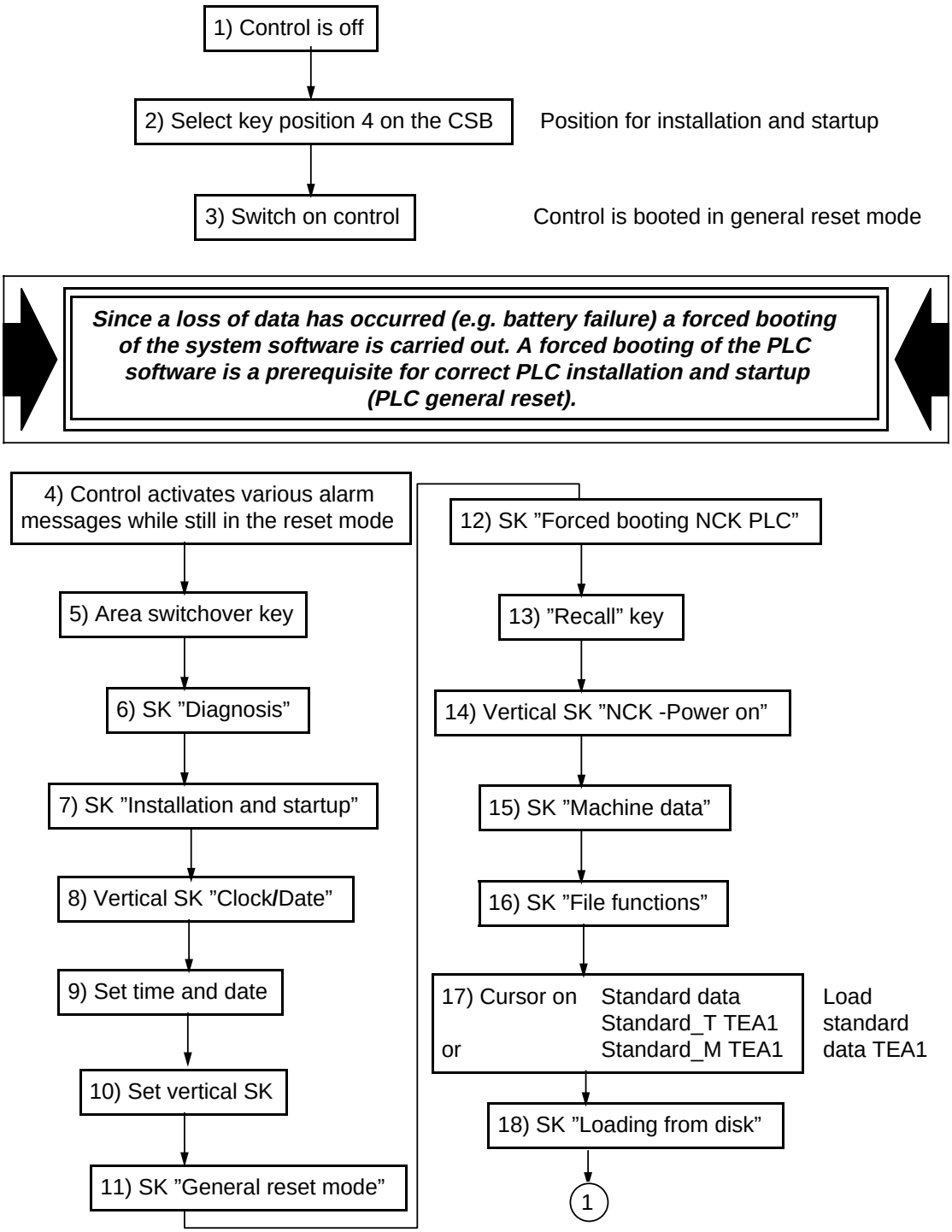
11.1.7 Loading from hard disk (control startup with user data)

Procedure for loading data from hard disk (HD) to RAM areas, e.g. after battery or CSB failure. The sequence is also applicable for the first startup (series installation and startup). User data must be loaded from external sources to the hard disk before the start.

Load NC, PLC, cycle machine data



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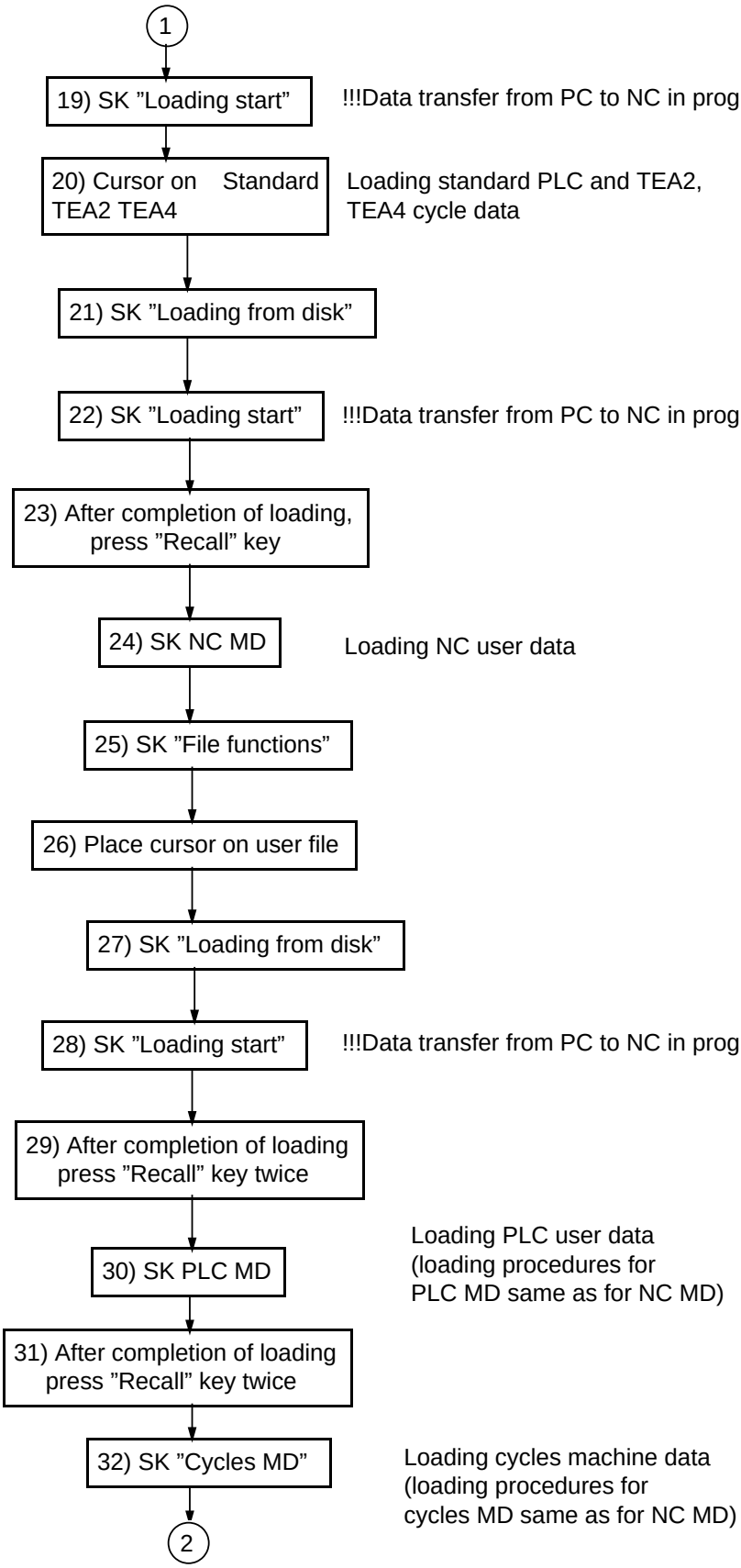

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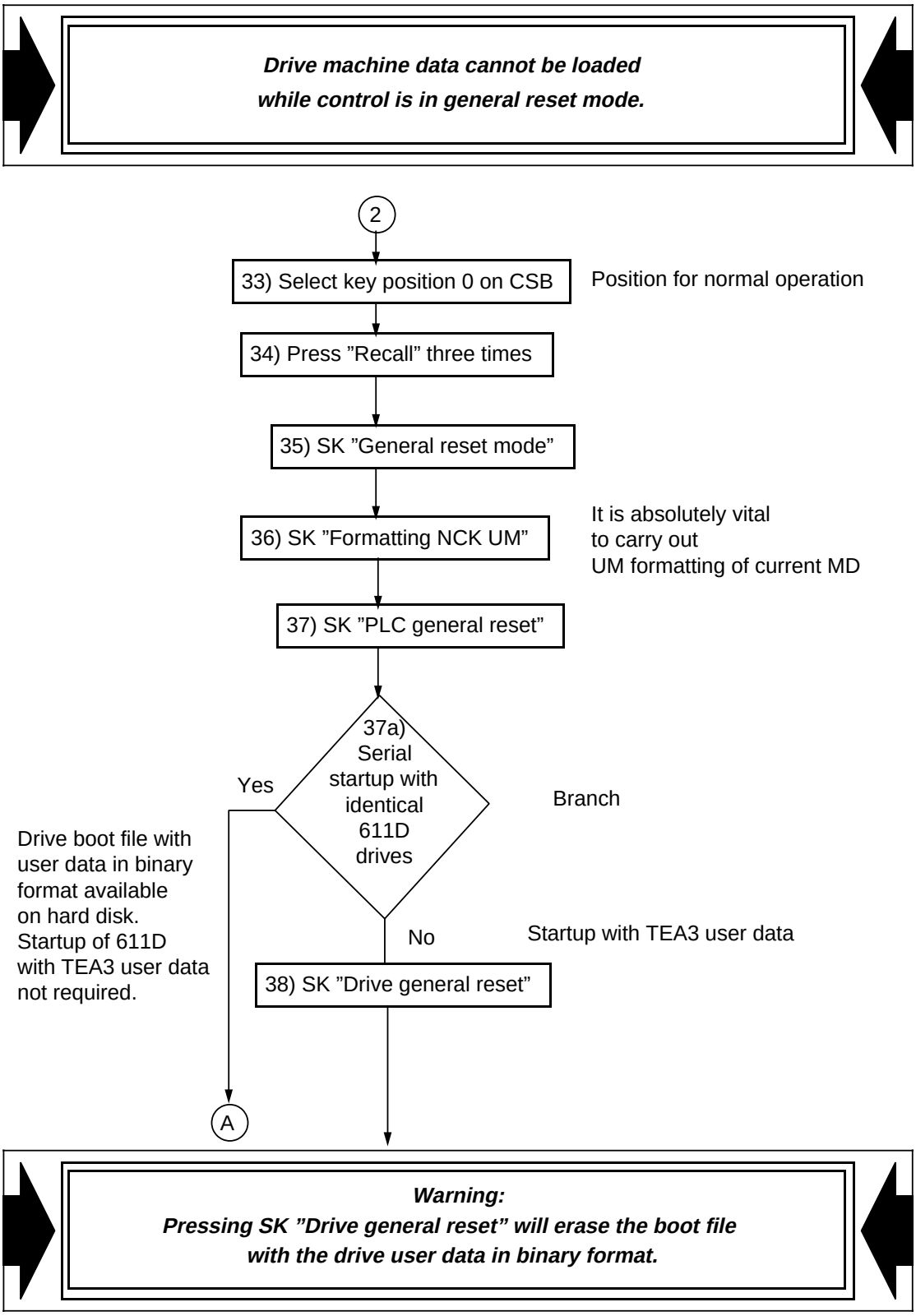

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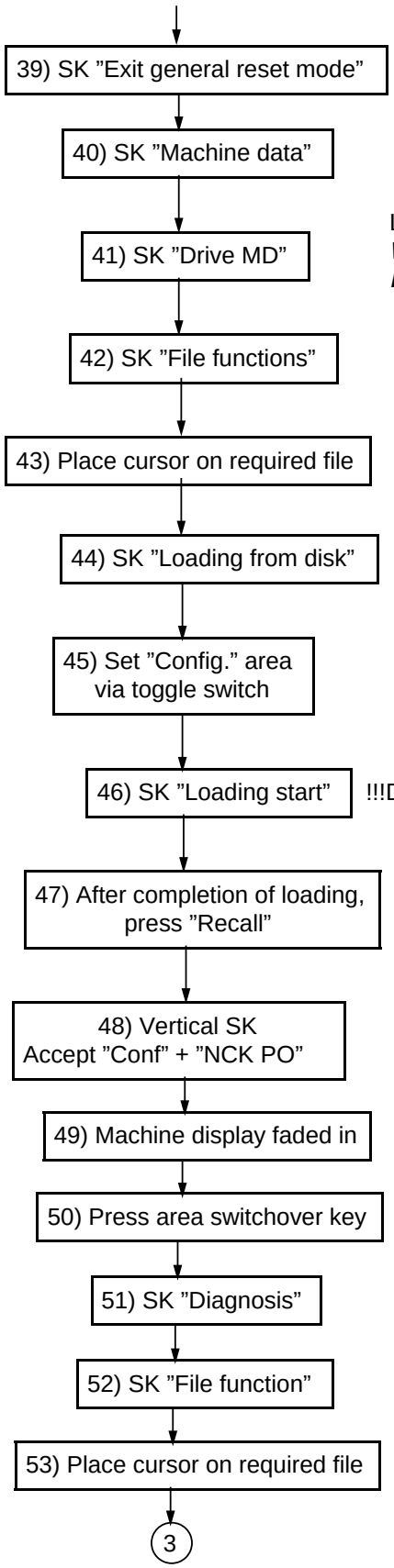

Loading drive user data TEA3
Warning:
Digital drives must be switched in!

!!!Data transfer from PC to NC in progress!!!

Boot file generated

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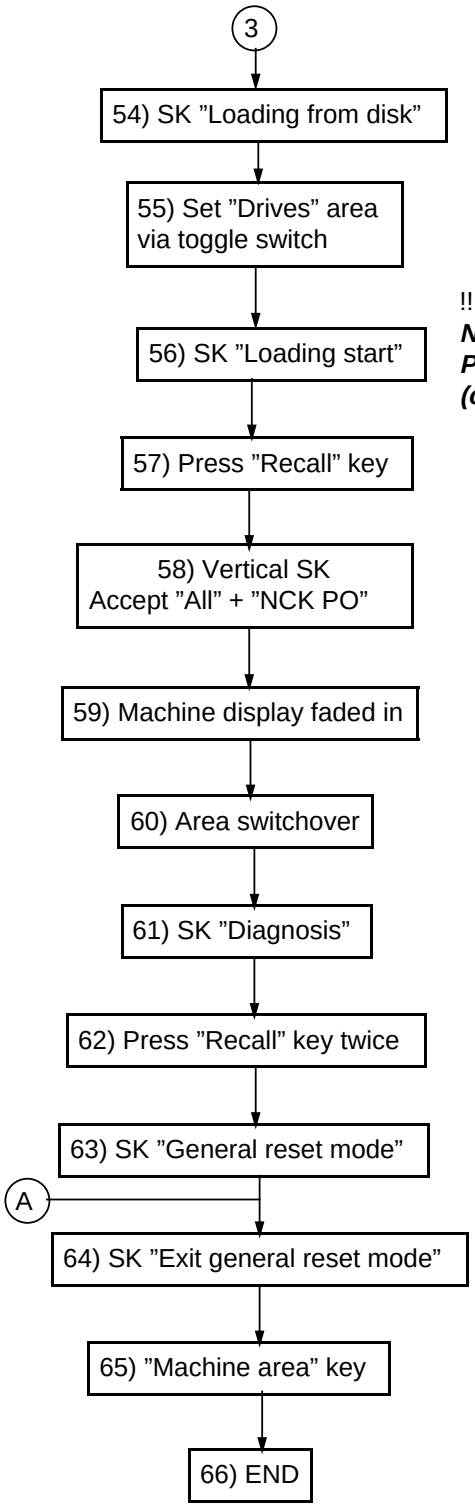

!!!Data transfer from PC to NC in progress!!!
Note:
PLC should be activated by this time (only green LED light on the PLC CPU)

Boot file generated
Warning:
If this SK is not pressed, all drive data will be lost after ”Power on”!

Note:
Missing data, e.g. TC, ZO, setting data must be reloaded later.

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11.1.8 CPU replacement

NCK CPU replacement

Follow installation and startup instructions according to flow diagram ”Loading from hard disk” (Section 11.1.7).

Note:

PLC data need not be loaded.

When replacing NCK CPU, items 8 to 14, 20 to 22 as well as 30, 31 and 37 to 63 do not apply.

After completion of the installation and startup procedure, switch to ”Power on”.

Note:

Setting data, zero offset and tool compensation are missing.

PLC CPU replacement

Follow installation and startup instructions according to flow diagram ”Loading from hard disk” (Section 11.1.7).

Prerequisite:

The current PLC fixed program is installed on the hard disk.

When replacing PLC CPU, items 8 to 10, 16 to 29 as well as 32, 36 and 37a to 63 do not apply.

Caution:

The contents of data blocks (e.g. tool management) are missing.

MMC CPU replacement

Follow installation and startup instructions according to flow diagram ”Loading using the streamer” (Section 11.1.5) or flow diagram ”Loading from hard disk”, steps 8 to 66.

Caution:

If MMC CPU requires replacement (e.g. because of a defective hard disk) ensure that no MMC software is installed on the new hard disk and that not the same software version as on the previous hard disk is installed.

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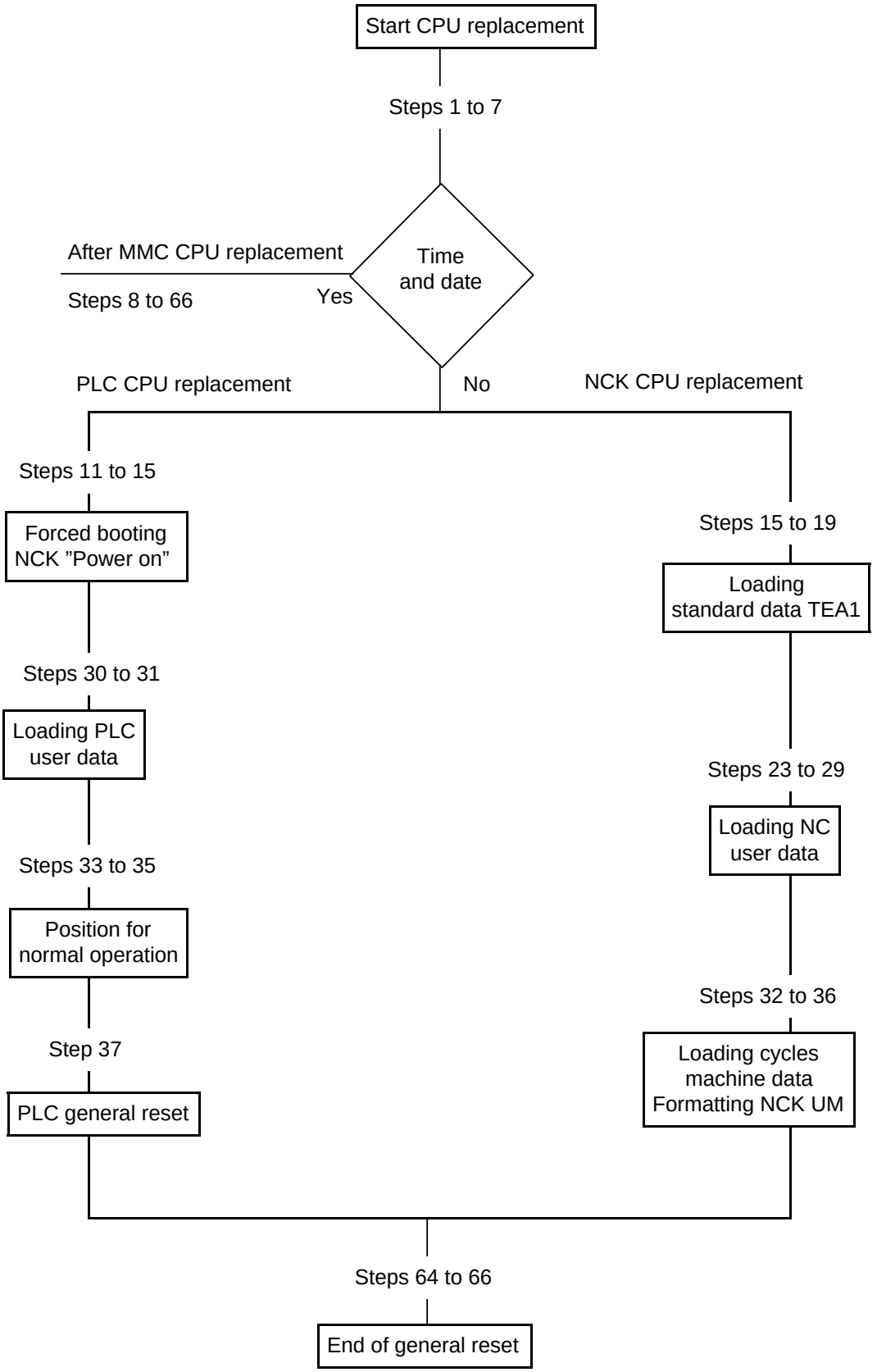

END OF SECTION

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12 Functional Descriptions

12.1 Leadscrew error compensation 6FC5 150-0AH01-0AA0

12.1.1 Corresponding data

- NC-MD 316* (Reference point pointer for + compensation)
- NC-MD 320* (Reference point pointer for - compensation)
- NC-MD 324* (Distance between 2 leadscrew error compensation points)
- NC-MD 328* (Compensation value)
- NC-MD 344* (Modulo value for rotary axis)
- NC-MD 6000 to 6249 (Leadscrew error compensation points)
- Option 6FC5 150-0AH01-0AA0

Note carefully:

Changes to NC MD data for leadscrew error compensation do not go into effect until after completion of POWER ON and reference point approach.

12.1.2 Functional description

The principle of "indirect measurement" in NC controlled machines assumes that the pitch of the leadscrew is constant at any point within the traversing range, thus allowing the actual axis position to be derived from the position of the drive spindle.

However, varying deviations result from manufacturing tolerances in the various spindle qualities. In addition, measuring system errors (although comparatively insignificant) and any other possible machine-dependent errors must also be taken into account.

The checksum error can be determined by plotting an error curve over the entire traversing range of the axis. The reference measuring system used must be a high-precision instrument, e.g. a laser interferometer. The dimensional deviation at the workpiece can be significantly reduced by means of compensating values which are input to the control at the time of installation.

The errors in each axis can be compensated separately. To this end, a total of 1000 compensation points (positions) are available for all axes. The compensation position spacing for each axis is selectable over a range of 1 to 32,000 units. It is possible to set a compensating value of 0 to 100 units which is identical for all positions on each axis.

Leadscrew error compensation can also be used with C axes. Yet another difference compared with earlier software versions concerns the "Direction-dependent leadscrew error compensation": No positioning error now occurs when switching from follow-up mode to position control mode, even if any changes of position during follow-up mode or a non position control mode occur.

Caution:

Changes to NC MD data for leadscrew error compensation do not take effect until POWER ON and reference point approach have been executed.

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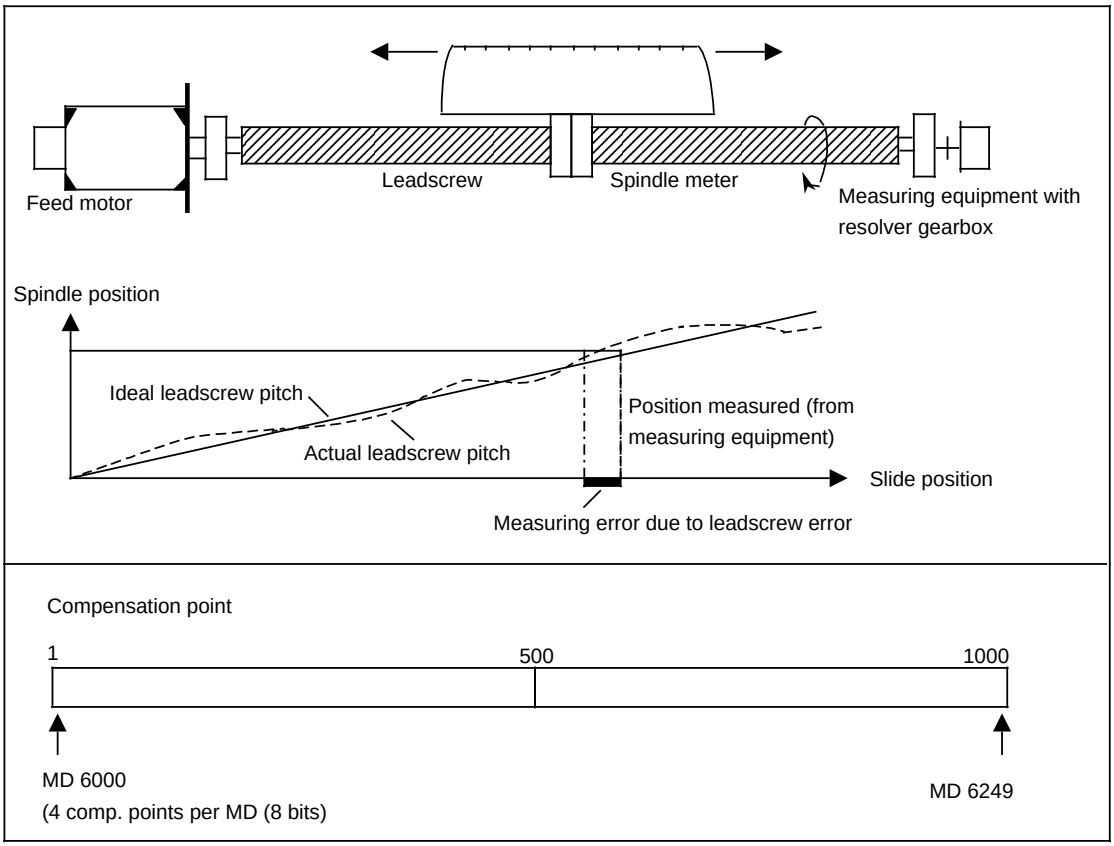
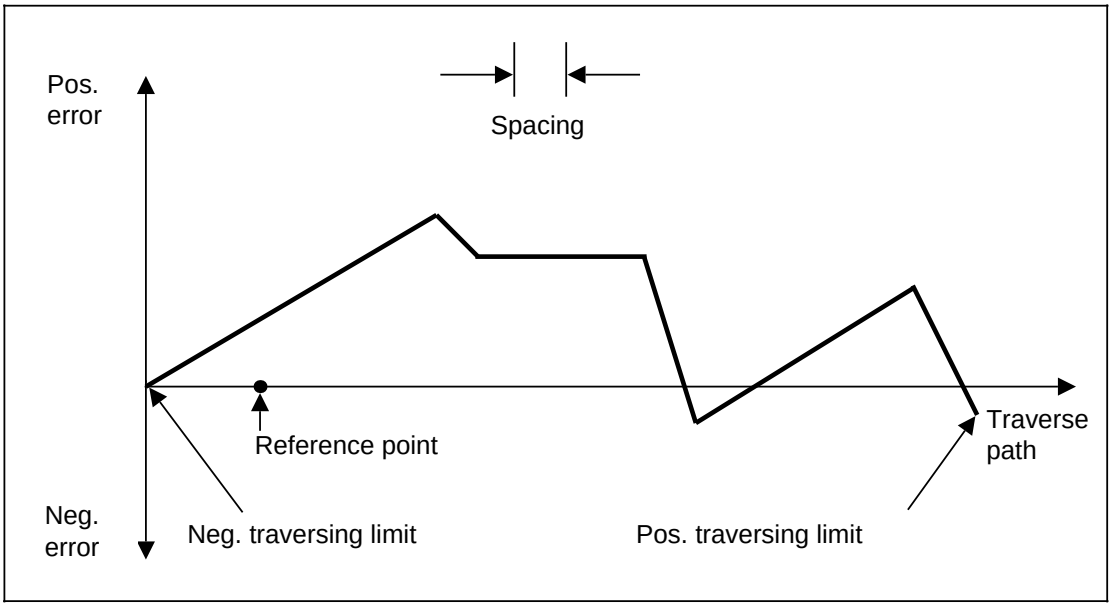


Measuring leadscrew error compensation

The reference point is first approached to synchronize the measuring system. This is then followed by travel to the negative range limit of the axis, commencing from this point to plot an error curve in the positive direction using an accurate instrument; the reference point must be identified.



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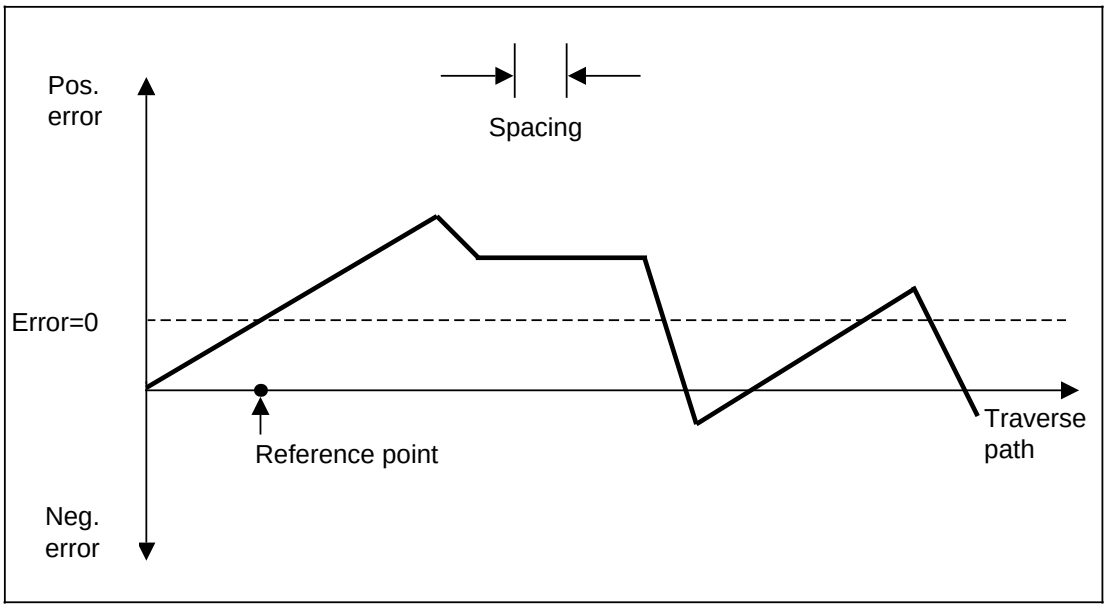
Because compensation is not possible at the reference point, the error curve must be shifted so that the error is zero at the reference point.



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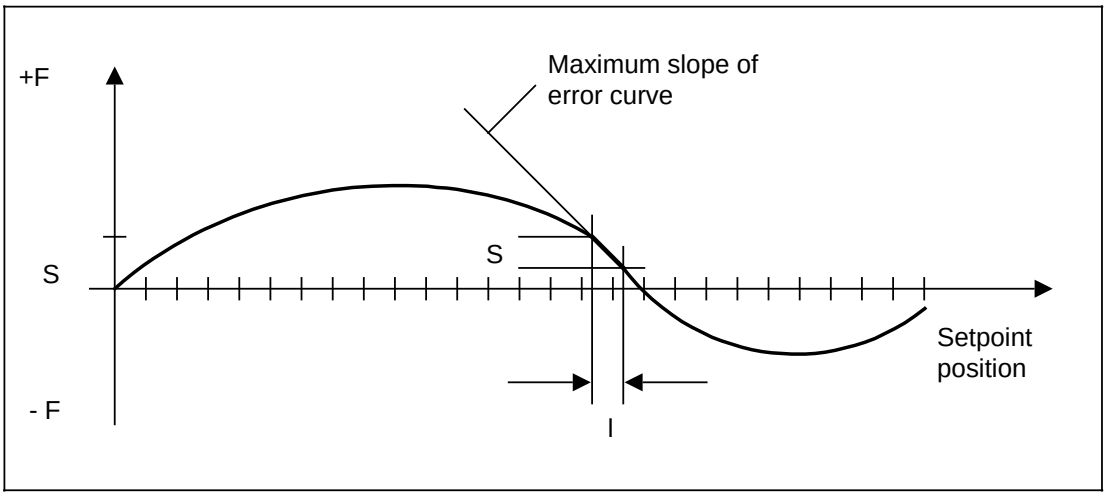
The spacing between 2 leadscrew error compensation points (MD 324*) is then specified, being based on the permissible tolerance of the final (compensated) leadscrew error curve, the actual leadscrew pitch error and the number of possible compensating values.

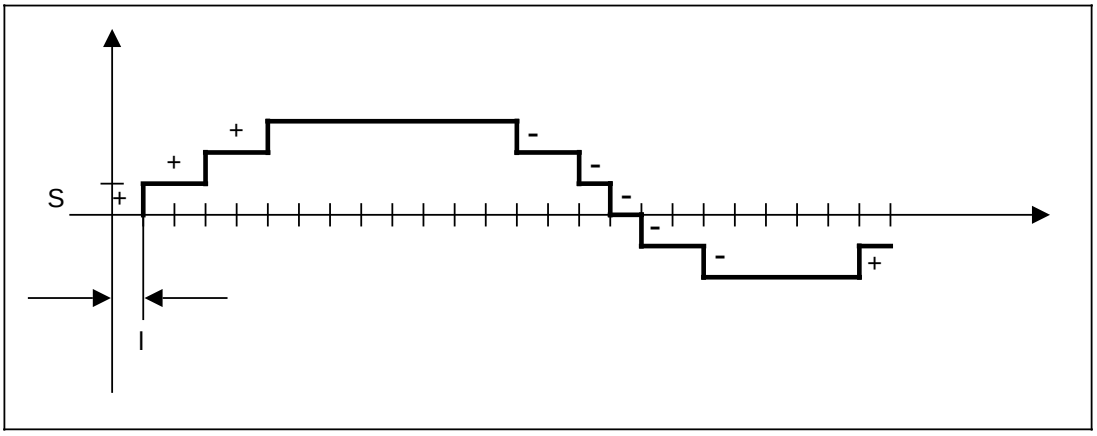
The following method for determining the spacing between 2 leadscrew error compensation points may be used:

S : Compensation amount, e.g. 1/2 tolerance band
l : Spacing between 2 leadscrew error compensation points



The point with the greatest pitch error is determined and the travel (l) in which the specified amount (S) is passed through is established.

S : Compensation amount = MD 328*
l : Spacing = MD 324*



The relevant compensating values for the spacing is based on the permissible tolerance band, and should be selected so that the compensated error curve approximates as closely as possible the ideal condition. The compensating value (0 to 100 units) is transferred to NC MD 328*.

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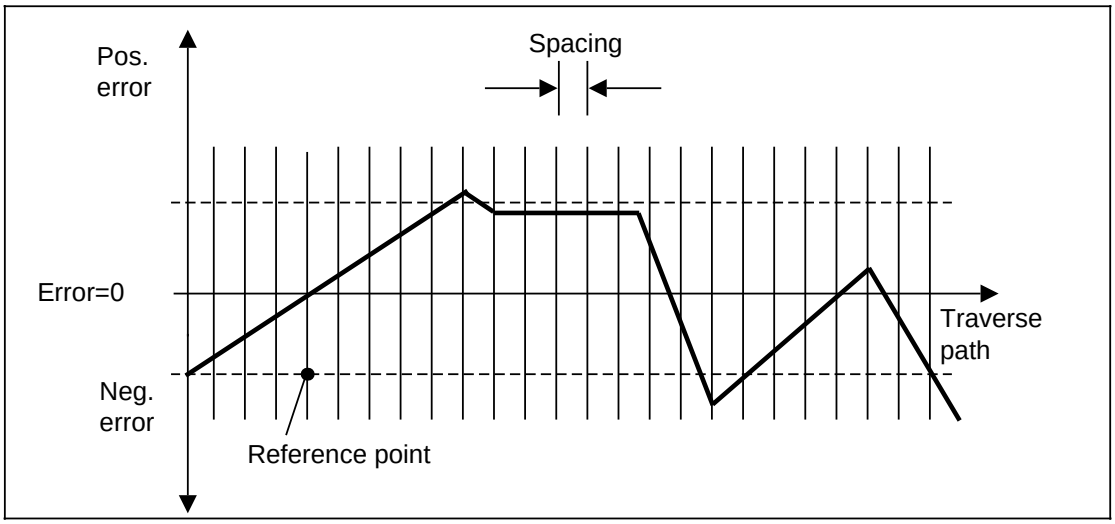
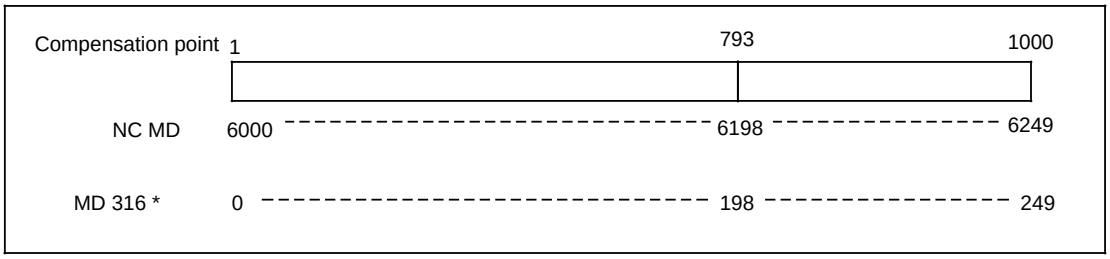


It is then specified how many compensating points must be supplied by means of the entered spacing between 2 leadscrew error compensation points and the end stops at the machine. Since leadscrew error compensation is only active when the axis is synchronized - at the reference point - particular significance is attached to the compensation point coinciding with the reference point. This compensation point is entered in encoded form in MD 316*. The compensating value at this point must be 0.



In view of the fact that the SINUMERIK 840C has a total of 1000 compensation points for all axes, the control must be informed via MD 316* as to which of these 1000 points corresponds to the axis reference point. The compensation point is not entered directly in MD 316*, the MD offset (MD 6125 = MD offset = 125) being entered instead, so the reference point can only be located on compensation points 1, 5, 9, 13, 17, ...

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MD No.	Bit No. 7	6	5	4	3	2	1	0
6000	Comp. point 4 Yes/No +/-		Comp. point 3 Yes/No +/-		Comp. point 2 Yes/No +/-		Comp. point 1 Yes/No +/-	
6001	Comp. point 8 Yes/No +/-		Comp. point 7 Yes/No +/-		Comp. point 6 Yes/No +/-		Comp. point 5 Yes/No +/-	
6002	Comp. point 12 Yes/No +/-		Comp. point 11 Yes/No +/-		Comp. point 10 Yes/No +/-		Comp. point 9 Yes/No +/-	
6248	Comp. point 996 Yes/No +/-		Comp. point 995 Yes/No +/-		Comp. point 994 Yes/No +/-		Comp. point 993 Yes/No +/-	
6249	Comp. point 1000 Yes/No +/-		Comp. point 999 Yes/No +/-		Comp. point 998 Yes/No +/-		Comp. point 997 Yes/No +/-	

- = 0
\+ = 1
No = 0
Yes = 1

Since 4 compensation points are available for each machine data, it is specified in the control that only the point on the far righthand side (bits 0, 1) can be defined as the reference point.

Example

- Reference point is to lie on compensation point 793

$$\text{MD offset} = \frac{793 - 1}{4} = 198$$

- MD offset 198 = MD 6198

Value in MD 316* ... 198

As stated above, the reference point determines the compensation point at which leadscrew error compensation is activated following reference point approach. No compensation is allowed at this compensation point!

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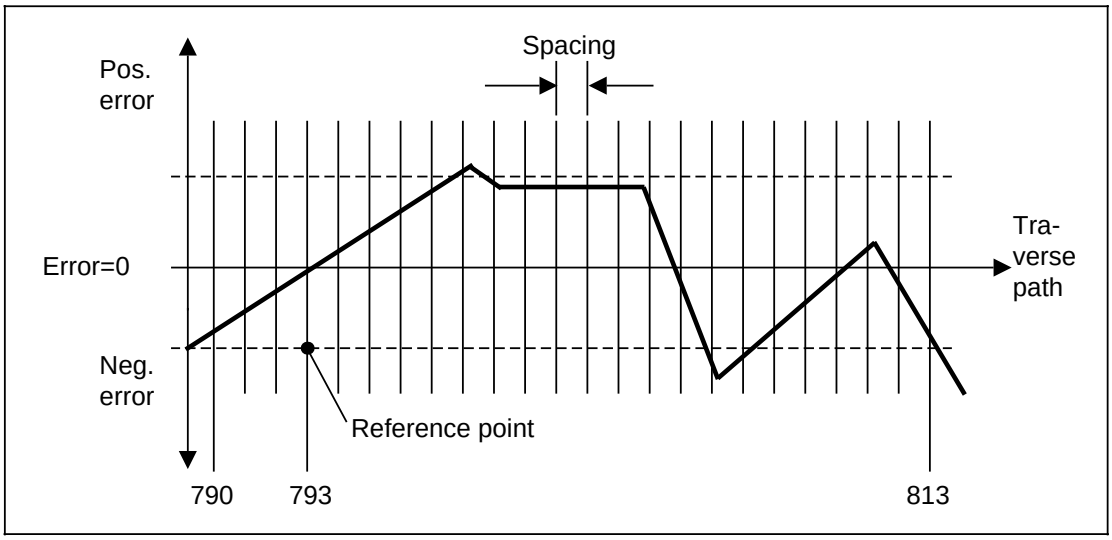

Example

Axis 1 shows the error curve; no compensation points have been used as yet.

Reference point value is 0

Max. - travel: - 35.000 mm
Max. + travel: + 205.00 mm

Tolerance band (prescribed by machine manufacturer), e.g. 0.01 mm
Spacing between two leadscrew error compensation points, e.g. 10 mm :

235 mm traverse path/max

A- **3 compensation values**
10 mm grid spacing

205 mm traverse path/max+

A+ **20 compensation values**
10 mm grid spacing

Total number of compensation values:

K =(A-) +(A+) + (Ref) = 3 + 20 + 1 **24 compensation values**

The result is NC MD 3161 = 1 (NC MD 6001), i.e. compensation point K5 is the point that corresponds to the reference point; compensation at this point is not allowed. Compensation point K4 is used when travel goes 10 mm in a negative direction, and K6 when travel goes 10 mm in a positive direction.

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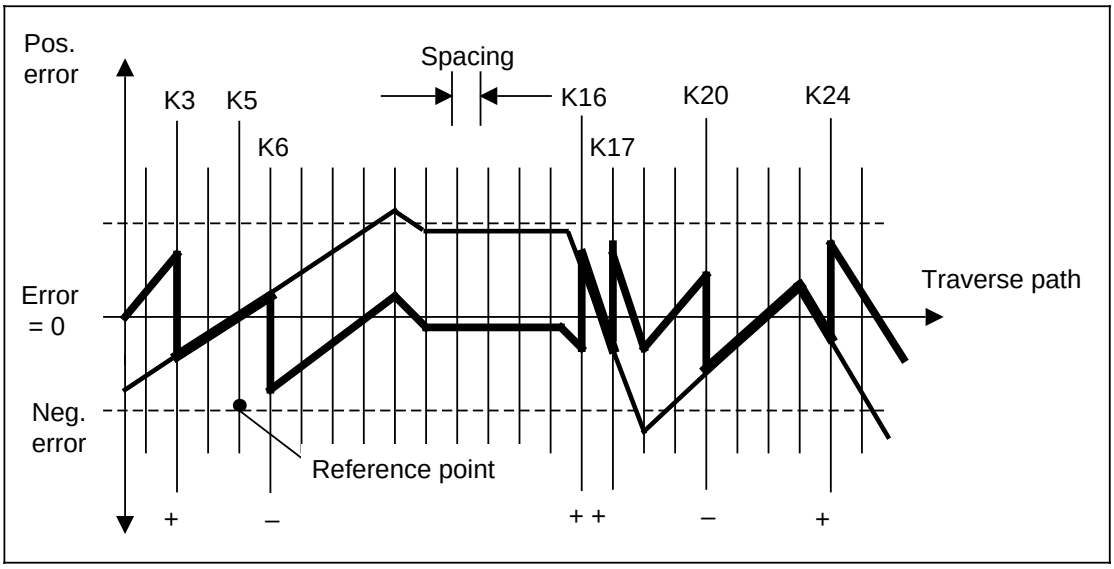

-------- Tolerance band e.g. 10 µm

Compensated curve
Compensation value e.g. 5 µm

Commencing at the reference point and proceeding in a negative direction, the error curve runs to the end of the traverse path within the tolerance band. No compensation is necessary. A better result is obtained through positive compensation at K3. To stick as closely as possible to 0 error, compensation in a positive direction of travel must be negative at K6, positive at K16 and K17, negative at K20, and positive again at K24.

The following machine data must be set:

- Option leadscrew errror compensation
- NC MD 3161 = 1 (to define K5 as reference point)
- NC MD 3241 = 10000 (10 mm spacing)
- NC MD 3281 = 5 (compensation value 5 µm for position control resolution of 1/2 x 10^{-3} mm)
- NC MD 6000 = 00 11 00 00 (positive compensation at K3)
- NC MD 6001 = 00 00 10 00 (negative compensation at K6; bits 0 and 1 must be 0)
- NC MD 6002 = 0 no compensation
- NC MD 6003 = 0 no compensation
- NC MD 6004 = 00 00 11 11 (positive compensation at K16 and K17)
- NC MD 6005 = 00 00 10 00 (negative compensation at K20)
- NC MD 6006 = 00 00 11 00 (positive compensation at K24)

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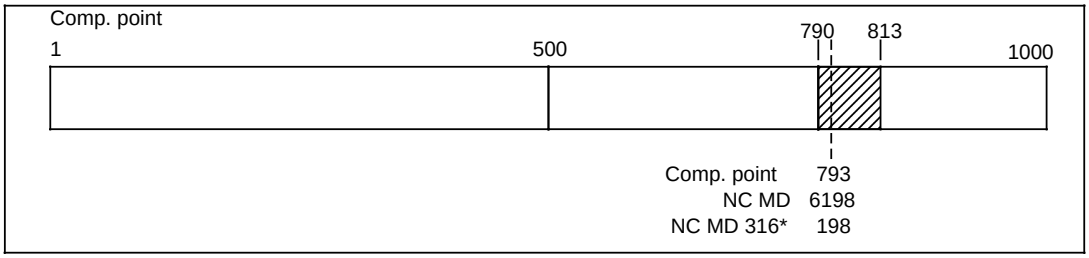
If the reference point is assigned to compensation point 793, breakdown of the 1000 compensation points is as follows:



The reference point determines the location of the hatched area of the compensation points used. This area terminates at point 790 or 813 due to the spacing between the leadscrew error compensation points and the maximum traversing range of the axis.

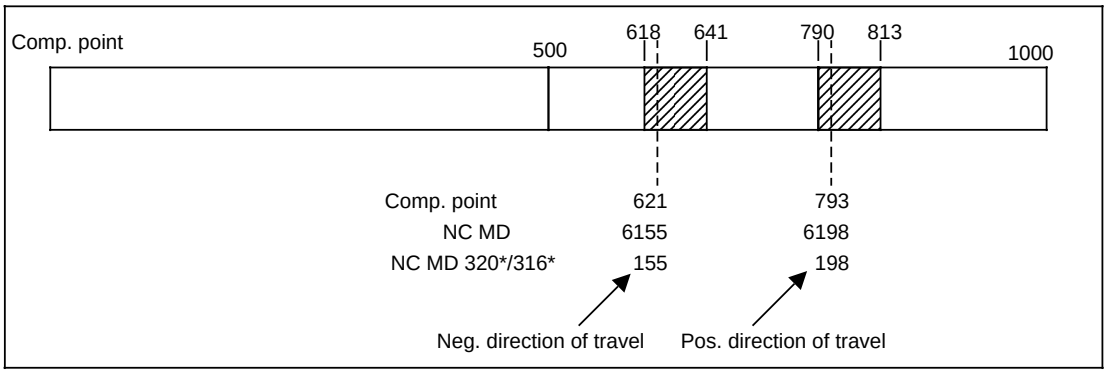
If leadscrew error compensation is used for a number of axes, the commissioning engineer must ensure when entering the MD that the compensation points do not overlap, as no check is carried out in the control. However, the gaps between the axes may be of any size, provided the total range of 1000 compensation points is not exceeded.

In direction-dependent leadscrew error compensation, there is a second compensation curve plotted from the positive to the negative direction.

In the case of ball screws, pre-stressing of the screw nut yields an identical error curve, irrespective of the plot direction during measurement. When worm drives are involved, however, significant differences may arise between the positive and negative directions of travel. Consequently, an error curve must also be plotted in the negative direction and input as compensation value.

The procedure is similar to that for entering the positive compensating values, ensuring that the compensation ranges do not overlap between the positive and negative traversing movements and between the axes. Since the reference point again determines with this compensation curve where the compensation points lie within the 1000 points, the reference point must be entered in NC MD 320* in encoded form (MD offset).

Example



Both direction-dependent and direction-independent leadscrew error compensation are options, and must therefore be ordered. MD modifications do not go into force until after POWER ON and reference point approach. Because the compensating value at the compensation point must be processed as quickly as possible, the specified acceleration value (NC MD 276*) is not applicable in this case.

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12.2 Rotary axis function

12.2.1 Corresponding data

Same data as for linear axes, plus the following additional or supplementary data:

- NC MD 344* (Rotary axis modulo value for leadscrew error compensation)
- NC MD 5052* bit 0 (No automatic generation of G68)
- NC MD 560* bit 7 (Actual-value display modulo 360°)
- ND MD 560* bit 3 (Rounding for rotary axes)
- NC MD 560* bit 2 (Rounding to whole/half degree)
- NC MD 564* bit 5 (Position control for rotary axis)
- NC MD 572* bit (Programming of rotary axis modulo 360°)
- NC MD 5002 (Input resolution)
- NC MD 1800* (Display resolution)
- NC MD 1800* (Position control resolution)
- Alarm 100* (Invalid grid spacing for leadscrew error compensation)
- Alarm 2064 (Rotary axis programming error)

12.2.2 Functional description

Different demands are made on a rotary axis, depending on the type of machine involved. The rotary axis function is therefore subdivided into three subfunctions. These subfunctions are activated either over the machine data or the program.

The control can be adapted to the various machine types by combining subfunctions.

"Rotary axis": NC MD 564* Bit 5

NC MD 564*, bit 5, declares the axis to be a rotary axis. The display is absolute (1 rev. 360°, 2 revs 720°, etc.), as are the @ functions. However, the axis is programmed as though it were a linear axis. The units of the axis-specific NC MD are treated differently.

Unit 10^{-3} degrees for position control resolution 1/2 x 10^{-3} units and input resolution 10^{-3} units.

Deactivation of automatic G68: NC MD 5052 Bit 0

G68 is generated by the NC automatically the first time rotary axes with modulo calculation are programmed in a part program or the first time they are programmed after a block search, i.e. the programmed position is approached along the shortest path.

This action is not always desirable. For this reason a new machine data bit has been introduced for deactivating this function the first time the axis is programmed. The user can now define how the control is to behave the first time the axis is programmed with G68, G90 or G91. Automatic generation of G68 cannot be deactivated as here the user cannot influence the program with programming commands.

Actual-value display "modulo 360°": NC MD 560* Bit 7

When this bit is set, the display is modulo, i.e. it is reset to 0 after 359.999 degrees. The axis is programmed like a linear axis.

"Modulo programming": NC MD 572* Bit 2

Programming of the rotary axis may be absolute (G90) up to max. 360 degrees. The programmed sign defines the direction of travel. Following a program start after a block search

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with calculation, and with G68, the programmed position is always approached over the shortest path.

G68 is modal and belongs to the G90/91 group. If "modulo programming" is not activated, G68 is treated like G90.

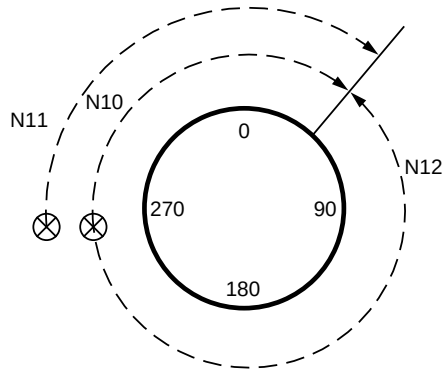
If the rotary axis is not to traverse over the shortest path, it must be programmed with G90 and a sign.

Example: Axis is at 270 degrees

N10 G68 C10

N11 G90 C10

N12 G90 C-10



The machine data "Modulo 360°" and "Modulo programming" are permissible only in conjunction with machine data "Rotary axis".

Subfunction combinations

Rotary axis	Modulo prog.	Modulo 360°	Comments
564* Bit5	572* Bit 2	560* Bit 7	MD
0	0	0	Linear axis
1 1 1	0 0 1	0 1 1	Use permitted
1 0 0 0	1 0 1 1	0 1 1 0	Use illegal

Axis-specific machine data

If an axis is defined as rotary axis (NC MD 564, bit 5), the following applies in dependence on NC MD (input resolution and position control resolution):

a) 1 unit = 2 units of position control resolution (reference system MS)
e.g. 1 unit of position control resolution = 0.5 x 10^{-3} degrees
(NC MD 1800* = xxxxx 0101)
1 unit = 10^{-3} degrees

b) 1 unit = 1 unit of input resolution (reference system IS)
e.g. 1 unit of input resolution = 10^{-3} degrees (NC MD 5002 = x0100 xxxx)
1 unit = 10^{-3} degrees

All axis-specific machine data is specified in degrees for a rotary axis, e.g. max. speed of a rotary axis = 15 revs**/**min

15 revs**/**min x 360 degrees**/**rev = 5400 degrees**/**min
Entry in NC MD 280* = 5400 (1000 degrees**/**min)
For combinations of the various types of resolution and max. values, refer to the Section on axis installation**/**start-up.

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12.3 Endlessly rotating axis (SW 4 and higher)

12.3.1 Corresponding data

- NC MD 330 (dead time compensation for dwell)
- NC MD 5024 Bit 1 (G200 after G [..] 105, G [..] 119)
- NC MD 5025 Bit 1 (axis-specific G functions to PLC)
- NC MD 5025 Bit 6 (activation of endlessly rotating axis)
- NC MD 521* Bit 2 (power-up as C axis)
- NC MD 584* Bit 0 (initial position of simultaneous axis)
- NC MD 1152* (speed tolerance of an endlessly rotating axis)

- Alarm 1300* (programmed axis is not a rotary axis)
- Alarm 1304* (axis rotates endlessly)
- Alarm 1308* (simultaneous axis incorrectly programmed)
- Alarm 1312* (simultaneous axis incorrectly programmed)

General

With SW 4 and higher, a rotary axis can also be operated as an endlessly rotating axis (ERA) [1].

The scope of functions of the existing rotary axis remains unchanged.

The "Endlessly rotating axis" functionality corresponds to that of a simultaneous axis. The ERA is not restricted by block limits, in other words, it continues to rotate in the desired direction at the desired speed provided no stop criterion is fulfilled (shutdown, axis reset, error).

Furthermore, shutdown can be effected with a specified position.

The **characteristics** of the **"Endlessly rotating axis"** are as follows:

- Axis is generally in position control mode
- Speed setpoint resolution corresponds to set position control resolution
- Feedrate input in input system * 10
  Example: If the input system is set to 10^{-4} by means of machine data, then the smallest programmable feedrate unit with G94 is active is calculated as follows:
  10^{-4} mm * 10 rev**/**min = 10^{-3} mm**/**min.

The "Endlessly rotating axis" function is programmed by means of **new axis-specific G commands**.

It can be controlled **from several channels independently of the selected operating mode**.

- The feedrate of the endlessly rotating axis is weighted with the axis-specific override.

1) ERA is the abbreviation for endlessly rotating axis.

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12.3.2 Display of endlessly rotating axis

The actual value display is the same as that for a rotary axis, i.e. it is dependent on existent machine data, either absolute or modulo.

The axis-specific G commands can be displayed in all operating modes. A new softkey "Axis-specific G functions" is provided for this purpose. When this function is selected, the axis-specific functions are superimposed on the program pointer. The pointer is displayed again when RECALL is selected.

12.3.3 Reaction of endlessly rotating function to NC-STOP and NC-RESET

An "endlessly rotating axis" cannot be stopped by means of NC-STOP. To stop an axis operating in this mode, the appropriate axis must be halted with the axis-specific feedrate stop command (which is not in this case displayed) when NC-STOP is initiated. The motion of an "endlessly rotating axis" cannot be stopped by means of a reset operation (key reset, mode group changeover and M02**/**M30) either.

Endlessly rotating operation can be interrupted with the new axis-specific signal "Axis reset" (in DB 32).

The "Endlessly rotating axis" function operates on a multi-channel basis, i.e. requests may come from several channels which means that it is not possible to automatically derive a stop or reset command for the appropriate rotary axis from an NC-STOP or RESET command in one channel.

Note:

In contrast to a leading spindle, the leading axis in a channel is not defined; this means that, unlike spindles, axes are not clearly assigned to any particular channel.

Through appropriate parameter settings in the PLC user program, the motion of the endlessly rotating axis can be linked to other axes/spindles, to a channel or to a mode group and can then be controlled as a function of the process. For this reason, no fixed settings are made by means of machine data.

EMERGENCY STOP (alarm 2000) as well as all alarms which effect cancellation of the interface signal "Mode group ready" always lead to shutdown of the "endlessly rotating axis" (specific to mode group).

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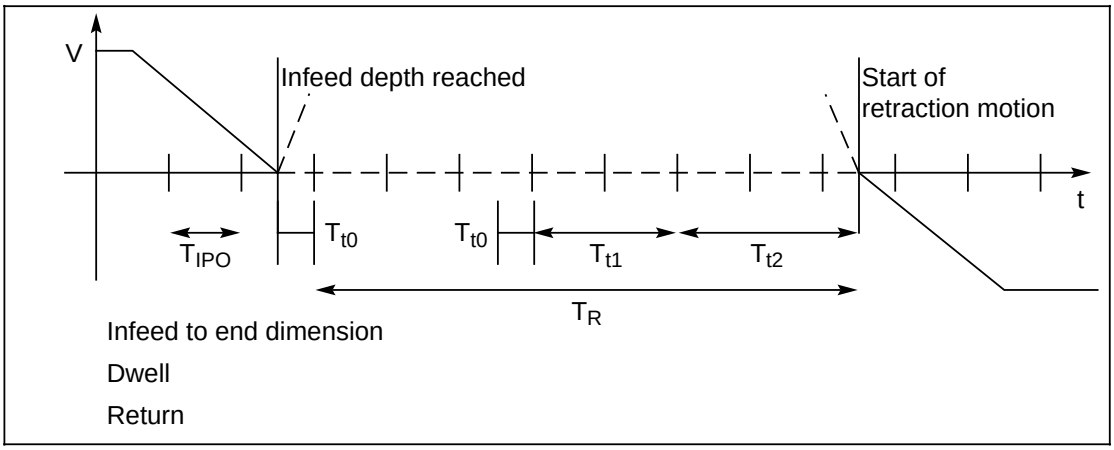
12.4 Dwell in relation to axes or spindles

With certain technological processes (e.g. gear shaping/hobbing, etc.), a defined path (circular movement or relief cut) must be traversed when the final infeed is reached. The infeed axis must be retracted on completion of this programmed path. This function must operate with the greatest possible accuracy.

12.4.1 Dead time compensation, NC MD 330



V/t chart for infeed axis

Legend:

T_{IPO}: IPO sampling time

T_{t0}: 0 t_{t_0} 2 IPO

Since "Exact stop reached" and "Dwell path limit evaluated/detected" are detected in the IPO cycle, the maximum possible "inaccuracy" will in this case be two IPO cycles.

$T_{t1} + T_{t2}$: (4.5 IPO cycles) 840 C operating times (fixed time)

T_R: Total time calculated from the programmed dwell path, the present actual velocity and the dead time to be compensated in the machine data.

The purpose of the dead time compensation is to ensure that the programmed dwell path is applied as accurately as possible in spite of existing internal system operating times. The deadtime to be calculated can be entered via a general machine data, NC MD 330. This MD value is calculated in relation to the actual velocity when the end of the dwell path is reached. An input of 5.5 IPO cycles (default setting: Refer to legend for velocity curve) is recommended to the 840C system.

Note:

Deadtime T_{to} cannot be compensated.

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12.4.2 Extension of dwell (SW 5 and higher)

12.4.2.1 Corresponding data

- NC MD 330 (Deadtime compensation for dwell with reference to the axis actual value)
- NC MD 332 (Deadtime compensation for dwell with reference to the axis setpoint)
- NC MD 333 (Deadtime compensation for dwell with reference to the spindle actual value)
- NC MD 334 (Deadtime compensation for dwell with reference to the spindle setpoint)

Following functions are implemented:

- Dwell at setpoint (G14)
- Dwell at any spindles (S1 to S6, at G14 and G24).
- Position-related dwell (G90) with overtravel direction (with G14 and G24 with axes**/**spindles).

The different "dwell types" cause different deadtimes. For this reason, there are new machine data for deadtime compensation (see above):

For description see Section 12.4.1 above.

Note:

During dwell in absolute positions (G90) the speed of the axis**/**spindle must not be larger than D_{max} so that overtravel beyond the dwell position is reliably detected. If the speed is greater**/**lower than D_{max} the dwell is terminated on the next IPO cycle.

$$D_{max}[rpm] < 30000 \,/\, (Tab[ms] * (1+K_{dead}[\%] \,/\, 100)))$$

Where:

Tab = IPO scan time in ms
K_{dead} = Deadtime compensation value in %

Example of standard machine data:

Tab = 16 ms, K_{dead} = 450%:
D_{max} < 30000 **/** (16 + (1+4,5)) rpm = 340 rpm

Note:

- The standard value for NC MD 330 has changed from 550 to 450 since SW 4.
- No zero offsets or tool offsets are included for the axes.

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12.5 Warm restart

12.5.1 Corresponding data

- NC MD 360* (Axis valid in BAG)
- NC MD 316* (Pointer for leadscrew error comp.)
- NC MD 320* (Pointer for leadscrew error comp.)
- NC MD 453* (Spindle valid in BAG)
- NC MD 876 to 899 (Coupled axis groupings)
- NC MD 5156 to 5183 (Coupled motion combinations)
- NC MD 5060 to 5139 (Transformation data blocks)
- Signal DB 48 DL 0 bit 0 (Initiate warm restart)
- Signal DB 48 DR 1 bit 0 (Terminate warm restart)
- Alarm nos. 70 to 80

12.5.2 Functional description

On some machines, it is necessary to assign arbitrary axes to a different mode group without having to shut down the control, which would result in loss of the reference point.

Example

A machine has two working areas:
Area I with axis B'
Area II with axes B1'.

To ensure effectivity, the working areas are subdivided into different mode groups.

The three main axes (X, Y and Z) are assigned separately to working area I (mode group 1) or working area II (mode group 2) over a warm restart. This necessitates use of a separate machine control panel for each working area; main axes X, Y and Z are allocated to each control panel.

The machine data can also be modified with @ functions by invoking a PLC cycle in a free channel. A warm restart is required to modify the machine data listed in 12.3.1.

When working area I is in use, the three main axes (X, Y and Z), axis B', and the spindle are allocated to machine control panel 1 and mode group 1.

Axes B1' can be traversed in JOG mode in working area II to load and unload a workpiece.

If the working areas are to be reversed, i.e. if working area II is to be used to machine a workpiece and working area I for loading and unloading, the axis assignments must be changed, i.e. there must be a switch to another mode group. When this switch takes place, the axes are reassigned to the machine control panels.

An auxiliary function is assigned to each working area to help switch mode groups. The relevant auxiliary function provides the information which the PLC needs to reassign the axes and to make any necessary changes in the machine data. Once the machine data has been modified, a warm restart (DB48, DL0, bit 0) must be initiated over the PLC interface. The "warm restart" function reconfigures the control without necessitating subsequent reapproaching of the reference points.

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No warm restart is required following modification of the following MD:

- 104* TO area number (modification goes into force at once)
- 304* IPO parameter name (modification accepted after each NC block)
- 548* Name of horizontal axis (")
- 550* Name of perpendicular axis (")
- 552* Name of vertical axis (")
- 554* Axis with constant cutting speed (")
- 576* Axis not permitted in channel (")

A warm restart is possible only when all channels are in the RESET state, i.e. the PLC must bring all channels to the RESET state, coupled motion and transformation must be deselected, and all spindles must be brought to a standstill (when M19 is active) before the warm restart is initiated.

The RESET state must be maintained in all NC channels while a warm restart is in progress.

The number of axes cannot be altered while the warm restart function is being executed. This is only possible with POWER ON RESET.

During a warm restart, the axial, spindle-specific interface and the EMERGENCY STOP signal on the NC PLC and PLC NC interfaces are not processed (control is in RESET state).

Functional sequence of a warm restart

1. NC
   - Data are written to NC MD 360* with the aid of CL 800 commands (can also be implemented via PLC).
   - Auxiliary function for warm restart request is output, e.g. H1234.
2. PLC
   - Auxiliary function is interpreted
   - The PLC writes to NC MD 360* (also possible over (NC)
   - Reset over PLC for all channels
3. NC
   - All part programs are aborted (channels 1 to 16)
4. PLC
   - User sets interface: "Warm restart" 1 (DB 48 DL0 bit 0)
5. NC
   - Sets interface signal "Warm restart terminated" 1 (DB 48 DR2 bit 0)
6. PLC
   - User resets interface: "Warm restart" 0
7. NC
   - Resets interface "Warm restart terminated" 0
8. The warm restart has been completed and program execution may be resumed.

Errors

If incorrect machine data are encountered during a warm restart, the NC issues alarms 70 to 80. The acknowledgement signal "Warm restart terminated" is set. Once the machine data that caused the error have been corrected, the alarm can be reset only by switching the control off and then on again (POWER ON).

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12.6 Coordinate transformation 6FC5 150-0AD04-0AA0

Coordinate transformation TRANSMIT (implemented from software version 1 onwards) is used for face milling of turned parts (lathes). In order to implement this, a C axis and a powered milling cutter are required in addition to the X and Z axes.

2D/3D coordinate transformation (implemented from software version 2) is required when surfaces are configured on a plane (2D coordinate transformation) or in space (3D coordinate transformation) in such a way that they can only be machined by the (real) axes by including rotations (the tool being positioned as normal on the plane to be machined).

12.6.1 Corresponding data

- NC MD 730 1st transformation, parameter 1
  NC MD 731 1st transformation, parameter 2
  NC MD 732 1st transformation, parameter 3
  NC MD 733 1st transformation, parameter 4
  NC MD 734 1st transformation, parameter 5
  NC MD 735 1st transformation, parameter 6
  NC MD 736 1st transformation, parameter 7
  NC MD 737 1st transformation, parameter 8
  NC MD 738 1st transformation, parameter 9
  NC MD 739 1st transformation, parameter 10
- NC MD 740 to 809 2nd to 8th transformation, parameter 1 to 10
- NC MD 5060 Channel numbers of the transformation
  NC MD 5061 G function for transformation selection
  NC MD 5062 Axis name 1st fictitious axis
  NC MD 5063 Axis name 2nd fictitious axis
  NC MD 5064 Axis name 3rd fictitious axis
  NC MD 5065 Axis name 1st real axis
  NC MD 5066 Axis name 2nd real axis
  NC MD 5067 Axis name 3rd real axis
  NC MD 5068 Axis name 4th real axis
  NC MD 5069 Axis name 5th real axis
  NC MD 5070 to 5139 1st to 8th transformation data set
- NC MD 5025 bit 3 Travel through transformation centre (SW 5 and higher)
- NC MD 540* bit 7 Transformation cancellation
- NC MD 564* bit 6 Fictitious axis
- OPTION transformation TRANSMIT/2D/3D coordinate transformation
- SIGNAL DB10-DB13 DR13 BIT 7 TRANSFORMATION ACTIVE
- Alarm 2043 Programming error during transformation
- Alarm 2189 Transformation undefined
- Alarm 2190 Transformation axes assigned
- Alarm 3086 Illegal transformation selection
- Alarm 3087 Error in transformation data

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12.6.2 Functional description

Whereas machine movements are executed in the real machine coordinate system, programming is carried out in the ficticious (Cartesian) coordinate system. Fictitious axes must be defined especially for the fictitious coordinate system. A fictitious axis can only be traversed when transformation is selected. Fictitious axes can be selected freely with respect to their axis name and their location. Up to eight transformations with varying axis groupings can be defined in any one control. The definition consists of a transformation data set and the associated parameters for each transformation.

The selection of the coordinate transformation is realized via G functions in the part program or via the command channel from the PLC.

The following G functions are defined:

G131, G231, G331 coordinate transformation TRANSMIT
G133, G233, G333 2D coordinate transformation
G135, G235, G335 3D coordinate transformation

Coordinate transformation can be cancelled via G130, G230 or G330 in part program, or via the command channel from the PLC.

It can be specified via NC MD 540* bit 7 whether cancellation occurs automatically on RESET of after a change in the operating mode.

See Section "Coordinate transformation" for applications of the coordination transformation TRANSMIT.

2D coordinate transformation - see Section "Coordinate transformation".

3D coordinate transformation - see Section "Coordinate transformation".

and in the Programming Guide to System 840C.

Note:

- When TRANSMIT is implemented, the programmed path velocity is reduced to a level where the maximum speed of rotation of the rotary axis is not exceeded. This applies especially to movements near the turning centre.

  The speed is also reduced in rapid traverse if the rotary axis is not involved in the movement.
- In the case of JOG mode, the feedrate reduction will only have a partial effect as the end point of the movement is not known. This can lead to drops in the feedrate.
- The use of angle head cutters is restricted in TRANSMIT mode, block search with calculation triggers an alarm.

Notes on TRANSMIT for SW 5 and higher

- Machining contours near the turning centre:

  The new function calculates the permissible feedrate in the fictitious coordinate system as a function of the current distance of the contour from the centre of turning and the MD "Maximum velocity rotary axis" such that the path feed changes continuously.

  In this way, the feedrate on the contour is always the maximum possible feedrate. At very low feedrates, larger velocity fluctuations of the rotary axis can occur because of the limited calculation precision.

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For this reason, there is a transformation-specific value "Minimum velocity for Transmit" MD 738, 748, ... The value is entered in units [IS] **/** IPO cycle. Tests have shown the value 10 to be a useful default value.

Because the feedrate is not reduced further after a certain distance between the contour and the centre of turning, the maximum velocity of the rotary axis can be exceeded. The NC therefore goes below the "Minimum velocity for Transmit" if the rotary axis velocity is more than twice as large as the permissible value. After that, the rotary velocity is limited to the maximum possible value.

This means there are no longer any velocity fluctuations of the rotary axis and the contour error that arises because the real setpoint of the rotary axis lags behind the setpoint calculated from the transformation is reduced. The magnitude of the contour error depends on the input resolution, the maximum velocity of the rotary axis and the MD "Minimum velocity for Transmit".

- **Travelling through the transformation centre**

  With the new function the velocity of the rotary axis is always limited to the maximum value independently of MD 5025.3.

  It is also possible to travel through the transformation centre in JOG mode independently of MD bit 5025.3.

12.6.3 The transformation data set

NC MD	Bit No. 7	6	5	4	3	2	1	0
5060	Channel number of transformation							
5061	G function for transformation selection							
5062	Axis name 1st fictitious axis							
5063	Axis name 2nd fictitious axis							
5064	Axis name 3rd fictitious axis							
5065	Axis name 1st real axis							
5066	Axis name 2nd real axis							
5067	Axis name 3rd real axis							
5068	Axis name 4th real axis							
5069	Axis name 5th real axis							

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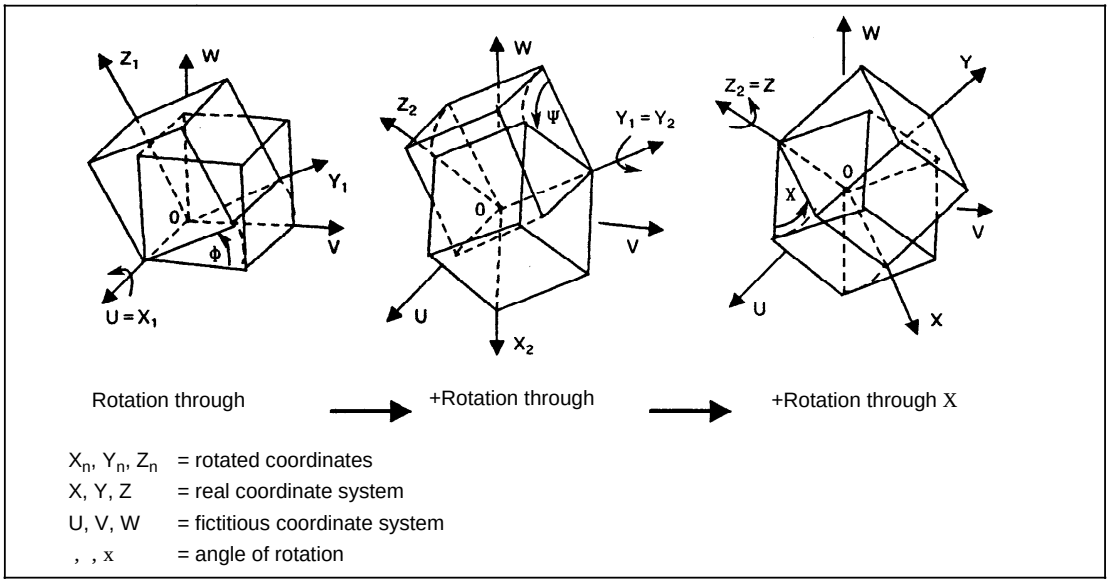
12.6.3.1 Definition of machine data for coordinate transformation



The angle or real machine axis through which the associated axis rotates, is always assigned to the 1st real axis (MD 5065).

The angle or real machine axis through which the associated axis rotates, is always assigned to the 2nd real axis (MD 5066)

The angle or real machine axis through which the associated axis rotates, is always assigned to the 3rd real axis (MD 5067).

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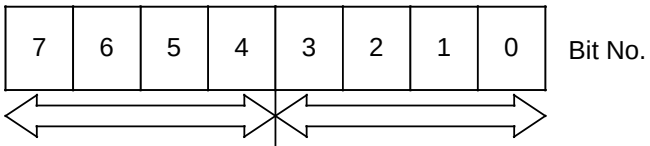
NC MD 5060 to 5069 1st transformation data set
NC MD 5070 to 5079 2nd transformation data set
⋮
NC MD 5130 to 5139 8th transformation data set

Conditions for a transformation data set

a) All axes and the channel must be assigned to the same operating mode group.
b) The transformation option must be available.
c) The transformation data are taken over internally by the control at restart (warm restart). Definition errors cause Alarm 3087 to be output. The incorrect machine data is coded in the block number in the alarm text.
d) NC MD 564* Bit 6 must be set for all fictitious axes.
e) The axis names of the real and fictitious axes of a transformation data set should not be repeated. Using the same axis name with a different extended address is permitted.



extended address (address number)

key:
blank = 0000
1 = 0001
2 = 0010
3 = 0011
4 = 0100
5 = 0101
6 = 0110
7 = 0111
8 = 1000
9 = 1001
10 = 1010
11 = 1011
12 = 1100
13 = 1101
14 = 1110
15 = 1111

address name

key:
X = 0000
Y = 0001
Z = 0010
A = 0011
B = 0100
C = 0101
U = 0110
V = 0111
W = 1000
Q = 1001
E = 1010

Example: 0000 0010=Z
0001 1001=Q1

Legal names for axes, angles, chamfer and radius

A	*unassigned address*	**N**	subblock
B	*unassigned address*	**O**	danger of confusion with 0 (zero)
C	*unassigned address*	**P**	subroutine - number of passes
D	tool offset number	**Q**	*unassigned address*
E	*unassigned address*	**R**	arithmetic parameter
F	feed	**S**	spindle speed, S function
G	G function	**T**	tool
H	H function	**U**	*unassigned address*
I	interpolation parameter	**V**	*unassigned address*
J	interpolation parameter	**W**	*unassigned address*
K	interpolation parameter	**X**	*unassigned address*
L	subroutine	**Y**	*unassigned address*
M	M function	**Z**	*unassigned address*

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12.6.4 Transformation parameters

730 - 739	1st transformation, parameters 1 to 10		Active on **Warm restart**
Default value	Lower input value	Upper input value	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

740 - 749	2nd transformation, parameters 1 to 10		Active on **Warm restart**
Default value	Lower input value	Upper input value	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

750 - 759	3rd transformation, parameters 1 to 10		Active on **Warm restart**
Default value	Lower input value	Upper input value	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

760 - 769	4th transformation, parameters 1 to 10		Active on **Warm restart**
Default value	Lower input value	Upper input value	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

770 - 779	5th transformation, parameters 1 to 10		Active on **Warm restart**
Default value	Lower input value	Upper input value	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

780 - 789	6th transformation, parameters 1 to 10		Active on **Warm restart**
Default value	Lower input value	Upper input value	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

790 - 799	7th transformation, parameters 1 to 10		Active on **Warm restart**
Default value	Lower input value	Upper input value	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

800 - 809	8th transformation, parameters 1 to 10		Active on **Warm restart**
Default value	Lower input value	Upper input value	Units
0	**-99 999 999**	**99 999 999**	**units (IS)**

The transformation parameters are needed for the 2D/3D coordinate transformation (and are of no consequence for the TRANSMIT coordinate transformation up to SW 4).

From SW 5, transformation parameters are also required for Transmit (see description below).

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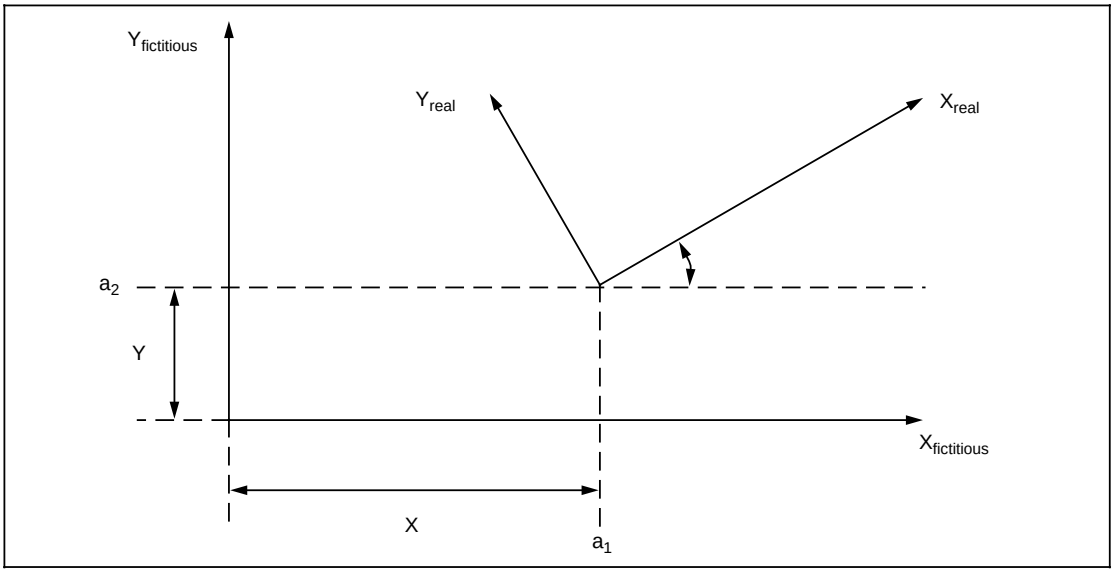
Transformation parameters for 2D coordinate transformation

Parameter 1: X shift of the real system in direction X relative to the fictitious origin a 1 [unit: units (IS)].

Parameter 2: Y shift of the real system in direction Y relative to the fictitious origin a 2 [unit: units (IS)].

Parameter 4: Angle of rotation of the real system relative to the fictitious system [unit: 10^{-5} degrees].

Parameter 10: Axis number which is used to calculate the G96 (constant cutting speed).



Transformation parameters for 3D coordinate transformation

Parameter 1: X shift of the real system in direction X relative to the fictitious system [unit: units (IS)].

Parameter 2: Y shift of the real system in direction Y relative to the fictitious system [unit: units (IS)].

Parameter 3: Z shift of the real system in direction Z relative to the fictitious system [unit: units (IS)].

Parameter 4: Angle of rotation , which occurs when the real coordinate system is rotated about the X axis (unit: 10^{-5} degrees].

Parameter 5: Angle of rotation , which occurs when the real coordinate system is rotated about the Y axis (unit: 10^{-5} degrees].

Parameter 6: Angle of rotation X, which occurs when the real coordinate system is rotated about the Z axis (unit: 10^{-5} degrees].

Parameter 10: Axis number for axis which is used to calculate G96 (constant cutting speed).

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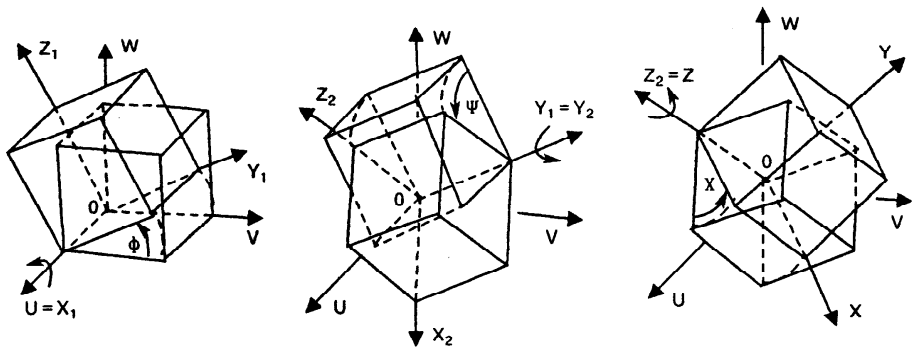

X_n, Y_n, Z_n = rotated coordinates
X, Y, Z = real coordinate system
U, V, W = fictitious coordinate system
, , x = angle of rotation (angle from MD)

Transformation parameters for transmit

Parameter 9: (MD 738...) minimum speed for transmit.
[Unit: units(IS)/IPO cycle]
Recommended value 10

On standard machines, the fictitious system rotates through the real machine coordinate system.

In this case, the rotation begins with the 3rd real axis (X). The angle through which the fictitious coordinate system is rotated, must be negated by a right-handed coordinating system (see angle definition pictured above).

The angles, through which the fictitious coordinate system is rotated, are - in the case of a Gimbal head millhead - equivalent to those of the axis positions of the rotary axis if these are set up according to the norm in the direction of rotation.

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12.6.5 Machine data for fictitious axes

MD 224*		Software limit switch
MD 228*		Software limit switch
MD 232*		Software limit switch
MD 236*		Software limit switch The software limit switch need not be input if the fictitious working area is outside the real possible working area, as the control always restricts the fictitious software limit switch to the limit switch of the A_{1R} axis (linear axis of transformation).
MD 276*		Acceleration The acceleration value must be calculated in such a way that the real axes of transformation are not overloaded (minimum acceleration value of A_{1R} to A_{5R}).
MD 280*		Maximum speed
MD 288*		JOG speed
MD 292*		Rapid JOG The speeds can be freely selected, as they are monitored by the control.
MD 304*		IPO parameter
MD 360*		Operating mode group of the axis
MD 564*	Bit 6	Fictitious axes The axis is declared as a ”fictitious axis”. Fictitious axes have no position control. The MD 200* measuring circuit assignment is therefore meaningless.
MD 564*	Bit 7	Axis exists
MD 568*		Encoding of the axis name
MD 576*		Axis not permitted in channel

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12.6.6 NC PLC interface signals

- In the case of fictitious axes, only the signals ”JOG, rapid overlay and handwheel 1,2 and the input interface” are processed.
  The output interface is neglected. The signal ”Reference point reached” is permanently set to 1.

- The program including the transformation is not stopped if the signal ”Axis disable” is set for a real axis in the transformation grouping. In this way an offset occurs between the transformation and the position control and it can be eliminated only by selecting transformation.

- If a real axis in the transformation grouping is switched into closed-loop control from the follow-up mode, a reverse transformation of the fictitious coordinates occurs automatically.

- If ”Feed hold” is applied to a real axis in the transformation grouping, this applies to the entire grouping.

- When ”Delete distance-to-go” occurs, the fictitious distances-to-go are cleared.

- The signal ”Transformation active” is set in the channel-specific interface NC PLC for every channel in which the transformation is active (see also Interface Description).

- Warm restart is possible when transformation is selected if the transformation grouping does not change the operating mode group.

- Command channel
  In order to traverse a fictitious axis in JOG mode, the relevant transformation must first be activated in the channel assigned via machine data. The activation, i.e. the selection/deselection, of the transformation is a function mode of the command channel. Selection of coordinate transformation from the command channel is described in the Interface Description, Part 1 "Signals".

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12.6.7 Explanation of the programming and operation of coordinate transformation

- Fictitious axes must not be programmed in the reset position (G130, G230, G330) Alarm 2043.

- A transformation may only be activated from the reset position, i.e. transition to a different transformation is only possible via a previous deselection block.

- Coordinate transformation is selected with:
  G131 or G231 or G331 TRANSMIT
  G133 or G233 or G333 2D coordinate transformation
  G135 or G235 or G335 3D coordinate transformation

  The selection block must not contain any traversing movements, auxiliary functions etc.

- When transformation is selected, none of the real axes in the transformation grouping must be programmed Alarm 2043.

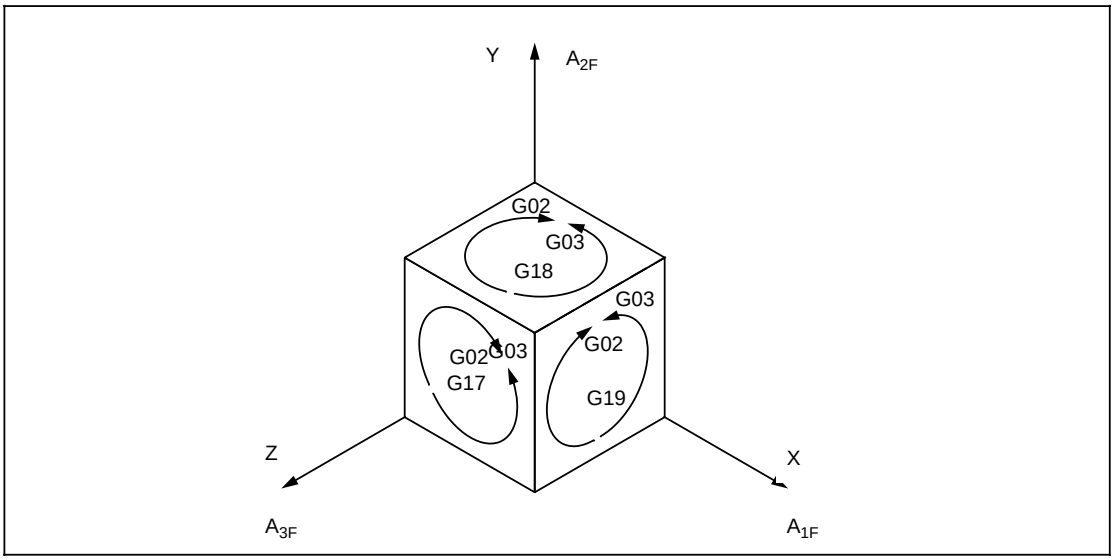
- Each selection**/**deselection of transformations is connected to the function ”Clear buffer” (@714). The @714 need not be programmed as it is automatically initiated by the control.

- Cutter radius compensation and tool nose radius compensation must be cancelled before activating the transformation (due to @714).

- Only **one** transformation can be selected at a time in any one channel.

- Transformations which are running parallel in different channels must not refer to the same axes Alarm 2190.

- The plane definition given in the channel-specific machine data applies for the real system. When a transformation is selected a plane is set for the **fictitious** system. The fictitious plane is defined in the transformation data by assigning the fictitious axes. Deviations from the base planes can be programmed explicitly via G16. The initial setting of the plane is defined as G17 (A_{1F}-A_{2F}) in TRANSMIT.
  G17 is automatically set when transformation has been selected. The plane which was valid before selecting transformation is automatically restored after transformation has been deselected.



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- Transformation must not be selected or deselected within a contour block sequence.
- Block search with calculation to a program part where transformation is active is permitted.
- The automatic block search to a program part where transformation is active is **not** permitted.
- PRESET shifts of real axes are ignored in transformation.
- Fictitious axes cannot be traversed with the handwheel. Real axes can only be traversed with the handwheel when transformation is not active.
- DRF is not possible with fictitious axes.
- DRF is possible with real axes only when a program block is active (not for NC STOP).
- The settable angle of rotation for coordinate system rotation (G54 to G57) must always be ZERO.
- The programmable angle of rotation for coordinate system rotation (G58, G59) must also be ZERO when transformation is selected or deselected.

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12.6.8 Examples of coordinate transformation

12.6.8.1 Example of TRANSMIT coordinate transformation

A transformation data set for the TRANSMIT transformation must be defined as follows:

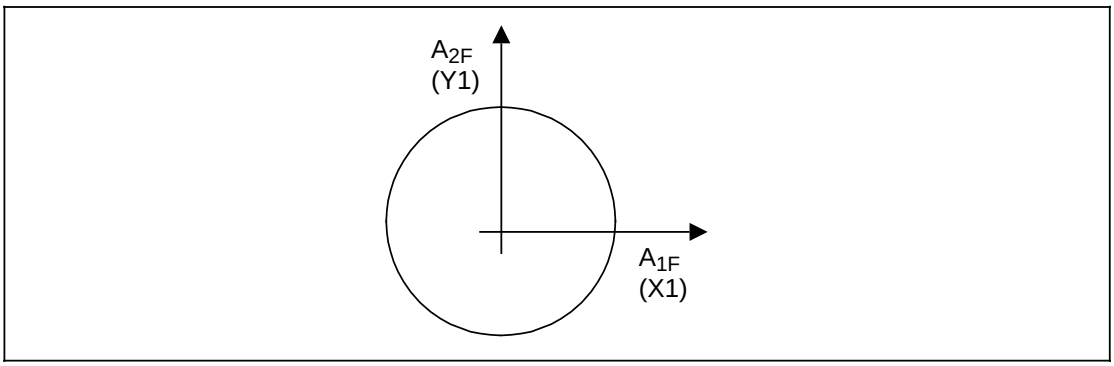
NC MD 5060 Channel number of the transformation Example: 0000 0010 (binary form) (channel 2)

NC MD 5061 G function for transformation selection

G131	0001 0001
G231	0010 0001
G331	0011 0001

NC MD 5062 Axis name 1st fictitious axis (A_{1F})

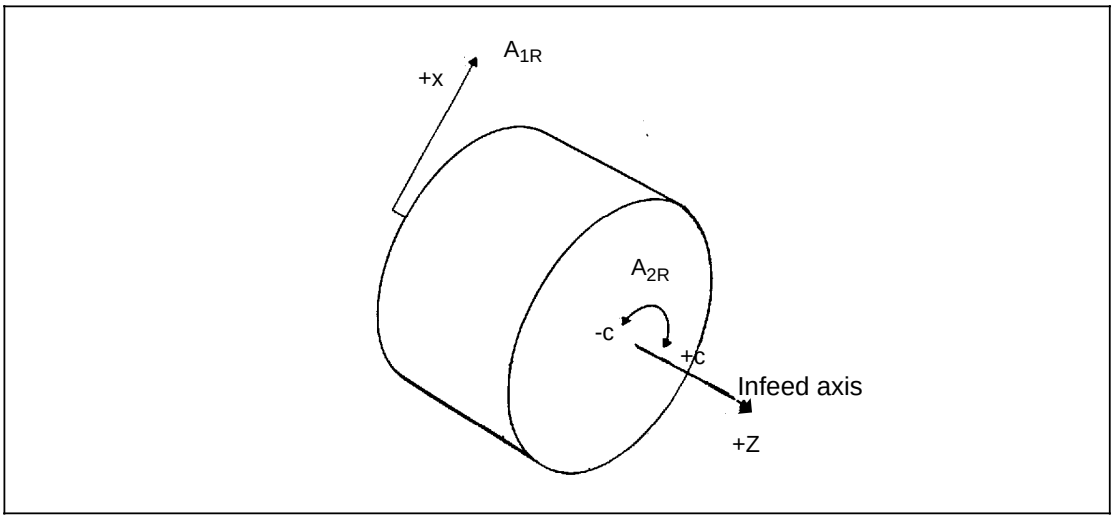
NC MD 5063 Axis name 2nd fictitious axis (A_{2F})



NC MD 5064 Axis name of the infeed axis (real axis) Example: 0000 0010 (Z)

NC MD 5065 Axis name of the 1st real axis (A_{1R}) - linear axis

NC MD 5066 Axis name of the 2nd real axis (A_{2R}) - rotary axis



NC MD 5067 to 5069 unassigned (Input: 1111 1111)

See NC Programming Guide for programming example.

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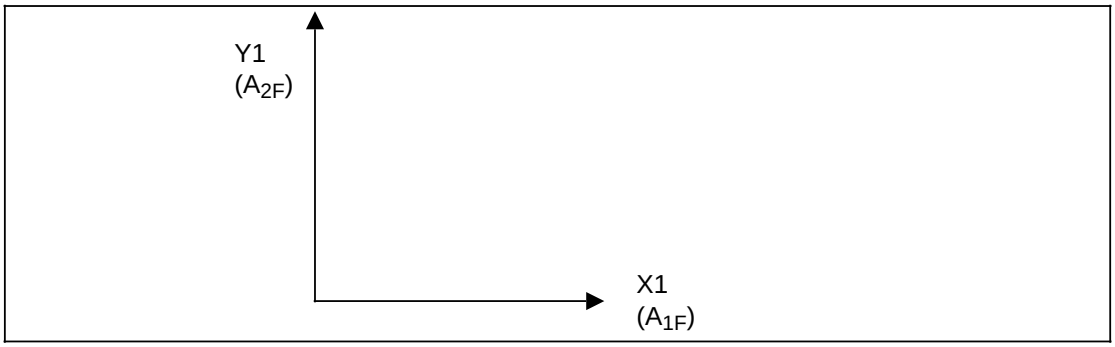
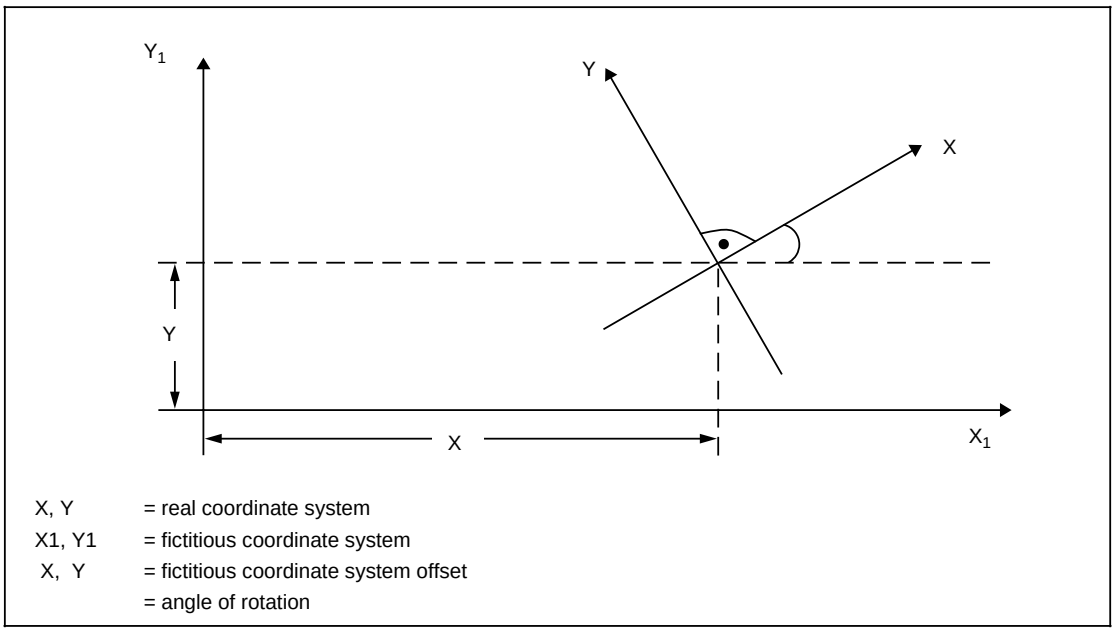
12.6.8.2 Example of 2D coordinate transformation

A transformation data set for 2D coordinate transformation must be defined as follows:

NC MD 5060	Channel number of the transformation Example: 0000 0010 (binary form) (channel 2)		
NC MD 5061	G Function for transformation selection	G133	0001 0011
		G233	0010 0011
		G333	0011 0011
NC MD 5062	Axis name 1st fictitious axis (A_{1F}) -X1		
NC MD 5063	Axis name 2nd fictitious axis (A_{2F}) -Y1		
NC MD 5064	Axis name of the infeed axis (real axis)		Example: 0000 0010 (Z)



NC MD 5065	Axis name of the 1st real axis (A_{1R}) - linear axis	Example: 0000 0000 (X)
NC MD 5066	Axis name of the 2nd real axis (A_{2R}) - rotary axis	Example: 0000 0101 (C)



NC MD 5067 to 5069 unassigned (Input: 1111 1111)

See NC Programming Guide for programming example.

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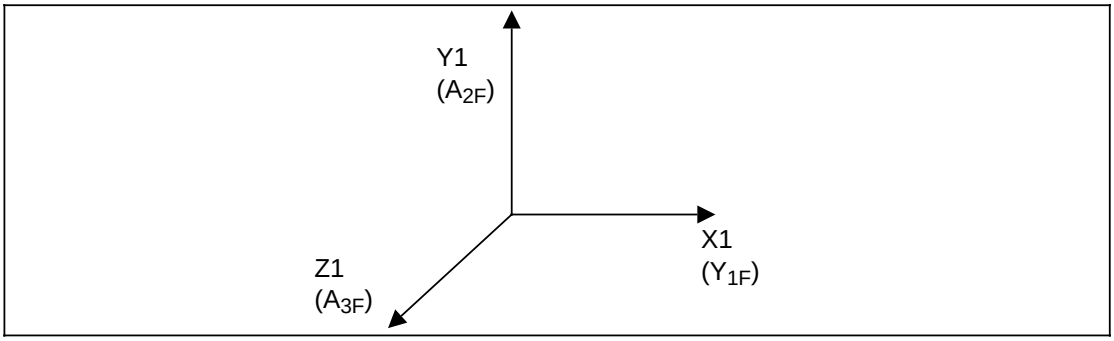
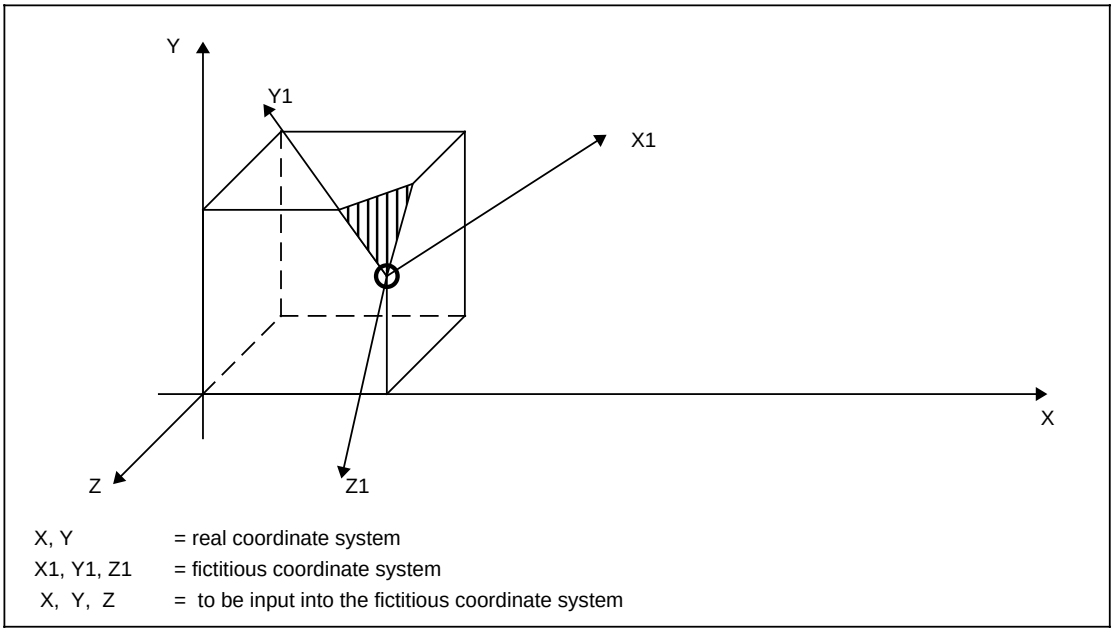
12.6.8.3 Example of 3D coordinate transformation

A transformation data set for 3D coordinate transformation must be defined as follows:

NC MD 5060	Channel number of the transformation Example : 0000 0010 (binary form) (channel 2)		
NC MD 5061	G Function for transformation selection	G135	0001 0101
		G235	0010 0101
		G335	0011 0101
NC MD 5062	Axis name 1st fictitious axis	(A_{1F})	- X1
NC MD 5063	Axis name 2nd fictitious axis	(A_{2F})	- Y1
NC MD 5064	Axis name 3rd fictitious axis	(A_{3F})	- Z1



NC MD 5065	Axis name 1st real axis	(A_{1R})	- X
NC MD 5066	Axis name 2nd real axis	(A_{2R})	- Y
NC MD 5067	Axis name 3rd real axis	(A_{3R})	- Z



NC MD 5068 to 5069 unassigned (Input: 1111 1111)

See NC Programming Guide for programming example.

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12.6.9 Transformation machine data change without warm restart

Corresponding data

Machine data

- NC MD 5017 bit 6 Transformation machine data change permitted during active transformation
- NC MD 5017 bit 7 Transformation machine data change effective without warm restart

General

If angles or offsets of the transformation data record are changed, these values are effective at the next transformation selection - even without a warm restart.

In order for all required data to be available at the next transformation selection, all internal data required for the transformation are instantly recalculated after each MD change (MD 730-809). This is executed parallel to machining thus avoiding loss of machining time.

Functionality is effective on the following transformation types:

2D coordinate rotation and 3D coordinate rotation

Functionality is effective in the following MD area:

MD 730 - MD 809

Caution:

Machine data must be changed in time (approx. 100 ms) before transformation selection. This can also be achieved by programming @714 before transformation selection.

A machine data change has no effect on active and current transformations.

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12.7 Spindle functions

12.7.1 Overview

The following spindle functions are available:

- Speed-controlled spindle
- Oriented spindle stop
- Position-controlled spindle (C axis)

The individual spindle functions are produced with the following **spindle modes**:

- **Control mode** Spindle rotates with constant speed or cutting rate (open-loop control of spindle speed)
- **Oscillation mode** Spindle rotates at constant motor speed setpoint (open-loop control of spindle speed)
- **Positioning mode** Spindle stops at a preset position (oriented spindle stop)
- **C axis mode** Spindle acts like a rotary axis (position-controlled spindle)

- Following error compensation for thread cutting
- Multiple thread
- Thread recutting

The principle improvements are:

- Spindle speeds up to 99 999 rev**/**min without actual-value encoder
- Spindle speeds up to 30 000 rev**/**min with actual-value encoder
- Encoder-specific resolution
- Monitoring of encoder cutoff frequency
- Adjustable zero mark
- Improved C axis mode
- Higher C axis speeds
- Improved positioning mode

General notes:

- With a spindle speed of 0.1, the feed actual value indication in the basic display with functions G95**/**G96 is too low by a factor of 10.
- If the system includes several spindles, a function must always be assigned to the first spindle.

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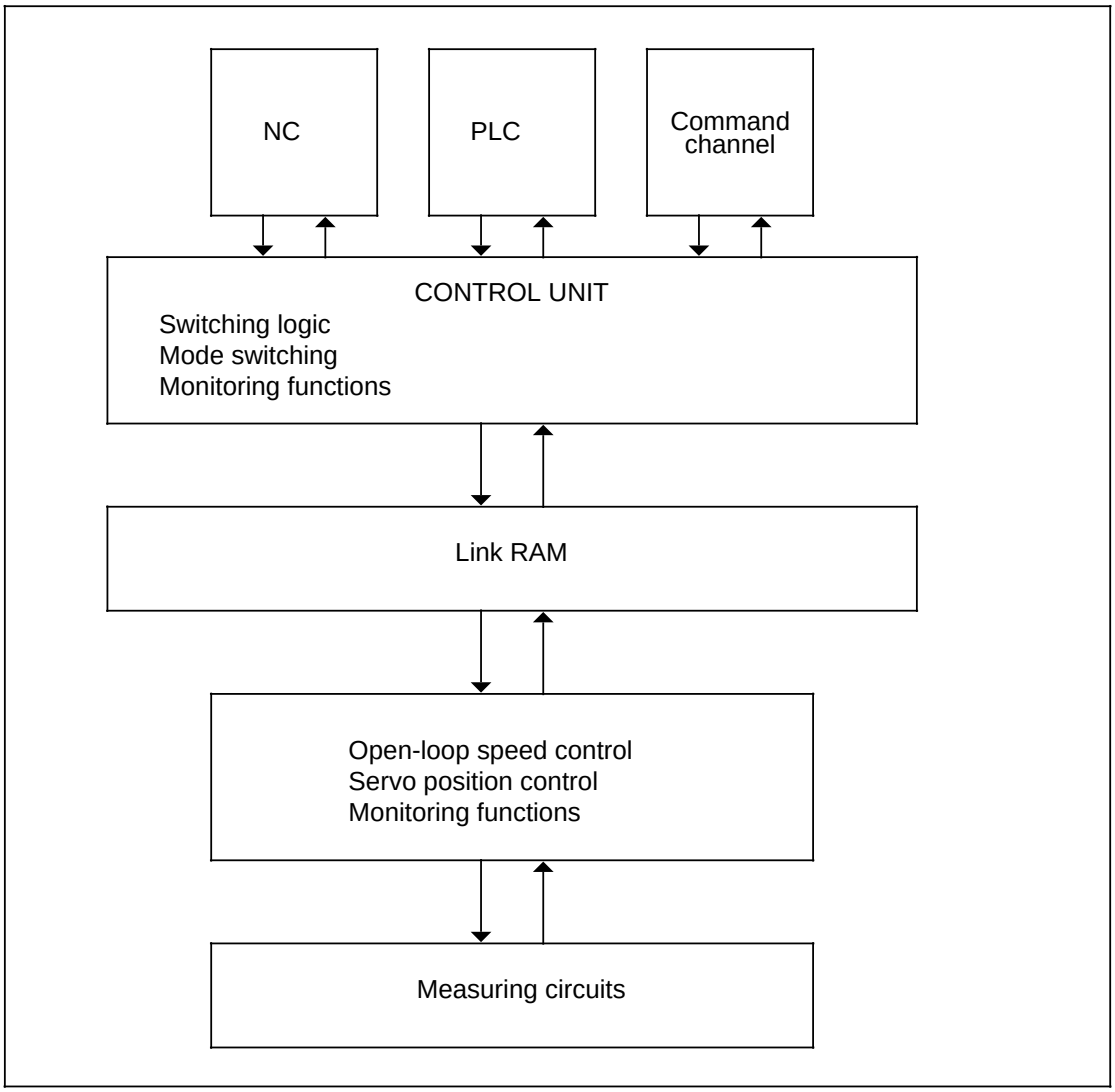
The diagram "Structure of spindle control" provides an overview of the functions available and also the flow of data and commands. Data flows in the direction indicated:

Setpoints and control data
Actual values and status data
Switching commands
Status



Structure of spindle control

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12.7.2 Description of the spindle modes

The following is a description of the various modes in which the spindle may be operated. The individual modes can be programmed by NC (part program MDA, overstore), PLC or command channel (CC). The functions that are then available are given in each case.

The various command sources (NC, PLC or CC) have different priorities, i.e. they can interrupt or interlock each other.

The various switching conditions and interlocks are dealt with in the section headed "Switching logic".

12.7.2.1 Open-loop control mode

General

In the open-loop control mode, the spindle is issued with a setpoint for speed (or cutting rate) and direction of rotation. The setpoint that has been input can be altered by "Speed override" when necessary.

Actual value acquisition

- The open-loop control mode normally requires no encoder for actual value acquisition except if the spindle is to be used for thread-cutting or the "Revolutional feedrate" function in which case an encoder must be mounted on the spindle.
- If an encoder is fitted, it is also used in the open-loop control mode for monitoring and displaying the actual values (of speed and position). The encoder must be mounted directly on the spindle so that the actual speed and position of the spindle can be measured.

Selecting the open-loop control mode

Open-loop control mode is selected by NC, PLC or command channel. The following functions are possible:

PLC: Request for open-loop control mode
- Constant speed and direction of rotation:
  - IS:INITIALIZE
  - set speed from MD 449*
  - set direction of rotation with IS:SET ROTATION CW

CC: Request for control mode
- Constant speed and direction of rotation:
  - ”S external” function
  - set S value (speed) and M3, M4 (rotation) or M5 (spindle stop) in user data of command channel

NC: Request for open-loop control mode
- Constant speed and direction of rotation
  - programming of S value, M3, M4, M5, G94, G95, G97
- Constant cutting rate
  - programming of S value, M3, M4, M5 and G96
- Thread-cutting
  - programming of S value, M3, M4, M5 and G33, G34, G35

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Gear ratio changing

Gear ratio changing is only possible in the open-loop control mode. There can be up to eight different ratios between motor and spindle.

A permitted range of speed can be laid down for each gear ratio by defining maximum and minimum speed values. If the speed setpoint does not fall within the range of the gear ratio that is currently active, the number of the required gear ratio is ascertained automatically and entered into the interface to the PLC together with IS:CHANGE GEAR.

The PLC user program executes the gear change, acknowledges the request by resetting IS: CHANGE GEAR and enters the new gear ratio into the interface.

If no suitable gear ratio for the programmed speed exists, no request for gear changing is generated. The programmed speed is then transferred to the current gear ratio. So it is important to ensure that there is always a suitable gear ratio available.

The behaviour of the spindle during gear ratio changing can be influenced by MD 521*, bit 5 "New S value after PLC acknowledgement". If the bit is set, the programmed speed setpoint will only be accepted when the PLC has acknowledged gear ratio changing. This prevents an unwanted increase in speed while still in the old ratio before changeover.

Data required

This section describes the data that is of particular significance to the open-loop control mode.

- **Limiting the speed**

  Parameters for maximum and minimum speed limits can be assigned for each gear ratio. Parameter assignment is effected through the machine data:
  – MD 403* to 410* ”Max. speed” per gear ratio
  – MD 411* to 418* ”Min. speed” per gear ratio

  If a gear stage is not used, the value zero **must** be entered for the maximum speed of this gear stage and not the value in the standard machine data.

  Regardless of which gear ratio is active, the speed is limited by:
  – MD 451* ”Max. chuck speed”
  – MD 448* ”Min. motor speed”
  – SD 401* ”Programmable spindle speed limit for G96”; programmed with G92
  – SD 403* ”Programmable spindle speed limit”; programmed with G26

- **Limiting the acceleration**

  In order to avoid excessive acceleration when changing speeds, the setpoint is ramped up or down accordingly by means of a ramp-function generator. The maximum value of acceleration to be used is assigned by means of an acceleration time constant. A separate acceleration time constant must be specified for each gear ratio employed:

  – MD 419* to 426* ”Acceleration time constant without position control”

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12.7.2.2 Oscillation mode

The oscillation mode can be used with gear ratio changing to facilitate engagement of the gear by oscillating the spindle.

When switching from open-loop control to oscillation control, the speed setpoint is first reduced to zero at the deceleration ramp defined by the active acceleration time constant. The oscillation speed setpoint is then output.

Preconditions

The request for the oscillation mode comes from the PLC. The PLC user program sets the IS: OSCILLATION SPEED. The following conditions must be satisfied:

- IS:PLC SPINDLE CONTROL set

Parameter assignment

- The motor setpoint for oscillation speed is issued by MD 450*. The sign of the setpoint, and hence the direction of rotation, is determined by IS: SET ROTATION CW
- There is no acceleration or speed limitation in the oscillation mode.

Implementation

- The spindle is actually oscillated by the setpoint being output with an alternating sign. This has to be implemented in the PLC user program by inverting IS:SET ROTATION CW.

12.7.2.3 Positioning mode (M19, M19 through several revolutions)

General

In the positioning mode, the spindle is driven to a preset position under position control and stopped there. The position is reached either directly (M19) or **through several revolutions** (M19tsr).

Position control and actual value acquisition

- Actual value acquisition is needed for position control. Therefore, an encoder must be mounted directly on the spindle.
- The reference point for the angle measuring system is the zero mark of the encoder. A permanent offset to the zero mark can be established by using the zero mark shift (MD 459*).

Accuracy

- The position is entered with an accuracy of 0.01°. The positioning accuracy achieved by the spindle depends on a number of factors:
  - The resolution of the angle measuring system
  - The gain factor of the active gear ratio
  - The drift
  - The interfacing to the drive system.

Restrictions

- Gear ratio changing cannot be employed in the positioning mode.
- M19 must not be activated or programmed when the G96 function is active.

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Selecting the positioning mode

Positioning mode can be selected by NC, PLC or command channel. The following functions are available:

PLC: Request for M19
- IS:POSITION SPINDLE
  - set position from MD 452*

CC: Request for M19tsr
- ”Incremental spindle positioning” function
  - set incremental traversing path in user data of command channel
  - spindle override remains active

NC: Request for M19
- M19 in part program or during overstore
  - set position as S value
  - set position from setting data (SD 402*) if no S value has been programmed.

Data required

This section describes the data that is of special significance to the positioning mode.
A detailed description of the machine data and setting data will be found in the Section "NC Machine Data (NC MD)/NC Setting Data (NC SD)".

- **Position**

  An absolute position is given in response to a request from the NC or PLC. The position is specified by S value, machine data or setting data. The values must be within the range 0 to 359.99° and the entry must be to an accuracy of 0.01°.

- **Distance traversed**

  An incremental path is given in response to a request from the command channel. This path is specified in the user data of the command channel and can be more than one revolution. The size is only limited by the numerical format. The value must again be accurate to 0.01° and its mathematical sign determines the direction of rotation for positioning.

- **Override factor**

  The speed during positioning can be influenced by the spindle override factor.

- **Other data**

  Positioning is effected with interpolation guiding and under position control. The following data is needed:
  – Maximum permitted speed during positioning
  – Maximum permitted acceleration
  – Gain factor
  – Position window

  This information is transferred to the user data on request from the command channel.

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When there is a request from the NC or PLC, the corresponding machine data of the active gear ratio is used, which is:

– MD 427* to 434* ”Creep speed for M19” as max. speed during positioning
– MD 478* to 485* ”Acceleration time constant with position control” for limiting the acceleration rate during acceleration and deceleration
– MD 435* to 442* ”Gain factor” for the position controller
– MD 443* ”Position tolerance” for establishing the position window (regardless of the active gear ratio)

If the gain factor is required to be changed in the positioning mode, the following will also be needed:

– MD 469* ”Factor for gain changing”

The positioning sequence

This section describes in detail the principle of the positioning sequence since it is now different from the conventional spindle control.

To begin with, it is necessary to distinguish between absolute positioning (M19 from NC or PLC) and incremental positioning (M19tsr from command channel).

- **Absolute positioning (M19)**

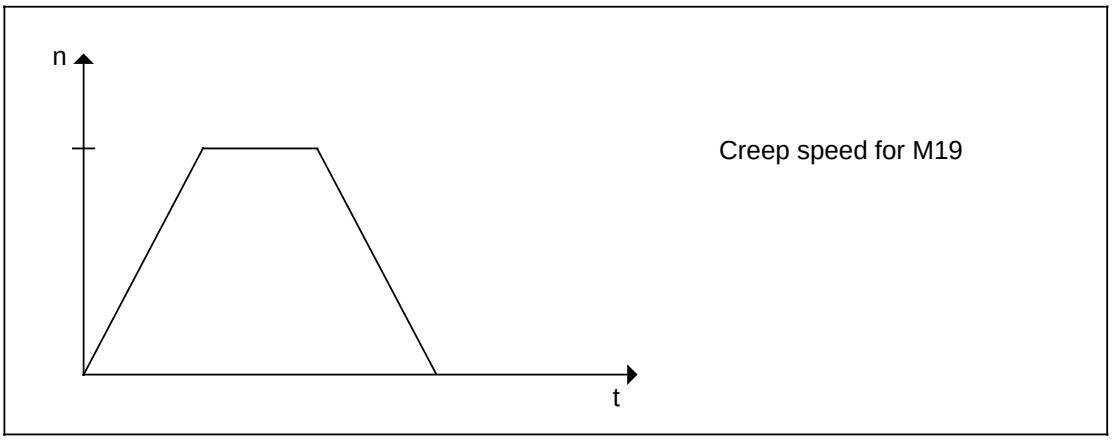
  The spindle is to be brought to a preset angular position as quickly as possible and stopped there. Driving to a particular position is only possible if the spindle is synchronized with the encoder, i.e. if the zero mark has been overtravelled once. It is only then that the absolute position of the spindle can be defined.

  1. Spindle synchronized with encoder

     a) Spindle stopped

     The spindle is driven to the preset position by the shortest path. This means that the path to be traversed is always within the range -180 to +180°. Determining the shortest path also determines the direction of rotation.

     The maximum speed attained during positioning is the creep speed.



Speed characteristic for case 1a

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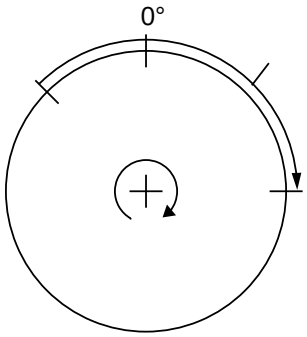

Example

Actual position:	315°
Programmed position:	90°
Shortest path:	+135°

Example for case 1a

b) Spindle running

The spindle is driven to the specified position as quickly as possible, without changing the direction of rotation.

The nearest position at which the spindle can be stopped is calculated from the actual position and the deceleration distance based on the momentary speed. The spindle is driven to the specified position in the direction of travel. The sum of this required distance and the deceleration distance then gives the distance to be traversed, which is covered as quickly as possible.

If the actual speed is less than the creep speed, the spindle is accelerated up to and no further than the creep speed.

If the actual speed is greater than the creep speed, the spindle decelerated until the creep speed has been reached (MD 427*). Then the M19 position is approached with interpolation until the spindle can be stopped at the specified position utilizing maximum deceleration.

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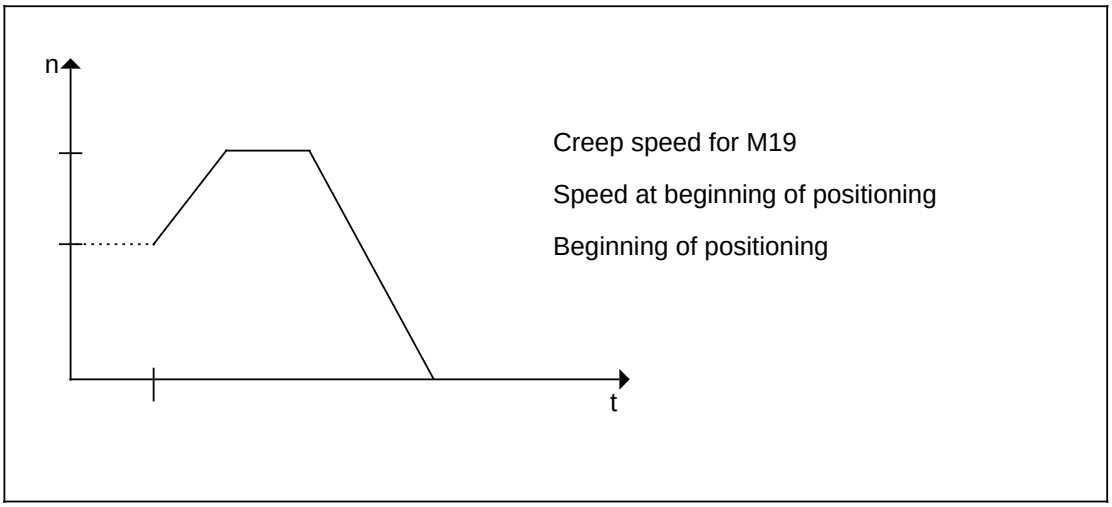
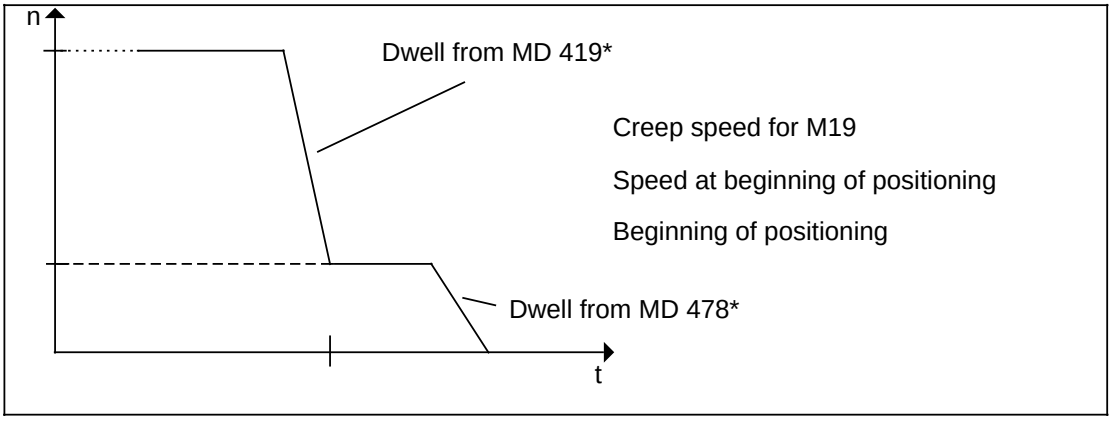


Speed characteristic for case 1b (actual speed < creep speed)



Speed characteristic for case 1b (actual speed creep speed)

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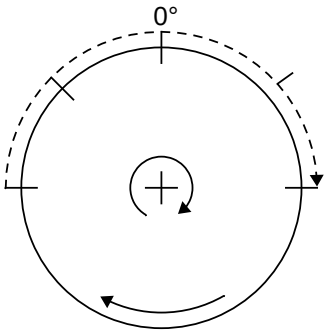

Example

Actual position:	315°
Actual rotation:	positive
Programmed position:	90°
Nearest position at which spindle can be stopped:	270°
Distance to be traversed in addition to the deceleration distance:	+180°
Total distance to be traversed:	+495°

Example for case 1b

2. Spindle not in synchronism with zero mark

   In this case, neither the actual position nor the distance to be traversed can be ascertained correctly.

   Therefore, the spindle is first driven at creep speed (MD 427* to 434*) until the zero mark of the encoder is recognized.

   This allows the internal actual-value counter to be synchronized with the encoder. The remainder of the positioning sequence is identical to that of case 1b.

   If, when M19 is selected, the spindle rotates at a speed above the encoder cutoff frequency (MD 462*), the spindle is first decelerated under control to the creep speed. If the speed of the spindle is below the limit speed, it must be resynchronized. Continue then as in case 1b).

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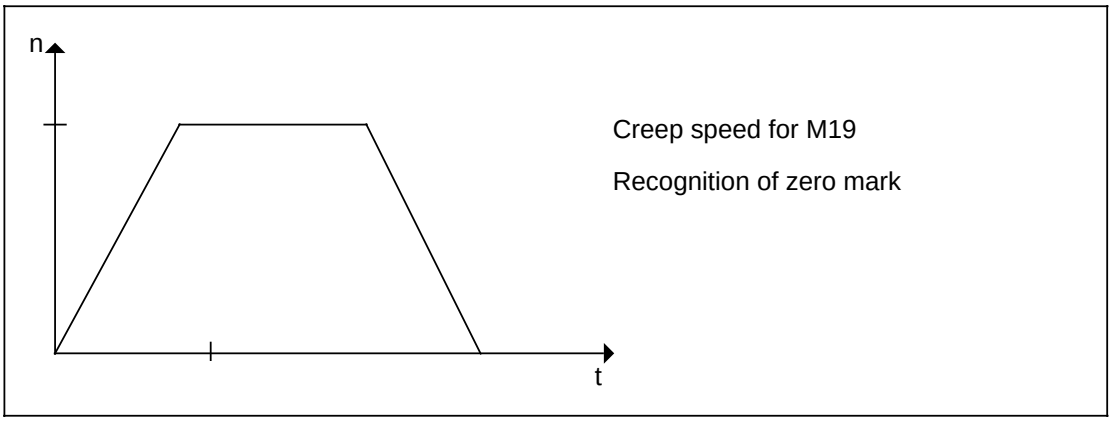

Speed characteristic for case 2

The following applies when selecting the creep speed:

The drive must have sufficient acceleration reserves in the speed range below the creep speed, corresponding to the programmed acceleration for position-controlled spindle operation.

The values in the preset range (100 rev/min to 500 rev/min) are generally suitable.

If the spindle leaves the target position when function M19 is selected (e.g. by being pushed out of position when the closed loop control is switched off), it is returned to the target position using interpolation when the servo enable is reactivated.
If the closed loop control is disabled while the position is being approached, the positioning operation restarts when servo enable is restarted, if M19 is still selected.

- **Incremental positioning**

  There are two preconditions to be fulfilled in this case:

  – spindle stopped
  – spindle synchronized with encoder

  The specified angle in this case is not the position to be reached but the distance to be traversed. The starting point for this distance is the last position to which the spindle was driven (last M19 position). The direction of rotation is determined by the sign of the programmed path.

  If the spindle has not been driven to an absolute position before incremental positioning is carried out for the first time, the starting point is assumed to be 0°.

  It is possible, e.g. due to drift, that the actual position does not agree with the last M19 position. In this case the discrepancy is included in the distance to be traversed.

  The actual position can be uniquely defined only within one revolution (0 ... 360°). Since one assumes that the spindle has moved little since the last positioning, the difference is defined in the range -180 to +180°.

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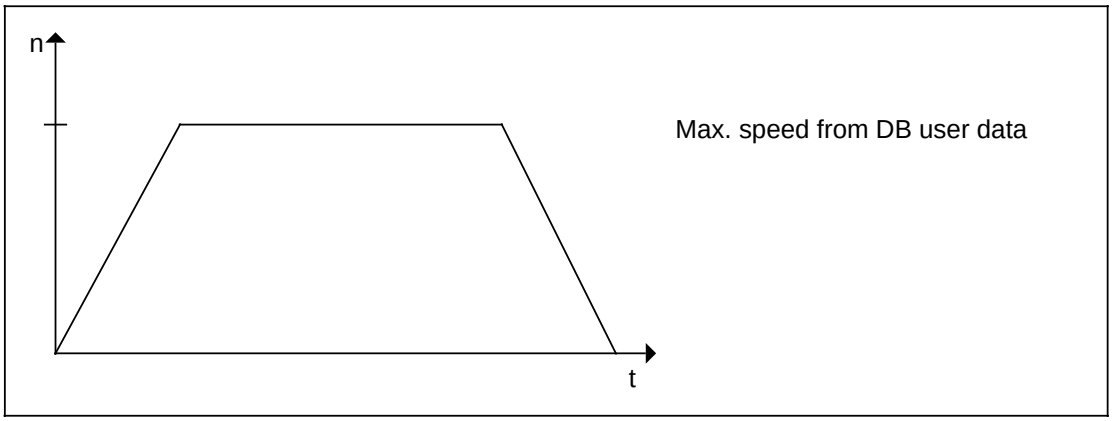
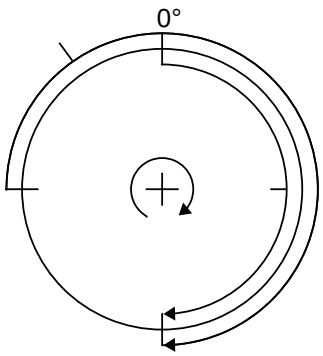


Speed characteristic for incremental positioning

Examples



Last M19 position:	0°
Actual position:	270°
Specified travel:	+180°

This means that the spindle has moved 90° from the last M19 position in the opposite direction to the specified direction, so the total is:

Distance to be traversed:	+270°

Example 1

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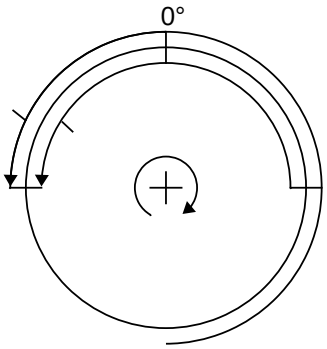

last M19 position:	90°
Actual position:	0°
Specified travel:	–180°

The spindle has thus moved 90° from the last M19 position in the specified direction, so the total is

Distance to be traversed:	–90°

Example 2

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Gain factor change

In the positioning mode it must be possible to drive the spindle to a target position from full speed under position feedback control. The spindle must be held at the target position even when there is drift.

To ensure that the spindle is steady at rest, even in the presence of drift, very small set speeds with very high resolution must be given to the drive actuator via the analog interface.

The speed setpoints are transferred as voltage signals via the analog interface between control system and drive actuator. Under some circumstances the control behaviour can be improved by increasing the voltage level (relative to the set speed) because it enables a higher resolution to be achieved and the analog interference noise can be reduced.

Consequently, with some drive actuators, such as the SIMODRIVE 650, a different scaling for the set speeds (voltage levels) can be selected by applying a configurable terminal signal.

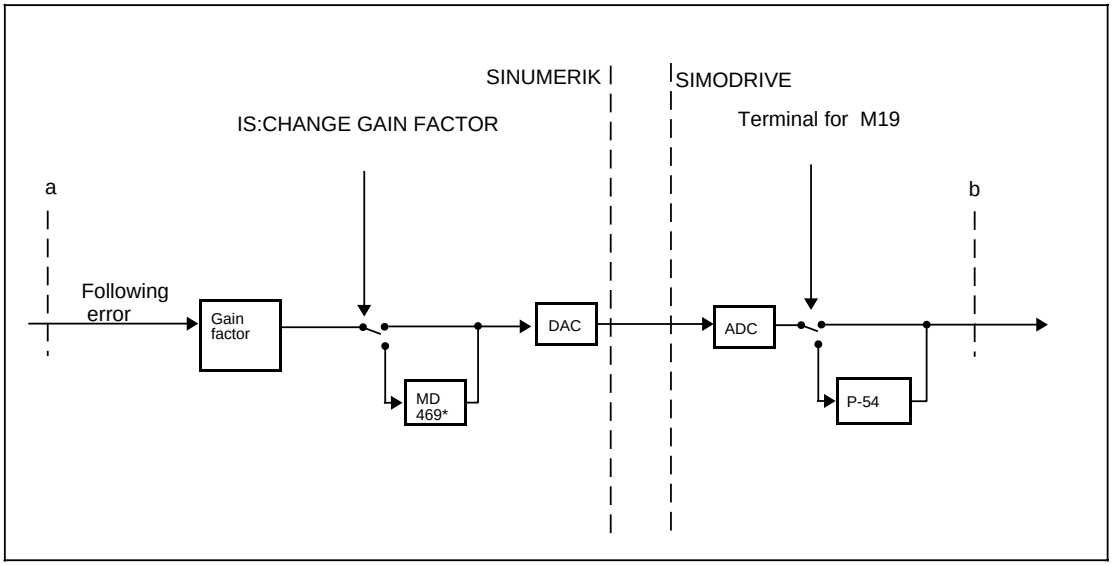
This changing of the scaling in the drive actuator must be allowed for in the control so that, overall, the effective gain factor remains the same. The gain factor (dependent on gear ratio, MD 435* to 442*) must be adapted to the new scaling.

The factor for gain changing is entered as machine data. The value is calculated from:

$$\text{MD } 469^* = \frac{1}{N} \qquad \text{where N = scaling factor in the drive actuator}$$

Changing of the gain factor must be initiated by the PLC user program with the interface signal CHANGE GAIN FACTOR (DW K + 1, bit 15).

The diagram below is intended to illustrate the changeover process using SIMODRIVE 650 as an example.



Simplified block diagram

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Referring to the SIMODRIVE 650 Operating Instructions will explain the following:

P-54:	Normalization factor for set speeds (M19 mode)
Terminal for M19:	Terminal configurable with P-83 to P-85

The block diagram shows that MD 469* and the SIMODRIVE parameter P-54 must add up to 1 in order to obtain the same effective gain factor between points a and b with or without changeover.

It is also apparent that, for stable control behaviour, the changeover of the gain factor and the speed normalization must always take place **simultaneously**. Only then will the effective gain factor remain the same.

Gain factor change in the positioning mode

In order to position the spindle from full speed, it must first be possible to transfer the maximum speed setpoints. Consequently, when the positioning mode is started, neither changeover of the drive actuator scaling nor changeover of the gain factor must be activated.

Changeover should only be effected when the spindle has come to rest. Therefore, it is sensible for it to be done when the interface signal SPINDLE STOPPED has been set by the NC system.

In all cases it is essential for the value of speed setpoint (voltage level) to be transferred to be less than 10 V after changeover.

If the spindle is to be positioned several times in succession, it can be convenient for changeover to remain activated at the start of the second positioning sequence and the subsequent ones. However, then it will be necessary to ensure that the maximum speed attained during positioning (see section headed "The positioning sequence") is less than the speed that can be transferred via the analog interface at a maximum of ± 10 V.

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Aborting the positioning mode

The specified position is regarded as having been reached (or the distance as having been traversed) when the spindle is within the position window. This is signalled to the PLC by setting IS:SPINDLE POSITION REACHED.

The position is held under position control until the M19 function is aborted. The conditions for aborting are as follows:

- IS ACKNOWLEDGE M19
- M3**/**M4 in part program or command channel
- Select C axis or synchronous mode
- Program end
- Reset

Abort behaviour can be influenced by MD bits (see section headed "Switching logic").

Setting IS:SPINDLE DISABLE or resetting IS:SERVO ENABLE interrupts the positioning mode. If the signal is reset again or set again, positioning is continued, but with the following exception:

- If the positioning mode was selected from the command channel, it will be interrupted if IS:SERVO ENABLE is reset. An error message will be entered in the user interface. Positioning will **not** be continued, however, if the signal is set again.

Curved acceleration characteristic (SW 4 and higher)

When induction motors are used (spindle operation), allowance must be made for their speed-dependent acceleration capability in position-controlled operation:

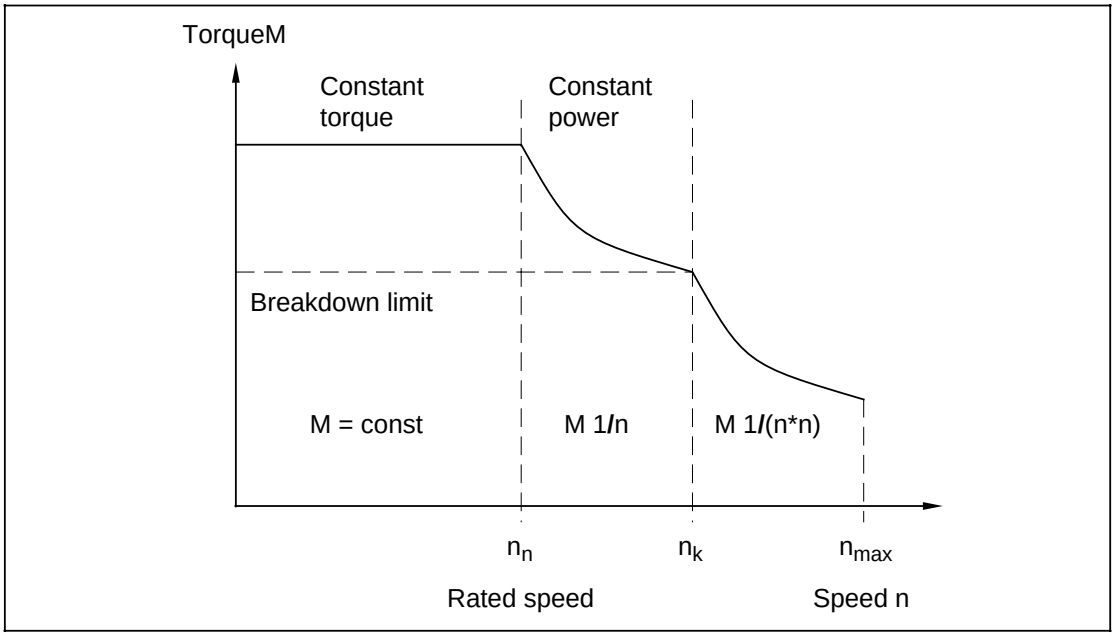

Fig. 1 Torque characteristic of induction motor

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At speeds (n) above rated speed (nn), the drive acceleration capability decreases in relation to the speed. Immediately above rated speed nn, there is a range of "constant power" in which the torque (and thus also the acceleration capability) drop in proportion to 1/n. When speed n increases further, there is a range ("breakdown limit") immediately above speed nk in which the torque decreases in proportion to 1/(n*n).

The required parameters are selected and set in the MSD drive unit.

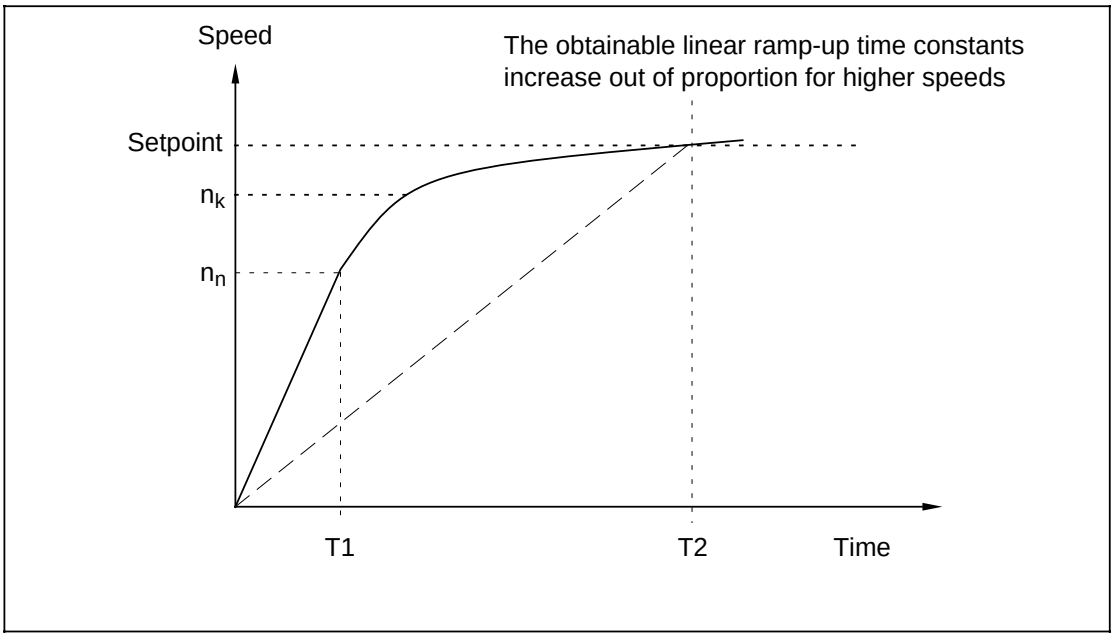

Fig. 2 Speed characteristic during acceleration (thick line)

Figure 2 shows the speed characteristics which are obtained when the acceleration capability is fully utilized.

In **speed-controlled** operation, the drive accelerates either according to the acceleration rate (dashed line for T2 in Fig. 2) set in MD 419* (ramp-up time constant T in open-loop control mode) or, when the ramp-up time constant is shorter, optimally in terms of time along the current limit.

With software versions up to and including SW 3, the ramp-up time constant in MD 478* for **position-controlled** operation must be set such that the current limit must not be reached when the drive accelerates to maximum speed to avoid the risk of instability or overshoot on positioning. The maximum acceleration capability of the drive cannot be fully utilized.

In the new software version, a speed-dependent acceleration characteristic, which can be adapted according to the prevalent physical conditions (speed-dependent adaptation), is implemented for the position-controlled spindle operating modes (most important application: Open-loop controlled operation of a leading spindle in the synchronous spindle or ELG grouping).

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In main spindle drives, the torque is limited as follows (cf. Fig. 1):

- Constant torque up to rated speed n_n: Torque = const
- Constant power above rated speed up to breakdown speed n_k: Torque 1 **/** n
- Power reduction at higher speeds up to n_{max}: Torque 1 **/** (n*n)

Allowance is made for these characteristics in the control in the form of an acceleration adaptation which is simple to parameterize:

- Constant acceleration (according to MD 478* as with previous SW) up to a freely settable speed limit n_x.

  The speed limit nx is entered via a new MD 2471* - MD 2478* which parameter-set-specific.

- Above speed limit nx, the acceleration rate is reduced according to the equation:

  Acceleration= MD 478* n_x **/** n

  n: Present speed

It may to be necessary to make allowance for the acceleration characteristic of the induction drive which drops in proportion to 1**/**(n*n) above the speed range of constant power. This can be achieved approximately by means of an additionally applied adaptation factor c (MD 2479* - MD 2486*):

Acceleration= (MD 478*) for n n_x
Acceleration= (MD 478*) * [n_x **/** (n * c)+(c - 1) **/** c] for n>n_x

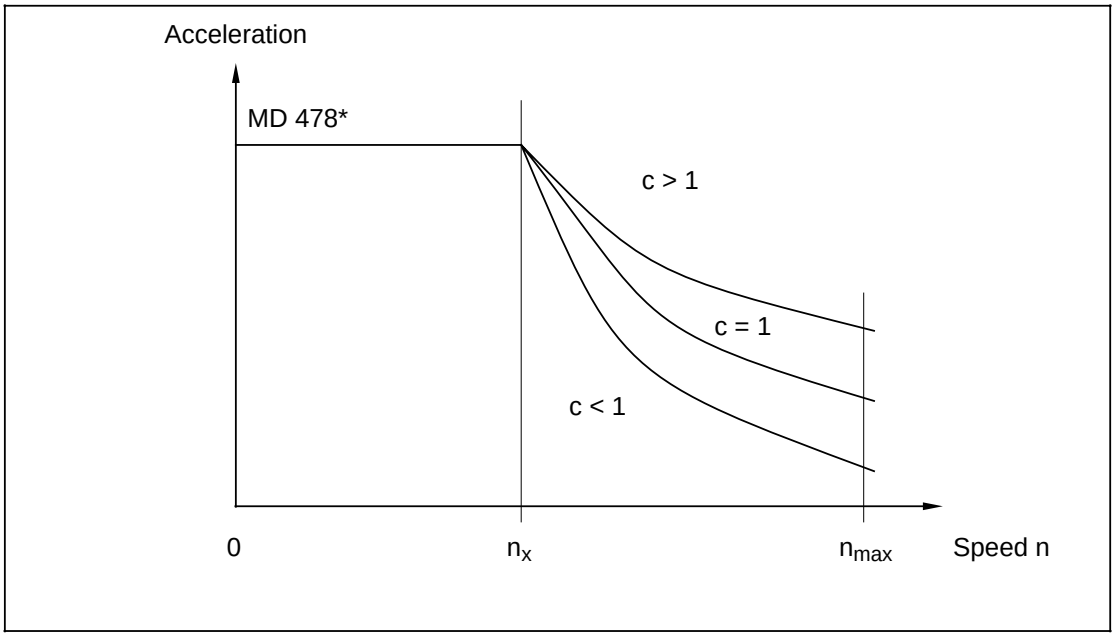

Fig. 3 Possible shapes of acceleration characteristic when adaptation factor is varied. For c = 1 (1 = 100 %), the acceleration above speed limit nx is reduced in inverse proportion to the speed.

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When speed n_x is set to the same value as limit speed n_{max} or when "0" (default setting) is input, the acceleration characteristic is the same as that obtained with previous software versions, i.e. without characteristic curvature (break point above maximum speed).

When "1" is entered for adaptation factor c, the acceleration rate is reduced according to the speed value reciprocal (1/n) above limit speed. This reduction rate can be increased ("steeper" acceleration characteristic) or decreased ("flatter" acceleration characteristic) as required by entering values lower or greater than "1" (i.e. 100 %).

In M19 operation, the search speed is limited internally to n_x.

With the exception of the parameter set extension, the acceleration response obtained with previous software versions is still only available in C-axis operation, i.e. it is not possible to adapt the acceleration rate to the speed value.

It is not necessary to parameterize the characteristic for spindles which are not operated in synchronous groupings or which are equipped with feed drives.

As with previous software versions, the acceleration characteristic is parameterized by the user according to technological requirements. In this case, analog and digital drives are treated in the same way. Automatic adjustment using drive data (e.g. breakdown limit) does not take place. It is thus possible to set the load side parameters (acceleration characteristic) and the drive side parameters (protection of motor and power section) independently.

The "Curved acceleration characteristic for spindles" is operative in the following spindle operating modes:

- Open-loop control mode (M3, M4, adjust PLC):
  The setpoint speed is specified according to the "Curved acceleration characteristic" when the position controller is active at the same time (main application: Leading spindle in synchronous spindle group).
- Positioning mode (M19, positioning from PLC or command channel):
  The maximum positioning speed is limited to nx ("Limit at which acceleration adaptation takes effect", MD 2471*).

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12.7.2.4 C axis mode

General

In the C axis mode the spindle is operated as a **position-controlled rotary axis**. As such, it can be included in the interpolation with other axes (e.g. TRANSMIT coordinate transformation).

General notes:

- Feed STOP is not displayed if a C axis is referenced in spindle mode with G74.
- Block changes are not prevented nor are any alarms output if M19 is programmed when C-axis mode is active.
- No negative acknowledgement of command channel by alarm 109 on "S-external start" in active C-axis mode.
- No feed display when an attempt is made to traverse a C axis conventionally in spindle mode.
- IKA can be switched off before switching from C axis mode to spindle to avoid NC axis alarms (e.g. 168*). As from SW 6, this can also be done via the PLC (DB48).

If a C axis has two measuring systems, the second measuring system is always that of the spindle, MD 400*. MD 1388* and MD ”2nd MS exists” have no effect with spindle C axis combinations. Measuring circuit switchover is set such that after a C axis switchover the spindle encoder is effective until the axis-specific interface signal ”Measuring circuit 2 active” has been evaluated. For C axes with one measuring system, the 1st measuring system must be the same as that of the spindle.

Assignment and parameterizing

- Each spindle can be assigned just one C axis by means of the machine data (MD 461*). Like all axes, this must be parameterized via the axial machine data.
- When switching from the spindle to the C axis, the spindle zero speed tolerance in MD 446* is decisive.
- Before switching to C axis operation, gear switchover and PLC spindle control must be acknowledged.

Position control and actual value acquisition

- In the C axis mode, the position controller works with the axial servo gain factor which must be adapted to the active gear ratio between motor and spindle. Therefore, no gear ratio changing is possible in the C axis mode.
- If the spindle encoder is not sufficiently accurate for the C axis mode, a separate encoder can be used. An alternative is to use a double-track encoder - one track for the C axis mode and the other for the remainder of the spindle modes.
- However, the axis-specific signal IS:REFERENCE POINT REACHED is not set, so it is also possible to employ reference point approach for the C axis (see also the section headed ”Synchronizing and referencing”).
- If reference point approach for the C axis is not to be used, MD 560*, bit 4 ”No start disable for reference point” must be set.

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Selection and deselection of the C axis mode

Selection and deselection of the C axis mode is effected by the NC system (part program, MDA, overstore) with customer-specific M functions. The numbers of the functions are stored in the machine data (MD 260, 261). The address extension as for spindles must be used in the programming.

The C axis mode can only be selected when the spindle is at rest. The USET**/**RSET switch in the user data of the "S external" command channel function must not be set and IS:PLC SPINDLE CONTROL must not be set.

The PLC system must enable selection of the C axis mode with IS:INITIATE C axis MODE. If necessary, the PLC user program must stop the spindle beforehand (e.g. M19 from PLC) and change over to the correct gear ratio.

The C axis mode can only be deselected with the appropriate M function or a hardware reset (depending on MD).

C axis operation cannot be deselected with an M function if the PLC spindle control is active.

If a spindle in one channel is switched to the C axis, deactivation should be executed in the same channel. If deactivation is to be executed in another channel, channel assignment of the spindle has to be implemented beforehand.

Block search via blocks with M functions for C axis ON/OFF

The M functions for C axis ON or C axis OFF are skipped during block search operations regardless of whether auxiliary functions are output or collected during these operations. These is no reaction to these functions being skipped, even if one of them is programmed in the target block.

If necessary, the user must execute an overstore operation to make sure that the C axis is in the correct operating mode.

C axis synchronization (SW 4 and higher)

Corresponding data

NC MD 521* bit 2 Ramp-up as C axis

Since only one absolute system exists for the spindle and associated C axis, the C axis is also synchronized with the zero mark, i.e. quasi referenced, after synchronization of the spindle.

- On switchover from spindle mode to C-axis mode, "Axis referenced" will be set or not depending on the state reached beforehand (i.e. spindle synchronized with zero mark or not).
- If the spindle is not synchronized at the instant of operating mode switchover, then "on-the-fly" synchronization with the next zero mark of the C-axis encoder is executed when the C axis is traversed in C-axis mode, i.e. "Axis referenced" is set even without a reference point approach process.

The status signal "Axis is referenced" is cancelled (as with previous SW versions) if the encoder limit frequency is exceeded in C-axis mode (alarm 1004* "Permissible feed**/**limit freq. exceeded").

- The difference is that - as in spindle mode - "on-the-fly" synchronization with the next zero mark is executed again as soon as the frequency drops below the limit value. With previous SW versions, "Axis is referenced" was only set after a new reference point approach process.

The absolute system remains unchanged on switchover from C-axis mode to spindle mode, i.e. the present status of the "Axis is referenced" signal remains valid for spindle operation.

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Synchronizing and referencing

The reference systems for the spindle and the associated C axis should always be identical. A parameterized shift of the zero mark (MD 459*) is taken into account.

Both systems have the absolute position 0 at the position determined by the zero mark and the shift.

Synchronizing the spindle

When the control system has been run up, the spindle is automatically synchronized with the encoder as soon as it passes the zero mark of the encoder for the first time. Only then can the absolute position of the spindle be determined.

Synchronism will be lost if the cutoff frequency of the encoder is exceeded at high spindle speeds. Resynchronizing takes place automatically when the frequency is reduced again below the critical value.

The PLC system can initiate re-synchronizing of the spindle with IS:RESYNCHRONIZE SPINDLE. Acknowledgement is with IS:SPINDLE SYNCHRONIZED.

Referencing the C axis

Reference point approach like that employed with feed axes is not normally needed for spindles operated in the C axis mode. No reference point cams are usually provided because the zero mark of the spindle encoder uniquely defines the reference point in relation to one revolution.

Nevertheless, reference point approach is still possible with the C axis (e.g. with G74). The sequence is the same as for normal feed axes.

Taking the zero mark offset into account provides the facility described below for optimizing reference point approach for a C axis.

Please observe:

If a double-track encoder is used for spindle and C axis operation, the zero marks of both encoder systems may be offset to each other. This offset must be compensated for by entering the appropriate software zero mark offsets on installation.

Please also note that with spindles/C axes, the 2000 units of reference point offset to the zero mark usually used for referencing the axis, have no effect. If an axis is redefined as a C axis, its reference point is offset by 2000 units. This must be compensated for in the "Reference point offset" (MD 244*).

Notes

- If no explicit reference point approach has been performed for the C axis, the axis-specific IS:REFERENCE POINT REACHED is not set. Therefore, the bit
  – MD 560*, bit 4 "No start disable for reference point"
  must be set if the axis is to be driven in the automatic mode.
- MD 560*, bit 4 must not be set if an explicit reference point approach has been performed for the C axis.
- If the mechanical link between spindle and C axis encoder is deactivated, IS:REFERENCE POINT REACHED must be cancelled by setting IS:PARKING AXIS (see below).

  PARKING AXIS may only be reset when the mechanical link is re-established.

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- With rotary axes it is usually unnecessary to monitor software limit switches. If monitoring is required for a C axis, an explicit reference point approach must be performed.
- The alarm "Excessive feed" is triggered if the cutoff frequency of the C axis encoder is exceeded.
- Explicit referencing must be employed (e.g. G74) if the difference between the accuracy of the entry and the accuracy of the measuring system is greater than a factor of 10 (e.g. entry accuracy 10^{-4} and position control accuracy 0.5 x 10^{-2} mm).
- The measuring system defined in MD 200* is permanently assigned to a spindle with C axis during C axis operation, the second measuring system applies to the spindle operating modes and must be parameterized in MD 400*. The C axis/spindle is assigned in MD 461*.
- One common absolute measuring system for determining the actual position of the spindle and C axis describes the machining position on the load side.
  This absolute system is reinitialized during referencing:
  MD 459* takes effect in spindle operation (inprocess encoder synchronization), as well as for ordinary spindles for the definition/offset of the zero position.

  In C axis operation (inprocess/via part program/via reference point approach mode) MD 240* and 244* have the same effect as with normal axes with the one exception that the usual 2000 units are disregarded here, as these 2000 units are dependent on the direction of movement and would therefore be ambiguous in inprocess referencing in both directions of movement.

  The reference point is kept when switching between spindle and C axis operation. Where this is not required, it can be ignored by using the signals "Resynchronize spindle" or "Parking axis". If the reference point remains valid, the zero mark found during C axis operation is also valid in spindle operation and vice versa.

  In this way, the unnecessary movements resulting with every spindle/axis switchover (for resynchronization**/**referencing) can be avoided as far as possible, on condition that (as mentioned above) the zero position defined in MD 459* is identical with the zero mark defined in MD 240*/244* parameterization on installation.

  The zero position has to be defined in two machine data because, in the case of a double-track encoder, for example, the two zero mark signals are offset by 180 degrees and in the case of two separate encoders any other offset is possible and can then be corrected in the machine data concerned. If the same encoder is used for spindle and C axis operation, you must ensure that the machine data are identical.

  If identical encoder definitions (MD 200* = MD 400*) are entered for spindle and C axis, only the encoder cutoff frequency of the spindle encoder (MD 462*) and not the cutoff frequency of the C axis encoder (MD 308*) is active. The same is applies to the "Sign reversal actual value" (only effective with MD 520*, bit 1, not 564*, bit 2). Differing pulse evaluations remain active.

  The following applies to backlash compensation and leadscrew error compensation: if the encoder definition is different for the spindle and C axis encoder, then backlash compensation and leadscrew error compensation are only active in C axis operation (for first measuring system), if identical encoder definitions have been entered for the spindle and the C axis, then backlash compensation and leadscrew error compensation effect this measuring channel.

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Parking axis

If a C axis is assigned to a spindle via MD 461*, axis-specific interface signals (DB 32) are also evaluated. Two axis-specific signals in particular should be mentioned here that have feedback effects on spindle operation.

The measuring circuit monitoring functions are switched off by setting the signal PARKING AXIS. Then, no alarm appears if the connection between encoder and measuring circuit module is broken (for instance, in order to detach the axis from the machine).

The signals SPINDLE SYNCHRONIZED and REFERENCE POINT REACHED are reset, the speed controller enabling command cancelled and the C axis automatically switched to follow-up mode.

The actual values are not activated.

The encoder frequency monitoring and measuring circuit monitoring functions of the C-axis encoder are automatically deactivated in spindle operation.

Note:

- The interface signal PARKING AXIS must never be cancelled in synchronous operation because the request for re-synchronization of the spindle is linked to this signal. This would, however, cause disturbances in synchronized operation.

  Re-synchronization of the spindle in synchronous operation is generally not permitted.
- If positioning mode is requested by the NC or PLC before the signal SPINDLE SYNCHRONIZED has been set again, then the spindle traverses the zero mark again before it approaches the programmed position.
- If the signal SPINDLE SYNCHRONIZED is cancelled in C-axis mode, then the axis must be referenced explicitly again (e.g. with G74) immediately afterwards.

Setting the signals in the C axis mode produces the following results:

- PARKING AXIS 0 1
  - The measuring circuit monitoring functions are deactivated.
  - The actual value display of the spindle position is no longer refreshed in the basic screen.
  - The axis-specific signal REFERENCE POINT REACHED is cancelled.
  - The spindle-specific signal SPINDLE SYNCHRONIZED is cancelled.
  - Position control is interrupted.
  - The analog speed setpoint 0 is output.
  - The speed controller enabling is cancelled.

When the signals are reset, the results are as follows:

- PARKING AXIS 1 0

Re-synchronizing of the spindle is necessary because the C axis too is always related to the zero mark of the spindle. The two possible ways of synchronizing are:

- Overtravelling the zero mark with any spindle motion
- Explicit reference point approach in the C axis mode (manually or with program via G74)

Note:

- If the positioning mode is requested by the NC or PLC system before the SPINDLE SYNCHRONIZED signal is set again, the spindle will first pass the zero mark before it approaches the programmed position.

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Initiating the C axis mode

This section describes various methods of changing over to the C axis mode.

The standard method

The C axis is referenced automatically when the spindle is synchronized (passing the zero mark of the spindle encoder).

When the C axis mode is selected, the spindle is stopped (e.g. M19 from PLC), then the interface signal INITIATE C axis MODE is set and machining with the C axis can begin.

This method cannot be used, however, if the actual value systems of the spindle and C axis are not in agreement, i.e. if the C axis encoder is uncoupled from the spindle in the spindle mode.

Possible reasons for uncoupling the C axis encoder are:

- Cutoff frequency of C axis encoder exceeded in spindle mode.
- C axis not programmed for modulo 360° (MD 572*, bit 2 not set). In this case, the actual value systems must be decoupled otherwise the actual value system of the C axis will track all the motions of the spindle.

  For example, if the C axis were to be driven to 0°, all the revolutions of the spindle in one direction would be cancelled.

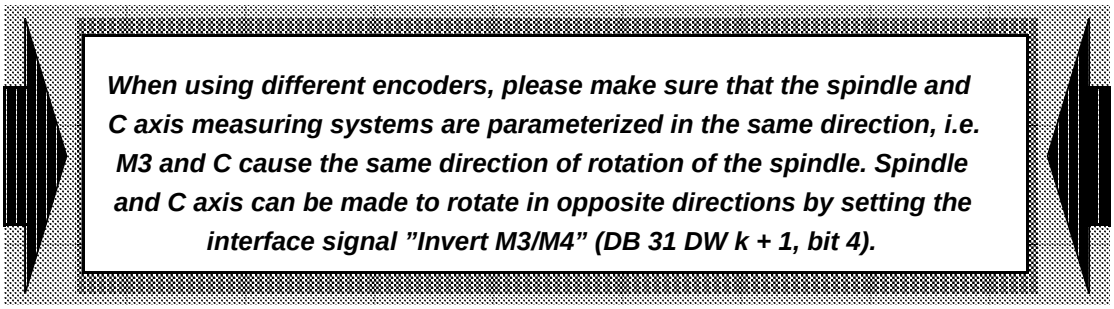
The axis-specific interface signal PARKING AXIS must be set in order to decouple the actual value systems (see "Synchronizing and Referencing").

To avoid long movements in the absolute positioning of the C axis after spindle operation, the absolute position "modulo 1 revolution" is reduced when switching from spindle operation to C axis operation.

The best results regarding costs, operation, precision and speed range are achieved with the high-resolution measuring system. Precision and speed range of the high-resolution measuring system meet the requirements of spindle and C axis operation.

When defining and installing spindle/C axis combinations with different encoders please note the following:

The same direction of rotation must be set for the spindle and C axis in MD bits 564*, bits 1 and 2 (for C axis) and MD 520*, bit 1 and MD 521*, bit 1 (for spindle).



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Example:

- Spindle**/**C axis with double-track encoder
- One motor for both modes (one setpoint output)
- In this example, the actual values from the two encoder tracks show the same direction of rotation, which means that MD 564*, bit 2 and MD 520* bit 1 have to have the same setting. The values for the sign in front of the setpoints are taken from these settings.
- If this is not the case (direction of rotation of spindle and C axis not the same), positioning with M19 will be incorrect after switching from C axis to spindle operation.
- Where opposite directions of rotation are required for C axis and spindle, "Resynchronize spindle" (DB 31, DW K +2, bit 0 and bit 3) must be triggered after switching back to spindle operation via the PLC and before repositioning with M19.

Procedure for ”parked” axis

The spindle-specific signal SPINDLE SYNCHRONIZED is cancelled when the PARKING AXIS signal is reset, although it is an essential precondition for the selection of the C axis mode.

So, if the PARKING AXIS signal is cancelled in the C axis mode, the C axis must be explicitly referenced (e.g. with G74).

If the signal is cancelled in the spindle mode, the C axis can be referenced automatically when the spindle is synchronized. The following can be employed:

1. Program an M function for selecting the C axis mode.
2. Decode an M function in the PLC user program.
3. Employ user program control:
   - Move the spindle to a position near the zero mark (IS:PLC SPINDLE CONTROL and POSITION SPINDLE).
   - Cancel the signals PLC SPINDLE CONTROL and PARKING AXIS (couple up the C axis encoder first if necessary).
   - Re-synchronize the spindle. There are several alternatives, e.g.:
     – Pass the zero mark at basic speed (IS:PLC SPINDLE CONTROL and INITIALIZE; ascertain direction of rotation with IS:SET ROTATION CW).
   - Cancel the signal PLC SPINDLE CONTROL and set the signal INITIATE C axis MODE.
4. Machining with the C axis

The advantage of this method is that machining with the C axis can begin sooner because a defined axis position is reached quickly.

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Encoder-specific resolution

Any type of encoder for actual value acquisition (e.g. digital encoders with any pulse rate, SIPOS signal generators) can be used for spindles controlled by 32-bit servo CPUs.

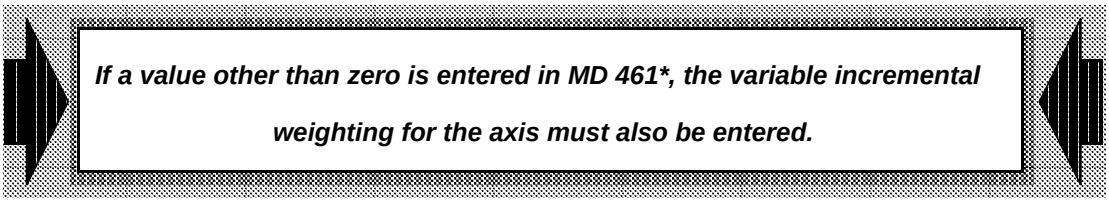
When SIPOS signal generators are used, employing the pulse multiplication on the HMS measuring circuit module also allows a higher resolution to be attained.

The internal calculations for the spindle are performed with the value of resolution provided by the measuring system (the measuring-system resolution). The matching to the different pulse rates is performed in the same way as with axes by means of variable incremental weighting (MD 455*, 456*).

When a spindle is assigned to a C axis via MD 461* (for C axis mode or synchronous mode), the internal calculations for the spindle are also performed with the measuring-system resolution of the C axis. Therefore, the variable incremental weighting for the axis must also be entered (MD 364*, 368*, 1800*).

If there is no separate encoder for the C axis mode, the values of the spindle encoder must also be entered in the axis-specific machine data.

If different encoders are used, please make sure that the spindle and C axis measuring system are parameterized with the same direction of rotation.



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Possible configurations for the C axis mode

The machine data listed below must be entered for configuring the interfaces and for format interfacing between actual value, internal computing resolution and setpoint A more detailed description of this machine data will be found in Section 4 and the Installation Instructions.

- **Machine data for configuring the spindle interface**

MD 400*	Spindle assignment, actual value input and servo CPU
MD 455*	Pulses, variable incremental weighting
MD 456*	Distance traversed, variable incremental weighting
MD 458*	Pulse multiplication for HMS
MD 460*	Spindle assignment, setpoint output
MD 462*	Cutoff frequency of spindle encoder
MD 520*	Configuration bits
MD 521*	Configuration bits

- **Machine data for configuring the C axis interface**

MD 200*	Axis assignment, actual value input and servo CPU
MD 308*	Cutoff frequency of C axis encoder
MD 364*	Pulses, variable incremental weighting
MD 368*	Distance traversed, variable incremental weighting
MD 384*	C axis assignment, setpoint output
MD 564*	Configuration bits (bit 5: axis is rotary axis)
MD 1116*	Pulse multiplication for HMS

The following diagrams give an overview of the possible input/output assignments for the C axis mode. When configuring with two encoders and two drives, the C axis must be declared an independent axis.

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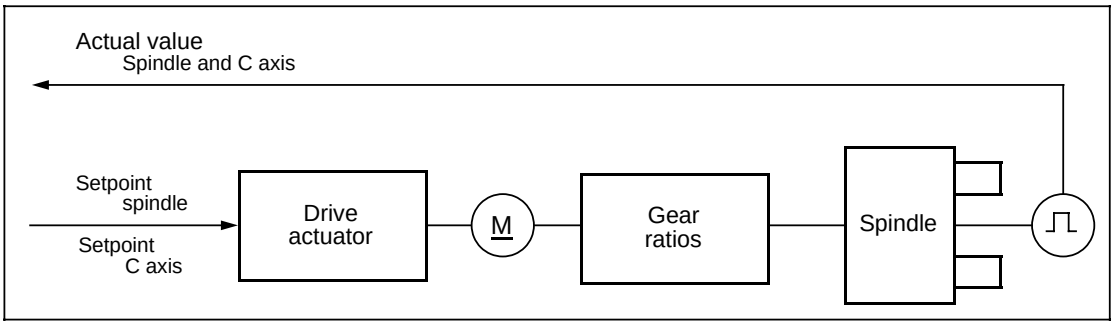
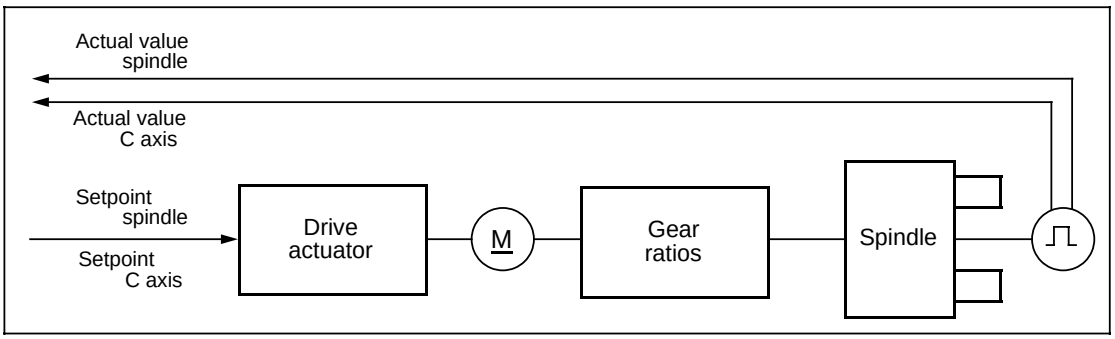
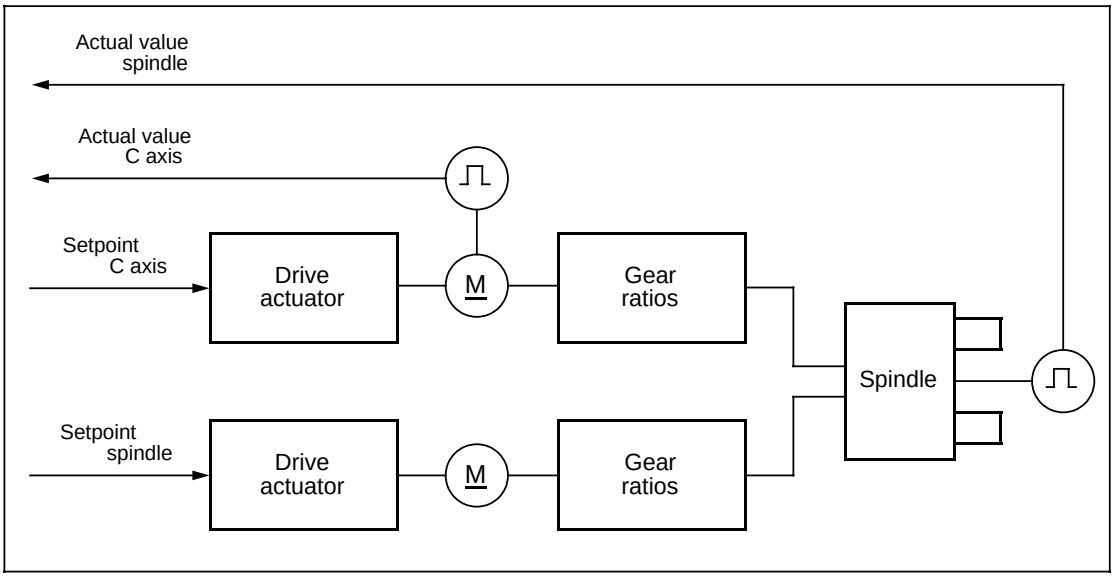


Configuration with one encoder



Configuration with two encoders or one double-track encoder



Configuration with two encoders and two drives

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**Relevance of machine data bits for sign inversion
Setpoint/actual value for spindle + C axis**

The following machine data are affected:

MD 564*, bit 1: "Sign inversion setpoint"
MD 564*, bit 2: "Sign inversion actual value"
MD 520*, bit 1: "Sign inversion actual value"
MD 521*, bit 1: "Sign inversion setpoint"

Whether these machine data bits have to be set or not depends on the configuration.

Possible configurations are:

a) Spindle and C axis have the same actual value input:

   Only MD 520*, bit 1, must be correctly set. MD 564*, bit 2, is of no significance, even in C axis operation.

b) Spindle and C axis have different actual value inputs:

   The sign must be correctly set for each actual value input. MD 520*, bit 1, and MD 564* bit 2, must be set correctly. The set signs take effect in one or the other of the operating modes.

   Spindle operation: MD 520*, bit1 active.
   C axis operation: MD 564*, bit2 active.

c) Spindle and C axis have different setpoint outputs:

   The sign must be correctly set for each setpoint input. MD 521*, bit 1, and MD 564*, bit 1, must be correctly set. The set signs take effect in one or the other of the operating modes.

   Spindle operation: MD 521*, bit1 active.
   C axis operation: MD 564*, bit1 active.

d) Spindle and C axis have the same setpoint output:

   The sign must be correctly set for each setpoint output. MD 521*, bit 1, and MD 564*, bit 1, must be correctly set. The set signs take effect in one or the other of the operating modes.

   Spindle operation: MD 521*, bit1 active.
   C axis operation: MD 564*, bit1 active.

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12.8 Following error compensation for thread cutting

This function is used to correct the starting angle of the spindle by the calculated following error. This is to ensure that the same number of thread turns is cut at a high speed as at a low speed.
The offset caused by the following error no longer occurs. This compensation only functions perfectly when cutting a thread with a constant lead. Depending on the size of the lead increase the decrease, deviations can occur.

Prerequisites:

- MD 5025, bit 2 ”Level-up thread” must be set.
- The servo gain factors of all the axes involved in the thread cutting function must be the same.
- The value of the servo gain factor in the MD must not be < 200, otherwise alarm no. 2192 ”Following error compensation not possible” is triggered.

Operation:

If all the above conditions are fulfilled no further steps are necessary.
However, if the compensation is not functioning perfectly, MD 164 (default value: 36) can be set to produce a fine compensation (8 to 48). The speed should be constant within one turn. Depending on the speed increase/decrease, deviations can occur with tapered threads with constant speed (G96).

12.8.1 Multiple thread

A multiple thread can be cut using a starting angle with this function. Here, the channel-specific starting angle of the leading spindle is programmed directly via G92A ... for the individual thread turn.

Example:

The part program will run first with the angle 0 degrees, then 120 degrees and then 240 degrees to produce a three-start thread.

The starting angle is stored in a channel-specific setting data (No. 202*), and is displayed in the setting data display ”Spindle data” where it can be altered.

This setting data can only be written if the MD is set (directly with @410 K202* K.. or using G92 A.. and direct input via the setting data display), otherwise the alarm ”Option not available” is triggered.

The angle is entered and displayed in 3.5 format. Maximum input value = 999.99999 degrees, input resolution = 10^{-5} degrees, without a sign.

The specified angle is always calculated modulo 360 degrees. Up to five places after the comma are accepted.

R parameter chaining is possible.

The last angle to be entered remains active after power off.

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Example:

Three-start thread (each offset by 120 degrees)

`G01 G90 X50 S200 M3 LF`	Starting point
`G92 A0 X100 LF`	1st thread start (0 degrees)
`:`	
`X50 LF`	Starting point
`G92 A120 X100 LF`	2nd thread start (120 degrees)
`:`	
`X50 LF`	Starting point
`G92 A240 X100 LF`	3rd thread start (240 degrees)
`:`	

12.8.2 Thread re-cutting/setting up

With this function a precut thread with a constant lead can be reloaded and then recut.
A thread with a varying lead cannot be recut!

Procedure:

Select the assigned channel-specific display in the machine area display for ”JOG mode” using the ”Recut thread” softkey. The option can only be selected if the MD is set, otherwise the message ”Option not available” appears.

Over store	INC variable	Recut thread				

The precut thread is loaded in the spindle.

Now use the direction keys to move the tool above one of the thread bases.

Then press the softkey ”Store position”. As a result, the ”Offset angle” and the ”Starting angle (G92A)” are automatically set to zero.

This completes setting up. Now you can start the part program for this thread in ”Automatic” or ”MDA” mode for which the offset angle of the first thread block is used for calculation. This offset angle is used until the softkey ”Delete offset angle” is pressed to set the offset angle to zero.

The offset angle does not remain active after Power On.
The angle is displayed in 3.5 format.
Maximum value: 359.99999 degrees
Resolution = 10^{-5} degrees, without a sign.

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12.9 Thread cutting position controlled spindle (SW 2 and higher)

The function THREAD CUTTING POSITION-CONTROLLED SPINDLE

is an option.

12.9.1 Corresponding data

- Option bit
- NC MD 1320*
  1260*
  1324*
  108*
  521* bit 4
- Signal DB 10 - 13 DR 13 bit 4

12.9.2 Description of function

The function is triggered when the control switches to linear interpolation between the spindle as an axis and the infeed axis. The function will only run if the spindle is in axis mode.

The function can also be used for thread cutting on lathes. Transversal and longitudinal threads (spindle as axis and linear axis) and tapered threads (spindle as axis and two linear axes) can be cut. A linear increasing/decreasing lead (as for G34, G35) cannot be cut with thread cutting, position control spindle (rigid tapping).

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12.9.2.1 Switching on the function

Two G functions are required for the ”Thread cutting position-controlled spindle” function:

G36: Thread cutting, position controlled spindle (rigid tapping)

G36 is modal and belongs to the following G group:

Internal G group division with @36b:

Internal G group	**G functions**														
0	00 MD	01 MD M**/**T	10 MD	11 MD	02 MD	03 MD	33 MD	34 MD	35 MD	06 MD	12 MD	13 MD	**36 MD**		

G group division for all other cases (not for @36b):

Internal G group	**G functions**														
1	00 MD	01 MD M**/**T	10 MD	11 MD	02 MD	03 MD	33 MD	34 MD	35 MD	06 MD	12 MD	13 MD	**36 MD**		

T**/**M = Initial setting**/**turning and milling
MD = Initial setting can be set via MD

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G98 F... Leading feedrate for a rotary axis in rev/min.

The path feedrate is calculated internally on the basis of the leading feedrate of the path axes involved.

G98 is modal and belongs to the following G group:

Internal G group division with @36b:

Internal G group	G functions														
11	94 MDM	95 MDT	96 MD	97 MD		**98 MD**									

G group division in all other cases (not for @36b):

Internal G group	G functions														
12	94 MDM	95 MDT	96 MD	97 MD		**98 MD**									

T = Initial setting for turning
M = Initial setting for milling
MD = Initial setting can be set via MD

When the ”Thread cutting position-controlled spindle” function is selected, G98 is automatically triggered when G36 is called. G98 can also be programmed on its own in a block in the same way as G94, G95, G96, G97. If G98 is programmed together with several rotary axes or with linear axes only, alarm 3006 ”Wrong block structure” is triggered.

12.9.2.2 Switching off the functions

The function G36 is deactivated by programming any other interpolation type (G00, G01, G02, G33 ...) from the 1st G group.

When G36 is switched off, the previous G command from the 12th G group (G94, G95, G96, G97, G98) becomes active.

The function G98 can also be switched off by programming any other command (G94, G95, G96, G97 ...) from the 12th G group.

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Example for thread on a cylindrical workpiece:

```
N10  ...                          (Switch spindle to rotary axis mode)
N20  G0  C30  Z2                  (Position rotary axis to 30 degrees,  position
                                  Z = 2 mm; corresponds to thread insertion point)
N30  G36  C  Z-30  K5  F1000      (Thread lead 5 mm/revolution, clockwise; feedrate of C
                                  axis 1000 rev/min)
N40  C  Z2  K-2                   (Thread lead 5 mm/revolution, counter-clockwise,
                                  feedrate of C axis 1000 rev/min)
:
```

Explanation:

In block N30 the rotary axis must be written with G36 (spindle as axis). A value written behind C is ignored.

To simplify programming, the final point of the rotary axis is not programmed. The control derives the final point from the programmed lead and the path of the linear axis.

The thread lead is programmed under address K (I, J). The sign in front of K shows the direction of rotation (see example above). Clockwise/counterclockwise movement is defined in the Programming Guide in the section Coordinate systems.

A lead must be assigned to the individual axes with G36 as well as with G33, G34, G35. The assignment is stored in MD 304*.

Thread lead 0 or a programmed address where axis and thread lead do not harmonize, triggers alarm 3006 ”Wrong block structure”.

At least 2 axes, of which one is a rotary axis, must be programmed, otherwise alarm 3006 ”Wrong block structure” is triggered.

G98 is triggered internally with G36, i.e. the programmed feedrate F refers only to the rotary axis in **rev/min**.

The resulting path feedrate (C axis and linear axis) is derived internally from the programmed lead.

The rotary axis (in this case C axis) must be written in every block with G36 active (N30/N40).

Starting conditions at block transfers can be influenced with G60 or G64.

Example for thread on a tapered workpiece:

```
N10  ...                          (Switch spindle to axis mode)
N20  G0  C30  X10  Z2             (Position rotary axis to 30 degrees, position
                                  Z = 2 mm, X = 10 mm; corresponds to the thread
                                  insertion point)
N30  G36  C  Z-30  X20  K5  F1000 (Thread lead 5 mm/revolution, clockwise;
.                                 Feedrate of C axis 1000 rev/min)
:
```

Explanation:

In block N30 the rotary axis must be written with G36 (spindle as axis). A value written behind C is ignored.

To simplify programming, the final point of the rotary axis is not programmed. The control derives the final point from the programmed lead and the path of the linear axis.

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The thread lead is programmed under address K (I, J). The sign in front of K shows the direction of rotation (see example above).

Clockwise**/**counterclockwise rotation is defined in the Programming Guide in the section Coordinate systems.

A lead must be assigned to the individual axes with G36 as well as with G33, G34, G35. The assignment is stored in MD 304*.

The address for the thread lead must correspond to the axis with the larger path (in the example path X = 10 mm, path Z = 32 mm thread lead K belongs to axis Z), otherwise alarm 3006 ”Wrong block structure” is triggered. Alarm 3006 is also triggered if thread lead zero is programmed.

Three axes must be programmed, of which exactly one must be a rotary axis. If more than three axes are programmed, alarm 3006 ”Wrong block structure” is triggered.

G98 is triggered internally with G36, i.e. the programmed feedrate F refers only to the rotary axis in **rev/min**.

The resulting path feedrate (C axis and linear axis) is derived internally from the programmed lead.

The rotary axis (in this case C axis) must be written in every block with G36 active (N30).

Starting conditions at block transfers can be influenced with G60 or G64.

12.9.3 Parameter set switchover with thread functions

As the function ”Rigid tapping” can be greatly influenced by mechanical and design aspects of the machine, a second set of parameters (servo gain factor, feedforward control factor, time constant for dynamic feed forward control) can be stored in MD 1320*,
MD 1260* and MD 1324* for adapting the function to the machine. Function G36 is used to switch over to the second parameter set if the second servo gain factor (MD 1320*) has a value other than 0.

Only the parameter sets for the axes involved in the thread cutting operation can be switched.

The values of the second parameter set are loaded by the position controller while the control is booting. It is thus possible to maintain G64 operation when G36 is programmed.

Note:

For further information, please refer to the description of the "Parameter set switchover" function.

12.9.4 Option

The function G36 can only be operated when the option bit ”Rigid tapping” is set, otherwise alarm 2047 ”Option not available” is triggered.

12.9.5 Reset behaviour

If M02**/**M30 is programmed, or on operator panel reset, the initial setting for the first G group stored in MD 108* is active.

The setting of machine data 521*, bit 4 dictates whether C axis mode remains active.

MD 521*, bit 4 = 0	C axis mode remains active.
MD 521*, Bit 4 = 1	C axis mode is switched off with RESET.

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12.9.6 Reading in G functions

G functions G36 and G98 can be read by the user with FB69 via the PLC and with @36b from the NC program.

12.9.7 Interface signal

DB 10 - DB 13 2), bit 4 ”Thread cutting position controlled spindle”
(Rigid tapping)

Byte address	Bit No. 7	6	5	4	3	2	1	0
DR 13				G36				

12.9.8 Display

G36 and G98 are displayed in the display field G functions.

The feedrate F is displayed with G36 and/or G98 are programmed in rev/min (refers to the rotary axis).

12.10 FIFO/predecoding

12.10.1 Rapid block change using FIFO function (up to SW 2 only) 1)

Corresponding data

- NC MD 5186 bit 4 must be set.
- NC MD 9140 bit 0 FIFO active in channel
  9141 bit 0
  9142 bit 0
  9143 bit 0

Description of function

When part programs with short traversing blocks are processed, sudden drops in feedrate can occur because the time taken by the block preparation function to process the short tranversing blocks is longer than the time taken to execute these blocks. The block change time (block preparation + block transfer) is too long in such a case.

A shorter block change time results if processing is carried out with the FIFO function.

A block buffer (FIFO memory) is first filled after NC START or by programming G171.

---

1) The FIFO function is omitted from SW 3 onwards

2) As from SW 4: DB 10 - DB 15

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The next part program blocks are temporarily stored in this FIFO memory in a prepared state (predecoded). Only when the memory is full with such preprocessed blocks is the program started or continued.

The NC can now access the prepared blocks in the FIFO memory and process them in quick succession.

If the NC occasionally processes a block with a longer traversing path or with auxiliary functions, there is time to replenish the FIFO (filling FIFO in background).

It can however happen during a long part program section with short traversing blocks that there is no spare time available to replenish the FIFO memory. As soon as the supply of predecoded blocks in the FIFO memory is exhausted a feedrate drop again occurs.

Filling the FIFO memory with G171

To avoid a drop in the feedrate at an important section of the program, it is possible to fill the FIFO memory selectively before such a program section occurs. Selective filling is initiated by programming G171 in the part program.

This ensures that the following program section from the FIFO memory can be executed with short block change times.

By programming G171, the following occurs in this order:

- Processing stopped
- FIFO memory filled up
- Execution continued

Execution is stopped until the FIFO memory is full, up to a block with M02/30, up to @714 or up to a block which generates a @714 (setting data block).

It only makes sense to program G171 in AUTOMATIC mode.

Behaviour on ”Program hold”

If a part program is stopped and edited during execution, the blocks already in the FIFO memory are no longer changed. On NC START these blocks are traversed in their original condition.

Note:

If the tool offset and zero offset values are altered in the stop state, the changes are included the blocks already in the FIFO memory.

FIFO memory size

The NC CPU has a FIFO memory which can hold up to 60 blocks. This total memory can be divided amongst the individual channels with NC MD 914* bit 0.

The following then applies:

FIFO active in one channel:	60 FIFO blocks available in the channel
FIFO active in two channels:	30 FIFO blocks per channel available.

The FIFO function cannot be activated in more than 2 NC CPU channels. If a FIFO buffer is activated for a channel which does not exist, it is ignored.

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12.10.2 Control of predecoding (SW 5 and higher)

12.10.2.1 Corresponding data

- NC MD 5052* bit 6 Programmed predecoding with G171/G172
- Maximum number of predecoded blocks
- Real number of predecoded blocks

Function description

With the introduction of block buffer management and flexible memory configuration, the number of predecoded blocks per channel (SW 4 and higher) has risen to over 3500 blocks (8 MB CPU, 1 channel). However, the user should note certain general conditions:

- On program start, or after a "Clear buffer" (@714), the predecoding function fills the available block buffer and only leaves a little CPU time for the display, which is then slow.
- The refresh (program stop/start, single block) takes a long time because it is performed on all predecoded blocks.
- The number of predecoded blocks can be limited with the channel-specific setting data SD 204* When the program is run in a small value should be set here (2 to 10).
- The real number of predecoded blocks is displayed in NC SD 206*. See the description of the setting data.
- The two setting data are displayed in the program control display.

Control by the user of predecoding (example):

The main application of the function is testing part programs. In this case the setting data 204* must be set to 2 to limit predecoding and to accelerate testing (e.g. in single block mode).

It is also possible to control predecoding during operation: An auxiliary function (H1234=1234) can be programmed in the part program so that the PLC sets a read-in disable and then scans the setting data 204* for the number blocks. Once these blocks have been predecoded (displayed in SD 206*), the read-in disable is cancelled again. The predecoded blocks are now processed without any drop in velocity.

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12.11 Absolute encoder

12.11.1 SIPOS absolute encoder up to SW 4

12.11.1.1 Functions

The SIPOS encoder system consists of a multiturn absolute encoder which functions absolutely when switched on and incrementally during operation.

To reduce the dimensions of the encoder, part of the encoder electronics are located on a submodule, the absolute submodule. The absolute submodule is plugged on the HMS measuring circuit module.

After each POWER ON, the control requests the encoder absolute value from the absolute encoder and then calculates the absolute position of the machine. The absolute encoder then functions in exactly the same way as a standard incremental encoder with amplified sine and cosine output signals.

The coded disc information (cyclic absolute) and the value from the battery backed tachometer are taken to determine the absolute information. The buffer battery is located on the absolute submodule and stores the information for up to three axes.

Encoder key data:

Max. sampling frequency:	500 kHz
Increments on disc:	2500
Revolution information::	16 bits
Accuracy on POWER ON:	1 µm at a 10 mm spindle pitch (10000 incr./rev)
Error information:	8 bits
Battery back-up:	5800 hours for 3 encoders, built in battery monitoring

Even during operation, the back-up battery level is checked every 10 minutes and a message displayed on the control if a fault occurs.

If an additional back-up battery is installed in the encoder, the measuring circuit module and the encoder cable can be replaced without loss of absolute information. This battery back-up lasts for up to 5 hours.

Since 1 October 1994, the SIPOS encoder has been available only as a spare part for existing installations. The EnDat absolute encoder must be used for new applications.

12.11.1.2 Hardware requirements

The absolute encoder submodule is plugged onto the HMS measuring circuit in the same way as conventional servo command modules.

The absolute encoder submodule is equipped with its own type 8096 processor which determines the values for up to 3 axes.

The absolute encoder back-up battery which is also for up to 3 axes, is located on the absolute submodule.

The SIPOS absolute encoder can only be used in conjunction with the HMS measuring circuit module (high-resolution measuring system).

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12.11.1.3 Synchronizing the absolute encoder with the machine absolute system

After installation or after replacing the absolute encoder, the measuring system must be synchronized with the machine system in the same way as with any incremental system. The absolute encoder is set up with the following NC machine data.

- **Axial machine data:**

  NC MD 240* reference point value
  NC MD 396* absolute offset

- **Machine data bits:**

NC MD 1808*	bit 0 = 1	axis with SIPOS absolute encoder
	bit 2 = 0	absolute encoder same direction as the machine system
	1	absolute encoder opposite direction to machine system
	bit 3 = 0	absolute offset not valid
	bit 3 = 1	absolute offset valid

Definition of terms:

Same direction:	The absolute encoder value rises and falls with the machine absolute value.
Opposite direction:	The absolute encoder value rises as the machine absolute value falls and vice versa.
Direct measuring system:	The absolute encoder is a position measuring system (e.g. linear scale) and is connected directly to the mechanical section.
Indirect measuring system:	The absolute encoder is used to measure position and speed and is therefore connected to the motor.

There are two synchronization methods; these are explained below.

- **Synchronization in ”Reference point approach” mode**

  Like any standard encoder, the SIPOS absolute encoder has A and B tracks and a zero pulse.

  Similar to the incremental system, the encoder is synchronized with the machine system by combining the zero mark of the encoder with the reference point cam signal.

  A distinction can be made between **two cases** by setting NC MD 1808* bit 0 = 1 ("Axis with SIPOS absolute encoder") during reference approach.

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Case 1: NC MD 1808* bit 3 = 0

If the bit "Absolute offset valid" is not set, reference point approach is executed as for an axis without absolute encoder. With "Reference point reached", the calculated absolute offset is transferred to the axial NC MD 396* and NC MD 1808* bit 3 "absolute offset valid" is automatically set for the axis relevant axis.

The absolute offset is automatically calculated according to the following equation:

Machine system = SIPOS absolute encoder value + absolute offset

Absolute offset = machine system - SIPOS absolute encoder value

Where:

- Machine system = desired absolute position = reference point value
- SIPOS absolute encoder value = displayed absolute position (actual value)

Note:

If NC MD 396* has a value other than 0, this value must be taken into account because it is contained in the SIPOS absolute encoder system (= displayed actual value).

Suggestion: Set NC MD 396* before synchronization.

Case 2: NC MD 1808* bit 3 = 1

If bit "Absolute offset valid" is set, reference point approach is suppressed. The condition prevails until the user resets the bit.

In the case of the function G74 "Reference point approach from part program", referencing is not carried out for the second case and processing starts with the following block.

Note:

Reference point approach can be restarted when NC MD 1808* bit 3 has been deleted.

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- **Setting up without a reference point**

  Where there is no reference cam, e.g. for reasons of cost.

  NC MD 1808* bit 0 = 1 is set, i.e. a SIPOS absolute encoder is installed.

  The machine is traversed manually in "JOG" or "incremental" mode to the customer's chosen reference point.

Calculating the absolute encoder offset:

Machine system = SIPOS absolute encoder value + absolute offset

Absolute offset = machine system - SIPOS absolute encoder value

Where the following is valid:

- Machine system = desired absolute position = reference point value
- SIPOS absolute encoder value = displayed absolute position (actual value)

The calculated absolute offset must be entered in MD 396* and declared valid through setting of MD 1808*, bit 3. After the next control power-up, the displayed actual position is synchronized with the machine system and the status signal "Reference point reached" is set.

Notes:

- If NC MD 396* has a value other than 0, this value must be taken into account because it is contained in the SIPOS absolute encoder system (= displayed actual value).

  Suggestion: Set NC MD 396* before synchronization.
- When the SIPOS absolute encoder is set up with reference point approach an overrun control is carried out automatically. An overrun results because the absolute encoder is absolute to $\pm 2^{15}$ revolutions and it cannot be ruled out that on setup an overrun of 0 to 2^{15} revolutions from the zero position will occur.
- When setting up without a reference point the customer must carry out the overrun control. All absolute values used must then have the format ± 99999999 input units.
- If a value larger or smaller than ± 99999999 input units results from the calculation of the absolute offset by the machine system - SIPOS absolute encoder value, it must be corrected as follows:

  Absolute offset > 99999999: Absolute offset - 199999999
  Absolute offset <-99999999: Absolute offset +199999999

Example:

a) Calculated absolute offset = 130000000
   correction: absolute offset = 130000000 - 199999999 = - 69999999

b) Calculated absolute offset = - 130000000
   correction: absolute offset = - 130000000 + 199999999 = +69999999

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12.11.1.4 What happens on warm restart (POWER ON)

When NC MD 1808* bit 0 "Axis with absolute encoder" is set, NC MD 1808* bit 3 "Absolute offset valid" is checked for the relevant bits. If both bits are set, the axis-specific interface signal "Reference point reached" is set on warm restart.

12.11.1.5 Special case ”Parking axis”

The axis-specific interface signal "Parking axis" deletes the signal "Reference point reached" even for an axis with a SIPOS absolute encoder.

12.11.1.6 Absolute encoder error

The absolute encoder errors are displayed axis-specifically in the control with the error message "**Absolute encoder defective**".

The exact type of error is displayed in the "Service number" line in the Service status display menu. The error number is displayed.

Error numbers are explained in the section "Absolute encoder errors".

Note:

- When the absolute encoder is **first switched on**, various absolute encoder numbers are displayed for a period of approx. 10 minutes. This is caused by the back-up battery of the absolute encoder which only establishes error-free communication with the control after a certain charge time.
- All absolute encoder errors are transmitted from the absolute encoder to the control on start-up. It is not possible to acknowledge the absolute encoder errors (e.g. using the reset key). The control can only be informed that the error has been eliminated after a renewed POWER ON.
- The specified axis numbers must be consecutive, i.e. no gaps in the numbering are permitted.

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Comments

- NC MD 1808* bit 3:
  - Software limit switch and leadscrew error compensation are enabled.
  - The leadscrew error between the reference point and the absolute position are included in the calculation.
- Reference point approach with a SIPOS absolute encoder is only possible when NC MD 1808* bit 3 has been reset.
- Information as to whether the SIPOS absolute encoder is in the same or opposite direction as the machine system is required by the control for calculating the absolute value without reference point approach. Once the SIPOS absolute encoder has been synchronized it is very easy to determine the direction of the SIPOS absolute encoder. This is done by traversing the axis concerned to any desired position and starting up the control.

  If, after setting up, positive approach and POWER ON, a larger absolute encoder value is displayed, the system is in the same direction and does not have to be corrected. If a smaller absolute encoder value is displayed, NC MD 1808* bit 2 = 1 must be set. The correct position is then displayed after the next POWER ON.
- If the mechanical traverse direction is changed with NC MD 564*, NC MD 1808* bit 2 must also be adapted correspondingly.

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12.11.1.7 SIPOS absolute encoder errors

With SIPOS, errors can occur in the encoder as well as in the absolute submodule located on the HMS measuring circuit module.

Please note that a faulty connection between the encoder and the absolute submodule can trigger nearly all the error messages because it is along this connection that communication takes place. This transmission line should therefore always be checked first when an error occurs.

The following is a list of all possible error numbers together with the possible cause of error provided that the connection between the encoder and the absolute submodule is not faulty:

Error No.:	**1-50, 93-195, 240-253**
Meaning: Remedy:	Absolute encoder and/or absolute submodule faulty. – Check whether absolute encoder and absolute submodule are damaged. – Check that connectors are firmly in position.
Error No.:	**51-70**
Meaning: Remedy:	Absolute submodule and/or connection between absolute submodule and measuring circuit faulty – Check whether absolute submodule is damaged. – Check that connector between measuring circuit and absolute submodule is firmly in position.
Error No.:	**71-80, 200-230**
Meaning: Remedy:	Absolute submodule faulty/discharge battery (after 10 min. "battery alarm" appears) – Check whether absolute submodule is damaged – Check that encoder connector is firmly in position.
Error No.:	**81-86**
Meaning: Remedy:	Connection between absolute submodule and measuring circuit faulty – Check whether absolute submodule is damaged. – Check that connector between measuring circuit and absolute submodule is firmly in position.

Note:

When sending in faulty components for repair, always state the error number.

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12.11.2 ENDAT absolute encoder (SW 5.2 and higher)

Relevant machine data and alarms

- NC-MD 1264* Grid spacing/EnDat measuring step for linear scale
- NC MD 1804* bit 0 Symmetrical traversing range for ENDAT absolute encoder
- NC MD 1808* bit 0 Axis with absolute encoder
- NC-MD 1808* bit 1 Value range extension of absolute offset (MD 396*)
- NC-MD 1808* bit 2 Absolute encoder counting method opposite direction
- NC-MD 1808* bit 3 Absolute offset valid (MD 396*)
- NC-MD 1808* bit 6 Singleturn absolute encoder present
- NC MD 1820* bit 2 First measuring system with external zero mark
- Drive MD 1011.3 Configuration actual-value acquisition, motor measuring system, absolute encoder with EnDat interface
- Drive MD 1030.3 Configuration actual-value acquisition, direct measuring system, absolute encoder with EnDat interface
- Alarm 1040* Absolute encoder defective

12.11.2.1 Function features

The ENDAT encoder system is an encoder with an absolute encoder section and an incremental encoder section.

The control requests the encoder absolute value from the encoder after every POWER ON or deselection of ”Parking” and then calculates the machine absolute position. After that, the control uses only the incremental encoder section with amplified sine/cosine output signals.

To determine the absolute information several binary-coded scale tracks are evaluated. With the EQN 1325, the tracks are on several gear-coupled discs and on the linear scale with the linear encoder LC 181.

Encoder key data:	Rotary absolute encoder HEIDENHAIN EQN 1325
Max. number of revolutions:	15.000 rpm
Max. sampling frequency:	500 kHz at 6 dB
Increments of the disk:	2048
Detectable number of revolutions:	4096
Activation precision:	Depending on encoder resolution and position controller resolution
Error information:	8 bits

Encoder key data:	Linear absolute encoder HEIDENHAIN LC 181
Max. traversing speed:	40 m/min
Measuring lengths:	240 mm to 3040 mm
Measuring system resolution:	0.5/0.1/0.01 µm
Activation precision:	Depending on encoder resolution and position controller resolution
Error information:	8 bits

The max. number of encoder revolutions is:
- ***± 2048 rev for linear axis***
- ***0 to + 4096 rev for rotary axis***

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12.11.2.2 Hardware requirements

The ENDAT absolute encoder can only be used in conjunction with the new digital SIMODRIVE 611D modules ”Standard and performance”.

Order No.: 6SN1118-0DM13-0AA0 2-axis version (Standard)
Order No.: 6SN1118-0DG23-0AA0 1-axis version (Performance)
Order No.: 6SN1118-0DH23-0AA0 2-axis version (Performance)

The necessary software is available as from NC software version 5.2.

12.11.2.3 Accuracy

Relevant measuring system data

- **Grid spacing:**
  The size of the grid spacing (=size of the pitch period of the finest track) is taken from the company data sheet for the EnDat encoder.
- **EnDat measuring step:**
  The EnDat measuring step (effectively the same as the EnDat encoder resolution) is taken from the company data sheet for the EnDat encoder.
- **Incremental measuring step:**
  The incremental measuring step (= measuring system resolution with which the NC position control is working) results from the interaction between incremental encoder and interpolating evaluation electronics (HW + SW).
  Incremental measuring step = grid spacing**/**product of all pulse multiplications).
- **NC-MD 1264* (grid spacing/EnDat measuring step):**
  The NC requires this MD to convert the EnDat measuring steps into incremental measuring steps. Only input values which are integer and can be divided by 4 are processed by the control. With this MD, the default value = 0 for the encoder EQN 1325 is correct, i.e. it is internally interpreted as value 4. In the list display: User displays**/**NC data**/**Axis**/**Measuring system data, this MD is entered directly after MD 1808*, bit 6.

Example EQN 1325:

Spindle pitch	10 mm
No. of encoder markings, finest track	2048
Internal pulse multiplication	4
External pulse multiplication (interpolation)	512
Position controller resolution	0.5 *10^{-3} mm, (0.5 µm)

$$\text{Rotary grid spacing} = \frac{1 \text{ revolution}}{2048} = 0.000488 \text{ rev.}$$

$$\text{Linear grid spacing} = \frac{10 \text{ mm}}{2048} = 4.88 \text{ µm}$$

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$$\text{Lin. incremental measuring step} = \frac{\text{Linear grid spacing}}{\text{Pulse multiplication}} = \frac{10\ \text{mm}}{2048} * \frac{1}{4 * 512} = 0.002384\ \mu\text{m}$$

The position controller resolution is coarser than the linear incremental measuring step and therefore determines the positioning accuracy. If the incremental measuring step were coarser than the position controller resolution, the incremental measuring step would determine the position controller resolution.

$$\text{Rotary EnDat measuring step} = \frac{1\ \text{revolution}}{2048 * 4} = 1.22 * 10^{-4}\ \text{rev.}$$

$$\text{EnDat measuring step} = \frac{10\ \text{mm}}{2048 * 4} = 1.22\ \mu\text{m}$$

$$\text{NC-MD 1264*} = \frac{\text{Linear grid spacing}}{\text{Lin. EnDat measuring step}} = \frac{10\ \text{mm}}{2048 *} * \frac{2048 * 4}{10\ \text{mm}} = 4$$

Example LC 181:

Grid spacing, finest track	16 µm
EnDat measuring step	0.1 µm
Internal pulse multiplication	4
External pulse multiplication (interpolation)	512
Position controller resolution	0.5 µm = 0.5 * 10^{-3} mm

$$\text{Lin. incremental measuring step} = \frac{\text{Lin. grid spacing}}{\text{Pulse multiplication}} = \frac{16\ \mu\text{m}}{4 * 512} = 0.0078125\ \mu\text{m}$$

$$\text{NC MD 1264*} = \frac{\text{Lin. grid spacing}}{\text{Lin. EnDat measuring step}} = \frac{16\ \mu\text{m}}{0.1\ \mu\text{m}} = 160$$

Calculation of the grid spacing with EnDat absolute encoders using 611D:

$$\text{Meas. system 1: 1264*} = \frac{\text{Drive MD 1022}}{\text{Drive MD 1005}}$$

$$\text{Meas. system 2: 1264*} = \frac{\text{Drive MD 1032}}{\text{Drive MD 1007}}$$

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12.11.2.4 Special features for large traversing ranges

For the linear absolute scale LC 181, the traversing range is predefined through the length of the built-on scale.

An overflow of the absolute value of the encoder EQN 1325 occurs after 4096 revolutions. This means that the calculated position value is unambiguous only over the specified ranges:

- Rotary axis, encoder on load: 4096 load revolutions
- Rotary axis, encoder on motor: 4096 motor revolutions
- Linear axis, encoder on motor: 4096* eff. spindle pitch

With a linear axis having an effective spindle pitch of 10 mm, a traversing range of -20.48 to +20.48 m is covered.

Since it is practically impossible to put the zero point of the encoder in exactly the same position as the zero point of the machine, overflow of the absolute value encoder can occur with large traversing ranges. The NC recognizes this overflow and corrects it appropriately. The complete traversing range can therefore always be utilized. In as from SW 6, the functionality ”Range extension with ENDAT absolute encoder” (see Section 12.11.3) can also be used for larger traversing ranges.

Restrictions with rotary axes

The following restriction applies for rotary axes with absolute encoders in endless operation up to SW 5:

- If the encoder is fitted to the motor the gear ratio to the load must be n:1 (n motor revolutions on 1 load revolution). Only powers of 2 are allowed for n.

In the standard case (encoder : load = 1 : 1) there are no restrictions for endlessly operated rotary axes.
In as from SW 6, any gears can be used with the functionality ”Range extension with ENDAT absolute encoder”.

- ***If a rotary axis does not fulfill the specified conditions, it must be referenced after every endless operation.***
- ***With MD 1808*, bit 6; Singleturn absolute encoder, you can parameterize whether the actual value is to be determined in the range of 1 or 16 load revolutions on POWER ON or after ”Park”.***

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Function extension of the symmetrical traversing range for rotary axes (as from SW 6)

General

In the case of rotary axes with EnDat absolute encoders and up to SW 5, a position between 0 and 360 degrees or between 0 and 16 revolutions was calculated (depending on MD 1808*, bit 6). Once switched off at an axis position of -45 degrees, e.g. a position of 315 degrees was calculated after the next POWER ON.

Bit 0 in MD 1804* must be set to 1 in order to achieve a symmetrical traversing range around the zero position for finitely turning rotary axes. In this case, no modulo offset is implemented between -180 degrees and +180 degrees (if MD 1808*, bit 6=1) or between -8 to +8 rotations (if MD 1808*, bit 6=0).

Examples for incorrect overflow:

MD 1808*, bit 6	MD 1804*, bit 0	Position before POWER OFF	Position after POWER OFF
1	0	-45 degrees	315 degrees
1	1	-45 degrees	-45 degrees
1	0	315 degrees	315 degrees
1	1	315 degrees	-45 degrees
1	1	2700 degrees (=7.5 rev)	180 degrees
0	1	2700 degrees (=7.5 rev)	2700 degrees
0	0	-45 degrees	5355 degrees
0	1	-45 degrees	-45 degrees
0	0	3060 degrees (=8.5 rev)	3060 degrees (=8.5 rev)
0	1	3060 degrees (=8.5 rev)	-2700 degrees (=7.5 rev)

The maximum traversing range for rotary axes remains at 16 rotations above which a modulo offset is implemented.

The symmetrical traversing range is not available in conjunction with the area expansion for the ENDAT absolute encoder (MD 1808*, bit 7=1).

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12.11.2.5 Offset of the absolute encoder from the machine absolute system

On initial installation or after replacement of the absolute encoder, the offset of the measuring system zero to the machine zero must be ascertained or set.

- **Relevant machine data:**

NC MD 240*	Reference point value		
NC MD 244*	Reference point value offset		
NC MD 396*	Absolute offset = Offset (measuring system ZP to machine system ZP)		
NC-MD 1808*	Bit 0 =	1	Axis with absolute encoder
	Bit 2 =	0	Absolute encoder counting method in opposite direction
		1	Absolute encoder counting method in same direction
	Bit 3 =	0	Absolute offset not valid
		1	Absolute offset valid

Notes:

- NC MD 1808*, bit 3:
  Software limit switch and the spindle pitch error compensation are enabled. The spindle pitch errors between the reference point and the absolute position are included in the calculation.
- Reference point approach with EnDat absolute encoders is possible only after resetting of the NC MD 1808*, bit 3.
- The counting methods in the same direction and in the opposite direction are determined as follows. Move the axis to any position, start the control and note down the absolute value. If a larger absolute value is displayed after a positive traversing step and another POWER ON, the system is in the same direction and must not be corrected. If a smaller absolute value is displayed, NC MD 1808*, bit 2 = 1 must be set. After the next POWER ON, the correct actual position is indicated in the display.
- When altering the mechanical traversing direction with NC MD 564*, NC MD 1808*, bit 2 must also be adjusted.

Ascertaining the offset in the ”Reference point approach” operating mode with external reference point encoder

Like any other standard encoder, the EnDat absolute encoder has tracks A and B, but no zero pulse. When the NC MD 1808*, bit 0, axis with absolute encoder, is set, a difference is made between **two types** in the reference point approach mode.

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Type 1: NC MD 1808* bit 3, absolute offset valid, = 0

If the bit is not set, referencing is performed like on an axis without the absolute encoder using the BERO proximity switch as the reference point encoder.

The absolute offset is calculated automatically from the formula:

Machine system = absolute encoder value + absolute offset

or

Absolute offset = machine system - absolute encoder value

Where:

- Machine system = required absolute position = reference point value
- Absolute encoder value = displayed absolute position (actual value) with ”Absolute offset invalid”

Type 2: NC MD 1808* bit 3, absolute offset valid, = 1

If the bit is set, reference point approach is suppressed. This applies until the user resets the bit.

With the function G 74 ”Reference point approach from a part program”, this second type of referencing is not performed and the next block is processed.

Reference point approach is enabled again when NC MD 1808* bit 3=0 is reset.

Limited traversing range

When the traversing range of the absolute encoder is limited due to the position controller resolution, the alarm 1204 ”Traversing range exceeded” and the alarms 148, 152* SW limit switch plus/minus can occur when the system is started up. In this case, it might be possible (depending on the direction) that reference point approach with Bero is not possible. For remedy, proceed as follows:

1st step	Enter the displayed position without the first digit in the NC MD 396*, absolute offset, and set NC MD 1808*, bits 1 and 3.
2nd step	POWER ON. Afterwards, the displayed actual position must be around zero and there is no longer an alarm pending.
3rd step	Reset NC-MD 1808*, bit 3.
4th step	Execute reference point approach.

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Example:

Position controller resolution = $0.5\ 10^{-4}$ mm

Displayed actual position = 140.0000

Positive travel direction

Reference point approach is not possible!

1st step	Enter 40.0000 mm in NC MD 396*, absolute offset, and set NC MD 1808*, bits 1 and 3.
2nd step	After POWER ON, an actual position of 0.0001 is displayed.
3rd step	Reset NC-MD 1808*, bit 3, absolute offset valid.
4th step	Execute reference point approach.

Ascertaining the offset without the reference point encoder

- There is no reference point cam or BERO present.
- NC MD 1808* bit 0: axis with absolute encoder is set (absolute encoder present).

The machine is traversed to the position that the machine manufacturer regards as the reference point manually in ”JOG” or ”Incremental” mode.

Calculation of the absolute value encoder:

Machine system = absolute encoder value + absolute offset

or

Absolute offset = machine system - absolute encoder value

Where:

- Machine system = required absolute position = reference point value
- Absolute encoder value = displayed absolute position (actual value) with ”Absolute offset invalid”

The calculated absolute offset must be entered in MD 396* and be made valid by setting MD 1808*, bit 3. After the next control start-up, the displayed actual position, the machine system actual position and the status signal ”Reference point reached” are set.

For set-up without reference point encoder,

the customer must take care of the overflow handling.

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It must be taken into account that all absolute values have the format± 99.999.999 input units:

In order to be able to enter a larger absolute offset, bit 1 must be set in NC MD 1808*. When this bit is set, the absolute value of 99.999.999 must be deducted from the ascertained absolute offset.

Example:

Absolute offset = -100000010
Set NC MD 1808*, bit 1
Enter -11 in MD 396*

Calculating a correction value:

The smallest traversing range (absmax) of the encoder that is greater than 99999999 must be calculated. This is done by continuous division of the maximum traversing range of the encoder by 2.

Absolute offset>	absmax	absolute offset = - (2 * absmax)
99999999<	absolute offset<	absmax use NC MD 1808*, bit 1
99999999>	absolute offset>	absolute offset>absmax absolute offset+(2 * absmax)

Example:

Assumptions:

Position controller resolution:	$0.5 * 10^{-4}$ mm
Spindle pitch:	10 mm
EQN 1325:	4096 revolutions

Maximum traversing range due to position controller resolution ± 2048 * 10 mm = ±20.48 m

1st step: Traversing range of encoder **/** 2 = 10.24 m > 9.99999999 m

2nd step: Divided again by 2 = 5.2 m < 9.99999999 m

If a value > 10.24 has been ascertained for the absolute offset, 20.48 m must be deducted from this value.

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12.11.2.6 Behaviour on power on)

If NC MD 1808* bit 0 is set the NC MD 1808* bit 3 ”Absolute offset valid” is checked for the corresponding axes. If both bits are set, the axis-specific interface signal ”Reference point reached” is already set on power-on.

12.11.2.7 Special case ”Parking axis”

With the axis-specific interface signal ”Parking axis”, the interface signal ”Reference point reached” is reset on an axis with an absolute encoder too.

If the axis-specific interface signal ”Parking axis” is cancelled and

- NC MD 1808*, bit 3, absolute offset valid, is not set, referencing is suppressed
- NC MD 1808*, bit 3, absolute offset valid, is set, referencing is performed immediately and the interface signal ”Measuring system referenced = Referenced point reached” is set.

12.11.2.8 Absolute encoder error

With the absolute encoder function, errors can occur both in and outside the encoder. Therefore, if an error occurs it is first necessary to check the transmission line between the encoder and the absolute module.

All absolute encoder errors are displayed axis-specifically in the control with the error message ”**Absolute encoder defective**”.

The precise type of error can be found in the line ”Service number” in the menu service status display. The error number is displayed.

If the error numbers are converted to 8-bit binary numbers (calculator accessory), the single error sources are defined as follows:

Bit 0 Not defined
Bit 1 Not defined
Bit 2 Alarm from ENDAT protocol
Bit 3 CRC error
Bit 4 TIMEOUT (shows missing start bit after 4.5 ms)
Bit 5 Wrong (old) hardware
Bit 6 Not defined
Bit 7 Drive ascertains ENDAT encoder error

Detailed information about the causes of error detected by the drive is provided in drive MD 1023* measuring system motor absolute track or in drive MD 1033*, direct measuring system absolute track.

Remedy:

- Check absolute encoder for damage
- Check for correct fit of connectors between absolute encoder and servo loop
- Replace encoder and motor.

12.11.3 Range extension with ENDAT absolute encoder (as from SW 6)

12.11.3.1 Description of function

If an ENDAT encoder is used as the indirect measuring system, a range extension can be set in NC MD 1808*, bit 7. Encoder overflows are recorded and stored in the NC-CPU (SRAM) as a rough encoder position.

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Each time the absolute encoder is evaluated (Power On or deselection of parking axis), both MD 396*, absolute offset, and the rough encoder position are used to determine the actual position. The absolute offset must have been declared active (MD 1808*, bit 3=1). MD 396* is not changed internally and is used as a storage medium to make it possible to load old NC-MD files.

12.11.3.2 Storing absolute information

Until now all absolute information was stored in the encoder. The absolute encoder only had to be restarted (axis measured) after the encoder was replaced. Restart is now also necessary on data loss in the SRAM of the NC-CPU when the range extension of the absolute encoder is used. However, axis measurement is not necessary if an NC-MD file was stored immediately before data loss in the SRAM. Possible applications are:

- SW update
- Replacement of the NC-CPU
- Replacement of the CSB board

Motion limitations when the axis is switched off

When switched off, the axis must only turned through half the definite traversing range of the absolute encoder (e.g. coasting after a power failure). A violation of this condition is not detected by the control and results in an incorrect actual position!

Example:

Rotary axis with position control resolution $0.5 \cdot 10^{-3}$ => 1 revolution=720000 units[MS];

Gearing 1**/**59;

Encoder EQN1325 with a definite traversing range of 4096 rev

Calculation of half of the definite traversing range S_G:

S_G=4096 rev**/**2·1**/**59·720000 Units[MS]**/**rev=24992542.4 units [MS]

S_G is the maximum permissible movement of the axis when it is switched off (=34.7 load revolutions).

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NC MD 3944*

The rough encoder position in NC-MD 3944* currently being used is stored at the following times:

- When an NC-MD file is stored (all NC-MD)
- On NCK Power On
- When ”Parking axis” is deselected.

Linear axes, encoder on motor

The new maximum traversing range is derived from the set position control resolution. Other limitations other than those mentioned above are not necessary.

Rotary axes, encoder on motor

In order to also avoid an error when determining the actual position of endlessly rotating rotary axes (endless traversing range) within one or 16 revolutions, the denominator of the gear encoder**/**load must be entered as NC-MD 3940* during start-up of the machine.

Example: Gearing 33**/**59:

59 encoder revolutions produce 33 load revolutions

MD 3940*=59

If the numerator and denominator of the gear have a common divisor, the denominator should be reduced by this divisor. An example is given in the description of NC-MD 3940*.

Service display

To provide a control for the operator, the number of ENDAT absolute encoder overflows are displayed in the axis service display.

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12.11.3.3 First start-up

Initial state

Initial state standard MD

MD 1808*, bit 3=0	Absolute offset not valid
MD 1808*, bit 7=0	No range extension
MD 1808*, bit 0=0	No absolute encoder exists
MD 3944*=0	Rough encoder position=0, no overflow
MD 3940*=0	Gear denominator=0

Note:

The initial state is equivalent to the standard data setting. If other parameter settings are active, bit 3 in MD 1808* must be set to 0 before continuing with step 1 (i.e.: absolute offset not valid).

Step 1:

Set MD 1808*, bit 0 and bit 7 to 1, with rotary axes the gear denominator is parameterized in NC MD 3940* and an NCK Power On is performed.

Step 2:

The drives equipped with an absolute encoder must now enter the closed-loop control (control e.g. via a small traversing movement). After that, the absolute encoder must be adjusted. The absolute offset is set correctly in MD 396* after the axis has been measured and declared valid by setting MD 1808*, bit 3=1.

Step 3:

With linear axes especially, it is advisable to approach a known position (e.g. a visible mark) and then back up the NC MD at this point. This MD file can then be used at this position after data loss in the SRAM instead of a file saved shortly before.

Note:

After each start-up, the service display should be checked for any number of overflows. After the first start-up, a value between -1 and 1 (usually 0) should be displayed here, in the case of endlessly turning rotary axes this value should be between 0 and 1.

The initial start-up process needs to be repeated whenever the service display shows unreasonably high values. For this, parameterize the following machine data:

MD 1808*, bit 0=1	Absolute encoder present
MD 1808*, bit 3=0	Absolute offset not valid
MD 1808*, bit 7=1	Initialize encoder coarse position

Subsequently, initiate NCK Power On and continue with step 2.

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12.11.3.4 Special start-up cases

Start-up after a SW update

The rough encoder position is not erased when the software is updated. The absolute encoder does not therefore have to be reinstalled.

Foreseeable SRAM failures

Foreseeable SRAM failures occur, for example, when the NC-CPU or the CSB board is replaced. In such cases the following procedure is necessary:

Step 1:
Save the NC-MD as an ASCII file via the MDD on the MMC. This can be performed on the highest machine data level or on the highest NC MD level. It is at this step that the rough encoder position is stored in NC-MD 3944*.

Step 2:
Replace the NC-CPU or the CBS board and then switch on the control. The control now powers up in initial clear mode and the entire SRAM area is erased.

Step 3:
Load the backed up NC-MD file in initial clear mode. After the file has been loaded, CANCEL alarm 1376*, ”Check position absolute encoder” is output. This alarm informs you that start-up is not yet complete and remains active even after a Power Off. The alarm cannot be acknowledged until normal mode is restored (after Step 5).

Step 4:
Set NC-MD 1808*, bit 7, to 0.

Step 5:
Terminate initial clear mode

Step 6:
The drives equipped with an absolute encoder must now enter the closed-loop control (control e.g. via a small traversing movement). However, the limitations for movements apply in the switched off status requiring the axis to be repositioned.

Example:

Traversing movement (JOG 1000 increments) in positive direction
Traversing movement (JOG 1000 increments) in negative direction

Then set bit 7 to 1 in MD 1808* (range extension active)

Step 7:
Initiate NCK Power On and check the position after it has powered up.

12.11.3.5 Start-up after data loss

If data loss in the SRAM occurs because of a hardware fault and it is not possible to back up the NC-MD file, the absolute encoder must be realigned. This task can be simplified with a visible mark on the machine from which the commissioning engineer (Siemens Customer Service) can determine the position offset as accurately as possible.

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12.12 Path dimension from PLC

General notes

You can traverse NC axes directly from the PLC user program via the command channel. Machine control (control response, traverse response) and the displays of the NC remain unchanged.

12.12.1 Execution of the function "Path dimension from the PLC"

The function "Path dimension from the PLC" is activated by the PLC user program via the command channel.

The following are entered in DB 41, e.g. starting at DW6 (m = 6 for the first ASS)

- In DW6: Function number (1 = static path dimension)
- In DW8: Source DB/DX number for the user data DB as well as selection of either DB or DX
- In DW9: DW number as of which entries are to be made in the user data DB

The user must set up a user data DB. The following values can be written in these DBs:

- DWx Length in words (6)
- DWx+1 Channel number/axis number
- DWx+2 and DWx+3 +/- position
- DWx+4 and DWx+5 Axis feed
- DWx+6 G68, G94/95, G90/91.

The function "Path dimension from the PLC" is activated via MD 5018 bit 5. In addition, the number of user interfaces (ASS) must be entered in PLC MD 33 and the function activated with PLC machine data bit 6026.1.

The path dimension is executed directly when the command channel strobe (DB41 DR0) is detected by the NC.

Depending on the path condition in the command channel (G90/G91), either

- an incremental path dimension is traversed or
- an absolute position is approached.

The function "Path dimension from the PLC" **does not** make allowance for

- zero offsets
- tool offsets
- DRF and PRESET shifts.

The axis feeds for the function "Path dimension from the PLC" are likewise transferred via the command channel. These feeds can be linear or rotational. The path conditions G94/P95 are also passed down the command channel.

The required axis is specified as an axis number in the command channel. The axis must be assigned to the mode group via whose NC channel the path dimension is traversed. You must also parameterize the number of the NC channel.

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Manual traverse commands (traverse keys) are ignored while the path dimension is being traversed from the PLC.

If G68 is passed down the command channel, the path dimension on a rotary axis is traversed along the shortest path (< 180°). The function G68 precludes the functions G90/G91. The function G68 is active only for axes to which the partial function ”modulo programming” has been assigned.

12.12.2 Termination of the function ”Path dimension from the PLC”

The path dimension function is terminated when an acknowledgement has been sent to the PLC (command channel).

- Positive acknowledgement (normal mode)
  The function ”Path dimension from the PLC” is acknowledged positively when the remaining path still to be traversed has reached the ”Exact stop window coarse” (MD 204). The acknowledgement frees the channel again, i.e. program mode can be continued or restarted. If the channel is in the RESET state and if the path dimension is started, then an NC start cannot be executed. The channel returns to the RESET state once the path dimension is terminated. The path dimension cannot be started when a part program is running (see negative acknowledgement).
- Negative acknowledgement (error condition)
  If an error occurs during path dimension processing, then the function is acknowledged through specification of an error number (DB 41, DWm + 1).

12.12.3 Interruption

The path dimension function is interrupted when the following conditions are fulfilled:

- Reset by key
- RESET by a PLC user program
- Change in operating mode
- EMERGENCY STOP
- Warm start
- Cancellation of controller enable command
- Follow-up mode
- Parking axis
- Traverse beyond the software or hardware limit switch or the working area limitation.

Note

All alarms which disable NC processing or mode group readiness to operate likewise terminate the path dimension function. There are no additional alarms specific to the path dimension function. If the function is aborted, then it is merely acknowledged negatively through specification of an error number in DB41, DWm + 1. The function is also terminated when the operating mode is changed without initiation of a reset.

When the following conditions are fulfilled, the active path dimension can be stopped; traversal can however be continued until the desired position is reached:

- Feed override 0 %
- Axis-specific feed inhibit (PLC interface signal)

NC stop and feed stop **do not** have any effect on an active path dimension function.

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12.12.4 Meaning of NC MD 5008, bit 7

Bit 7=0: Path dimension is started in the AUT/MDA modes only in the NC stop/RESET state (read-in disable and end of block have no meaning).

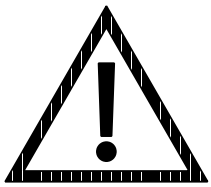
Bit 7=1: Path dimension is started in NC stop/RESET state **or** on read-in disable and end of block.

Default setting: 0

The following conditions generally apply:

	NC MD 5008.7	
	0	1
Reset	+	+
NC stop	+	+
Read-in disable	–	+

\+ Path dimension from PLC can be executed
– Path dimension from PLC cannot be executed



CAUTION

For reasons of safety, it is advisable to set this machine data bit to a **specific value**. The following situation may occur: The NC MD 5008.7 is set and the path dimension from the PLC selected. If the read-in disable is set, then the programmed path dimension is traversed from the PLC as soon as the end of block is reached. The axis traverses without any operator control action (e.g. NC stop) taking place (danger of collision).

12.12.5 Influence of the modes on the path dimension function from the PLC

The function ”Path dimension from the PLC” can be activated in the AUTOMATIC, MDA, TEACH IN and JOG modes. The function is not legal in the REFPOINT and PRESET submodes; in these modes, it is disabled and acknowledged negatively with an error number to the PLC.

12.12.5.1 Path dimension from the PLC and JOG operating mode

If the specified NC channel is free, then the path dimension is traversed as soon as the function is transferred via the command channel.

The path dimension function is disabled whenever:

- An incremental path is being traversed (INC, REPOS)
- A manual path is being traversed, i.e. a traverse key is pressed.

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The path dimension is traversed if the disabling commands are cancelled and all required enabling commands present.

The REPOS offset is updated whenever a program is interrupted in the AUTOMATIC mode and a path dimension then traversed.

12.12.5.2 Path dimension from the PLC and MDA, TEACH IN and AUTOMATIC modes

The following generally applies to the MDA, TEACH IN and AUTOMATIC modes

- If no program is running in the specified NC channel, then the path dimension is started immediately after the command channel transfer. If a program is interrupted in the MDA, TEACH IN or AUTOMATIC modes, not active or JOG, INC or REPOS activated, then the control behaves in the same way as in INC mode (for example, no setpoint/actual value difference is displayed).
- If a program is running in the specified NC channel, then the path dimension can be started - depending on NC MD 5008.7 - either only in the NC stop state or when a read-in disable is set. If a program is stopped in the MDA, TEACH IN or AUTOMATIC modes by a read-in disable and a path dimension transferred from the PLC, then the control behaves in the same way as in AUTOMATIC mode (the setpoint/actual value difference is displayed). While the path dimension is being traversed, the interface signal ”Program in progress” remains active (if the status displays are configured, then the appropriate icon is displayed).

The following effects occur as a result of program influences and the corresponding machine functions:

Block search:	If block search is active, a path dimension cannot be traversed. The path dimension function is not permitted and the request is acknowledged negatively by the PLC.
Overstoring:	If the path dimension function is active, overstoring cannot be activated because NC start cannot be evaluated. If overstoring is active in the path dimension channel, then the path dimension function cannot be activated because the channel is occupied.
Single block:	It is possible to start path dimension after program stop as a result of single block in combination with read-in disable only.
Dry run feedrate:	No effect

Note:

The conditions described apply only to the operating mode group in which the channel selected for path dimension is situated.

Interface signals ”Program interrupted” and ”NC start possible” can be applied as the criterion for NC channel in the stop state.

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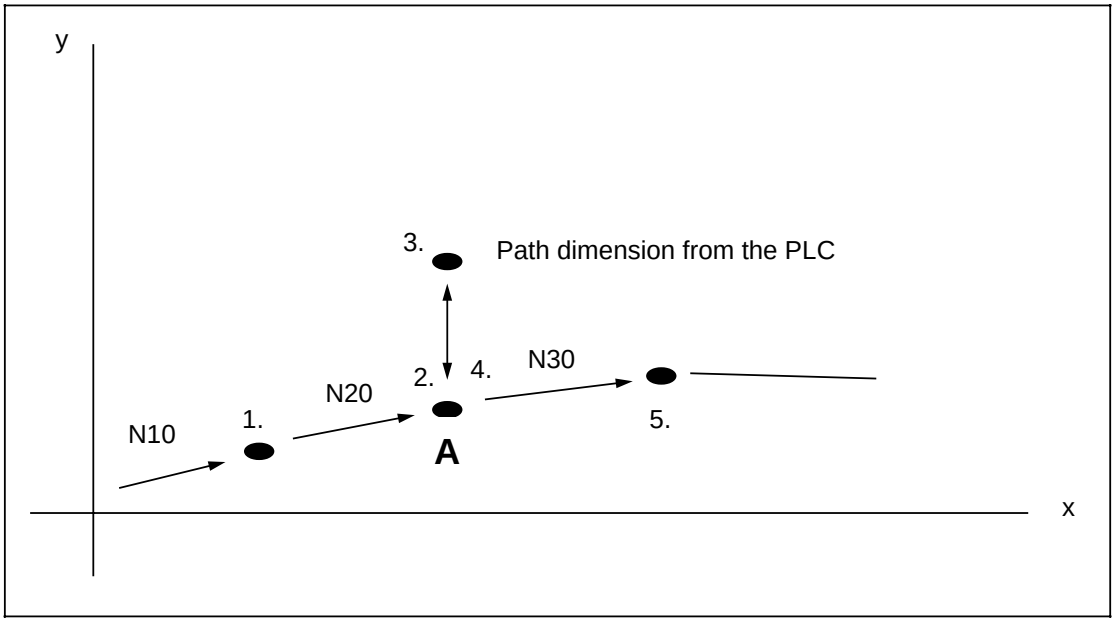
If a path dimension is passed down the command channel, the NC traverses the path dimension as a fixed destination as in INC and REPOS modes. This applies whatever mode has been selected at the machine control panel.

If the path dimension has been traversed and acknowledged to the PLC and the selected mode is AUT or MDA, the axes moved by the PLC are actually in a different position from the one specified in the NC program.

After NC start, the incorrect axis positions programmed in the block before the path dimension are corrected, i.e. the end point of the block is approached again. The other axes are only corrected when they are traversed again in the part program.



As you can see in the above diagram, the axis positions are corrected to the end point of block N20 (point A) after the path dimension has been traversed and NC start executed. Then block N30 is executed (e.g. with a new tool).

Note:

If a path through several revolutions is programmed for rotary axes with G91, the programmed end position is approached again (several revolutions) after NC stop followed by NC start. (Same response as for part program interruption followed by NC start)

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Comments:

- Keys/switches on the machine control panel:

  Direction keys, rapid traverse overlay, axis selector switch have no effect.

- Feedrate override switch:

  The switch position 0% is always active for path dimension, irrespective of the setting of the PLC interface signal ”Feedrate not active”.

- Program control:

  Dry run feedrate and rapid traverse override are not active.

- Facing axis function as a diameter:

  If the path dimension axis selected is a facing axis, the facing axis functions usual in the NC apply. If diameter incremental dimensioning is selected, the path dimension along which the facing axis has to traverse is halved. (MD bit: INC/DRF/handwheel: facing axis functin in diameter).

- Rotary axis traversing functions:

  If the selected path axis is a rotary axis, then the usual NC rotary axis traversing functions such as modulo programming for rotary axes and actual value display modulo 360 degrees apply. The path dimension to be traversed is evaluated by division into degrees according to the selected input resolution.

  On an NC start after a block search with calculation after a rotary axis path dimension, the calculated distance to go is projected within a range of -180° < distance to go < 180°.
  On NC start after automatic interrupt, the complete distance to the part program block end point is traversed!

- Indexing axis

  If an axis is an indexing axis, the path dimension is not interpreted as a division number. The path dimension is traversed as specified.

- Handwheel mode

  Handwheel mode can be active while a path dimension is being traversed (overlay). If you do not want this, you can deselect the handwheel in the machine data or with a PLC interface signal.

- Preset/DRF offset

  The actual value offset DRF and preset apply to the absolute axis actual value.

  When the path dimension axis is traversed to an absolute position, the DRF and PRESET offset are not included in the calculation.

- Rounding axis

  No rounding logic is performed! If the path dimension axis is a rounding axis, the path dimension must be a multiple of the rounding position. (Dealt with as in the part program). A check is made to see whether an incorrect position was given. The path dimension is aborted to prevent an incorrect position from being traversed. (Negative acknowledgement with error/number to the PLC).

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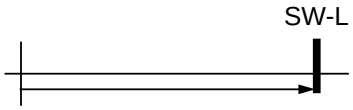
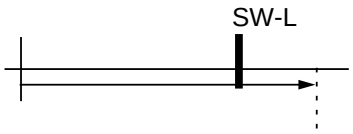
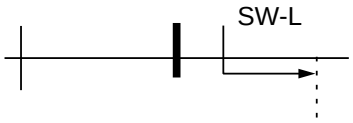
- Software limit switch (SW-L):
  The following effects occur:

1. 

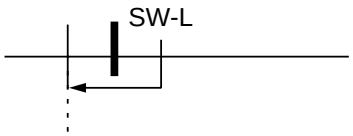
The path dimension is traversed

2. 

The path dimension is not traversed and aborted

3. 

The path dimension is not traversed and aborted

4. 

The path dimension is traversed

- Transformation
  Requirement: Transformation is selected and active.

  The following conditions apply:

  1. Fictitious axis as a path dimension axis
     The path dimension axis is transformed into a real axis and traversed.
  2. Real axis as a path dimension axis
     The real axis is not traversed.
     The path dimension function is aborted and a negative acknowledgement is sent to the PLC.

  If the transformation is not selected and not active and the path dimension axis is a fictitious axis, the path dimension function is aborted.
  Delete distance to go has no effect.
  In-process measurement is not possible.

- Coupled motion
  Requirement: Coupled motion is selected and active.

  The following conditions apply:

  1. Leading axis as the path dimension axis:
     The coupled-motion axes traverse with the leading axis.
  2. Coupled-motion axis as the path dimension axis:
     Coupled-motion axes are not traversed.
     Path dimension is aborted and a negative acknowledgement is sent to the PLC.

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12.13 Indexing function from the PLC

Corresponding data

- MD 244*
  1104*
  1108*
  1112*
  MD 564* bit 3
  MD 564* bit 4
  MD 5018 bit 4, division from PLC (this bit must be set to 1, otherwise the indexing axis is not activated)
- General
- Division in set-up mode
- Division from the PLC
- Explanation of indexing function terms
- Machine data
- Traversing an indexing axis to the reference point
- Monitoring
- Alarms
- Actual value display
- PLC user interface
- Conditions
- Error messages from the NC to the PLC

General

NC axes in (rotary and linear axes) can be positioned at certain grid points using the indexing function from the PLC (setup mode division related).

This function is used for various applications such as positioning auxiliary axes (turrets, tool magazines) as well as for machining teeth (gear machining, tool grinding).

The initial setting of this function and the parameters are set in the machine data.

Positioning in the indexing grid is carried out with traversing keys ”+” and ”–” in JOG or INC mode. It is also possible to traverse an NC axis to the desired indexing position from the PLC via the command channel in NC modes AUT, MDA, JOG, INC and REPOS.

The divisions are calculated in such a way that no additive indexing errors occur. Absolute reference to setpoint and actual position means that the same starting position is always used in calculation. In the case of a rotary axis, the same starting position is always reached even after several revolutions.

Even where a division leaves a remainder, indexing positions are calculated to a tolerance of $0.5 \cdot$ input resolution and approached.

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12.13.1 Division in set-up mode

With this function the indexing positions are traversed incrementally in set-up modes INC and JOG.

INC mode (incremental dimension)

The indexing axis is traversed incrementally by one division when the traversing key ”+” or ”–” is operated. This function is independent of the position on the mode switch. Incremental dimensions INC 10, 100, 1.000, 10.000 have the same effect as INC 1 in the function ”Setup mode division related”.

JOG mode

The indexing axis is moved as for normal JOG mode when the traversing key ”+” or ”–” is operated.

If the traversing key ”+” or ”–” is let go in JOG mode, the axis moves to the next indexing position to be reached in the direction of travel. If the direction is changed, the next indexing position is approached in the direction of travel before changing direction.

12.13.2 Division from the PLC

Division from the PLC is sent via the command channel. The user must specify axis number, division number, velocity, preparatory functions etc.

Division from the PLC can be executed in NC modes AUT, MDA, JOG, INC and REPOS. The indexing position can be approached incrementally and absolutely. These are defined in the preparatory functions in the command channel (G90/G91).

Please refer to the function ”Path dimension from PLC” with regard to the conditions for modes, channels, abort conditions, error behaviour, stop conditions, part program interruption, part program stop, travel behaviour, travel logic etc. with division from the PLC.

Overview: Division from the PLC via command channel

Preparatory function	Rotary axis	Linear axis
G90	Positioning to division number within 360° Limit: 1 ... number of divisions	Positioning to define division number Limit: 1 ... division number below or on software limit switch
G91	Positioning by division number Limit: 1 ... $\frac{10^9 \times ND}{DRD}$	Positioning by division number Limit: none (however a check is made whether <indexing position 1> or the software limit switch should be approached

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Preparatory function	Rotary axis	Linear axis
G68	Positioning to division number along shortest direction of rotation within 360° Limit: 1 to number of divisions	– – –

ND = Number of Divisions
DRD = Division Reference Dimension

12.13.3 Explanation of indexing function terms

Number of divisions:

The number of divisions specifies the number of divisions (e.g. number of magazine locations) per absolute dimension. Any integer between 1 and 999 is possible. The number 0 is not possible!

The number of divisions is defined in NC MD 1104*.

Axis is an indexing axis:

This states that the indexing functions refer to this axis.

This is defined in NC MD 564*.

The axis can be a rotary or a linear axis.

Actual indexing position:

The actual indexing position is the location of the magazine location that has been approached.

Division number:

The division number states for incremental division (G91) the number of divisions by which the axis must be positioned. Where absolute division is programmed (G90), the division number is the setpoint indexing position to which the axis is to be positioned.

Division reference dimension:

The division reference dimension defines the reference path to which the number of divisions refers (see illustration on next page).

Rotary axis: If the indexing axis is defined as a rotary axis, the reference dimension is 360 degrees.

Linear axis: The reference dimension corresponds to a linear path which is divided into divisions.

The division reference dimension can be input by NC MD 1108*. No input need be made for rotary axes since the dimension is set to 360 degrees internally in the control.

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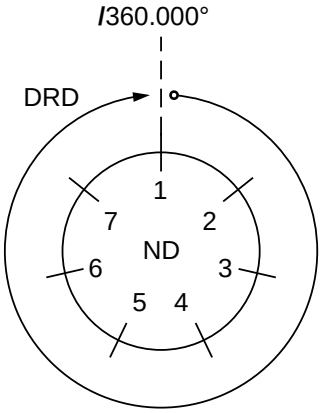
Significance of number of divisions and division reference dimension

ND = Number of Divisions
DRD = Division Reference Dimension

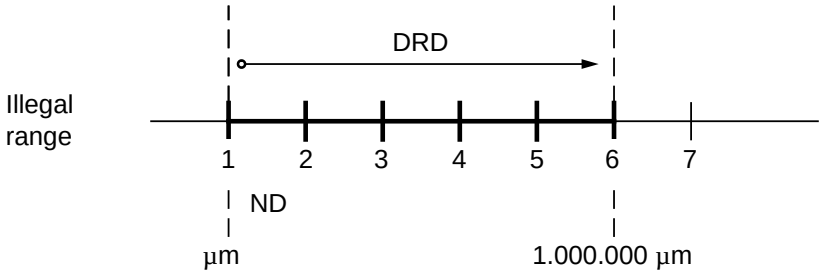
Rotary axis:

ND = 7
DRD = 360 degrees
Input resolution : 10^{-3}



Linear axis:

ND = 5
DRD = 1000 mm
Input resolution : 10^{-3}



Indexing function offset

The indexing function offset defined by how many measuring system units the indexing position ”1” has been offset by the actual value 0.

To calculate the division, the control equates the indexing position 1 with the actual value 0. As these two points do not coincide in most cases, this reference point can be offset. This is done with machine data ”Division offset” in which the distance between actual value 0 and division 1 is defined.

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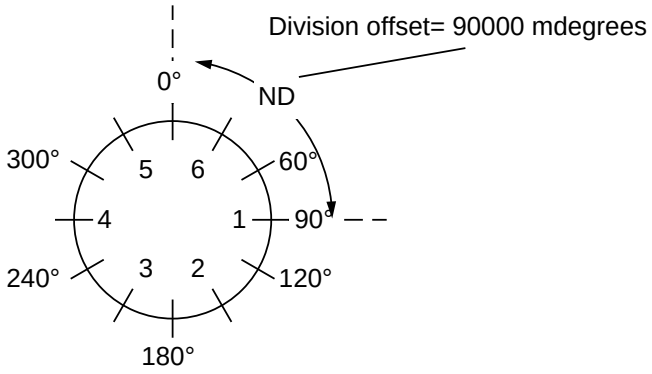
Example:

Number of divisions = 6
Rotary axis Division reference dimension= 360 · 10^3 mdegrees



This offset becomes active as soon an the machine data has been altered.

Incremental division in the specified direction of rotation: (G91)

The indexing axis moves from the current indexing position **by** the number of division specified by the division number. The division number can be larger than the number of divisions.

Absolute division in the specified direction of rotation: (G90)

Rotary axis: The indexing axis is positioned **to** the defined division number within 360 degrees. The division number must not be larger than the number of divisions.

Linear axis: The indexing axis is positioned to the defined division number.

Divisions along shortest direction of rotation: (G68)

For rotary axes only!

The rotary axis is positioned as for G90 to the defined division number within 360 degrees, however the division number is approached along the shortest path (time optimized positioning).

Note:

The listed function behave in the same way as corresponding G functions. However, no G functions are displayed and none are transmitted to the PLC.

Division counter

Several axis actual values in the indexing grid can be displayed for an indexing axis. The division counter converts the actual values into indexing positions. An indexing position can be, for example, an approached location number of a tool magazine or the number of a tooth space on a gear to be machined.

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12.13.4 Machine data for the function "Setup mode division related"

NC MD 1104*:

Name	:	Number of divisions (ND)
Significance	:	Number of divisions per reference dimension
Standard value	:	0
Input value limit	:	1 ... 999
Reference system	:	---
Input resolution	:	---
Active	:	Every 100 ms

NC MD 1108*

Name	:	Division reference dimension (DRD)
Significance	:	Defines the reference to which the number of divisions refers
Standard value	:	0
Input value limit	:	Linear axis
Reference system	:	MS (Machine System)
Input resolution	:	units
Active	:	Every 100 ms

Note:

The rotary axis has an internal reference dimension of 360 degress according to the input resolution. No inputs necessary.

When using the functions with chain magazines, a rotary axis may need several revolutions to match one magazine revolution.

The division reference remains in this case, however, 360 degrees. The rotary axis or chain magazines can be matched with the variable incremental weighting.

NC MD 1112*:

Name	:	Division offset		
Significance	:	Relation between actual value= 0 and indexing position 1		
Standard value	:	0		
Input value limit	:	Linear axis	:	+/ - 1 ... 99 999 999
		Rotary axis	:	+/ - 360 degrees
Reference system	:	MS		
Input resolution	:	units		
Active	:	Every 100 ms		

NC MD 564*, bit 3

Name	:	Actual values division related		
Significance	:	The actual value is converted to an indexing position (if the axis is an indexing axis).		
		Bit 3 = 0	:	No conversion
		Bit 3 = 1	:	Conversion of actual value to indexing position
Standard value	:	Bit 3 = 0 (for all axes)		
Active	:	Every 100 ms		

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NC MD 564* bit 4:

Name	:	Indexing axis
Significance	:	The indexing functions apply to this axis. The axis can be a rotary or linear axis. Bit 4 = 0 : Axis is not an indexing axis Bit 4 = 1 : Axis is an indexing axis
Standard value	:	Bit 4 = 0 (for all axes)
Input value limit	:	1 ... 999
Active	:	Every 100 ms

NC MD 5018* bit 4:

Name	:	Division from PLC
Significance	:	Bit 4 = 0 : Indexing process not in setup mode Bit 4 = 1 : Indexing process also in setup mode
Standard value	:	0
Active	:	Every 100 ms

Notes regarding effects of machine data

If the function is used **workpiece related**, the machine data are altered during workpiece machining and in setup mode. This is possible by:

- altering the MD from the PLC
- altering the MD during configuring (user memory submodule UMS)
- altering the MD via CL 800

If the machine data are altered during configuring, this can be carried out without using the installation mode. They become active immediately after they have been altered without a warm restart or RESET being necessary.

If the indexing machine data are altered during machining with the indexing function, **they become active after approximately 100 ms!**

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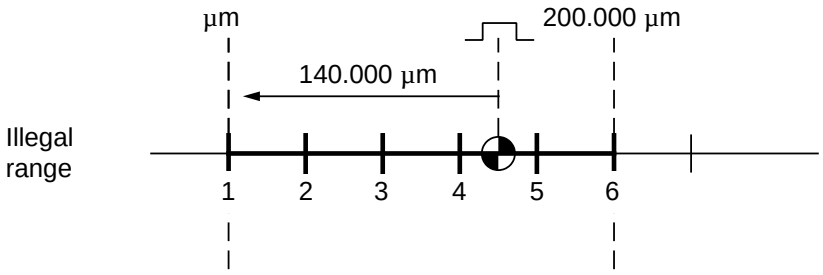
12.13.5 Traversing an indexing axis to the reference point

If the function is used **machine-specifically**, the indexing axis can be traversed to an indexing-specific reference point. The distance between a zero mark and an indexing position can be defined in MD ”Reference point offset”. The indexing axis does not have to be traversed through a reference point to an indexing position. The axis is automatically traversed to an indexing position on the next traversing movement after a reference point approach.

Example:

Linear axis;	ND	=	5	(number of divisions)
	DRD	=	200.000 µm	(division reference dimension)
Reference point		=	140.000 µm	
Reference point offset		=	0	



NC MD 244* should be preset as follows for machine-specific division:

MD 244* : Reference point offset
S = Distance between zero mark and an indexing position

If the function is used **workpiece related**, an indexing axis should be set as described above in order to arrive at the defined division conditions. If the reference dimension, number of divisions or the indexing axis are altered during machining, the actual division reference value is lost.

Note:

The illegal range (indexing position < 1) must no be selected as the reference point.

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12.13.6 Monitoring

Monitoring reacts to illegal MD input values for division:

Permissible input values are:

- Number of divisions : 1 ... 999
- Reference dimension linear axis : 1 ... 99 99 999
- Offset linear axis : +/- 1 ... 99 999 999
  rotary axis : +/- 360 degrees

Otherwise alarm 1200* is triggered.

The monitoring function also checks that the number of divisions and the reference dimension are not equal to 0 (for linear axes) with the indexing axis is selected. Otherwise alarm 1200* is triggered.

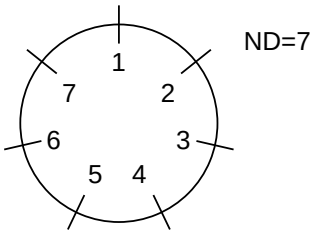
If the axial MD bit ”Software limit switch active” is set, the actual values of the indexing axis are checked.

The monitoring checks to make sure that the axis is not a rounding axis. Otherwise alarm 1200* is set.

12.13.7 Actual value display

The actual values are displayed as divisions if the option ”Indexing function” is set, the axis is an indexing axis, the MD bit ”Actual values division related” is set and the special actual values PRESET offset, axis actual position or workpiece-oriented actual value are selected. The actual values on the service display cannot be displayed as divisions.

- For rotary axes the calculation is modulo ”Number of division”. The division counter counts from the initial value ”1” to the end value (”Number of divisions”) and returns to ”1” when it moves again.
- The calculation for linear axes is absolute. The division counter does not return to 1 after crossing the end value but continues to count.



Example: rotary axis
ND = Number of Divisions

Example: linear axis

- The system does not check whether the linear axis is in the illegal range. Undefined values are used in the calculation (indexing position < 1 refers to the illegal range).
- The division counter
  – **can be read** by the NC via the CL 800 (360, when a division-related display has been set)
  – **can be read** by the PLC
  – can be configured (with its own actual value display with division counter)
  – cannot be written

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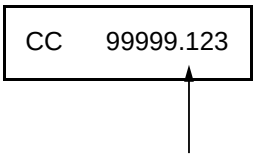
- The division counter display is shown in the following example (example for display resolution 10 E - 3 mm).



The places after the decimal point are used to check travel and to display a non-division position

The number of displayed decimal places after the point depends on the set display resolution. The division counter includes the division offset (MD 1112*) in its calculations. The division offset shows which actual value corresponds to indexing position 1 (offset=0: actual value=0 corresponds to indexing position 1).

Actual value No.	Actual value identification	Actual value division related
0	DRF offset	————
1	PRESET offset	X
2	————	————
3	Actual offset (TO+ZO)	————
4	Actual position	X
5	Distance to go	————
6	JOG offset	————
7	Workpiece related actual value	X
8	Simulation actual value	————
9	Interpolation actual value	————
10	Machine-related actual value with following error	————

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12.13.8 PLC user interface

The parameters for the command channel can be set via two interfaces:

a) User interface UI in the permenantly set data block DB 41
b) Any DB or DX set by the user in which the parameters for the function triggered in the NC are entered.

The user must enter function number 2 in DB 41 for the function ”Indexing function from PLC”.

12.13.9 Conditions for the function ”Setup mode division related”

- **DRF function**

  With the DRF function the position of an indexing axis is altered but not the display actual value.

- **PRESET offset**

  With PRESET offset, the display actual value of the indexing axis is set to a new value. The PRESET value, however, cannot be entered division related. It must be entered as usual as an absolute value or modulo 360 degrees.

- **Handwheel**

  The handwheel is used to traverse the indexing axis across geometry resolutions in the same way as the normal axes (i.e. no divisions).

- Zero offsets, tool offsets

  Zero offsets and tool offsets have no effect on an indexing axis.

- **Coupled motion**

  Prerequisite: Coupled motion is selected and active

  1.) Main axis as indexing axis
  The coupled motion axes are traversed with the main axis.

  2.) Coupled motion axis as indexing axis
  The coupled motion axes are not traversed. Travel is aborted at an indexing position or travel is not activated.

- **Coordinate transformation**

  Prerequisite: Transformation is selected and active

  1.) Fictitious axis as indexing axis
  The indexing axis is transformed and traversed in the same way as a real axis.

  2.) Real axis as indexing axis
  The real axis is not traversed. Travel is aborted at an indexing position or travel is not activated.

- **Linear axes have no ”Modulo number of divisions”**

  Ratio as for rotary axes. Their indexing position is always displayed in absolute values, linear axes cannot approach an indexing position which is < 1!

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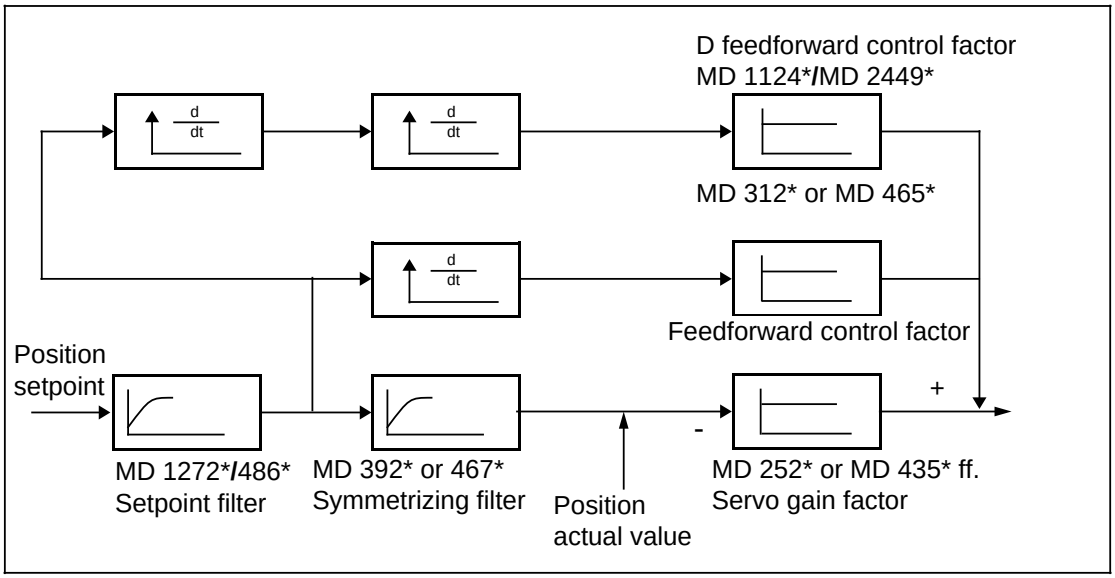
12.13.10 Error messages from the NC to the PLC

Indexing from the PLC is via the command channel. If disturbances occur while this function is being executed, an error message is sent to the user interface.

The error messages are divided into general and function-specific command channel errors.

12.14 Dynamic feedforward control and setpoint smoothing filter

A P feedforward control (MD 312* and MD 465*) and a D feedforward control (MD 1124***/** MD 2449*) with a symmetrizing element to prevent overshoots (MD 392* and MD 467*) are implemented in the position controller. In addition, a smoothing filter in the setpoint path can be activated (MD 1272* with option bit MD 1820*, bit 0**/**MD 486*) to level out dynamic differences between interpolating axes. (See figure for structure of feedforward control). Please note the additional calculation time required for this function.



Note:

The parameters for the 1st parameter set are shown in the diagram above. A total of 8 parameter sets are available. Refer to ”Parameter set switchover” function for further details.

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12.14.1 Feedforward control

The FEEDFORWARD CONTROL function

is an option.

12.14.1.1 Corresponding data

NC MD 312*	P-component feedforward control for axes
NC MD 465*	P-component feedforward control spindle
NC MD 1260*	P-component feedforward control for rigid tapping
NC MD 1124*	D-component feedforward control axes
NC MD 392*	Time constant (balancing filter) for feedforward control for axes
NC MD 467*	Time constant (balancing filter) for feedforward control for spindles
NC MD 1324*	Time constant (balancing filter) for feedforward control for rigid tapping
NC MD 1272*	Setpoint smoothing filter for axes
NC MD 486*	Setpoint smoothing filter for spindles
NC MD	For parameter set switchover (see functional description)

12.14.1.2 Functional description

Static feedforward control

The feedforward control can be used to compensate position errors caused by a following error within a range of 0 to 100 %. The following error is decreased according to the P-component when feedforward control action is applied. A differential component of the control can also be specified for axes, although this is generally not required. As a result of the static feedforward control, the axis also travels "harder" into the specified position.

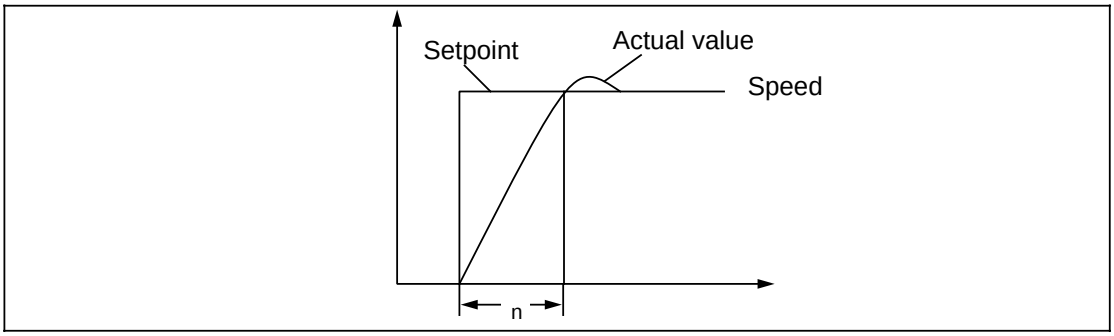
Recommended setting: Feedforward control P-component: 1000 $\hat{=}$ 100 %

Dynamic feedforward control

A very high static feedforward control setting may however cause severe overshoots on acceleration. In this case, the partial setpoints can be passed to the position controller, delayed by an additional time constant for feedforward control (balancing filter). This PT1 element compensates the rise time of the speed control loop.

Recommended setting: Feedforward control time constant: $T_{feedf}=0.5 \cdot T_n$

T_n= Rise time of the speed control loop



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Setpoint smoothing

A position overshoot may occur even when the dynamic feedforward control setting is correct. In this case, an additional PT1 element (setpoint smoothing filter) can be used to slightly flatten the position setpoint ramps or to smooth the setpoint peaks so that the position control has enough time to correct the setpoint changes.

Note:

From software version 3 of the SINUMERIK 840C onwards, the machine data dialog includes an optimization menu which allows settings to be optimized on the basis of measuring curves. See Section MACHINE DATA DIALOG for further details.

12.14.2 Setpoint filter in drive (SW 4 and higher)

In conjunction with 611D feed drives or main spindle drive DSP, it is possible to activate preliminary filters in the speed setpoint channel to allow utilization of the feedforward control function and a high servo gain, even with high natural resonance values. This filter is calculated in the drive and parameterized by means of drive MDs. Low-pass, band-stop and compensation filters are available.

It may be necessary to adjust the balancing time constant (MD 392*/MD 467*/MD 4657*) in the control when the preliminary filter function is used. With SW 4 and higher, please note description of "Parameter set switchover" function.

The filtering effect can be checked by means of the servo drive start-up application. The filter functionality is available only for digital drives.

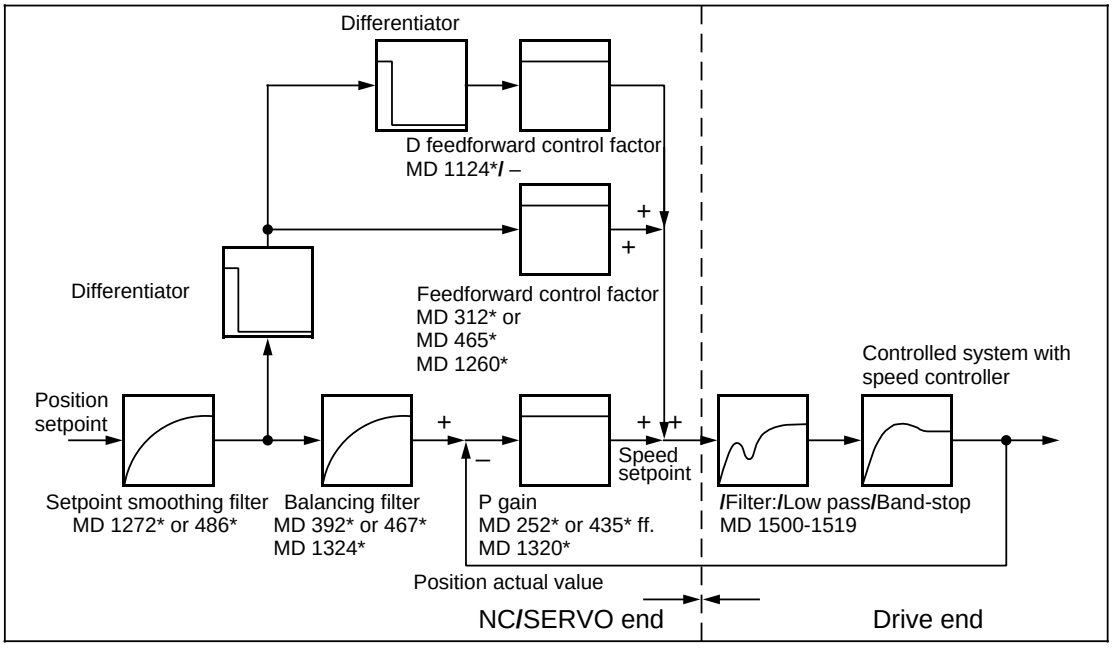

Fig. Position controller structure with filters

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12.15 Switchover measuring system 1 or 2 (SW 2 and higher)

12.15.1 Corresponding data

NC MD 200*	1st measuring system connection	
NC MD 220*	Backlash compensation 1st measuring system	
Spindle MD 400*	Measuring system connection	
Spindle MD 461*	Assigned C axis	
Axial MD 1288*	Torque compensatory controller reset time	
NC MD 520*	bit 1	Sign change actual value
NC MD 521*	bit 1	Sign change setpoint value
NC MD 564*	bit 1	Sign change setpoint value
NC MD 564*	bit 2	Sign change actual value
NC MD 1820*	bit 1	Zero monitoring ON
	bit 6	Pulse coder monitoring ON
Signal DB 32 DL k+2	Measuring system 1/2	

12.15.2 Feed axes

Two actual value inputs are available for each axis with this function.

To compensate for offsets after switching on the control and before reference point approach, the function ”Second measuring system” can be implemented to activate an absolute encoder as the first measuring system (indirectly connected) and a linear scale (directly connected) as the second measuring system. This means that the absolute actual position of the axis is known directly after switching on (except for the backlash). After this it is possible to switch over to the second measuring system (e.g. linear scale).

Reference point approach is always executed with the currently selected measuring system.

The first measuring system always serves as the reference system in the control, it determines the resolution of the position control. Only the actual values of the selected measuring system are used for the position control.

It is possible to switch to the second measuring system via the axis-specific PLC control signal (DB 32, DL k+2). It is possible to switch between the two measuring systems at any time, axes do not have to be at zero speed to do this.

SPC or HMS measuring circuit modules can be used as measuring circuits for the second measuring system. It is not possible to connect absolute encoders to the second measuring system. Linear scales with distance coded reference marks can be connected.

Compensation functions:

- A parameterized lead screw error compensation is permenantly assigned to the first measuring system. The actual values of the second measuring system are not compensated. While the second measuring system is active, the control ensures that the lead screw error compensation will take effect when the first measuring system is activated.
- The quadrant error compensation always uses the actual values of the active measuring system.
- Compensation values for the backlash can be set for each measuring system separately (MD 220***/**MD 1288*).
- Temperature compensations always effect the actual value of the active measuring system.

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12.15.3 Measuring circuit monitoring and alarm processing

- The functions pulse code monitoring and zero monitoring are either active or inactive for both measuring systems (selection made via MD 1820*, bit 1 and 6).

  If an error is detected in one of the two measuring systems, the associated alarm is triggered (alarm 140* ”Pulse code monitoring”, alarm 144* ”Zero mark monitoring”). They are acknowledged with the RESET keys.

- The absolute encoder error alarm 1040* ”Absolute encoder defective” and alarm 1044* ”Battery absolute encoder submodule” are also triggered irrespective of the measuring system currently active.

- Measuring circuit monitoring for alarm 132* ”Control loop hardware axis” and alarm 136* ”Contamination measuring system” are only active for the active measuring system. This makes it possible to change the encoder on the inactive measuring system without having to carry out a warm restart of the control. If one of these errors still exists when the other measuring system has been selected, the alarm in question is triggered.

12.15.4 C axes to spindles

For the function C axes to spindles, the second measuring system has a different definition. Here the first measuring system is the axis measuring system parameterized in MD 400*. The second measuring system is defined in MD400* via the spindle machine data. Any additional second measuring system defined in the axis machine data is ignored.

The measuring system parameterized in MD 200* (first) is permanantly assigned to a spindle with C axis for C axis operation, the second measuring system is used for the spindle operating modes and must be parameterized with MD 400*. C axis/spindle are assigned in MD 461*.

Control bit ”Measuring system 1/2” in DB32 can also be used for C axes, however the switchover tolerance MD 1216* has no effect. If the control signal is kept to ”1”, the mode controlled measuring circuit switchover spindle C axis measuring system is disabled. This means that

- if a reference point approach is executed with the C axis, synchronization is with the precision of the spindle encoder,
- the limit frequency of the spindle encoder remains active, i.e. C axis mode with higher feedrate is possible.

The spindle encoder (MD 400*) is always used in the spindle modes, i.e. the switchover signal only effects C axis mode.

If different encoders are being used for spindle and C axis mode, please ensure that the control directions of the axis and spindles are parameterized in the same direction of rotation in MD 564*, Bit 1 and bit 2 and MD 520*, bit 1 and MD 521*, bit 1. The correct parameterization cannot be ascertained by the system software from the MD bits. The spindle direction of rotation can be reversed from the PLC with the interface signal ”Invert MD 3/4”.

For backlash compensation and lead screw error compensation the following applies: if spindle and C axis encoder are different, backlash compensation and lead screw error compensation are only active in C axis mode (for first measuring system), if identical encoder definitions have been entered for the spindle and C axis, backlash compensation and lead screw error compensations are active in the position control mode M19 (M19 absolute, M19 through several revoltions) and C axis mode.

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12.16 Quadrant error compensation (SW 2 and higher)

12.16.1 Corresponding data

MD 1232*	Compensation value in range 2
1236*	Comensation time constant
1240*	Compensation value in range 4
1244*	Upper limit range 1 (a_1)
1248*	Upper limit range 2 (a_2)
1252*	Upper limit range 3 (a_3)
1256*	Smoothing time constant
MD 1804, bit 6	Quadrant error compensation
1804, bit 7	Adaptation

Technical reasons for quadrant error compensation

If an axis is accelerated from a negative to a positive velocity (or vice versa), it sticks when passing through zero speed because of the changing friction conditions. This action causes contour errors with interpolating axes. This action seriously effects machining of circular contours, where one axis moves at the maximum path velocity whereas the second axis is still at the quadrant transition point. Measurements on machines have shown that this disturbing friction moment can be compensated for by applying an additional speed setpoint pulse (with a high enough amplitude and correct sign).

Other measurements have shown that the compensating amplitude of the friction feedforward value does not remain constant across the whole acceleration range. Where the acceleration is higher, feedforward control must be applied with a smaller compensation value than for smaller acceleration. For this reason, a quadrant error compensation (QEC) with adapted amplitude has been developed.

12.16.2 Parameterization

Quadrant error compensation is activated axis-specifically via MD 1804*, bit 6. If MD 1804*, bit 7 is set, the adaptation characteristic (see Fig. 1) also becomes active.

The following machine data are available for parameterization:

MD 1232*	Compensation value in range 2	[0.1 mV]	[0.01 %] 1)
MD 1236*	Compensation time constant	[0.1 ms]	
MD 1240*	Compensation value in range 4	[0.1 mV]	[0.01 %] 1)
MD 1244*	Upper limit range 1 (a_1)	[100 units MS/s^2]	
MD 1248*	Upper limit range 2 (a_2)	[100 units MS/s^2]	
MD 1252*	Upper limit range 3 (a_3)	[10000 units MS/s^2]	

QEC is the abbreviation for Quadrant Error Compensation

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12.16.3 Installation

The compensation value of the QEC essentially depends on the machine configuration.

The easiest way to install QEC is to carry out a circularity test. With a circularity test, deviations from the programmed radius when a circle is described can be measured and displayed graphically, most especially at the quadrant transition points. To obtain an optimum compensation in the whole working range of the QEC, the compensation dependancy on the acceleration must also be considered. This is done by measuring this dependancy at various points in the range between acceleration 0 and set maximum acceleration. The characteristic obtained from these measurement results must then parameterized axis-specifically in machine data 1232*, 1236*, 1240*, 1248*, and 1252*

See Section 5, MDD, Section File functions, for a description of how to save NQEC data.

---

1) 100 % in the two compensation values from MD 1232 and 1240* correspond to a speed setpoint of 1V in analog drives and to 10 % of the maximum speed set in the drive system in digital drives.*

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12.16.3.1 Installation without adaptation characteristic

The installation is carried out in two stages. In stage one, the QEC without adaptation (MD 1804*, bit 6 = 1) is derived.

Two parameters (compensating amplitude and compensation time constant) can be altered. These two parameters are each increased or decreased until the deviations from the programmed radius become minimal or have completely disappeared in the circularity test at the quadrant transition point (figures 2 - 6).

A starting value of a relatively small compensating amplitude (e.g. MD 1232* = 100) and a time constant of a few position controller cycles (e.g. MD 1236* = 80) should be defined at the beginning of the measurement.

Changes can most clearly be seen when the circularity test is first carried without QEC (MD 1804*, bit 6 = 0).

Figure 2 shows typical quadrant transition points without QEC.

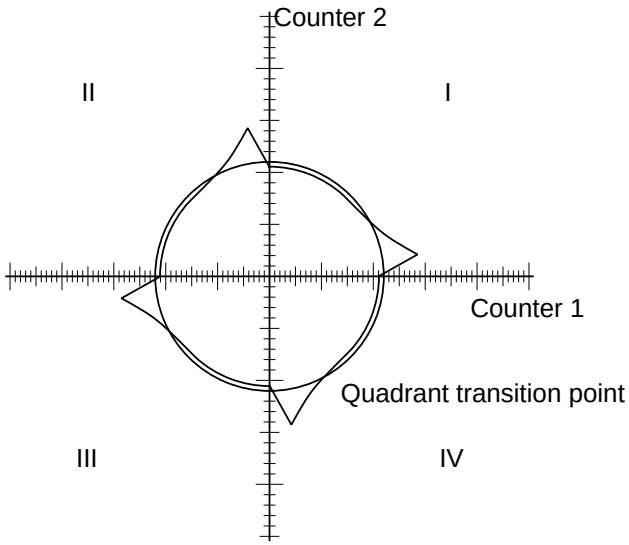

Figure 2 Radius deviations at the quadrant transition points without compensation

Setting the compensating amplitude

If the compensating amplitude is too small, the circularity test shows that the radius deviations from the programmed radius at the quadrant crossover points have insufficient compensation (see Figure 3).

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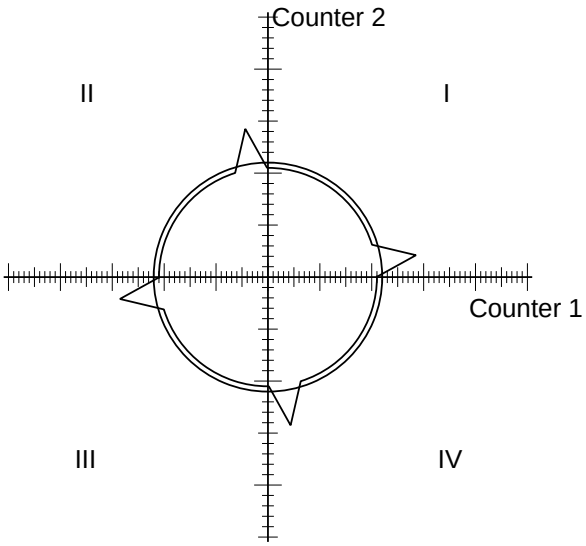

Figure 3 Radius deviations at the quadrant crossover points with insufficient compensation

If the compensating amplitude is too high, the circularity test clearly shows the overcompensation of the radius deviations at the quadrant crossover points (see Figure 4).

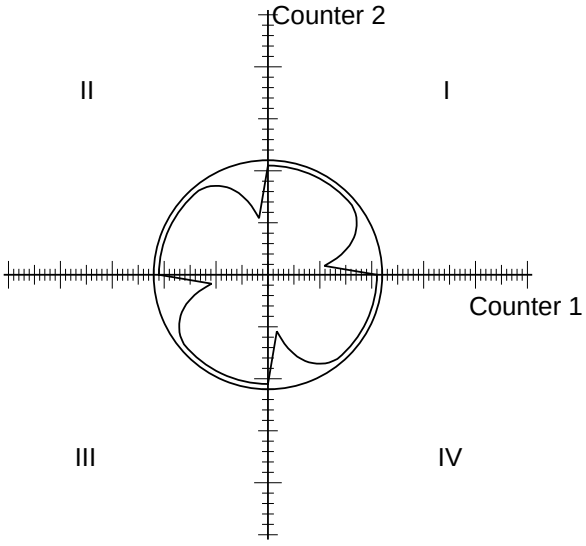

Figure 4 Compensating amplitude too high

Setting the compensation time constant

If the compensation time constant used in the circularity test is too small, the test shows that the radius deviation is compensated for a short time at the quadrant transition points but that larger radius deviations from the programmed radius again occur immediately after (see Figure 5).

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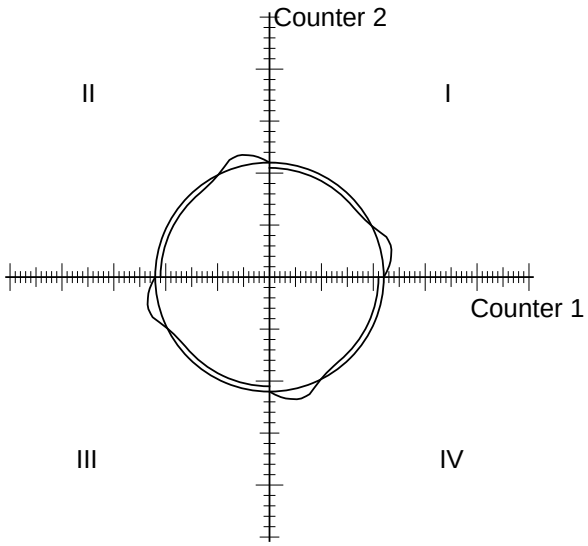

Figure 5 Compensation time constant too small

If the value for the compensation time constant chosen for the circularity test is too high, we see that the radius deviation at the quadrant transition points is compensated for (it is assumed that the optimum compensating amplitude has been found), but that after the quadrant transition point the radius deviation is less that the programmed radius (see Figure 6).

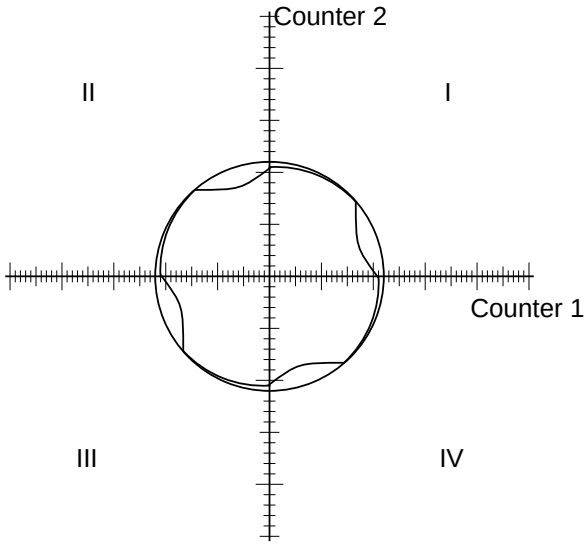

Figure 6 Compensation time constant too large

If it is not possible to find a uniform compensation time constant for the various radii and velocities, the average value of the derived time constants is used.

If it has been possible to achieve a good result with these time constants and the constant compensating amplitude across the whole working range, i.e. for all required radii and velocities and for positioning, characteristic adaptation (MD 1804*, bit 7) is no longer needed.

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12.16.3.2 Installation with adaptation characteristic

If the compensation is acceleration dependant, a characteristic must be determined in a second stage.

The required compensation amplitudes for differend radii and velocities are determined, the effect of the compensating amplitudes checked in a circularity test and the optimum compensation amplitudes logged.

The following characteristic is used for the adaptation:

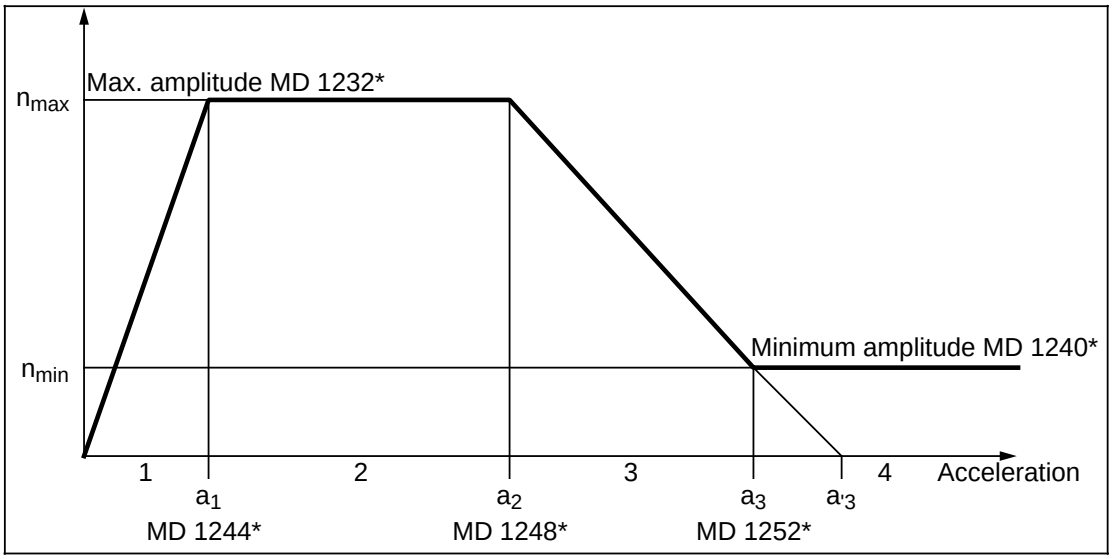

Figure 1

A distinction is made between four ranges in the characteristics:

$$n = \begin{cases} n_{max} \cdot \dfrac{a}{a_1} & \text{for } a < a \\ n_{max} & \text{for } a_1 \quad a \quad a_2 \\ n_{max} \left(1 - \dfrac{a - a_2}{a_3 - a_2} \right) & \text{for } a_2 < a < a_3 \\ n_{min} & \text{for } a_3 \quad a \end{cases}$$

The characteristics in Figure 1 are used for the following examples. It is defined by the values ”Maximum compensating amplitude”, ”Minimum compensating amplitude” and the three acceleration values a_3, a_2 and a_1. Considerably more measured values should be determined as a control, most importantly there should be a sufficient number of points for high velocities with small radii. The characteristic values are most easily derived from a graphic representation.

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The acceleration values are derived from | a | = v^2/r from the radius and travel velocity. The acceleration value can easily be varied using the override switch.

Before entering these acceleration values a_3, a_2 and a_1 in machine data 1244*, 1248* and 1252*, it may be necessary to convert to the input format of the machine data ([mm/s^2] [100 units MS/s^2] and/or [10000 units MS/s^2]).

A monitoring function in the control ensures that incorrect parameterization of the characteristics for the friction feedforward control are avoided.

The following conditions must be met when entering accelerations a_3, a_2 and a_1 for the characteristic.

$$a_1<a_2<a_3$$

If this condition is not met, parameter error 328 is output. The user should therefore follow the input sequence a_3, a_2 and then a_1 when entering the acceleration values . Parameter error 328 is also output if internal formats are exceeded as a result of calculation errors when determining the accelerations from inputs a_3, a_2 and a_1. If this happens, the user must check whether the break points in the curve have been correctly calculated and/or have been entered in the correct input format (caution: MD 1252* uses a format factor 100 larger than MDs 1244* and 1248*!)

Example for setting the characteristic:

a) To derive the actual acceleration

The acceleration when passing through zero speed in a circular path is calculated as follows:

a = v^2/r

A radius of 10 mm and a circular velocity of 1 m/min = 16.7 mm/s produces an acceleration a = 16.7^2/10 [mm/s^2] = 27.78 mm/s^2.

b) Entering the characteristic break points

The following accelerations were determined as the characteristic break point:

a_1 = 1.11 mm/s^2, a_2 = 27.78 mm/s^2, a_3 = 695 mm/s^2

The position control resolution 0.5 · 10 - 4 mm was selected, resulting in:
1000 units[MS] = 1 mm

The characteristic break points are therefore:

a_1 = 11100 units/s^2, a_2 = 277800 units/s^2, a_3 = 6950000 units/s^2

The following values must therefore be entered in the machine data in the given order:

MD 1252* = 695, MD 1248* = 2778, MD 1244* = 111

If unsatisfactory results are obtained for very low speed values,

a) increase the position control resolution

b) raise the smoothing time constant (MD 1256*), values 100 ms are recommended

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12.17 Axis converter / spindle converter (SW 2 and higher)

12.17.1 Corresponding data

- SDD 600*
  602*
  604*
  606*
  608*
  610*
  612*
  626*
  628*
  630*
  632*
  SD 540* bit 0
- MD 304*
  548*
  550*
  552*
  568*

General

The function axis/spindle converter implements the assignment of the axis/spindle names of a neutral part program to the axes and/or spindles defined in the machine. The function is activated with MD 5186, bit 2 and MD 5006, bit 6.

This makes it possible to run the same part program on machines with different axis names as well as on the same machine tool but with different channels.

12.17.2 Axis converter

12.17.2.1 Description of function

If the converter is active, it converts the axis address (and address extension) in neutral part programs into a different axis address (and address extension).

Up to 8 axes per NC channel can be converted at the same time.

Example:

X	X3
Y4	Q14
Z10	Y2
X3	X

This list is stored in binary form in the setting data

SD 626*	1st prog. axis channel-specific	SD 628*	1st machine axis channel-specific
SD 630*	2nd prog. axis channel-specific	SD 632*	2nd machine axis channel-specific
...	...	...	...

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These setting data can be altered via @311, @312, @411, @412 @/PLC/RS 232 C (V24).

The status active/inactive of the axis converter is stored in SD 540* bit 0.

Conversion functions are active in AUTOMATIC, MDA and TEACH-IN modes but not with overstore.

In the following machine data

304* Interpolation parameter name
568* Axis name
548*
550* } Axis name of set of planes
552*

the values (axis addresses) must refer to the axes which can be traversed after conversion at the machine.

Operation is via the conversion display.

12.17.2.2 Programming

The status active on/off can be set and the axis conversion list can be read or written via @311, 312, 411 and 412.

Interfaces - axis converter

The data can be transmitted via RS 232 C (V.24).

12.17.3 Spindle converter

12.17.3.1 Description of functions

This function makes it possible to execute part programs with spindle definitions on a machine on which these spindle names are either not defined or which have a different designation.

The spindle converter is switched on and off from the PLC. In the same way the spindle names are defined from the PLC via the NC data channel.

The spindle address letter does not have to be transferred as it is always the same.

A maximum of 3 spindles can be converted simultaneously per NC channel.

Example:

S	S4
S1	S2
S2	S5

This list is stored in binary format in the setting data as follows:

SD 600*	1st prog. spindle channel-specific	SD 602*	1st real spindle channel-specific
SD 604*	2nd prog. spindle channel-specific	SD 606*	2nd real spindle channel-specific
SD 608*	2nd prog. spindle channel-specific	SD 610*	2nd real spindle channel-specific

SD 612* Spindle conversion list on/off (1 = on, 0 = off)

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These setting data can be altered via @311, @312, @411, @412 @/PLC/RS 232 C (V24).

The spindle converter is only active in AUTOMATIC, TEACH-IN and MDA modes but not with overstore.

The AUTOMATIC basic display does not show that the spindle converter is active.

12.17.3.2 Programming

1) The conversion status (spindle converter) on/off and the spindle conversion list can be read or written via @311, 312, 411, 412. The spindle number must be entered in binary format.

Example:

```
R10   =   6000    (Address SD first programmed spindle channel 1)
R0    =   101     (Spindle No. 5)
@411      R100    R0
```

2) The PLC can alter the spindle groups during an active part program via FB61/62 (see function macros).

The NC and the PLC, however, run as synchronously. The following block combination must be written in the part program to synchronize the PLC with the part program:

```
N10  Mxy  LF
N20  @714  LF
N30  S1=500  M1=03  LF
```

The auxiliary function (here Mxy) in the block tells the PLC that the read-in disable must be placed here.

The function @714 stops block processing and empties the NC channel buffer.

Now the PLC can read the spindle conversion data via FB62 into the setting data of the NC. After this, read-in disable must be cancelled.

The block is converted to S2 = 500 M2 = 03 if S1 = S2 is assigned in the active spindle converter.

Caution:

S1 has been declared the leading spindle. If block N30 were to be programmed as follows

```
N30  S1=500  M03  LF,
```

then S1 = 500 would be converted to S2 = 500, but the M function conversion M03 to M2 = 03 would not take place, i.e. spindle S2 would not rotate.

Only if S2 is declared the leading spindle will spindle S2 turn at the speed 500 rev/min in the above case.

12.17.3.3 Interfaces

The spindle converter can be switched between read/written and on/off channel-specifically via the PLC with function block 61/62.

The data can be transmitted via RS 232 C (V.24)

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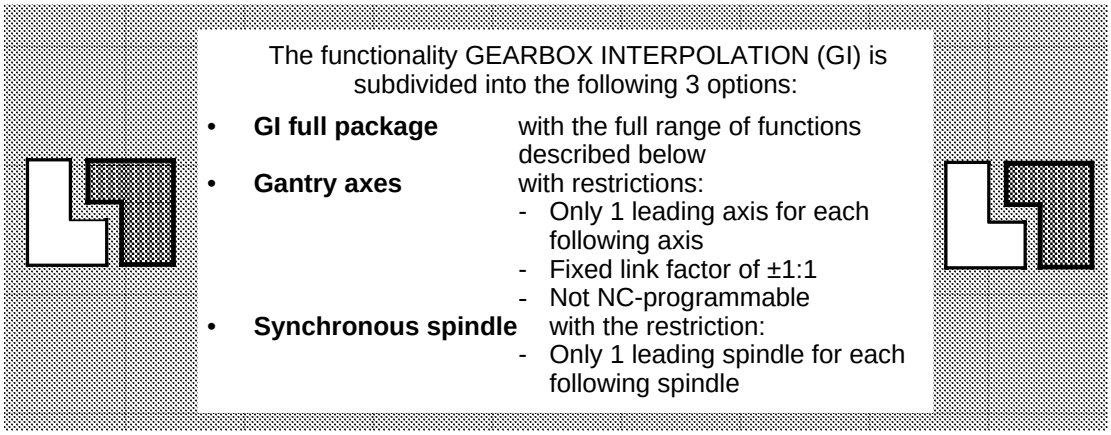
12.18 Functional description of gearbox interpolation (up to SW 3)



12.18.1 Corresponding data

Machine data

• NC MD 312, 313		Assignment mixed I/O for emergency retraction to one mode group
• NC MD 5006	Bit 4	Key switch interlock of input display
• NC MD 588*/528*		Tilting output bit on emergency retraction
• NC MD 1328*		Substitute time constant of setpoint filter
• NC MD 1420*/487*		Parameter for compensatory controller of following axis/spindle, P-component
• NC MD 1424*/488*		Parameter for compensatory controller of following axis/spindle, I-component
• NC MD 1428*/489*		Parameter for compensatory controller of following axis/spindle, D-component
• NC MD 1432*/490*		Time constant parallel model for following axis/spindle
• NC MD 1436*/491*		Tolerance band for fine synchronism of following axis/spindle
• NC MD 1440*/492*		Tolerance band for coarse synchronism of following axis/spindle
• NC MD 1444*/493*		Emergency retraction threshold for following axis/spindle
• NC MD 1448*/494*		% warning threshold n_{max} and a_{max} for following axis/spindle
• NC MD 1452*/495*		Delay controlled follow-up for following axis/spindle
• NC MD 1456*/496*		Default setting for link structure
• NC MD 1736*-1768*		Alarm limit velocity 1st-8th PaSe
• NC MD 1844*/525*	Bit 0	Axis/spindle may be FA/FS
• NC MD 1844*/525*	Bit 1	Reconfiguration allowed
• NC MD 1844*/525*	Bit 2	Switchover of link factor allowed
• NC MD 1844*/525*	Bit 3	Overwriting of positions allowed
• NC MD 1844*	Bit 4	LINK_ON after Power On
• NC MD 1844*/525*	Bit 5	Test bit compensatory controller
• NC MD 1848*/526*	Bit 2	Block change with synchronism fine
• NC MD 1848*/526*	Bit 3	Suppression of acceleration limitation
• NC MD 1848*	Bit 4	FA overlay, index-related
• NC MD 1848*/526*	Bit 5	Block change after synchronism reached
• NC MD 1848*/526*	Bit 7	Synchronization in tooth pitch
• NC MD 1852*/527*	Bit 0	Reference system GI positions for synchronization
• NC MD 1852*/527*	Bit 1	Include DRF and preset in calculation for synchronization
• NC MD 1852*/527*	Bit 2	Include G54 to G57 in calculation for synchronization
• NC MD 1852*/527*	Bit 3	Include external ZO in calculation for synchronization
• NC MD 1852*/527*	Bit 4	Include G58 and G59 in calculation for synchronization
• NC MD 1852*/527*	Bit 5	Include tool length compensation in calculation for synchronization
• NC MD 1856*/531*	Bit 4	Synchronization time-optimized
• NC MD 2522*-2529*		Alarm limit speed 1st-8th PaSe

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PLC user interface

- Data block DB29 for axes
- Data block DB31 for spindles

12.18.2 Brief description of GI functions

The gearbox interpolation (GI) function replaces mechanical gear couplings (gears and differentials) on the basis of software functionality and single-axis drives.

The advantage of the GI function as compared to a mechanical gear train is the variable transmission ratio and the free definition of drive (leading quantity) and output (following quantity).

The GI function makes it possible to achieve a highly accurate, kinematic link between several axes and spindles which must be moved in a defined position and/or speed ratio with respect to one another.

A gearbox interpolation grouping consists of at least one leading drive and one following drive.

The advantage of gearbox interpolation is that the user need only program the operating characteristics of the leading drives. The following drive then responds according to the set link factor.

The following drive setpoints are calculated from the setpoints or actual values of the leading drives depending on the type of link selected. The GI function allows the transmission ratio (link factor) to be freely programmed.

The SINUMERIK 840C makes the gearbox interpolation function available in parallel to the basic interpolations (linear, circular, spline interpolation).

The following are typical GI function applications:

- Gear tooth machining on hobbers, gear shapers or grinders
- Complete, rear-face or "polygonal turning" machining operations on lathes
- Gantry machines (axes)
- Flying tool changes with magazine in motion (on-the-fly synchronization)

The gearbox interpolation function can be activated in all operating modes.

The experience gained from the applications of the electronic gearbox (ELG) and synchronous spindle functions of the SINUMERIK 880 system formed the basis for the significantly extended functional scope of the GI function provided by the SINUMERIK 840C.

Note:

With following axes, the handwheel function must not be activated without following-axis overlay.

12.18.2.1 Definition of leading and following drives

The kinematic linking of two or more motions is generally based on the synchro system principle. The movement of a motor or drive is detected by means of a path measuring system (so-called leading motion) and applied to another servo drive as a manipulated variable (following motion).

The servo drive, which follows the motions of other drives (so-called leading drives), is referred to below as the "following drive". In the case of several leading drives, the following drive position is determined from the overlay of the leading drive motions.

The GI function distinguishes between

- a real leading drive and
- a simulated leading drive.

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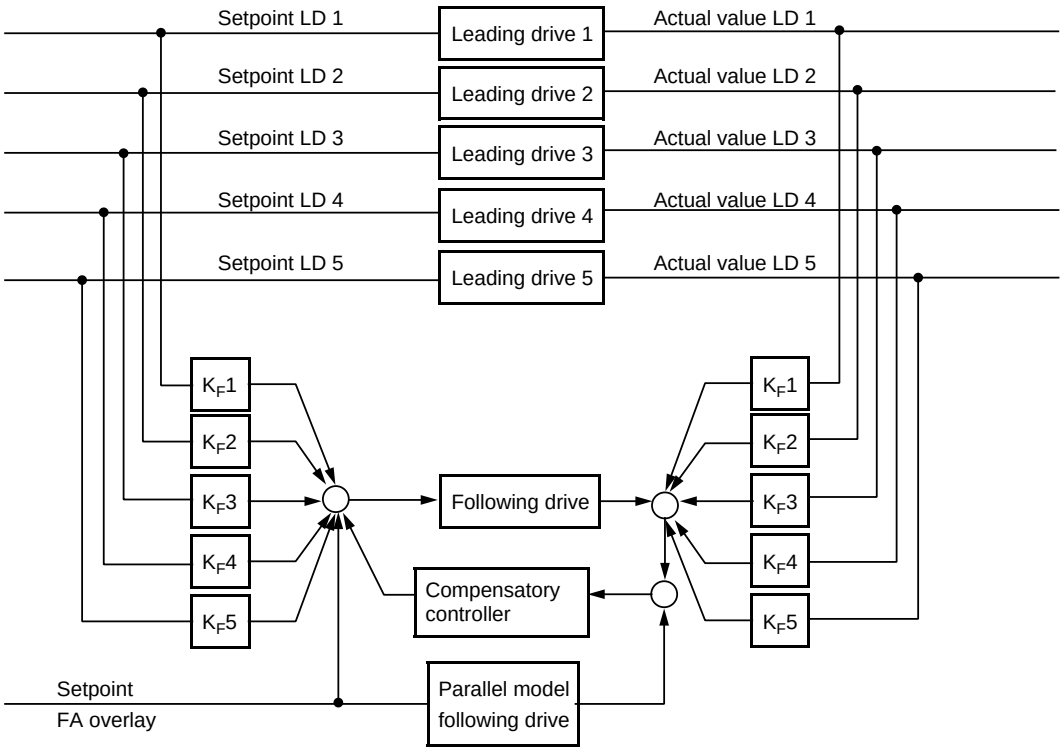

Leading drives/Following drives

a) Real leading drives

The term "Real leading drives" refers to axes or spindles which actually move. This movement is detected by means of incremental position actual value encoders and passed to the SINUMERIK via measuring circuit inputs. Real leading drives are subdivided into the following groups:

- Leading axes which are position-controlled by the SINUMERIK (linear or rotary axes)
- Leading spindles which are position-controlled by the SINUMERIK
- Leading spindles which are speed-controlled as a spindle by the SINUMERIK
- Other leading axes/spindles which are neither speed nor position-controlled by the SINUMERIK, but whose actual values are detected, for example, via incremental shaft encoders and additional measuring-circuit inputs (NC axes in follow-up mode).

b) Simulated leading drives

The term "Simulated leading drives" refers to axes or spindles which, in contrast to real leading drives, do not actually move. The setpoint of simulated leading drives is used exclusively to influence the following drive. These simulated drives do not have a position actual value encoder or a motor.
The NC MD 564* bit 6 must not be set for simulated axes.

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12.18.3 Operating principle

Several gearbox interpolation groupings can be operated simultaneously in the SINUMERIK 840 C system.

In principle, every real axis or spindle in the system can be defined as a following drive. Likewise, every real or simulated axis or spindle may act as a leading drive. It is also possible to program a drive to operate as the leading drive in several different GI groupings at once.

A following drive can, however, also be the leading drive in another grouping in order to allow the cascading of GI groupings.

A single gearbox interpolation grouping consists of one following drive and up to 5 leading drives.

A GI grouping can be configured in the following ways:

- One following axis (real) and max. 5 leading drives (real or simulated, rotary/linear axes or spindles)
- One following spindle (real) with exactly one leading spindle (real or simulated) and a maximum of 4 leading axes (real or simulated, rotary/linear axes).

In this case, the following drive is controlled by the leading drives. The leading drives and the following drive can be programmed in different channels of the same mode group.

The following drive setpoint is derived from the part setpoints or part actual values (depending on link type) of the leading drives. The NC multiplies these leading drive values with the appropriate transmission ratio (link factor) and applies them to the following drive as a total.

Apart from these leading drives, the compensatory controller and overlaid following drive motions can also supply an additional setpoint for the following drive.

$$FD_{Set} = LD1*K_F1 + LD2*K_F2 + LD3*K_F3 + LD4*K_F4 + LD5*K_F5 + FD_{over}$$

FD_{Set}	=	Part setpoint following drive
LD1..5	=	Part setpoint or part actual value leading drives 1 to 5
$K_F1..5$	=	Link factor or transmission ratio between leading drives 1 to 5 and the following drive
FD_{over}	=	Additional following drive overlay

By programming the NC in a special way, it is possible to define a new gearbox interpolation grouping even when a part program is already running. Inputs can also be made manually via the GI input display in set-up mode.

The requirements of the control response of the coupled drives are in general considerably higher than for normal NC drives.

The following basic conditions must be fulfilled to obtain a high degree of accuracy:

- Short position controller sampling times (particularly with actual value link)
- Dynamically well co-ordinated drives
- Most precise actual value information possible from the path measuring systems of leading and following drives
- The transmission ratio K_F between the leading and following drives should be less than 1 if possible to ensure that a large leading movement results in a small following movement.

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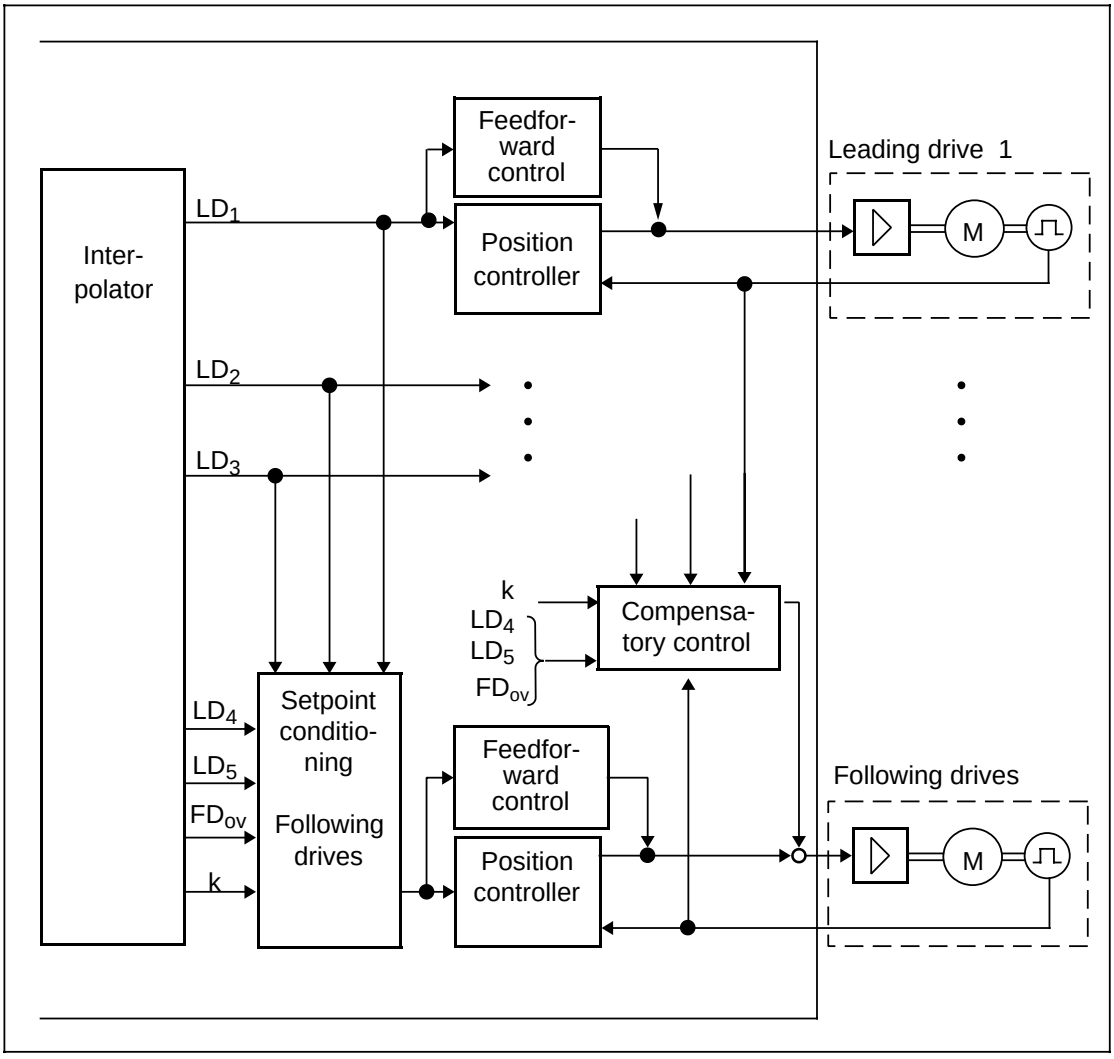
12.18.4 Link types with constant link factor

12.18.4.1 Setpoint link

When position-controlled leading drives are used, the command variable for the following drive can be derived from the part setpoints of the leading drives, thus ensuring a better response to dynamic control processes than can be achieved with an actual value link. The setpoint-position link is the most effective when the leading and following drives have been well co-ordinated. The quality of synchronism can be improved still further when the compensatory controller is activated.

Since the part setpoints for the leading and following drives are input simultaneously, synchronism during acceleration and braking can also be assured provided that the leading and following drives are set to have the same dynamic response (identical rise time, servo gain factor, setpoint filter, etc.). For this reason, the setpoint link should be used only for leading and following drives of the same type (leading axis -> following axis or leading spindle -> following spindle) since the dynamic performance of the drives is comparable only in such cases.



Leading/following drives in a setpoint link with compensatory controller and following drive overlay

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12.18.4.2 Actual value link

The setpoint link described above cannot be used in some cases. This applies particularly to leading and following drives which differ greatly in terms of dynamic response or to leading drives, such as spindles which are not position-controlled.

With an actual value link, the command variable for the controlled following drive is derived exclusively from the part actual values of the leading drives and from any overlay of the following drive. In this case, the dynamic response of the following drive should be considerably better than that of the leading drive (not vice versa under any circumstances).

In this case, the individual drives are optimally adjusted according to their dynamic performance.

The following drive always registers disturbing torques on the leading drive as setpoint changes and follows them accordingly.

Leading axes (electric handwheels, PLC auxiliary axes, hydraulic axes, etc.) which are not position-controlled may only be operated in an actual-position link; a position measuring system is always required.

12.18.4.3 Setpoint velocity/actual position link (SW 4 and higher)

General

The "Setpoint velocity**/**actual position link" is available as an alternative link type K4 with software version 4 for ELG**/**synchronous spindle applications. This is an actual position link (corresponding to the existing link type K2); however, its feedforward control path is supplied by the setpoints of the leading axes**/**spindles (instead of by the "less steady" actual values for link type K2). To ensure that the dynamic response of the leading and following axis(axes) is effectively matched, an independent "Time constant setpoint velocity link K4" (MD3300* or 2567*) has been introduced as a new feature. When the dynamic response values of the leading and following axis**/**axes are identical, the values of the existing "Time constant setpoint filter" (MD 1272* or 486*) must be applied. With different dynamic response values, the dynamic response can be matched in relation to the dominant leading axis.

Parameterization

If several leading drives are controlling a following drive by means of link type K4, then it must be noted that the "Time constant setpoint filter" (K4) is available only once for the entire ELG grouping, i.e. jointly for all K4 leading drives. For this reason, it is not advisable to link several leading drives with K4 link to a following drive unless

- all the K4 leading drives have the same dynamic response from the outset or
- the dynamic response of all K4 leading drives has been matched by means of the "Time constant setpoint smoothing" function (MD 1272* or 486*).

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For normal operating conditions, it is advisable to operate only one leading axis with K4 link; this will generally be the least well tuned axis(disturbances in measurement or closed-loop control) or the axis with the slowest dynamic response (e.g. main spindle).

It must also be noted that a spindle in open-loop control mode which is operating as the leading spindle will activate the position controller (link type K1) or deactivate it (K2 or K4) depending on the link type used while a (leading) axis always operates with active position controller. To ensure that the difference in dynamic response between activated and deactivated position control is negligible, it is advisable to apply the dynamic feedforward control function as a matter of principle.

When the dynamic feedforward control function is not used, the time response of the position control (following error) has - in addition to the intrinsic dynamic response of the drive - a smoothing action (e.g. KW = 1 corresponds to a smoothing time constant of approximately 60 ms) and must be taken into account when the setpoint filter is set.

The major advantage of the new GI link type is the "more steady" setpoint velocity control. This GI link type should be applied when the leading and following drives do not have the same dynamic response.

When the 611D system is used, an additional compensatory controller can be omitted. In analog drive systems, the I-action component function should be activated to compensate drift errors. It is still useful to implement dynamic response matching by means of the setpoint filters which reduces the time required to optimize the controllers involved in the link during start-up.

Compensatory control

In addition to the setpoint/actual value link, a compensatory controller can be connected into the system. This controller checks the present actual values of the leading drives and following drive, making allowance for the present link factors. The deviations (synchronism errors) calculated in this way are used to generate an additive speed setpoint for the following drive on which an inverted sign is superimposed.

The link can therefore be maintained in the event of a disturbance (e.g. load disturbance or failure of a leading drive) and the dynamic response between the leading and following drives (feedforward control effect) improved. The compensatory controller also causes an indirect increase in the position control loop gain of the following drive. This generally has a positive effect on the synchronism.

The compensatory controller can be activated and deactivated only for the whole GI grouping from the PLC.

When the GI grouping is defined, the compensatory controller can be suppressed for a certain leading drive by means of the setpoint link without compensatory control (K3). In this case, it is not the actual values (which may be affected by load disturbances) which are evaluated, but simulated actual values of the leading drive concerned which are derived from the setpoint. Disturbances in the leading drive do not therefore have any effect on the compensatory control.

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12.18.5 Curve-gearbox interpolation (CGI) (SW 4 and higher)

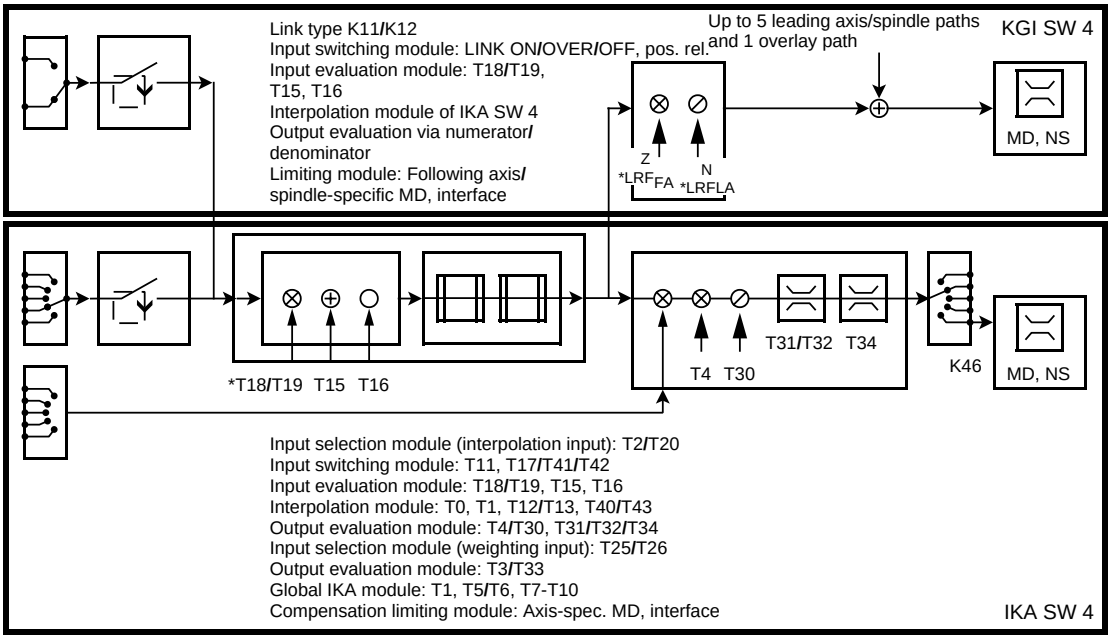
The "Curve-gearbox interpolation" function is available as an option.

12.18.5.1 General

The curve-gearbox interpolation option allows an IKA curve to be overlaid on a following axis involved in a gearbox interpolation grouping of the type available to date. The IKA curve (see IKA description) is stored in the control in the form of a table. This function can be used, for example, to machine non-circular geometries. **A CGI cannot be implemented without the IKA function.**

12.18.5.2 Functional description

In contrast to the gearbox interpolation (GI link branches) which operates with a constant link factor (LF), the IKA implements a fully optional curve-gearbox interpolation (IKA link branches) by means of a tabulated control curve (diagram below).



IKA calculation sequence

The following can be applied to IKA input quantity A:

- Absolute axis setpoint position,
- absolute axis actual positions or
- R parameters.

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The R parameter can be either the output quantity of an IKA positioned upstream (cascade) or any other quantity which is assigned a default value or changed from the process (PLC) or the part program.

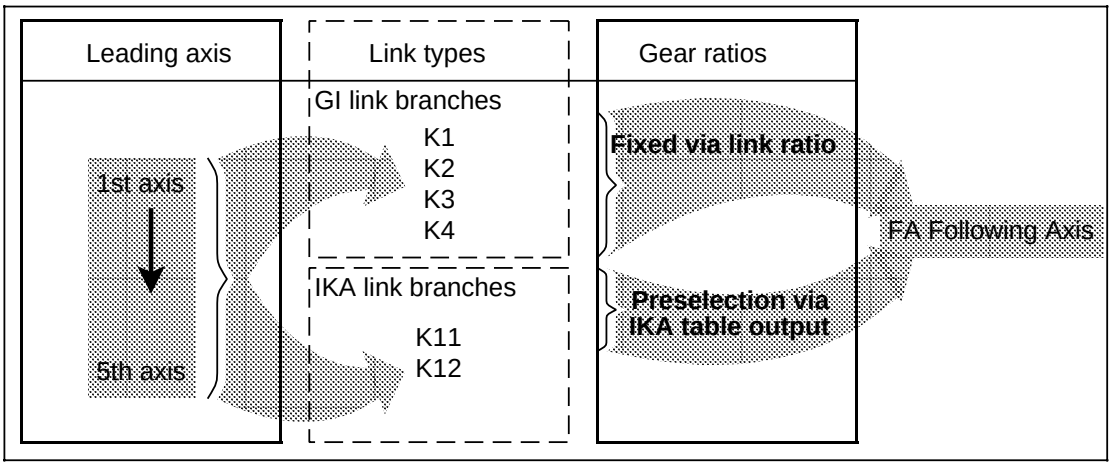
Input A can be additionally weighted by means of T No. 18 or 19. This weighting function can be used to implement a scaling factor of input quantity A.

A modulo compensation and an offset can be provided or programmed for input A. The zero offsets and tool offsets available in the system cannot be applied to input A since the input quantity always refers to the absolute actual value or setpoint of an address. A start position or a start value of the input quantity can be specified as the ON condition (operating principle analogous to position-related G402 for GI).

IKA input quantity B (not applicable to CGI) allows the value read from the table

- to be weighted variably. For this purpose, this input B can be supplied by
  - an absolute axis setpoint position or
  - an R parameter.
- If variable weighting is not configured, the calculation is based on a constant, internal quantity (as specified in IKA T parameter). Weighting = 1

GI/IKA link branches:



Interconnection options for IKA/GI link branches

Using programming measures with G401, it is possible to configure GI link branches (as with previous SW versions) as well as non-linear IKA link branches. IKA link branches can be defined next to GI link branches, the number of branches being limited to 5. The link types specified for GI branches are K1 to K4 and those for GI/IKA branches K11 (setpoint link) and K12 (actual value link). Both **IKA input quantity A** and the **IKA output quantity** (setpoint for an axis) are absolute axis positions when programmed with G401. Due to this extension, all G functions from G400 to G403 are extended by the IKA link branches. It is not possible to connect input B in these cases (G400 to G403).

The following table gives an overview of possible GI/IKA link structures.

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Link type	GI/IKA link types	FA position input is linked to		Output of link branch is connected to
	GI link branch with:			
K1	Setpoint position link (and possibly actual position link via compensatory controller)	Setpoint position of leading address		Setpoint position input of following address
K2	Actual position and actual velocity link	Actual position of leading address		Setpoint position input of following address
K3	Setpoint position link "simulated leading address"	Setpoint position of leading address		Setpoint position input of following address
K4	Actual position and setpoint velocity link	Actual position of leading address		Setpoint position input of following address
	GI link branch with:	**IKA input A supplied by:**	**IKA input B supplied by:**	
K11	Setpoint link	Setpoint position of leading address	Specification of weighting factor in G402/3 command (I, J)	Setpoint position input of following address
K12	Actual value link	Actual position of leading address	Specification of weighting factor in G402/3 command (I, J)	Setpoint position input of following address

Link types of GI/IKA link structures

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12.18.6 Variable cascading of GI following drives (SW 4 and higher)

Note:

The user must always make sure that the ring is never completely closed at any time; the error message "NC-CPU timeout" (3085) will be output if the ring is closed with software version 4.

There is no explicit "Monitoring for following axis rings" with separate alarm message and suppression of the last GI link requested (which would close the ring).

If a GI ring has to be closed, re-sorting can be disabled with MD 5016, bit 7.

12.18.7 Gearbox interpolation chain

A gearbox chain is produced when a following drive acts in turn as the leading drive for another following drive. In principle, different link structures can be configured within a gearbox chain. However, it is not meaningful to create a gearbox chain consisting only of setpoint links since all links can be derived from the first leading drive.

In a gearbox chain with actual value links, the dynamic response of the axes should improve as the gearbox depth increases (increasing servo gain).

A gearbox chain with a mixture of link structures should be configured only if the individual GI groupings fulfil the above conditions. Once an actual value link has been inserted in a chain, all the following links must be of the actual value type.

Example: Setpoint link (K1) Actual value link (K2/K4) Actual value link (K2/K4)

LD1----------> FD1/LD2------------>FD2/LD3---------------->FD3

servo gain=0.5 servo gain=0.5 servo gain=0.7 servo gain=0.9

A gearbox chain must never be closed. It is not permissible to create a feedback to a leading drive already in the chain;
e.g. LDx --> FDy/LDy --> FDx
This type of chain may be defined (see gantry axes), but it must be ensured that these links are not active simultaneously.

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12.18.8 Following drive overlays

When the LINK ON gear link is activated, the following drive follows the movements of the leading drives according to the link factors entered. At the same time, i.e. when LINK ON is active, the following drive can be traversed with an additional overlay.

However, the following basically applies: The overlay is included in the calculation only if the required enabling command from the PLC is present (interface signal ENABLE FD-OVERLAY).

1. Programmable positional offset of the following drive in the AUTOMATIC and MDA modes

- Incremental positional offset of the following axis in the part program, e.g. G91 C... F...LF. When an absolute overlay is programmed with G90, the following axis traverses into the wrong position. Monitoring is not possible.
- Overlay of following axis to obtain an absolute offset to one or several leading axes (on-the-fly synchronization)
- Overlay of following spindle to obtain positional synchronism with drives in operation (on-the-fly synchronization)

2. Manual offset of following axis

• In the AUT or MDA mode:	Overlay of following axis with handwheel with a DRF offset.
• In the JOG and JOG-INC modes:	Overlay of following axis with handwheel or with directional keys.
• In the TEACH IN mode:	Depending on mode, overlay of following axis via directional keys or handwheel.

The overlay is traversed at the velocity programmed in each case.

ELG: With a following axis override, only 75% of the acceleration value are used for the following axis. The remaining 25% are reserved for possible actual value linkage.

3. On-the-fly synchronization

For some applications (e.g. hobbing, synchronous spindles), the leading and following drives must not only operate in synchronism, but also at a specific angle in relation to one another.

The term "On-the-fly synchronization" is used to describe the process of switching the link on and over when the leading and following drives are already running, followed by automatic positional synchronization of the drives. If NC MD 1848*/526* bit 2 is set, then a block change is executed only when the drives are synchronized (interface signal SYNCHRONISM FINE).

"On-the-fly synchronization" can be selected via the part program (G403), the interface signal ON-THE-FLY SYNCHRONIZATION ON or the input display. The function is operative in all operating modes.

The link is switched on for the drives involved through specification of the synchronous positions which can be entered in the part program or input display. Synchronization is implemented as if all drives had started to traverse from the programmed synchronous positions with the link activated. In other words, at the end of the synchronization process, the drives are not at the programmed synchronous positions, but merely positionally offset in relation to one another as determined by the synchronous positions.

A following drive and up to 5 leading drives can be synchronized simultaneously.

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The overlay path FD is calculated on the basis of the present actual positions and the specified synchronous positions; this path is then transferred to the following drive as an incremental overlay path.

$$FD= (FD_{syn} - FD_{act}) + KF1*(LD1_{act} - LD1_{syn}) + KF2* (LD2_{act} - LD2_{syn}) +....$$

The overlay path is traversed as a speed offset with the incremental velocity (NC MD 300*) in the case of following axes and with the M19 creep speed (NC MD 427*-434*) in the case of following spindles.

With speeds**/**velocities which are lower than half the maximum value, the "Shortest path logic" (maximum overlaid traverse path 0.5 revolutions) is traversed. In this case, half the maximum velocity is the maximum permissible overlaid velocity.

In the case of speeds**/**velocities which are higher than half the maximum value, the overlay is applied "in the slower velocity direction", i.e. overlay path in opposite direction to present traversing direction, (maximum overlaid traverse path 1 revolution). In this case, half the maximum velocity is the maximum permissible overlaid velocity.

The leading drives involved can also be simulated drives; in this case, the setpoint positions of the leading drives are evaluated rather than the actual positions.

Leading drives which are not to be synchronized must be at standstill or decoupled. Synchronization will not otherwise be successful. It will likewise not be possible to synchronize the drives if the following drive is traversed simultaneously with overlay by the user or from the program.

Depending on the setting of NC MD 1848***/**526* bit 5 (Block change after synchronization reached), block changes are disabled until the drives are fully synchronized.

Successful completion of the synchronization process is indicated by the interface signal SYNCHRONIZATION REACHED.

The synchronization process can be aborted with RESET or LINK OFF; it remains, however, active after RESET.

FEED DISABLE or override = 0 for the leading axis can abort synchronization. SPINDLE DISABLE or override = 0 do not have any effect on the following axis.

12.18.9 Influencing the following error

Contour errors resulting from following errors can be reduced by means of the feedforward control function (option).

The feedforward control permits a compensation component within the 0 % to 100 % range to be specified via machine data. The feedforward control is effective for all setpoint inputs (setpoints for actual/setpoint-linked leading drives, following drives, FD overlays) and can be activated for leading and following drives (see Section "Functional description of feedforward control" for further details).

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12.18.10 Block search

Block search is only meaningful if executed with calculation. The GI commands are in this case executed as in normal program mode, i.e. the GI status is established as if the system were operating in normal program mode.
Exception: On-the-fly synchronization is not executed (no traversal of following drive).

A block change is implemented immediately in response to GI commands even when the signal INTERLOCK LINK ON/OFF is present.

In order to prevent traversal of following drives after LINK ON as a result of leading axis movements from other channels, the signal INTERLOCK LINK ON should be applied from the PLC while the block search is in progress. The link does not then become effective until the target block is reached.

If a block search is carried out when the link is active, the following drive positions in the target block remain undefined since no axis movements take place. If reference is made to defined positions of the following drive on completion of the block search, then a G403 (on-the-fly synchronization) must be executed after the target block.

In the case of other block search modes, problems may occur if it is necessary to enter into an active link. In such cases, the skipped GI commands must be activated prior to NC start (for example, via input display).

12.18.11 GI monitors

In the LINK ACTIVE state, GI-specific monitoring routines are activated for the following drive in addition to the monitoring functions which are normally performed on NC axes/spindles. These routines are described in detail below.

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12.18.11.1 Monitoring for maximum velocity/speed and maximum acceleration

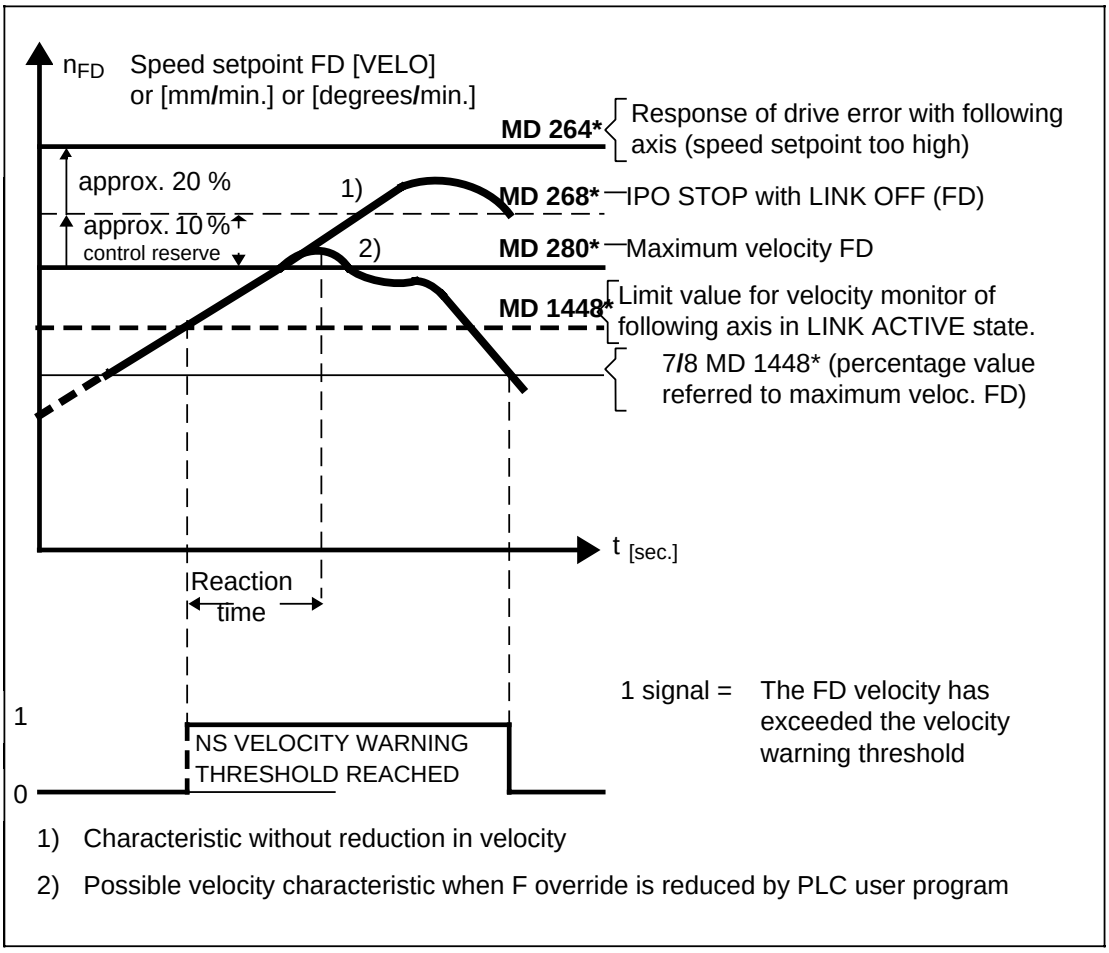
The velocity**/**speed of the following drive is limited to a maximum velocity value (MD 280* or 403*-410*) 1). With an unfavourable constellation, the following drive may be influenced by the leading drives such that it would be forced to exceed this maximum velocity in order to maintain synchronism. However, since this is not possible, the leading and following drives fall out of synchronism.

In order to identify and eliminate the risk of this type of disturbance in advance, the velocity of the following drive is monitored by an additional velocity limit value (prewarning limit) in the LINK ACTIVE state. When this limit is exceeded, the PLC interface signal VELOCITY/SPEED WARNING THRESHOLD REACHED is set.

The user is thus able to initiate appropriate measures to reduce the velocity via the PLC. As an example, the velocity of the leading drives can be reduced via the feed or spindle override.

In view of the reaction time, the velocity warning threshold should not be set too high as this causes de-synchronization between the leading and following drives.

The following diagram shows the velocity monitoring functions which are available for the following axis. The monitoring characteristics for following spindles are identical.



1) Characteristic without reduction in velocity

2) Possible velocity characteristic when F override is reduced by PLC user program

Diagram showing velocity monitoring functions for following axis

1) As from SW 4: See functional description for "Parameter set switchover"

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The velocity warning threshold is input as a percentage value of the maximum velocity (NC MD 280* or 403*-410*) in NC MD 1448***/**494*. [1)]

The interface signal VELOCITY/SPEED WARNING THRESHOLD REACHED is automatically reset when the following drive velocity drops below 7/8 of the warning threshold (hysteresis characteristic).

The same also applies to following drive acceleration.

The percentage value of the maximum acceleration (MD 276* or 478*-485*) is derived from the same machine data (NC MD 1448*494*) as the velocity.

In some applications, it is impossible to prevent the following drive from exceeding the acceleration value specified in MD 276* or 478*-485*. In order to avoid the output of an alarm in these cases, it is possible to deactivate the acceleration monitor by means of NC machine data 1848*/526* bit 3 "Suppression of acceleration limitation". The acceleration of the following drive produced by the leading drive movements is then output directly without limitation or alarm message.

12.18.11.1.1 Velocity/speed limitation of ELG following axes (as from SW 6.4)

Functionality to date

By linking the following axis to the leading axes of the ELG grouping, the velocity**/**acceleration of the following axis is the sum of the leading velocity**/**acceleration multiplied by the speed ratio plus a possible following axis override. Dependent on the parameterization and programming of the leading axes, the maximum permissible values of the following axis may be exceeded.

When machining the workpiece, the maximum values of the following axis should normally not be exceeded. As the velocity**/**acceleration is limited when the maximum velocity is reached, the position reference of the link would be lost. To make sure that the following axis does not exceed the maximum velocity, the user has to take appropriate measures as for example a prior test of the part program.

For reasons of user support, the so-called "warning threshold for n_{max} and a_{max}" (MD 1448*) configurable via machine data has been provided for.

If the warning threshold is exceeded, the axis-specific interface signal "velocity**/**acceleration threshold warning reached" is set. By means of the interface signal, the value of the channel-specific and**/**or axis-specific override could be changed as a countermeasure via the PLC-program such that the actual velocity**/**acceleration of the following axis is reduced below the maximum values.

In view of the relatively long reaction time caused by the PLC cycle time, this method can be used only under certain conditions to solve the above mentioned problem.

Description of the new functionality

In order to achieve a more dynamic behavior of the velocity**/**acceleration limitation of the following axis, the leading axis velocity can now be adapted NCK-internally when the warning threshold for n_{max} and a_{max} is reached using the new function "Velocity**/**acceleration limitation of the following axis".

When this function is active, an acceleration stop is triggered for all enabled axes and spindles of the mode group as soon as the warning threshold for n_{max} or a_{max} is exceeded.

Caution: The leading spindle is limited only to one value. A leading spindle is not taken into account in the velocity limitation control. When starting a 2nd leading axis, this leading axis will be limited or set to standstill.

---

1) As from SW 4: See functional description for "Parameter set switchover"

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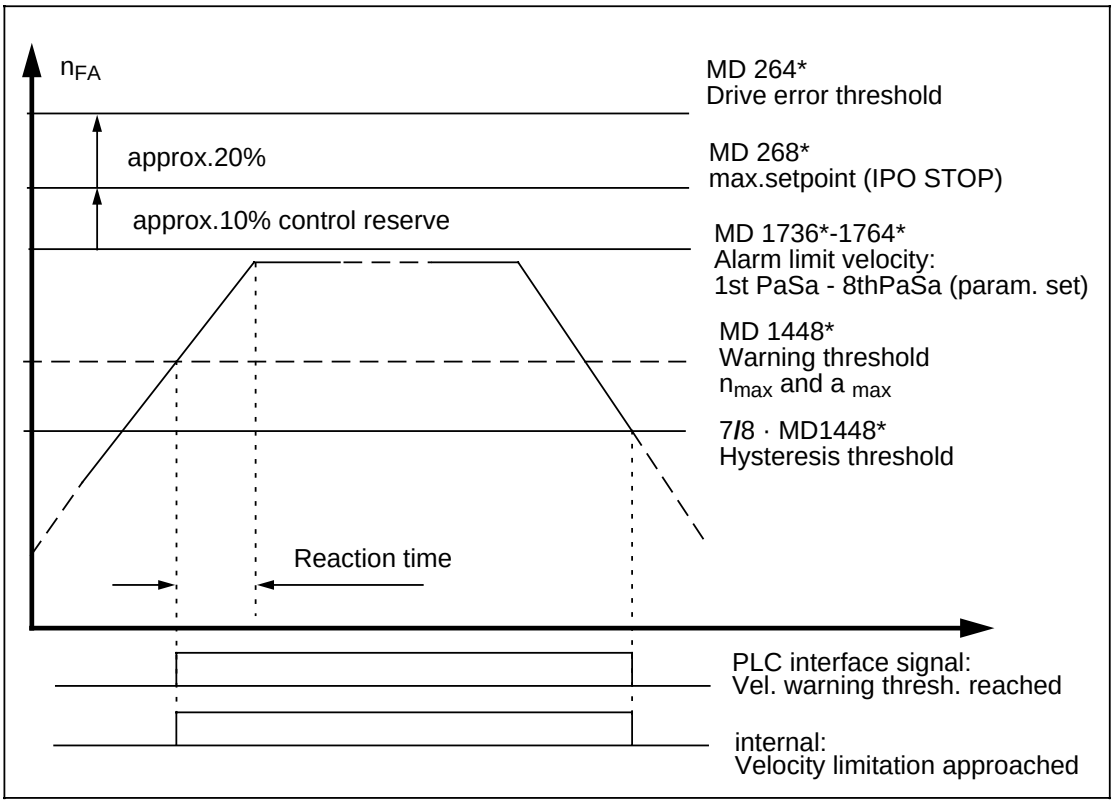

Characteristic of the velocity setpoint with the characteristic rising above and falling below the warning threshold

In NC channels where axes are traversed which are enabled for velocity/acceleration limitation, the acceleration in the path is stopped as follows:

Path set velocity = path actual velocity

The acceleration of released spindles is stopped if:

Set speed = actual speed

Due to non-linear movements of the leading axes (circle, Spline, IKA, transformation, etc.), the velocity of the following axis may increase despite an acceleration stop of the leading axes.

In order to reduce the path velocity, the actual path set velocity is evaluated with a reduction factor (MD 335 "Minimum reduction factor with velocity limitation following axis warning threshold"), similar to an override. The channel thus calculates the path set velocity as follows:

$$V_{path_set}=V_{path_set} \cdot MD335$$

In doing so, the interpolation grouping of the axes involved in the path, as well as the active links, remain unchanged.

If the following axis velocity falls again below the hysteresis threshold, the request for velocity/acceleration limitation is reset for all axes and spindles of the mode group. The reduction factor in the NC channels is reset to 100%.

In order to avoid oscillations within the range of the hysteresis threshold and to bridge machining steps temporarily resulting in an unfavorable velocity/acceleration override, the increase of the reduction factor can be slowed down by means of MD 336 "Velocity increase factor".

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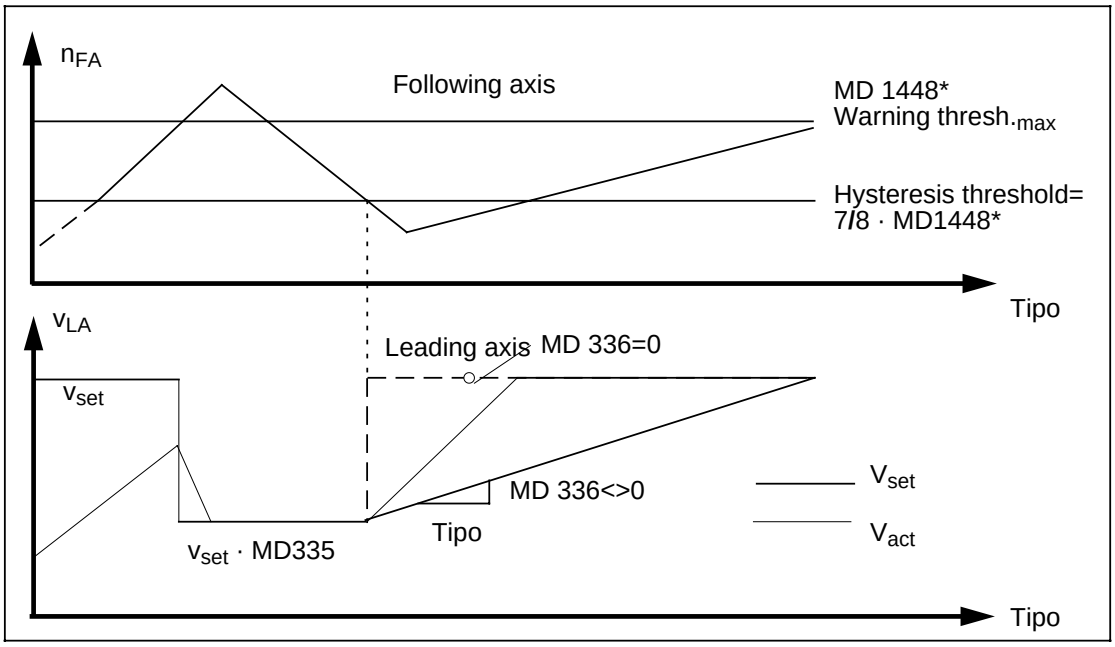

Enabling/disabling of axes and spindles for velocity/acceleration limitation

Dependent on the actual machining situation, it may be necessary to enable only certain axes and spindles of the mode group for velocity/acceleration limitation.

The following G functions of the part program are used for enabling or disabling the velocity/acceleration limiting function of the axes and spindles.

G405
Meaning: "Velocity/acceleration limitation at following axis warning threshold n_{max}/a_{max} enabled"
Syntax: G405 {<axis identifier>} {<spindle identifier>}

G404
Meaning: "Velocity/acceleration limitation at following axis warning threshold n_{max}/a_{max} disabled"
Syntax: G404 {<axis identifier>} {<spindle identifier>}
Remark: G404 without axis/spindle identifier means that all axes/spindles of the mode group are blocked

G group: 20

Internal coding: G404=7, G405=8

G functions must be programmed separately in one block.

A maximum of 5 axes and 1 spindle can be programmed in one block. Enabling/disabling the axes is effected additively, i.e. the status of non-programmed axes/spindles remains unchanged.

Note:

On ELG chaining, the first leading axis of the chain, and possibly all following axes working in following axes override mode, must be enabled.

Example:

The chaining of three electronic gearboxes (ELGs) and FA3 is to be limited.

LA1 FA1=LA2 FA2=LA3 FA3

LA1, FA1 and FA2 need to be released to achieve full velocity/acceleration limitation.

Leading axis priorities

Due to the system-dependent dead times, it is not reasonable to reduce the leading axes classified by priority.

Activating the function

The function "Velocity/acceleration limitation of ELG following axes" is activated axis-specifically via the MD bits 1844*.7 and MD bits 1856*.0.

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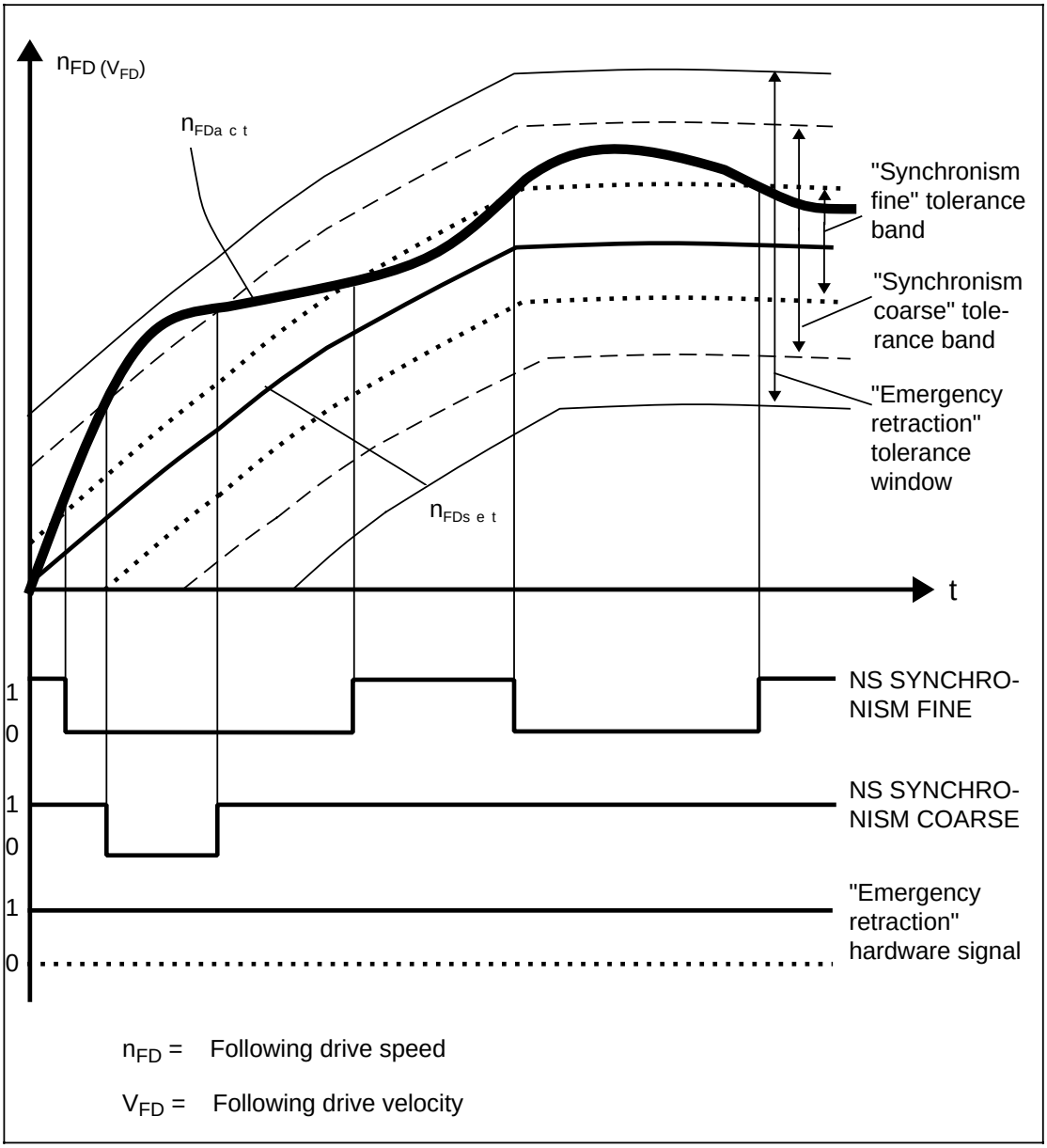
12.18.11.2 Fine/coarse synchronism

In the LINK ACTIVE state, the interface signal SYNCHRONISM FINE or SYNCHRONISM COARSE indicates that the present setpoint position and setpoint velocity of the following drive is within the tolerance window specified by means of machine data.

For this purpose, the deviation of the following axis from its setpoint path is continuously measured in the LINK ON state and checked against the two tolerance windows "SYNCHRONISM COARSE" (NC MD 1440*492*) or "SYNCHRONISM FINE" (NC MD 1436*/491*). If the deviation exceeds the permissible tolerance limit, the associated PLC interface signal is set to 0.

These interface signals make it possible to control the process sequence as a function of the synchronized state of the following drive from the PLC user program. For example, it is possible to delay enabling of the hobber feed until the NS SYNCHRONISM signal is present.



Synchronism monitoring in LINK ON state

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12.18.11.5 HW/SW limit switches of following drive

If the following axis traverses beyond an HW or SW limit switch, then an internal limit switch is simulated for all leading axes depending on the sign of $K_{ü}$. The effect is the same as if every leading axis had traversed into contact with an SW limit switch. Accordingly, the channels of the leading axes (and thus also of the other axes interpolating with the leading axes) are also stopped. The leading axes can be traversed away from the limit switch (ensure correct direction of traversal).

If the following axis traverses onto the prelimit switch, then the velocity of the leading axes which are moving the following axis towards the limit switch is reduced depending on the sign of $K_{ü}$ (simulated prelimit switch for leading axes).

Leading spindles are stopped (regardless of their rotational direction) as soon as the following axis reaches a HW/SW limit switch. The spindle cannot be traversed in any direction as long as the following axis is situated behind a limit switch.

If the leading spindle is being traversed by oscillation or alignment, then the oscillation/ alignment function must be aborted (cancellation of interface signals) once the following axis has been traversed away from the limit switch before the spindle can be restarted.

The following axis always traverses beyond the limit switches by a few increments because the following axis stop command cannot be released until the limit switch is reached.

Note:

If a following axis is driven with a leading axis that is moved in follow-up mode using the actual value link, the following axis cannot be stopped if it overshoots the SW limit switch.

Remedy:

- Stop the leading axis (e.g. external conveyor belt)
- Deactivate the link via the hardware limit switch

From SW 5.6, the function "Dyn. SW limit switches for following axes" can be used if the path velocity is to be reduced and the following axis must not traverse beyond the software limit switches (see Sect. Dyn. SW limit switches for following axes).

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12.18.11.6 Special features relating to following axes

- If a following axis cannot execute its traversing motion in the LINK ON state because certain enabling signals (controller enable, etc.) are missing, then the active leading axes and leading spindles defined in the GI grouping are also stopped.
- The link is activated even if the CONTROLLER ENABLE is not set when LINK ON is selected. The following axis naturally cannot be traversed without a CONTROLLER ENABLE. Therefore, if the leading drives were to move in the LINK ON state, the GI monitoring functions would respond.

12.18.11.7 Special features relating to following spindles

- If a following spindle stops in the LINK ON state because the required enabling signals are missing, then the leading spindle also stops. Leading axes are not affected.
- The link is not activated if the CONTROLLER ENABLE is not set when LINK ON is selected. The signal REQUEST LINK ON is set. In order to activate the link in this case, another LINK ON request must be programmed after CONTROLLER ENABLE has been set.

12.18.12 Programming

A basic distinction must be made between two different terms with regard to the configuration and programming of gearbox interpolations:

- Configuration of gearbox interpolation (definition of link structure and link type).
  The GI grouping - consisting of a maximum of 5 leading drives and one following drive - is defined by the configuration. The configuration also includes specification of the link type which determines how each individual leading drive in the grouping is to act on the following drive. The required signal paths are set up internally, but not activated. The link factor KF = 0 applies, i.e. a movement by the leading drives does not cause the following drive to move.
- Switching gearbox interpolation on, off or over. (LINK ON, LINK OFF).
  A gearbox interpolation grouping defined by the configuration can be activated (LINK ON) or deactivated (LINK OFF).
  Through activation of the appropriate G function, it is possible to select LINK ON/LINK OFF for a specific leading/following drive pair or LINK ON/LINK OFF for all leading drives linked to a following drive. On-the-fly synchronization of leading/following drives is thus also possible.

The user must therefore make the following inputs for the purpose of gearbox interpolation:

- Definition of link structure with specification of leading and following drives to be linked
- Definition of link type between leading and following drives
- Link factors KF with numerator I and denominator J

  FDset = KF * LDset = Numerator I**/**Denominator J *LDset
- Programming of certain positional references between the leading and following drives (synchronous positions as required).

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If a following spindle is programmed, the only possible leading spindle must also be programmed. If a link motion on the part of the leading spindle is not desired, then a link factor of "0" must be specified.

The gearbox interpolation can be programmed from various sources and also configured within specific limits. The possible sources are:

1. G function in part program or via MDA
2. PLC (interface signals)
3. Input display
4. Default setting via machine data

The following table shows an overview of the functionality provided by the individual sources.

Function	Part program	PLC	Input display	Machine data
Define configuration	G 401			
Erase configuration	G 401			
LINK ON total not referred to position	G 402			
LINK ON total not referred to position	G 400			
Selective LINK ON/OVER/OFF not referred to position	G 402 G 400			
On-the-fly synchronization	G 403	1)		
Setting of link structure defaults				
Enabling of reconfiguration				
Enabling of link factor switchover				
Enabling of programmed synchronous positions				
Enable/disable FD overlay				
Compensatory controller ON/OFF	G 401 2)			

: Possible : Not possible

1) Variable synchronous positions cannot be specified via the PLC

2) Only via definition of link type K3

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General information about programming

- When a GI function is programmed, the following block is not read in until the GI request of the preceding block has been fully executed. The ultimate response of the control system to block changes can be influenced by means of machine data (NC MD 1848*/526*).
- Only one G function in one G group may be programmed for each NC block.
- The gearbox interpolation G functions may be programmed with any permissible NC function. However, all GI parameters must be inserted at the end of the NC block in the correct program sequence. G90/G91 may also be inserted into a GI command.

  Example:
  N10 G91 G01 Z500 F200 **G403 G90 X200 I1 J3 Y100** LF
- The gearbox interpolation is operative within a mode group, but is also a cross-channel function, i.e. the leading drives may be situated in different channels.
- The maximum number of possible GI groupings is restricted only by the capacity of the computer. GI groupings are defined on a drive-specific basis, i.e. every axis**/**spindle can theoretically act as a following axis**/**spindle. The number of possible groupings is dependent on the required computing capacity (LR**/**IPO clock cycle, number of drives**/**mode groups**/**channels, etc.)

Configuration of the GI grouping

- Up to 5 leading drives and one following axis may be included in a GI grouping. The status of the leading drives is entirely optional, i.e. they can be real or simulated drives, rotary or linear axes or spindles.
- The following axis can be a real rotary axis or a real linear axis.
- Up to 4 leading axes/1 leading spindle may act on a following spindle within a GI grouping. The leading axes can be real or simulated, rotary or linear axes.
- In the case of a following spindle, exactly one leading spindle may and must be defined within the grouping. However, another 4 leading axes may also be defined.
- Every GI grouping must be defined by means of a separate configuration block in the NC program.
- A given axis or spindle can be defined only once as the following drive.
- There are two configuring options in the case of spindles with C-axis, i.e. to define the spindle as the following spindle or the C-axis as the following axis.
- When a configuration is changed by adding or removing a leading drive or selecting another link type, the entire NC block must be written with all leading drives.
- The configuration can only be changed after LINK OFF and ERASE CONFIGURATION.
- When the link factor is re-programmed to KF = 0, no further setpoints are generated for the following drive although the link remains in the LINK ON state.
- When a GI grouping is configured, all link factors initially have a default setting of zero. Only after LINK ON/OVER do the values programmed in the LINK ON command (e.g. G402...) become valid; setpoints are then generated for the following axis.
- The gearbox configuration can be changed in any channel of the mode group. The last instruction given is the active instruction, i.e. there are no priorities.

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- The defined gearbox configuration is maintained in the following events:
  – End of block
  – End of program
  – Change of operating mode
  – Warm start
  – Power off
- Reconfiguration of the GI grouping can be prevented by appropriately setting NC MD 1844*/525*.
- The link between a leading spindle/C-axis and a following drive can be defined in the configuration via the leading spindle name or by means of the C-axis name. The link is maintained even during the leading drive change "spindle -> C-axis -> spindle". The actual value information for the gearbox interpolation is always, however, supplied by the encoder of the defined leading drive (spindle encoder or C-axis encoder).

Switching the link on and off

- The LINK ON/OFF command can be issued via the NC part program and the input display either selectively for individual leading drives or for the entire GI grouping.
- A LINK ON/OFF command can be issued from the PLC, but only for the entire GI grouping. The gearbox link can therefore be selected or deselected from the PLC depending on certain operating states.
- In order to select LINK ON/LINK OFF for gearbox interpolations from two gearbox configurations, two NC program blocks in each case must be written.
- After G400, G402 and G403 have been programmed, block changes can be delayed or stopped on the basis of the following three signals:
  – INTERLOCK LINK ON
  – INTERLOCK LINK OFF
  – SYNCHRONISM FINE in conjunction with NC MD 1848*/526* bit 2
  – SYNCHRONIZATION REACHED with NC MD 1848*/526* bit 5.
- When LINK ON (G402, G403) is programmed, the block change is inhibited as long as the interface signal INTERLOCK LINK ON is present. The signal REQUEST LINK ON is set.
- If the signal INTERLOCK LINK ON is set when LINK ON is selected, the link request is not cancelled. However, it does not become operative until the signal INTERLOCK LINK ON is reset.
- When LINK OFF is programmed, the block change is inhibited as long as the interface signal INTERLOCK LINK OFF is present. The signal REQUEST LINK OFF is set.
- If the signal INTERLOCK LINK OFF is set when LINK OFF is selected, the deactivation request is not cancelled. However, the link is not deactivated until the signal INTERLOCK LINK OFF is reset.
- In the LINK ON state (G402, G403), block changes can be inhibited via NC MD 1848*/526* bit 2 until the interface signal SYNCHRONISM FINE is present.
- While the signal PLC SPINDLE CONTROL is set, block changes are disabled after selection of synchronous operation.
- In "On-the-fly synchronization" mode (G403), block changes can be inhibited via NC MD 1848*/526* bit 5 until the interface signal SYNCHRONIZATION REACHED is present.

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- NC MD 1852*/527* can be set such that tool length compensation, zero offsets and the preset/DRF values are calculated into the synchronous position of the following drive. It is also possible to specify the reference system in which the synchronous positions must be programmed. (Only for G403, not PLC, IS)
- After LINK OFF, axis synchronization for the following axis must be executed prior to absolute programming of the following axis. This synchronization process is activated with G200.
- When the CONTROLLER ENABLE command is not available or when the following drive is in the FOLLOW-UP or PARKING AXIS mode, the leading drive cannot be traversed either.

Link factor

- The following drive velocity is determined by the magnitude of link factors KF_1...KF_5 and the velocities of the leading drives.
- One or several link factors (KF) can be changed in an NC program block for a gearbox configuration. Any unspecified link factors remain unchanged.

$$\text{Link factor KF} = \frac{\text{Following drive path}}{\text{Leading drive path}} = \frac{I}{J}$$

- The link factor units for the various drive configurations are as follows; they are independent of the position control and input resolutions of the drives:

Following drive	Leading drive	Link factor unit
Linear axis	Linear axis	mm/mm
Linear axis	Rotary axis, spindle	mm/deg
Rotary axis, spindle	Linear axis	deg/mm
Rotary axis, spindle	Rotary axis, spindle	deg/deg

- The interpolation parameters I and J must be specified in the G function or the input display. Format: 8 decimal places + point + sign (floating-point representation) Permissible value range for KF: ±0.00000001 to ±10.000000
- There is no upward limit on the link factor. For reasons of accuracy, the link factor KF should be 1, i.e. when the measuring systems of the leading and following drives have the same resolution, one increment of the leading drive should not correspond to several increments of the following drive.
- The link factor must be specified complete with numerator and denominator.

Gearbox chain

- A gearbox chain should be programmed in the same order as the setpoints are to be generated afterwards. In other words, the GI grouping at the start of the gearbox chain must be programmed (G402) first, followed by the GI grouping of which the leading drive acts as the following drive in the first GI grouping, etc.

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A gearbox chain must not be closed in the active state, i.e. if a chain is defined such that a following drive at the end is also acting as the leading drive at the start of the chain, then it is strictly illegal for all links to be active at the same time. The user must take measures via the PLC, e.g. INTERLOCK LINK ON to ensure that this situation does not arise.
No system monitoring function is provided.

Note:

This function is replaced by the "Variable cascading" function with SW 4 and higher. If a gearbox chain is incorrectly defined, the error message "NC timeout" is output.

12.18.12.1 Programming via NC part program

Function	G function
Define/erase configuration	G401
Switch link on/off	G402
Switch on link with on-the-fly synchronization	G403
Switch off link	G400
Axis synchronization	G200

Please refer to the documentation entitled "NC Programming Guide" for further information.

12.18.12.2 Programming via PLC

The gearbox interpolation groupings can be influenced and checked via the interface signals of DB29(following axes) and DB31(following spindle). ON and OFF commands for the gearbox link can also be issued via the PLC. However, the PLC cannot be used to change a gearbox link configuration.

12.18.12.3 Programming via input display

Please refer to the documentation entitled "Operator's Guide" for further information.

12.18.12.4 Default settings via machine data

Machine data can be used to set defaults for the link structures and to disable reconfiguration and link factor switchover. These functions are particularly important for machines with forced-linked drives (e.g. gantry or portal machines).

- NC MD 1456*/495* Default setting for link structure
- NC MD 1844*/525* bit0 Axis/spindle may be following axis/spindle
- NC MD 1844*/525* bit1 Reconfiguration permissible
- NC MD 1844*/525* bit2 Switchover of link factor permissible
- NC MD 1844*/525* bit3 Overwriting of synchronous position permissible

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12.18.13 Start-up

Before commencing start-up of the GI grouping, you must complete the start-up procedure described in the Section headed "Start-up of axis (analog) and spindle".

12.18.13.1 Brief start-up of a GI grouping

- Declare the desired following axis/spindle as a following drive by setting NC MD 1844*/ 525* bit 0.
- Set the position control sampling time for the following drive and its leading drives to the same value.
- In the case of a setpoint link, the same servo gain factor must be set for all drives involved. Check whether the following error at a given velocity is the same for all drives.
- In the case of an actual value link, set the servo gain factor of the following drive to a higher value to increase its dynamic performance.
- The following error of synchronous spindles can be checked only when the link is activated (position controllers are then active).
- Set the following NC MDs so that the GI grouping can be configured and programmed during start-up:
  - NC MD 1844***/**525* bit1 Reconfiguration permissible
  - NC MD 1844***/**525* bit2 Switchover of link factor permissible
  - NC MD 1844***/**525* bit3 Overwriting of synchronous positions permissible
  - Execute a Power On to make the change effective (changes can be saved via the machine data dialog beforehand)
- In cases where a following drive overlay (e.g. for on-the-fly synchronization) is required, you must set the signal ENABLE FOLLOWING AXIS/SPINDLE OVERLAY (DB29/31) to "1".
- For the on-the-fly synchronization function, the incremental speed (NC MD 300*) for axes and the M19 creep speed of the appropriate gear stage (NC MD 427* to 434*) for spindles must be set to a value other than "0".

The gearbox interpolation grouping is now functional and ready for programming.

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12.18.13.2 Full start-up procedure

Step	Action	Important information
1	Define position control sampling time	Following drive and associated leading drives must generally have the same position control sampling times.
2	Set drift compensation (applies only to analog drives)	Deactivate feedforward control and link beforehand
3	Carry out general optimization of axes and spindles	Servo gain factor must be correct (following error check)
4	Set feedforward control	Check effect of feedforward control on the following error
5	Match dynamic response of individual drives	With setpoint links, the leading and following drives must have the same dynamic response (rise time).
6	Set the required machine data	Initial configuration must be enabled
7	Optimize the compensatory controller	Switch on link and FD overlay
8	Calculate the time constants of the parallel model	Check synchronism error in service display; deactivate compensatory controller; feedforward control must be fully set
9	Define the GI monitoring tolerances according to manufacturer's data	Check in service display (individual spindle/individual axis) Synchronism error
10	Check the GI programming functions	Configuration; Activate/deactivate link; on-the-fly synchronization
11	Set the interlocks	Interlocks, e.g. set reconfiguration etc. (NC MD bits)

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12.18.13 Start-up

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12.18.13.1 Brief start-up of a GI grouping

- Declare the desired following axis/spindle as a following drive by setting NC MD 1844*/ 525* bit 0.
- Set the position control sampling time for the following drive and its leading drives to the same value.
- In the case of a setpoint link, the same servo gain factor must be set for all drives involved. Check whether the following error at a given velocity is the same for all drives.
- In the case of an actual value link, set the servo gain factor of the following drive to a higher value to increase its dynamic performance.
- The following error of synchronous spindles can be checked only when the link is activated (position controllers are then active).
- Set the following NC MDs so that the GI grouping can be configured and programmed during start-up:
  - NC MD 1844***/**525* bit1 Reconfiguration permissible
  - NC MD 1844***/**525* bit2 Switchover of link factor permissible
  - NC MD 1844***/**525* bit3 Overwriting of synchronous positions permissible
  - Execute a Power On to make the change effective (changes can be saved via the machine data dialog beforehand)
- In cases where a following drive overlay (e.g. for on-the-fly synchronization) is required, you must set the signal ENABLE FOLLOWING AXIS/SPINDLE OVERLAY (DB29/31) to "1".
- For the on-the-fly synchronization function, the incremental speed (NC MD 300*) for axes and the M19 creep speed of the appropriate gear stage (NC MD 427* to 434*) for spindles must be set to a value other than "0".

The gearbox interpolation grouping is now functional and ready for programming.

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12.18.13.2 Full start-up procedure

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4	Set feedforward control	Check effect of feedforward control on the following error
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6	Set the required machine data	Initial configuration must be enabled
7	Optimize the compensatory controller	Switch on link and FD overlay
8	Calculate the time constants of the parallel model	Check synchronism error in service display; deactivate compensatory controller; feedforward control must be fully set
9	Define the GI monitoring tolerances according to manufacturer's data	Check in service display (individual spindle/individual axis) Synchronism error
10	Check the GI programming functions	Configuration; Activate/deactivate link; on-the-fly synchronization
11	Set the interlocks	Interlocks, e.g. set reconfiguration etc. (NC MD bits)

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Set position control sampling times

The position control sampling times for the following drive and associated leading drives within a GI grouping must be set to the same value. This sampling time may however vary from grouping to grouping (provided the groupings are not chained as a gearbox).

By increasing the position control sampling times for non-critical axes (loader axes, drives not included in the GI grouping), you can release computing capacity which you require to obtain a short position control sampling time for the GI grouping.

Drift and tacho compensation

- General

  You have various options for compensating non-linearity of the drive or tacho (e.g. drift):
  – Drift compensation
  – Automatic tacho compensation

- Setting the drift compensation

  The drift can be set either manually via machine data MD 272* or 401* or semi-automatically (for axes only) through selection of the following softkeys (in service display)

  Drift comp.
  Axis----

  (with the axes at standstill). The value calculated is then automatically entered in MD 272*.

- Setting the automatic tacho compensation (for axes only)

  This setting can be made only if the drift compensation setting is correct. Select tacho compensation with NC MD 1804 bit 1. This function is fully automatic, i.e. no further settings need be made.

  The tacho compensation function calculates a direction-dependent compensation value at constant traversal of the axis; this value can compensate deviations of up to 12 % of the multgain. The compensation value is injected in parallel to the P feedforward control, i.e. the tacho compensation function also activates the feedforward control (computing time requirement!).

  If a compensation value cannot be calculated (e.g. axes not traversing constantly, 12 % limitation, speed less than 1/8 of maximum speed), the last valid value to be calculated is used. The compensation value is erased when compensation is deselected. Refer to Section NC machine data, NC MD 1804* bit 1 for further details.

When the link is activated, the currently valid compensation value for the following axis is frozen. Deviations in synchronism caused by changes to the controlled system can therefore only be compensated by the I-action component of the compensatory controller.

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General optimization of axes and spindles

- Axes:

  You must set all axes in the GI grouping according to the optimization instructions in the Start-up Guide (section headed "Drive optimization"). It is particularly important that the set servo gain factor corresponds to the actual servo gain factor occurring on the machine (check via following error in the service display). Set the acceleration of the following axis to approximately 20 % higher than that of the leading axis to ensure correct operation. If link factors of > 1 are expected, then you must raise the following drive acceleration by a corresponding amount.

  You can install a second measuring system for axes. If you wish to do so, set the appropriate machine data in the MD 1204* to MD 1388* range.

  Caution:

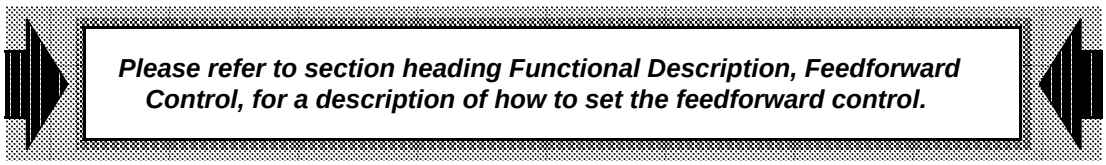
  If the following axis is an endlessly turning rotary axis, you must not activate your software limit switches since the axis will otherwise reach the working area limitation as a result of the modulo motion and come to an abrupt halt in the middle of a cut. If the following axis is a rotary axis, you must enter the modulo value of the axis in NC MD 344*.

- Spindle:

  Spindles must also be set according to the instructions under section headings GENERAL RESET and STANDARD START-UP.

Setting the feedforward control

When the dynamic feedforward control function is active, the part setpoint is multiplied by the feedforward control factor and applied directly to the speed controller input. The setpoint is injected at the position controller input via a PT1 element with a delay defined by the time constant set in the machine data.



Matching the dynamic response of the drives

The following drive and all leading drives connected to it in a setpoint link must have the same dynamic control response. The same dynamic response means that the following errors of all drives are equal when measured at the same velocity (check required).

- If the dynamic response of all the drives involved is virtually the same, you should enter exactly the same values for the servo gain and feedforward control; these should be the lowest possible value in each case (referred to the axis with the worst dynamic response).

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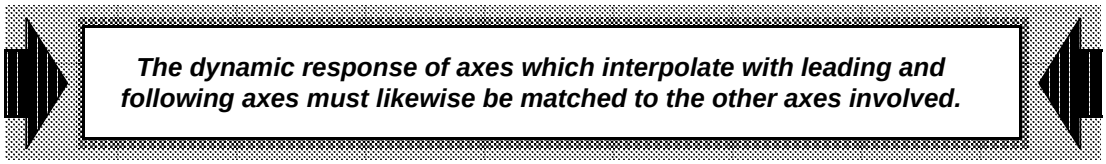
- If the drives involved have varying dynamic response characteristics (and if it is not meaningful to match them by setting the same response values), then you can use a setpoint filter for the purpose of matching. You can activate the setpoint filter for axes with NC MD 1820*, bit 0; you must enter the setpoint filter time constant in NC MD 1272* or 486*.

Note:

Please note "Parameter set switchover" function description with SW 4 and higher.

- If the individual drives deviate too much in terms of dynamic response (e.g. following axis and leading spindle) and if a setpoint filter does not produce satisfactory results, then you must select the actual value link as the link structure.



Instructions for setting with feedforward control

- Set individual axes with servo gain factor, feedforward control factor and symmetrizing time constant such as to obtain a good response to disturbances and setpoint changes.
- Calculate substitute time constants of the individual axes according to the formula:

  $T_{SUBS} = \frac{1-V}{K_v} + T_{SYM}$

  V: Feedforward control factor

  T_{SYM}: Symmetrizing time constant

- Make fine adjustment by changing the setpoint filter time constant when all axes/spindles are traversing at constant speed until the following error on all axes/spindles is the same.
- Set the axial setpoint filter (NC MD 1272* or 486*) by entering the difference between the time constants of this axis/spindle and the slowest axis/spindle in the grouping.

Kvx= value (NC MD 252*, 1320* or 435*ff) * 100

Vx= value (NC MD 312*,1260* or 465*) * 1000

T_{SYM_1}= value (NC MD 392*, 1324* or 467*) * 10

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K_{v_1}=33.33 s^{-1} V_1=0.66 T_{SYM_1}=5 ms

$$T_{SUBS_1} = \frac{1-0.66}{33.33} + 5 \text{ ms} = 15 \text{ ms}$$

K_{v_2}=33.33s^{-1} V_2=0.66 T_{SYM_2}=5 ms

$$T_{SUBS_2} = \frac{1-0.66}{33.33} + 5 \text{ ms} = 15 \text{ ms}$$

K_{v_2}=25.00s^{-1} V_3=0.66 T_{SYM_3}=7 ms

$$T_{SUBS_3} = \frac{1-0.66}{25} + 7 \text{ ms} = 20.2 \text{ ms}$$

T_{X_1}=20.2 - 15.0=5.2 ms
T_{X_2}=20.2 - 15.0=5.2 ms
T_{X_3}=20.2 - 20.2=0.0 ms

Setting the GI machine data and the necessary PLC signals

In order to be able to configure a gearbox link via the input display or the NC part program and to enter the synchronous positions and link factors, you must set the following NC MD bits for the following drive to "1":

- NC MD 1844*/525* bit0 Axis/spindle may be FD/FS
- NC MD 1844*/525* bit1 Reconfiguration permissible
- NC MD 1844*/525* bit2 Switchover of link factor permissible
- NC MD 1844*/525* bit3 Overwriting of positions permissible

For inputs via the input display, you must set NC MD 5006, bit 4 to "0".

As soon as you wish to traverse the following drive with overlay (e.g. for on-the-fly synchronization), the PLC signal ENABLE FOLLOWING AXIS/SPINDLE OVERLAY (DB29/31) must be set to "1".

After start-up, the bits must be set in accordance with the machine philosophy of the manufacturer.

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Optimization of the compensatory controller

When it is activated, the compensatory controller basically increases the servo gain factor of the following drive. However, if the axis or spindle-specific servo gain factor of the following drive is already set to the maximum value, the following drive starts to oscillate if the compensatory controller is activated. In this case, the resulting servo gain factor (sum of the servo gain factors of the axes and compensatory controller) is too high. We therefore recommend you to follow the procedure described below:

- **Drive start-up for LINK OFF**
  The leading and following drives are separately parameterized (with the link deactivated) according to the conventional method. The highest possible servo factors (LD-KV_{max} and FD-KV_{max}) above which the position control loop tends to oscillate and become unstable must be calculated.
- **Drive start-up for LINK ON (P component)**
  – The P component of the compensatory controller (NC MD 1420*/487*) operating in parallel acts as an additional servo gain factor for the following drive (FD-KV_{CC}). The gain factor FD-KV_{Drv} of the following drive controller must therefore be set to a value that is lower than the FD-KV_{max} calculated beforehand. The servo gain factor of the following drive (FD-KV_{Drv}) must fulfil the following conditions:
  FD-KV_{max} FD-KV_{Drv}(NC MD252***/**435*..442*) [0.01**/**s]+ FD-KV_{CC}(NC MD1420***/**487*) [1**/**s]
  FD-KV_{max} [FD-KV_{Drv}(NC MD252***/**435*..442*)+ 100* FD-KV_{CC}(NC MD1420***/**487*)] [1**/**s]

  – **Actual value link with and without feedforward control**
  When an actual value link with or without feedforward control is used, we recommend that FD-KV_{CC} always be set to 0 (NC MD 1420*/487* = 0).

  – **Setpoint link without feedforward control**
  When a setpoint link without feedforward control is used, it is essential to set the leading and following drive position control loops such that they both have the same dynamic response to setpoint changes. If the P component of the compensatory controller is applied, the following drive must have a better dynamic response, and therefore a higher maximum servo gain factor (FD-KV_{max}), than the leading drive. Effectively, however, the same servo gain factor is set for the following drive as for the leading drive.
  The value of LD-KV_{max} is calculated first and entered in NC MD 252*/435*..442* of the leading drive. The same dynamic response to setpoint changes is now set for the following drive by means of FD-KV_{Drv} (NC MD 252*/435*..442*). The value calculated for LD-KV_{max} is entered for this purpose. The differential value up to FD-KV_{max} is applied for FD-KV_{CC}.

  – **Setpoint link with feedforward control**
  When a setpoint link with feedforward control is used, it is not necessary to set the leading and following drives such that they both have the same dynamic response to setpoint changes. It is also not necessary for the following axis to be more dynamic by setting FD-KV_{max} > LD-KV_{max} when the P-component of the compensatory controller is applied. There is also no need to set the servo gain factors in the leading and following drive position control loops to the same value.
  The dynamic response of the drives is matched by means of setpoint smoothing filters and feedforward control action. The best possible response of the GI grouping to disturbances and setpoint changes can be obtained by means of 100 % feedforward control with appropriately set setpoint smoothing and balancing filters (no positional overshoot during rapid traversal). Please refer to the functional description of "Feedforward control" for further information about setting setpoint smoothing filters and the feedforward control function.

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1) Please note "Parameter set switchover" function description with SW 4 and higher.

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The following servo gain factor settings are recommended:
FD-KV_{Drv}(NC MD252*/435*..442*) = 1 [1)]

FD-KV_{CC} (NC MD1420*/487*) = FD-KV_{max} -1 [1)]

Please note, however, that only FD-KV_{Drv} (NC MD252*/435*..442*) remains active in the LINK OFF state. If the following drive must contribute to the execution of a multi-dimensional path motion in the LINK OFF state, then FD-KV_{Drv} can be reset to FD-KV_{max} from the part program in the LINK OFF state.

- **Drive start-up for LINK ON (I-action component)**
  The I-action component of the compensatory controller (FD-KI_{CC}) is used solely to compensate for slowly changing disturbance variables (drift, temperature, etc.). It is parameterized with a unit of 1/s^2. The reset time T_N of the compensatory controller is thus calculated as follows:

$$T_N = \frac{\text{FD-}KV_{Drv}\,[1/s] + \text{FD-}KV_{CC}\,[1/s]}{\text{FD-}KI_{CC}\text{(NC MD 1424*/488*)}\,[1/s^2]}$$

- **Drive start-up for LINK ON (D component)**
  You should always leave the compensatory controller D component (NC MD 1428*/489*) set to the value "0". [1)]

Notes:

- The compensatory controller setting can be checked and documented by means of the analog signal "Positional difference for synchronism" which can be output by the control via analog outputs on the mixed I/O module.
- For this purpose, the mixed I/O module must be installed in the NC area.
- Please refer to the section headed "Drive servo start-up" for details of how to set the mixed I/O module in order to output the analog signal.

Calculating the time constant for the parallel model

To ensure that the compensatory controller operates correctly, allowance must be made in the controller for the setpoints generated by the simulated leading axes and the overlaid motion of the following axis. The purpose of the parallel model is to produce an actual value from this setpoint.

The parallel model must be set to the position control loop time constant of the following axis. The time constant is influenced by the servo gain factor and the feedforward control.

The time constant must be entered in NC MD 1432* or 489* and is automatically calculated when the maximum value 16000 is input. [1)]

Owing to the influence exerted by the speed controller, the automatically calculated value must be checked and re-optimized if required.

Checking the time constant of the parallel model:

- Deactivate compensatory controller
- Activate link
- Activate FD overlay
- Select service display for following axis
- Traverse FD in jog

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1) Please note "Parameter set switchover" function description with SW 4 and higher.

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While the following axis is traversing, the positional difference for synchronism (contour deviation FD) should be approximately 0, otherwise the time constant needs to be re-optimized.

- Re-optimizing the time constant of the parallel model:
  – Change machine data "Time constant parallel model" manually until the positional difference for synchronism (see above) has been minimized.

Entering the monitoring threshold values

After optimizing the controllers and setting the feedforward control, you must input the monitoring threshold values.

Calculate the values for synchronism, emergency retraction, etc. depending on the requisite degree of accuracy and the safety requirements laid down by the machine manufacturer.

These values can be checked via the PLC interface.

The actual position deviation between the following axes and the leading axes is shown in the service display of the following axes under synchronism error. The emergency retraction can also be interrogated as a rapid signal on the mixed I/O module.

- Machine data
  – NC MD 1436* or 490* Synchronism fine 1)
  – NC MD 1440* or 491* Synchronism coarse 1)
  – NC MD 1444* or 492* Emergency retraction threshold 1)

  Measurements are taken in the following drive resolution.

If the two synchronism limits are not reached, then the associated PLC interface signals are set to "1".

When the emergency retraction threshold is exceeded, a rapid HW signal is released on the servo level provided the interface signal has enabled the monitoring function. The hardware signal must be parameterized in NC MD 588*/528*.

The following drive is limited to maximum acceleration and maximum velocity. 1)

In addition, a warning threshold is monitored in both cases, the value of which is defined as a percentage of the maximum value in NC MD 1448* or 494*. This percentage values applies to both limits. 1)

If, for example, 50 is entered in MD 276* as the acceleration value, then the NS ACCELERATION WARNING THRESHOLD signal is set when 45 is exceeded in the standard setting,

When faults in the leading drives occur, the following drive switches to controlled follow-up mode, i.e. traversal with actual values as reference. On expiry of the delay time specified above, the following drive switches from controlled follow-up to normal follow-up mode.

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1) Please note "Parameter set switchover" function description with SW 4 and higher.

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Effect of the input values in NC MD 1432*/495* (case distinction):

0:	No controlled follow-up; immediate normal follow-up
1...15000:	Controlled follow-up initially; switchover to normal follow-up on expiry of delay
15001 and higher:	Controlled follow-up at all times

Definition of "Controlled follow-up of following drive":

The following drive attempts to following the movements executed by the leading drive. In this case, the leading drive actual values act as the reference variables. The following drive continues to operate under positional control.

Definition of "Follow-up of following drive":

Behaves in the same way as a normal NC drive, i.e. the drive is braked rapidly during traversal with the maximum braking current. The state of synchronism cannot be maintained in this case.

On expiry of a time defined in MD 1224* or 447*, the position control loop is opened. From this point onwards, only the position actual value is recorded.

Service data of following drives

The service data for the following drives are shown in the standard displays of the NC axes/spindles.

The following axis service data are identical to those of other NC axes/spindles with the exception of the "Contour monitoring" service display.

The following applies to the "Contour monitoring" service display:

- With IS LINK ACTIVE = 0 signal (i.e. LINK OFF)
  The current contour deviation for the following axis is displayed. The display in the "Synchronism error" field remains at 0.

- With IS LINK ACTIVE = 1 signal:
  The contour deviation display remains at 0. In the active link state, the synchronism error is indicated in the "Synchronism error" field.

The current positional difference between the leading and following axes is entered in the "Synchronism error" field in the "Individual axes/individual spindles" service display. The difference is displayed in units (MS).

Checking the GI programming functions

You now need to configure and activate the gearbox grouping. You should also test the "On-the-fly synchronism" performance of the grouping if necessary. The requisite programming functions are described in the document entitled "SINUMERIK 840C, Programming Guide".

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Setting the interlocks

To complete the start-up procedure, you now need to set or reset the interlock or enable bits for certain GI functionalities according to the machine manufacturer's data. The following settings are available:

- NC MD 1456*/496* Default setting of link structure
- NC MD 1844*/525* bit1 Reconfiguration permissible
- NC MD 1844*/525* bit2 Switchover of link factor permissible
- NC MD 1844*/525* bit3 Overwriting of positions permissible
- NC MD 1844* bit4 LINK_ON after power on

12.18.14 Special cases of gearbox interpolation

12.18.14.1 Synchronous spindle

If only the "Synchronous spindle" option is set, then several pairs of synchronous spindles can be configured. The selected gearbox interpolation type is subject to the following restriction:
Only one leading spindle can be configured for each following spindle.

The synchronous spindle function is especially important for the "on-the-fly transfer" of the workpiece from the working spindle. During this process, the workpiece is transferred to the synchronous spindle (following/counter-spindle) while the main (leading) spindle is rotating. In this case, the synchronous spindle must be synchronized with the main spindle in terms of speed and, with shaped workpieces, also in terms of position.

The synchronous spindle is programmed by means of the G400, G401, G402 and G403 commands in conformity with the general programming options for gearbox interpolation.

The interface signal INTERLOCK LINK ON can also be applied in this case to influence the activation and deactivation of the gearbox link from the PLC.

The following special features must be noted with respect to the "Synchronous spindle" functionality or following spindles:

POWER ON/Ramp-up/Start-up

- The leading and following spindles are always in the spindle mode after POWER ON. LINK ON cannot be activated after POWER ON in this case (in contrast to axes).
- A pulse encoder must be provided for the leading and following spindles.
- The spindle drift must be compensated.
- The position control loops of the spindles must be set to the same following error for a setpoint link.
- The leading and following spindles are always operated under position control in synchronous operation.
- If a simulated spindle is to act as the leading spindle, NC MD 520*.2 (pulse encoder installed) and the NS SPEED CONTROLLER ENABLE must be set for the spindle (even when a pulse encoder is not connected).

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Selection

- Before synchronous operation is selected, the CONTROLLER ENABLE signal must be present for both spindles. If this signal is not present, the reaction is as follows:
  – No switchover to synchronous operation takes place
  – No alarm is output
  – The block changes immediately.
- After activation of a link, the block changes as a function of NC MD 526*bits 5,2 (block change with fine synchronism or after synchronization reached).
- Block changes are interlocked after G402 and G043 as long as the signal INTERLOCK LINK ON or PLC SPINDLE CONTROL is set.
- Synchronous operation for the following spindle can be activated even for non-referenced leading and following spindles (no zero mark sensing). In other words, synchronous operation can be activated even if the leading and following spindles are friction-locked via a clamped workpiece after power on. Positional synchronism (G403) is not however achieved until the leading and following spindles have been synchronized.

Deselection

- Synchronous operation can be deselected through programming of G400 or through setting of the LINK OFF interface signal in the PLC for the following spindle.
- Block changes are interlocked after deselection of synchronous operation as long as the signal INTERLOCK LINK OFF or PLC SPINDLE CONTROL is set.
- The following spindle continues to rotate at the current actual speed after deselection of synchronous operation.

Operating modes

- When the link is not activated, the following and leading spindles can be traversed in all operating modes.
- When the link is activated, the leading spindle can be traversed in the following operating modes:
  – Control mode from NC, PLC, command channel
  – Positioning mode from NC, PLC, command channel
  – C-axis mode (assignment between leading and following drives is maintained even if the leading spindle is in C-axis mode and the link then activated).
- The leading spindle cannot be operated in oscillation mode when the link is active.
- When the link is active, the following spindle is inhibited with regard to any commands from the NC, PLC or command channel. In this case, only the controller enabling command and GI-specific spindle signals have any influence on the following spindle.
- If a leading spindle is operating in C-axis mode, then it can act as a leading or following axis in a GI grouping.
- The leading and following spindles cannot be switched over to C-axis operation when the link is active. The GI grouping of the synchronous spindle may, however, remain configured during switchover.
- When the link is active, the following spindle may only be operated in the mode specified in the GI configuration (C axis or spindle).

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- The same drive may not be configured as the following drive as a C-axis and a spindle in two GI groupings at the same time.
- Synchronous operation is not cancelled when the operating mode is changed or after RESET.
- The system limits the speed of the leading spindle to a maximum value which is determined by the link factor and the spindle limitations of the following spindle (max. motor speed, max. spindle speed, max. gear stage speed).
- If an M19 gain switchover is implemented for the drive actuator, the following must be noted: The position control is active in synchronous mode, i.e. the servo gain factor of the M19 creep speed is applied as the servo gain factor. However, the actuator is not switched over to M19 mode in synchronous operation. This M19 servo gain factor is not however rated for maximum speed. Before you activate the link, therefore, you should switch over to a gear stage which is identical - with the exception of the servo gain factor (matched to maximum link speed) - to the gear stage of the actuator, which has not been switched over.
- If the leading and following spindles are friction-locked via a clamped workpiece, the speed controllers of the spindles may be working in opposition to one another. In such cases, the I-action component of the speed controller must be reduced; the function can also be activated via interface signals ”Cancel synchronism deviation”.

Interface signals

- The spindle override is operative only for the leading spindle in synchronous operation.
- In synchronous operation, the normal spindle interface signals are relevant for the leading spindle; only the CONTROLLER ENABLE and the extended signals of the following spindle are relevant for the following spindle and the synchronous operation status.
- When the SPINDLE DISABLE signal is applied to the leading spindle, then the same signal is set internally for the following spindle.
- Synchronous operation is not aborted if the signal SPINDLE DISABLE is set at the following spindle interface or the CONTROLLER ENABLE signal removed. Since, however, the following spindle is then stationary, the monitoring circuit for emergency retraction or synchronism responds as soon as the leading spindle rotates and the monitoring threshold is exceeded.
- If the signal PLC SPINDLE CONTROL is applied to the following spindle, then the G400, G402 and G403 commands are also blocked. The last command in each case is executed after reset of the signal.
- If the CONTROLLER ENABLE signal for the following spindle is removed after spindle stop without the link being deactivated at the same time, then a synchronism error caused by external action (e.g. manual rotation, drift, etc.) will not be compensated when the CONTROLLER ENABLE signal is applied again.
  This may cause loss of the defined allocation between leading and following spindle for some applications (e.g. polygonal turning). This problem can be remedied by starting "On-the-fly synchronization" with the appropriate synchronous positions from the PLC interface.

Gear stage

- Before synchronous operation is selected, the same mechanical gear stage must always be engaged for the following spindle so that the same position control parameters are always applied for the following spindle.
- No request for a gear change may be present when synchronous operation is selected.

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- Gear stage switchover and the transfer of new actual gear stages are not possible in synchronous operation.

Synchronous spindle in mechanically coupled operation

When a pair of synchronous spindles is operated with clamped workpiece, certain factors including

- the rigidity of the workpiece
- the closing force of the chuck and
- the stiffness of the drive mechanical components

cause backlash via the workpiece.

These effects can cause shutdown of the drive both at standstill and in dynamic operation.

Dynamic:
During acceleration in mechanically coupled operation, asymmetries in the control loop concerned may cause very strong torque deviations to develop between the individual spindles, leading to an imbalance in power distribution, i.e. one drive takes over or carries the main load.

Static:
When a workpiece is transferred to the following drive, an angular offset may develop between the leading and following drives as a result of the mechanical closing action of the chuck . Provided that both drives are coupled via the workpiece,

- this offset cannot be corrected or eliminated
- the workpiece may be strained by torsional forces or
- the workpiece may be damaged by the chuck.

The following procedure is recommended:

Position controller level

Dynamic:
Asymmetry between the control loops involved can be corrected via setpoint filters.

Static:
The angular offset which develops, for example, when the chuck closes, causes straining on intervention by the position control/compensatory controller. This type of strain can be prevented by means of the interface signal "Follow up synchronism deviation".

Speed controller level

When SIMODRIVE 611A/D and 1FT drive systems are used, a so-called integrator feedback can be activated in the speed controller. The feedback function does not lead to integration of the torques by the I-action component at low speeds.
When main spindle drives are used, it is necessary - depending on prevailing conditions - to deactivate at least the I-action component of the following axis speed controller, particularly in static operation.

Note:

With synchronous spindles avoid rigid linking as this may possibly lead to running off of the spindle/axis during automatically controlled correction.
NC MD 1432*/495*: At the initial setting ”automatically controlled correction” is always selected (16 seconds).

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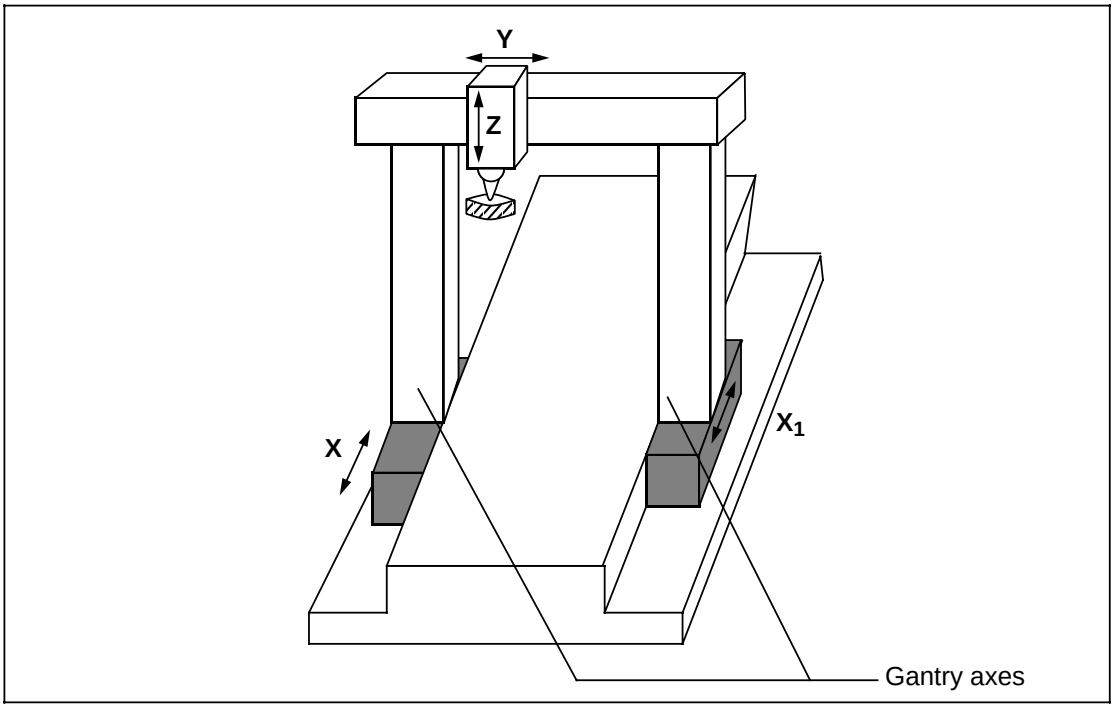
12.18.14.2 Gantry axes; machines with forced coupling

Several gantry axis pairs can be configured if only the "Gantry axis" option is set. The selected gearbox interpolation type is subject to the following restrictions:

- ***Only one leading axis permitted per following axis***
- ***Fixed coupling ratio of 1:1 or -1:1***
- ***No programming using G commands possible***
- ***Coupling can be defined only via input display or read-in of GIA data***

For gantry axis applications, two mechanically coupled machine axes must be traversed synchronously by mutually independent axis drives. A gantry milling machine is an example of a typical application.



With gantry axes, the two axes should be traversed as one. In addition, only one axis (e.g. X) must be programmed by the user.

The link can be activated immediately after reference point approach or when absolute encoders are installed and will then be maintained in all operating modes.

The set configuration is stored. Reconfiguration or, if required, switchover of the link factor can be inhibited for the appropriate following axis by means of machine data settings.

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The following interlocks are effective:

- Inhibition of reconfiguration (axis 1844*)
- Inhibition of link factor switchover (axis 1844*)
- Inhibition of synchronizing position switchover (axis 1844*)
- INTERLOCK LINK OFF (interface signal)

To ensure that the links become active immediately after power on, "LINK ON after POWER ON" (axis 1844*) must be set for the currently active following axis.

Reference point approach by gantry axes

When a portal machine with gantry axes is switched off, mechanical strains in the portal can cause misalignment of the axes in relation to one another. A certain sequence must therefore be followed on restart or when the gantry axes execute their mandatory reference point approach.

- **Absolute measuring system for both gantry axes**

When both gantry axes are equipped with an absolute measuring system as the sole measuring system, there is no need for special referencing since these measuring systems report their absolute positions to the control after power on. The axes are therefore "referenced" immediately after power on.

- **Incremental measuring system for both gantry axes**

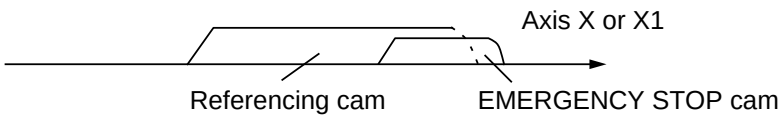
During referencing (synchronization) of gantry axes, the axes involved are operated alternately as either the leading or following axis. In other words, only one of the two gantry axes is referenced initially (the second operates simultaneously as a coupled axis); the other axis is referenced afterwards (the first axis then operates simultaneously as a coupled axis). Finally, any dimensional offset is then eliminated by means of the "On-the-fly synchronization" function.

Caution:

An undesirable feedback loop develops when both GI groupings are active at the same time. No check is made for this state. This problem can be best avoided by mutually interlocking the two gantry groupings by means of the INTERLOCK LINK ON signal.

Prerequisites:

- Automatic reference point approach is active (NC MD 560*.4 = 1)
- Long referencing cams are mounted on portal axis X or X1.



- The following GI groupings have been configured via the input display:
  - GI grouping 1 Leading axis X1; following axis X; link factor 1:1; link type K1; enter reference point positions as synchronous positions
  - GI grouping 2 Leading axis X; following axis X1; link factor 1:1; link type K1; enter referencing point positions as synchronous positions

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Flowchart for PLC-controlled reference point approach

Activate control

Activate GI grouping 1

Selection ref. point mode

Initiate reference point approach with leading axis X1 (following axis X follows X1)

Reference point reached?

Deactivate GI grouping 1

Activate GI grouping 2

Initiate reference point approach with leading axis X (following axis X1 follows X)

Reference point reached?

Enable following axis overlay

Initiate on-the-fly synchronization for grouping 2

Synchronization reached (following axis)

Disable following axis overlay

Selection "Automatic" mode

END

Note

It is advisable to deactivate the synchro monitors in the PLC program until the gantry axis reference point approach process is complete.
The ”Set reference dimension via PLC request” function is available with SW 4 and higher.

- **2 measuring systems for each gantry axis**

In order to carry out the referencing process when the gantry is unstressed, you can install 2 different measuring systems at the same time for each gantry axis, i.e. an (indirect) SIPOS absolute system as the 1st measuring system and an incremental (direct) measuring system as the second.
After power on, the SIPOS systems - as the 1st measuring system - transmit their absolute values to the control. It must be ensured that the NC MD "Absolute offset valid" (1803*.3) is set. The absolute positions of the two gantry axes are therefore available to the control. GI grouping 1 is then linked in (leading axis X1, following axis X). Any dimensional offset between the two axes is eliminated with the absolute values during the subsequent "on-the-fly synchronization" process. The incremental, direct system is then activated for referencing purposes. During referencing, NC MD "Absolute offset valid" (1808*.3) must be reset (referencing is not otherwise possible). The procedure subsequently applied for reference point approach is the same as if only incremental measuring systems were in use. Finally, any existing small dimensional offset can again be eliminated by means of another "on-the-fly synchronization".

Note:

Please refer to functional description of the SIPOS absolute encoder for further information.

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- **Distance-coded reference mark system for each gantry axis**

To avoid the need to traverse large distances for reference point approach purposes, it is possible to use a measuring system with distance-coded reference marks as the sole or as the second measuring system. This measuring system is referenced after a distance of approximately 2 cm. The referencing procedure is in this case the same as for normal incremental measuring systems.

Note:

Please refer to functional description of "Distance-coded measuring system" for further details.

Prerequisite

- As for incremental measuring system for gantry axes
- The 1st measuring system (OB 32, DW k + 2 bit 12) must be activated in OB 20 and the absolute offset (NC MD 1808*bit 3) of the gantry axes in FB 62.

Flowchart for PLC-controlled reference point approach

Activate control

SIPOS measuring systems send their absolute positions to the control

Activate GI grouping 1

Enable following axis overlay

Initiate on-the-fly synchronization for grouping 1

Synchronous position reached? Deactivate grouping 1

Declare absolute offset (NC MD 1808*3) for the leading and following axes to be invalid via FB 62.

Select 2nd measuring system for leading and following axes (DB32, DWk + 2 bit 12)

Activate grouping 1

Selection reference point mode

Initiate reference point approach with leading axis X1 (following axis X follows X1)

Reference point reached?

Deactivate grouping 1

Activate grouping 2

Initiate reference point approach with leading axis X (following axis X1 follows X)

Reference point reached?

Enable following axis overlay

Initiate on-the-fly synchronization for grouping 2

Synchronization reached? (following axis)

Disable following axis overlay

Select "Automatic" mode

END

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12.18.15 Gearbox interpolation status data

In the SINUMERIK 840C control system, the currently valid configuration and status data of the active and inactive GI groupings are stored in the so-called gearbox interpolation (GI) status data. A memory area is reserved for each axis and spindle because every axis**/**spindle could be a following axis/spindle. The memory area is buffered so that the gearbox configurations are not lost after power off. The data are read after power on and the link activated during ramp-up (used for gantry axes) provided that the enabling command is present (NC MD 1844***/**525* LINK ON after POWER ON). The GI status data can be erased in general reset mode.

These data lists can be read in or out as %GIA data via the RS 232 C (V.24) interface. Data can be read in only in start-up mode and read out only when the SINUMERIK is in the reset state.

12.18.15.1 Format of data list (SW 3)

	Type 0 Axis 1	. . .	Type 29 Axis 30		Type 40 Spindle 1	. . .	Type 45 Spindle 6
FD	GIA 0...5	FD	GIA 0..5	FD	GIA 0..5	FD	GIA 0..5
LD1	GIA 100...106	LD1	GIA 100...106	LD1	GIA 100...106	LD1	GIA 100...106
LD2	GIA 200...206	LD2	GIA 200...206	LD2	GIA 200...206	LD2	GIA 200...206
LD3	GIA 300...306	LD3	GIA 300...306	LD3	GIA 300...306	LD3	GIA 300...306
LD4	GIA 400...406	LD4	GIA 400...406	LD4	GIA 400...406	LD4	GIA 400...406
LD5	GIA 500...506	LD5	GIA 500...506	LD5	GIA 500...506	LD5	GIA 500...506

Format of data list (SW 4)

	Type 0 Axis 1	. . .	Type 29 Axis 30		Type 40 Spindle 1	. . .	Type 45 Spindle 6
FD	GIA 0...5.9	FD	GIA 0..5.9	FD	GIA 0..5.9	FD	GIA 0..5.9
LD1	GIA 100...109	LD1	GIA 100...109	LD1	GIA 100...109	LD1	GIA 100...109
LD2	GIA 200...209	LD2	GIA 200...209	LD2	GIA 200...209	LD2	GIA 200...209
LD3	GIA 300...309	LD3	GIA 300...309	LD3	GIA 300...309	LD3	GIA 300...309
LD4	GIA 400...409	LD4	GIA 400...409	LD4	GIA 400...409	LD4	GIA 400...409
LD5	GIA 500...509	LD5	GIA 500...509	LD5	GIA 500...509	LD5	GIA 500...509

Note:

This data list is merely intended as a back-up file for servicing purposes and must not therefore be changed by the user.

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12.18.16 Examples

12.18.16.1 Overview of application examples

- Hobbing
- Inclined infeed axes

12.18.16.2 Hobbing

Interrelated functions in hobbing process

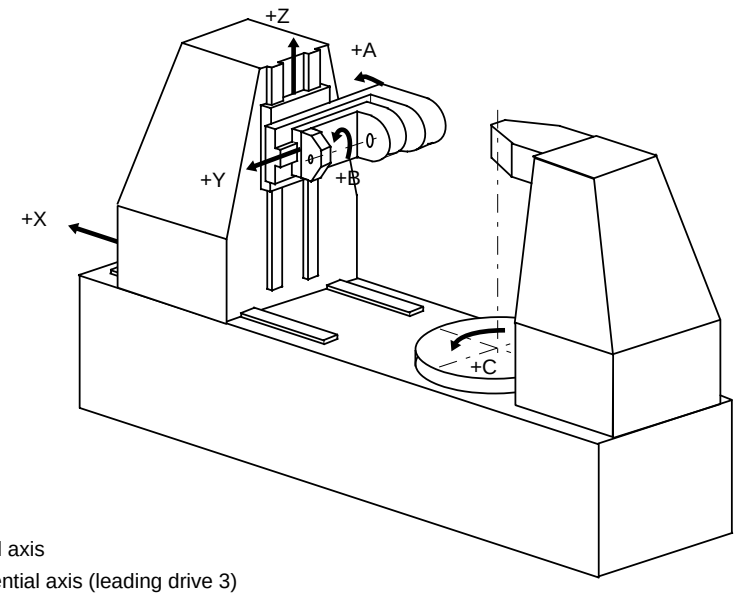
The following diagram shows the configuration of a typical hobbing machine.

The machine comprises five numerically controlled axes and a controlled main spindle.

These are:

- the rotary motion of the workpiece table (C) and hobber (B),
- the axial axis (Z) for producing the feed motion over the entire workpiece width,
- the tangential axis (Y) for shifting the hobber along its axis,
- the radial axis (X) for the infeed of the cutter to tooth depth,
- the cutter swivel axis (A) for setting the hobber in relation to the workpiece depending on the cutter and tooth lead angles.

The machine can also be equipped with further NC axes to obtain an automatic workpiece and tool changer.



X = Radial axis
Y = Tangential axis (leading drive 3)
Z = Axial axis (leading drive 2)
A = Cutter swivel axis
C = Workpiece rotary axis (following drive)
B = Cutter rotary axis, main spindle (leading drive 1)

Definition of axes on a hobbing machine (example)

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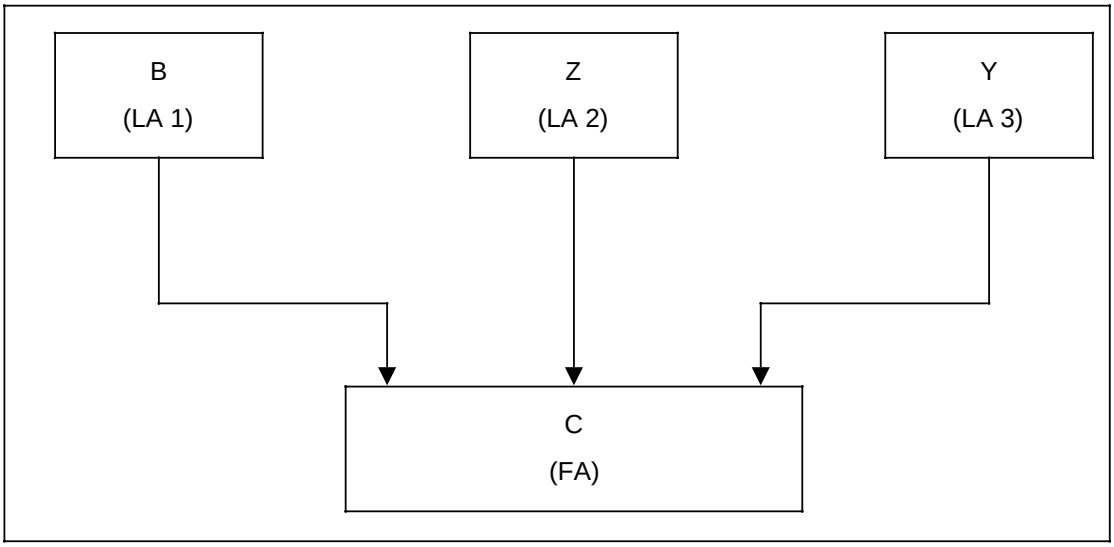
The hobbing machine functions are interrelated as follows:



The workpiece table axis (C) is the following axis; in this example, it is influenced by three leading drives.

The following axis setpoint is calculated cyclically by means of the following logic equation:

$$n_c = n_b \cdot \frac{z_0}{z_2} + v_z \cdot \frac{u_{dz}}{z_2} + v_y \cdot \frac{u_{dv}}{z_2}$$

n_c Speed of workpiece axis (C)

n_b Speed of cutter spindle (B)

z_0 Number of hobbing operations

z_2 Number of teeth on workpiece

v_z Feed velocity of axial axis (Z)

v_y Feed velocity of tangential axis (Y)

u_{dz} Axial differential constant

u_{dy} Tangential differential constant

The first summand in the above equation determines the speed ratio between the workpiece table and the cutter and therefore the number of teeth on the workpiece. The second summand effects the requisite additional rotation of the C-axis for inclined gearing as a function of the axial feed motion of the cutter to produce the tooth pitch. The third component also makes allowance for additional rotation of the C-axis which compensates the tangential motion of the cutter in relation to the workpiece. In this way, the tool can be evenly loaded over its entire length.

The values z_0, z_2, u_{dz} and u_{dy} are dependent on workpiece and tool and are specified by the NC user or in the part program.

The differential constants u_{dz} and u_{dy} make allowance for the workpiece tooth pitch and the geometry of the cutter. The differential constants can be calculated in user-specific cycles.

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Example calculations of u_{dz} and u_{dy}.

$$u_{dz} = \frac{\sin \circ}{m_{n*}} \cdot 360 \left[\frac{\text{degrees}}{\text{mm}}\right]$$

$$u_{dy} = \frac{\cos \circ}{m_{n*}} \cdot 360 \left[\frac{\text{degrees}}{\text{mm}}\right]$$

in which

m_n = Normal modulus (in mm)

$\circ$ = Angle of incline of gear

$\circ$ = Lead angle of hobber

Configuring the GI grouping via the part program

1st leading axis = Cutter spindle B (setpoint link K1)

2nd leading axis = Axis Z (setpoint link K1)

3rd leading axis = Axis Y (setpoint link K1)

Following axis = Rotary axis C

Define configuration: `G401 B K1 Z K1 Y K1 C LF`

Activate link:

```
R100=z0 R101=z2 R102=udz R103=z2 R104=udy R105=z2 LF
G402 B I=R100 J=R101 Z I=R102 J=R103 Y I=R104 J=R105 C LF
```

Please refer to previous page for explanation of abbreviations.

12.18.16.3 Inclined infeed axes

Many users of machines with inclined axes require an NC part program which allows non-perpendicular NC axes to be treated in the same way as perpendicular axes for programming purposes.

Two different systems of co-ordinates are therefore provided:

- A non-cartesian, **real** co-ordinate system of machine axes
- A cartesian, **simulated** co-ordinate system

The GI functionality is so universal in design that the above demand can be satisfied.

This option is explained below using the example of a grinding machine with an inclined axis.

The diagram below shows a plain grinding machine with a U axis inclined in relation to the Z1 axis by an angle of 90°- .

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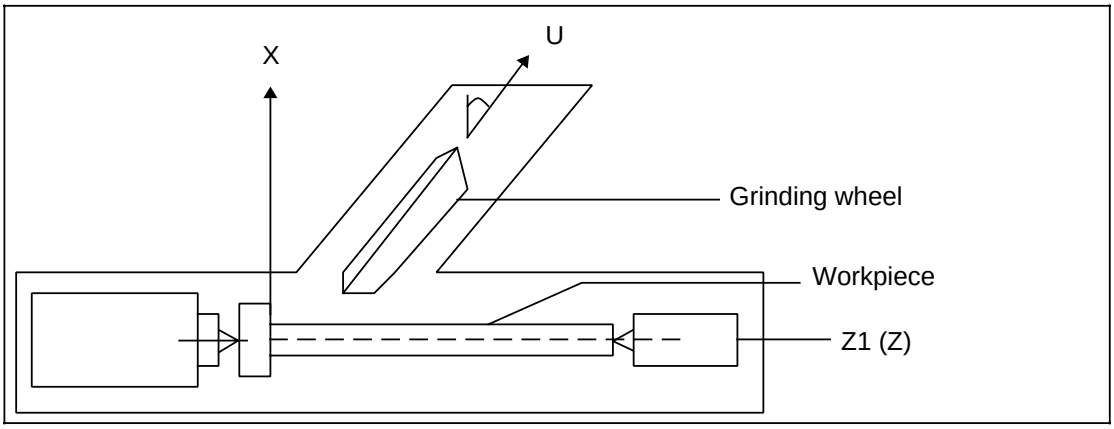
Two co-ordinate systems are defined:

X/Z = Simulated cartesian co-ordinate system
Axes X and Z have no measuring circuit assignment. They are therefore referred to as "simulated axes". The machine axes U/Z1 are programmed in the cartesian co-ordinate system.

U/Z1 = Real, non-cartesian co-ordinate system.
Axes U and Z1 are assigned via hardware measuring circuits. They are referred to as "real axes".

The real machine axes U and Z1 must be moved in order to traverse the programmed paths in the X axis.



Plain grinding machine with inclined U axis

The mathematical relations in this case are as follows:

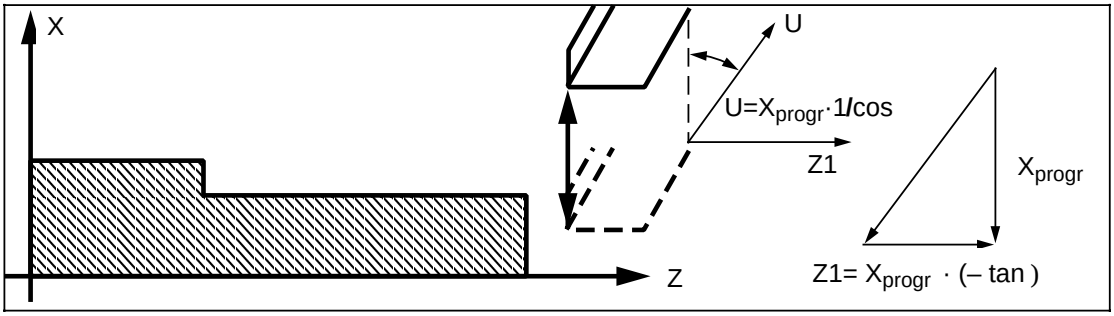
$$U = X \cdot \frac{1}{\cos}$$

$$Z1 = X \cdot (-\tan)$$

Solution with GI

Axes X and Z, which form the simulated, cartesian co-ordinate system, are defined as simulated leading axes for the real machine axes U (following axis 1) and Z1 (following axis 2). 2 gearbox interpolation groupings are therefore required.

Axis Z1 (following axis 2) allows for the path distance traversed by both the simulated X axis and the simulated Z axis.



Simulated, cartesian co-ordinate system (X, Z) and real, non-cartesian co-ordinate system (U, Z1)

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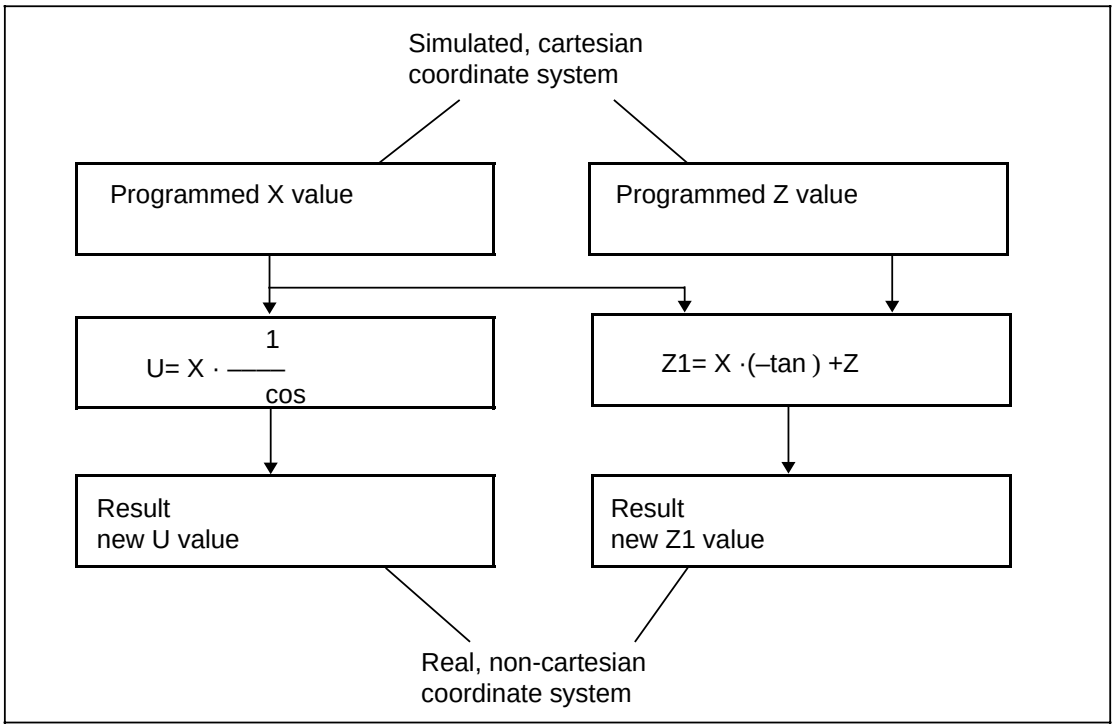

Relationship between the simulated leading axes and the following axes

Example of parameterization of GI grouping machine data:

Axis	Name
1	X (Leading drive)
2	Y (Leading drive)
3	Z (Leading drive)
4	Z1 (Following axis)
5	U (Following axis)

=20.5°

GI machine data required:

- NC MD 18444 bit0 = 1 — Axis Z1 may be following axis
- NC MD 18444 bit1 = 1 — Reconfiguration permissible
- NC MD 18444 bit2 = 1 — Switchover of link factor permissible
- NC MD 18444 bit3 = 1 — Overwriting of synchronous positions permissible

- NC MD 18445 bit0 = 1 — Axis U may be following axis
- NC MD 18445 bit1 = 1 — Reconfiguration permissible
- NC MD 18435 bit2 = 1 — Switchover of link factor permissible
- NC MD 18445 bit3 = 1 — Overwriting of synchronous positions permissible

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Programming the GI groupings via the part program:

GI grouping 1: 1st leading axis = X
Following axis = U
Setpoint position link without compensatory controller (for simulation axes, K3)

Define configuration:

```
G401  X  K3  U  LF
```

Activate link:

```
@631  R100  K20.5  LF
G402  X  I1  J=R100  U  LF
```

GI grouping 2: 1st leading axis = X
2nd leading axis = Z
Following axis = Z1
Setpoint position link without compensatory controller (for simulation axes, K3)

Define configuration:

```
G401  X K3  Z  K3  Z1=  LF
```

Activate link:

```
@632  R101  K20.5  LF
G402  X  I=-R101  J1  Z  I1  J1  Z1=  LF
```

Measures to be taken after machine is switched on

The real following axes must first approach the reference point. They must then be synchronized with the simulated leading axes (on-the-fly synchronization).

Notes on application:

For the execution of NC part programs, the solution based on GI for compensating the inclined axis can be applied provided that the following points are considered:

1. No axis disabling signals may be present for the fictitious axes. The latter must be declared as simulated axes via machine data MD 200* or the axis actual values will otherwise be set to zero on reset.
2. The real axes must be prevented from traversing in JOG mode. They may move only on traversal of the simulated axes. In other words:
   Traversal of the X axis in JOG traversal of both real axes (in this case, U and Z1).
   Traversal of the Z axis in JOG traversal of the real axis (in this case, Z1).
   It must however be possible for the real axes to approach the reference point.
3. Since only the real axes are capable of approaching the reference point, the simulation axes must be synchronized with them on completion of this approach.

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12.19 Interpolation and compensation with tables and temperature compensation

Corresponding data:

- IKA data 1 - 3 IKA configuration, IKA curves, IKA compensation points
- NC MD 356* IKA warning limit
- NC MD 1148* IKA/TC velocity
- DB32 DRK bit 5 IKA/TC velocity exceeded
- DB32 DRK bit 6 IKA warning limit exceeded
- The TEMPERATURE COMPENSATION (TC) or INTERPOLATION AND COMPENSATION WITH TABLES (IKA or IKA Stage 2) option must be installed.

General notes

As a result of the increasing demands placed on machine tools, there is a need for improved functionality between the machine and measuring system in order to compensate for the effects of errors. In addition, this level of functionality allows the traversal of an optional movement overlaid on the programmed geometry.

All the functions are described below.

12.19.1 Options

The following functions are available

- Temperature compensation (TC)
  Scope of functions SW 3
- Interpolation and compensation with tables (IKA)
  Scope of functions SW 3
- Interpolation and compensation with tables 2 (IKA stage 2)
  Scope of functions SW 4

which are available as separate options.

Compensation of errors with TC and IKA

The control system may fail to sense the actual value correctly as a result, for example, of the following influences:

- Temperature (thermal expansion)
- Effects of mechanical action between axes (e.g. sag)
- Lead screw errors (production tolerances of spindles)

These influences can be compensated as an internal control function by means of TC or IKA. For this purpose, the machine or measuring system parameters measured by laser are stored in the control during start-up so that they are available for inclusion in the compensation calculation. The calculated compensation values are also taken into account by the position control loop with the result that the axes approach the machine setpoint position selected by the user.

A method of compensating lead screw errors is already available (see section "Leadscrew error compensation"), but is limited in terms of application owing to the fixed grid spacing and the absolute compensation value.

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Implementation of any geometry or velocity profiles SW 4 and higher with IKA Stage 2

IKA Stage 2 makes it possible to define a fully optional geometry between an input variable and the associated output variable. For this purpose, the relevant values of the output quantity are allocated to a number of interpolation points of the input quantity and stored as a table in the NC. During part program processing, the values from the output quantity table assigned to the current values of the input quantity are overlaid. Interpolation between two intermediate points can be linear or cubic.

Input and output quantities can also be preset to influence velocities and R parameters.

12.19.2 Activation

The following options can be activated at the same time:

- Temperature compensation (TK) for compensation of thermal expansion
- Interpolation and compensation with tables (IKA), e.g. for compensation of lead screw errors, sag compensation for telescopic axes

Both options are completely independent of one another. The individual results are added on an axis-specific basis and produce the absolute traversing path of an axis. If several interpolations or compensations are to be calculated, then all of them have only one common value as the input quantity. Within an IPO cycle, therefore, a TC value which may have been calculated beforehand (within the same IPO cycle) is not taken into account in the IKA value calculation.

The functions are active in all modes after the reference point approach of the axes involved. If a referenced axis is re-referenced, then the functions are deactivated after cam approach until the reference point approach process is complete.

The traversing path resulting from the functions involved is shown in the service display in position control resolutions.

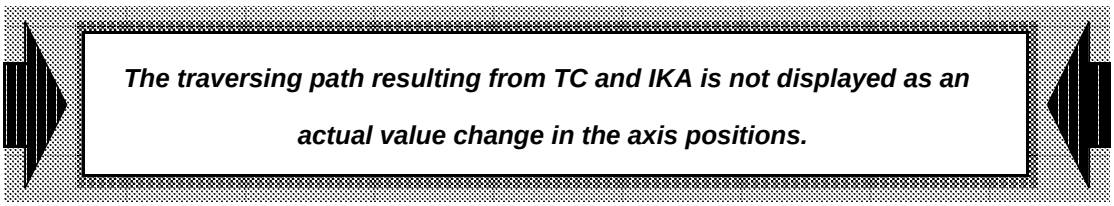
The resulting traversing path or compensation value (sum of TC and all IKA configurations) is included as an absolute position error in the actual value path calculation. This value must not be changed by more than a specific amount within each IPO cycle. This limit is distributed among several IPO cycles by means of a ramping function.

Machine data "IKA warning limit" and "IKA/TC speed" as well as the interface signals "IKA/TC speed exceeded" and "IKA warning limit exceeded" only apply to the machine error compensation area.

Example:

MD 300* = 500 mm/min, IPO cycle = 6ms
max. change in output quantity per IPO cycle = 50 µm.

The output quantity is traversed with the velocity set in NC MD 1148*.



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Activation of IKA Stage 2

The option IKA Stage 2 applies from SW 4 and contains the IKA option. With IKA Stage 2 it is possible not only to implement compensations but also any (non-linear) interpolations.

The options for presetting the input and output quantity have been expanded in IKA Stage 2 for use with interpolation.

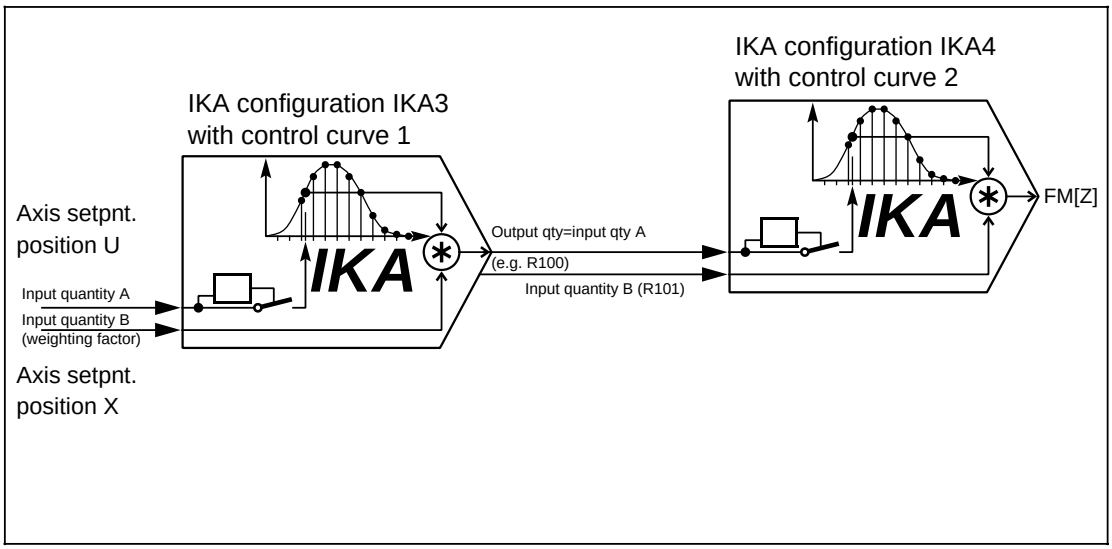
An input can be:

- Axis setpoint position
- Axis actual position
- R parameters

An output can be:

- Axis setpoint position
- Axis compensation value
- R parameters
- Feed weighting

Since it is now possible to parameterize R parameters for both input quantities and output quantities, the user is able to cascade IKA tables (see following diagram).



Example of cascaded IKA link branches

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12.19.3 Interlocks and monitoring

Interlocks

In the case of axis-specific interlocks of IKA/TC movements, the current IKA/TC value is "frozen", it remains applied in static form. In this case, a distinction is made between:

- Direction-dependent interlocks
  - SW limit switch:
    After alarm 148* or 152* "SW limit switch" has responded, both normal IPO movements as well as IKA/TC movements, which lead in a direction away from the traversing range, are interlocked. In addition, all channels of the mode group assigned to this axis are aborted.
  - HW limit switch
- Direction-independent interlocks:
  - Parking axis
  - Axis disable
  - Controller disable
  - Follow-up mode

All interlocks are cancelled as soon as the cause itself has been eliminated (and not following a RESET).

If it is necessary to disable the traversing axis from the PLC program or to stop the IKA/TC movement, then the axial PLC signals "Controller disable", "Follow-up mode", "Axis disable" and "Parking axis" must be applied.

The axial feed stop and the channel-specific feed stop or override zero can be applied to all axes in the mode group only via the leading axis or via the channel.

If the axis programmed as the input quantity loses its reference point (e.g. due to parking axis), then the output quantity is not "frozen", but reduced to zero.

Limit switch monitoring

When IKA/TC is active, the effective machine position of the output quantity axis is always evaluated when limit switch monitoring is activated:

NC setpoint - IKA/TC value.

The braking ramp is not activated until the SW limit switch is reached so that traversal slightly beyond the switch (depending on feed) is possible.

When an SW limit switch is reached, alarm 148* "SW limit switch +" or alarm 152* "SW limit switch -" is always output.

The response of the monitor is dependent on the following factors:

Automatic/MDI mode:

A part program block is always examined prior to traversal for the points at which limit switches are reached. When the IKA/TI is active, however, it is not possible to identify the path characteristic in advance. The following situations may occur when this part program is traversed:

a) With an NC setpoint P_{NC}, a machine position P_M is reached during traversal as a function of compensation (positive IKA/TC motion).

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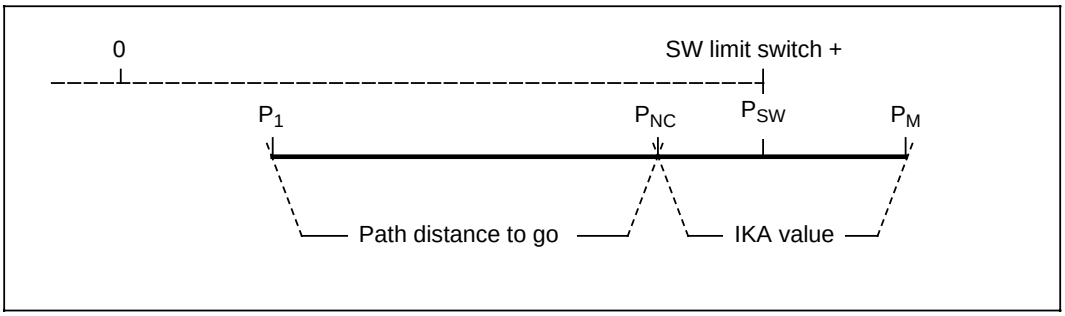
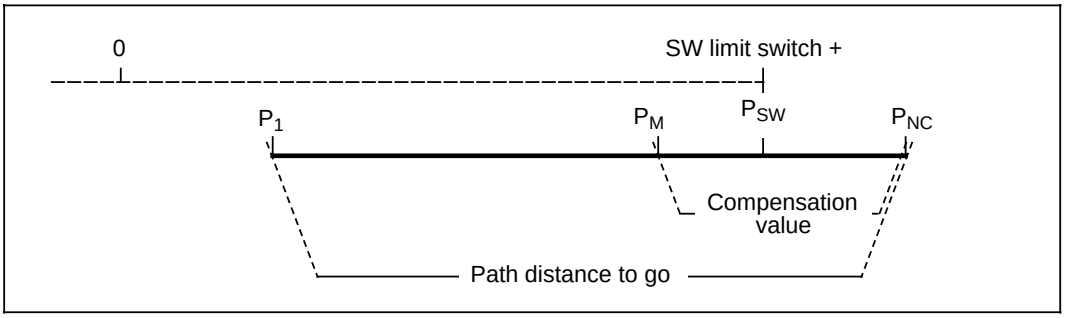


- IKA/TC motion in positive direction
- SW limit switch monitoring prior to traversal knows only P_{NC} and does not therefore output an alarm
- Alarm 148* is output during traversal when P_{SW} is reached.

b) With an NC setpoint P_{NC}, a machine position PM is reached during traversal as a function of IKA/TC (negative IKA/TC motion).



- IKA/TC motion in negative direction
- SW limit switch monitoring prior to traversal knows only P_{NC} and therefore outputs alarm 2065, "Programmed position beyond SW limit switch" even though machine position P_M belonging to this NC setpoint is located in front of the SW limit switch.

With IKA Stage 2, the time when the software limit switch is scanned depends on the axis setpoint position. Monitoring in the position controller might result in a slight overshoot of the software limit switch.

Effect of direction-dependent compensation - backlash compensation

When an IKA/TC table is defined with positive and negative output values, the output quantity axis is moved in various directions. This does not however mean that this reversal of direction is detected or evaluated by any other direction-dependent IKA compensation (backlash compensation) which may be present. These types of compensation detect reversals of direction on the basis of part setpoints at the output of the velocity control.

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IKA warning limit with axis compensation

When the compensatory**/**additional values of the output quantity are high, the machine may make unexpected movements which are only partly limited by the monitoring functions. The present output value is therefore checked against the limit set in NC MD 356* and, in the case of limit violation, an axis-specific interface signal of the PLC is set (DB 32, DR0, bit 6). In the same way, the permissible velocity for the compensation (NC MD 1148*) is checked for violation. The value is displayed in DB 32, DR k, bit 5. As a result of this signal, the PLC can then, for example, activate follow-up mode in order to stop the axis.

8 decades with sign can be specified as the maximum permissible setting for the output quantity compensatory**/**additional values. With this setting, long traverse distances can be generated on the machine when the IKA configuration is selected, deselected or changed.

The traversing ranges that occur as a result of temperature, leadscrew error and beam sag compensation are in the range 0.01 to 0.2 mm.

An IKA warning limit has been provided to ensure that excessive IKA movements are not caused unintentionally by incorrect inputs (protected by password). When this limit is violated, the PLC can decide which measures should be taken. The velocity must be as high as possible in order to minimize contour errors when the IKA executes large-scale compensatory/additional movements. The axial machine data "IKA**/**TK velocity" (NC MD 1148*) is used for this purpose and defines the velocity at which the compensatory**/**additional movement is performed.

The output quantity axis completes any compensatory/additional movement it has started, even if the RESET command is given. HW limit switches, EMERGENCY STOP, etc. interrupt the additionally required movement.

The effective velocity of a motion results from the input quantity axis velocity, the (in some cases) subordinate velocity of the output quantity and the required compensatory/additional motion.

The alarm checks evaluate the speed setpoint which effectively results.

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12.19.4 Temperature compensation TC

The TEMPERATURE COMPENSATION (TC) function is available as an option.

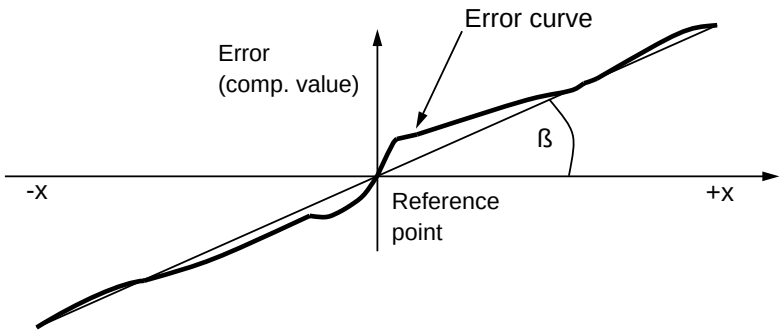
With this compensation function, the compensation values applying to the current temperature are transferred from the PLC to the NC via the command channel. The requisite compensation values must have been calculated in the PLC beforehand by the machine manufacturer.

12.19.4.1 Types of influence

There are two different types of temperature influence:

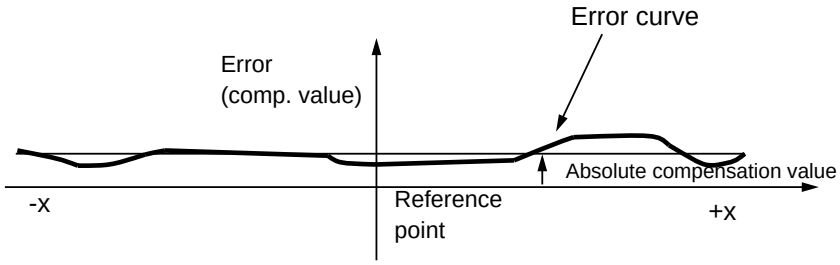
Position-dependent influence on actual value

The temperature-related actual-value deviation for an axis can be represented by an error curve. It can be assumed that the position-dependent expansion develops evenly from one reference point. It can be approximated by means of a straight line of which the gradient is determined by the temperature.



Position-independent influence on actual value

The measured axis actual value deviates by an absolute temperature-dependent value which is not dependent upon the actual axis position. The characteristic of this error curve can likewise be approximated by a straight line.



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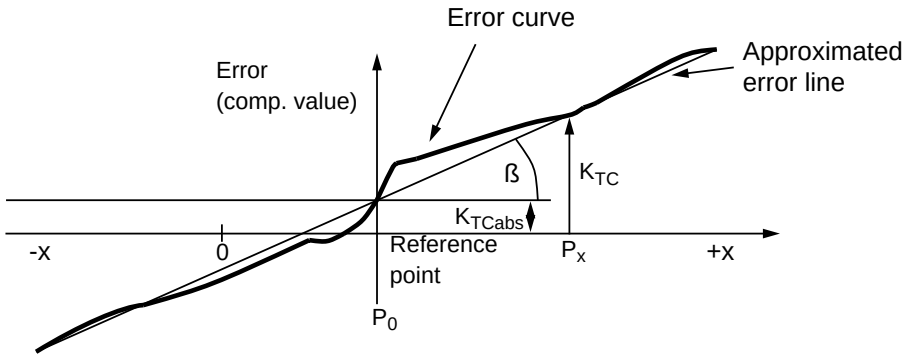
The effects of both errors are cumulative and mutually superimposed so that the approximation with regards to actual value influence is as follows:



Please note the following definitions:

K_{TC} : Temperature compensation value for axis i at position P_x

K_{TCabs} : Position-independent TC value for axis i

P_x : Actual position of axis i

P_0 : Reference position for axis i

tanß : Coefficient for position-dependent TC
(depends on temperature and coefficient of linear expansion of machine).

$$\tan ß = \frac{K_{TC} - K_{TCabs}}{P_x - P_0}$$

Caution:

Reference point P_0 must not coincide with the axis zero point.

The approximated error line of the axis is now used by the control for temperature compensation of this axis.

Since the error line applies only to the current temperature value, the parameters of new error lines occurring as a result of increases or drops in temperature must be transferred to the NC again.

Only in this way can it be ensured that varying degrees of thermal expansion are compensated in the correct way.

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12.19.4.2 Functional description

Temperature error compensation can be performed for every axis. The parameters for TC can only be transferred via the command channel of the PLC to the NC.

The following parameters must be defined and transferred for every axis that is to be compensated:

- A position-independent compensation value K_{TCabs}
- Reference point P_0 for position-dependent compensation
- Coefficient tanß of position-dependent compensation
- Activation flags of the two compensation modes

The compensation value K_{TC} is calculated internally from these values and the current actual position. This compensation value is then included in the position control calculation.

The following applies to the sign:

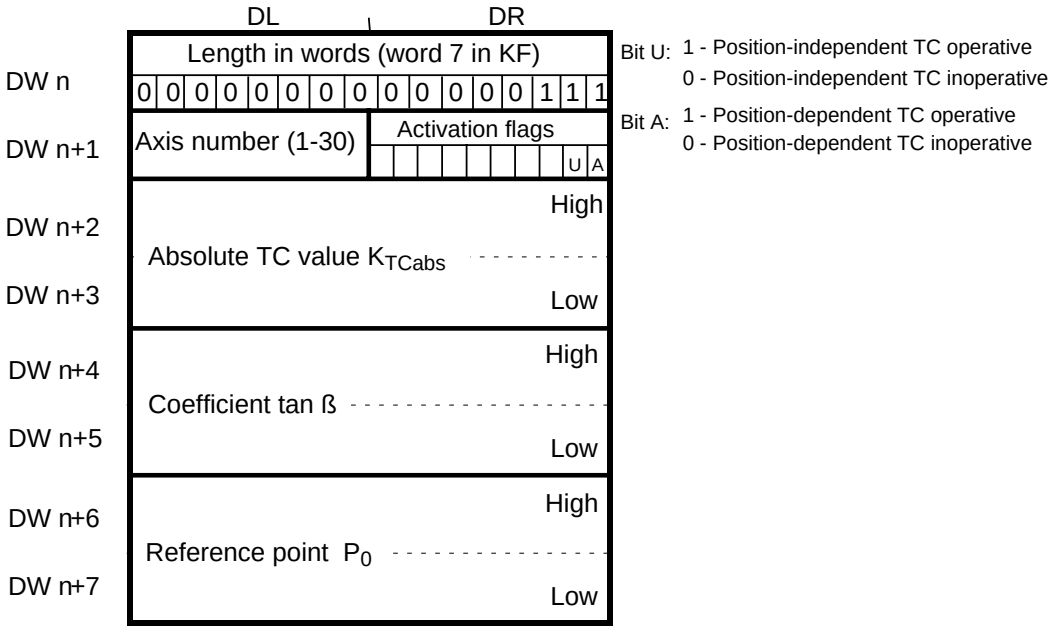
Error K_{TC} = Machine position - Setpoint
i.e. when the K_{TC} is positive, the axis traverses in a negative direction.

12.19.4.3 Data structure

The transfer of data from the PLC to the NC via the command channel is implemented via function number 9 (entry in DB41).
Data must be transferred separately for each axis. These data are erased after power on which means that the temperature compensation function is no longer effective.

The contents of the user DB are as follows for each axis:

Format of user DB:



Activation flags:

These flags are used to determine which TC methods are to be applied. Both methods can be active at the same time.

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Data format of user DB

- Length in words: Always value 7 in KF format
- Axis number: Values 1 to 30 in KF format
- Absolute TC value K_{TCabs}: With sign, in units (MS), in KF format (value range ±1 073 741 823)
- Coefficient tan ß: With sign, with significance 2^{-31} in KF format (value range -1....+1)

  The following table gives an example description of the data format of tan ß

ß	tan ß	(tan ß) · (2^{31}–1) (dec.)	(tan ß) · (2^{31}–1) (hex.)
0	0	0	0000:0000
30	0.577	1 239 850 262	49E6:9D16
45	1	2 147 483 647	7FFF:FFFF
-30	-0.577	-1 239 850 262	B619:62EA
-45	-1	-2 147 483 647	8000:0001

- Reference point P_0: With sign, in units (MS), in KF format (machine reference system, value range ±1 073 741 823)

The values K_{TCabs}, tan ß and P_0 can be entered as the result of a floating-point calculation, followed by a fixed-point format conversion.

12.19.4.4 Activation of function

- TEMPERATURE COMPENSATION option must be available.
- Transmission of applicable compensation values via command channel to the NC (cyclically or as a function of the NC PLC interface). Please refer to Interface Description, Part 1, Signals, for more detailed description of command channel.

Caution:

Since the compensation values are immediately included in the calculation for the position control, the surface quality may suffer if an axis is traversing and the change in compensation value between two transmissions is too large.

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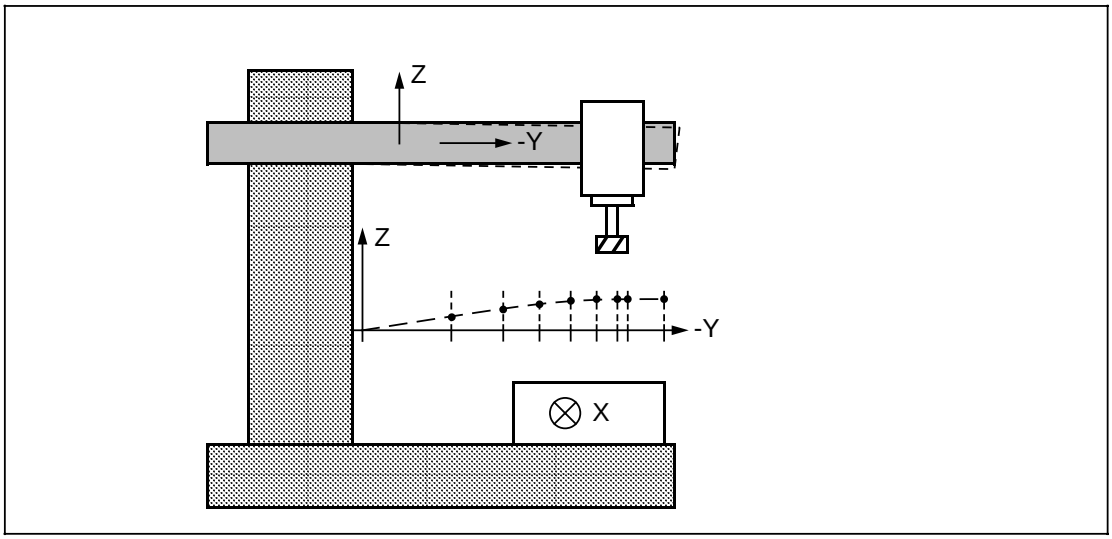
12.19.5 Interpolation and compensation with tables

The INTERPOLATION AND COMPENSATION WITH TABLES (IKA and IKA stage 2) functions are available as options.

This function can be used to establish dependencies between an input quantity and an associated output quantity.

Example of application of IKA:

Compensation of a hanging axis (machine-defining IKA)
The position of a (basic) axis can influence the absolute position of another (compensation) axis without being detected by the measuring system. This influence can be compensated by the "Interpolation and compensation with tables" function.



The further the machining head traverses in the negative Y direction, the more the cantilever arm sags in the negative Z direction.

The Z value (output quantity) must therefore be corrected as a function of the current Y position (input quantity). For this purpose, correction values for the Z axis are recorded for a number of interpolation points of the Y axis and stored as a table in the control.

Example of application of IKA Stage 2:

Implementation of geometric profiles and velocities (workpiece-defining IKA)
If a workpiece has a complicated geometric profile (e.g. a cam shaft) which can only be obtained by complicated, sophisticated DIN programming, the function IKA Stage 2 can be used to break the profile down into interpolation points and to store the values of these points in a table.

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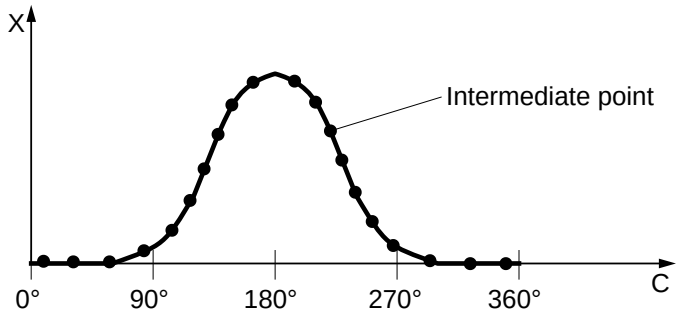
In the case of a cam contour, a rotary axis value of the C axis (input quantity) and the associated X axis value (output quantity) are required for each intermediate point. The output quantity is added to the programmed X axis position as an offset. Either linear or cubic interpolation is performed between the intermediate points.

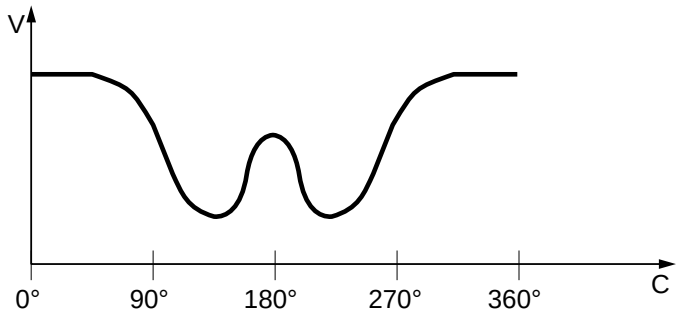
The infeed can be programmed independently of the compensation with IKA Stage 2 in the part program. The offset values of the output quantity are included in the display system of the position actual values.

In the same way, the multiplication factor for speed control (output quantity) can be defined for each rotary axis value (input quantity). This multiplication factor influences the programmed axis or path feedrate.

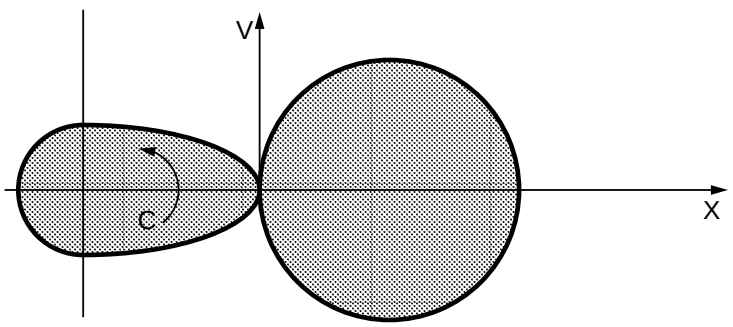
Interpolation of C and X (stroke)



Speed profile V, depends on C axis position



Cam profile



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12.19.5.1 Functional description

Possibilities with

- **IKA**

– 32 IKA configurations
– 32 IKA curves (SW 3)
– 16 000 IKA points (from SW 3)
  65 535 IKA points (from SW 4)
– Scanning in IPO cycle
– Control of axis and actual values
– Changes to the input and output quantity value are active after Power On or warm restart
– Only axes can be defined as the input**/**output quantities

- IKA Stage 2

– Easily programmable
– Output influences axis setpoint**/**axis actual value
– Output influences channel or axis override
– Output influences R parameter (cascading)
– Intermediate point interpolation also cubic
– Tables can be retroloaded individually and activated for up to 65 535 IKA points

General

For the purpose of interpolation and compensation with tables (IKA), a maximum of 32 mutually independent IKA configurations can be defined. These IKA configurations can all be operative at the same time. This type of configuration defines the relationship between an output and input quantities. Some of the 32 IKA configurations can be used to compensate machine errors (sag, leadscrew error compensation, etc.) and the remaining configurations to implement geometric profiles. The manufacturer should therefore reserve a number of IKA configurations for machine compensation purposes; the others are then available to the user as workpiece-defining and tool-dependent IKA configurations.

A table containing a sequence of curve points is assigned to each IKA configuration. A compensatory**/**additional value of the output quantity can be entered against every interpolation point value of the input quantity.

The intermediate points (e.g. actual positions of input quantity) can be entered at variable distances and with variable compensatory values. If the IKA is to act as a leadscrew error compensation (LEC), then the same axis is assigned to the input and output quantities.

If the input quantity is located between two interpolation points, then the compensatory**/**additional value is calculated from the outer values according to the selected interpolation type (linear or cubic). Each output value is calculated in an interpolation cycle.

To facilitate handling of IKA data for specific workpieces and tools, it can be stored under a workpiece. When the workpiece is loaded, the appropriate IKA data are transferred to the NCK at the same time. A warm start, which must be configured in the PLC, is required to activate the newly loaded IKA data.

Depending on the scope of the function, the function is activated on a warm restart or corresponding control functions (softkey**/**CL800 operation).

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12.19.5.2 Data structures and data assignment

The functions of IKA and IKA Stage 2 are parameterized by the user via the individual data types depending on the functions that he wants.

The sum of the data types can be divided into three data areas.

- %IKA1 Definition of IKA configuration
- %IKA2 Definition of compensation curves (IKA curve)
- %IKA3 Definition of compensation points (IKA points)

%IKA1

This data area comprises all the definitions for the **32** possible **IKA configurations** (IKA1 to IKA32). In this data area, a parameter block exists for every IKA configuration. This data area can be partly parameterized by G functions in the part program.

%IKA2

The compensation points for each of the **32** possible **compensation curves** (IKP1 to IKP32) can be selected via the start and end pointers and combined to produce the actual control curve.

%IKA3

This data area represents the sum of all the used and unused compensation points.

The data area range can be defined via the flexible memory configuration. The maximum configuration consists of 65 535 value pairs, each of which consists of the position of the input quantity and the associated value of the output quantity.

12.19.5.3 Data access

The data areas %IKA1, %IKA2 und %IKA3 can be read and write-accessed in the following manner:

- Via operator panel**/**machine data dialog
  – IKA configurations
  – IKA curve pointers
  – IKA points
- Via part program
  - with @ 30c**/**@ 40c
    – IKA configurations
    – IKA curve pointers
    – IKA points
  - with G functionsG410**/**G411**/**G412 and for CGI G400**/**G401**/**G402**/**G403
    – IKA configurations
- Via MMC**/**data transfer
  – IKA configurations
  – IKA curve pointers
  – IKA points
- From PLC via command channel (fct. no. 10 and 11)
  - IKA configurations
- Via OEM applications

  You will find a description of this procedure in the OEM documentation for the SINUMERIK 840C: Users Guide and Reference Guide.

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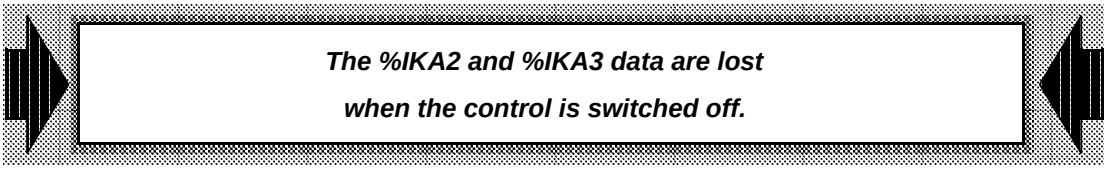
Data access via operator panel/machine data dialog

The IKA data can be edited in machine data dialog input displays. These must be handled in the same way as the machine data (password protection). The data can be erased only in start-up mode.

The IKA data input displays are stored in the start-up menu under softkey "IKA data".



Data back-up

- Up to SW 4: The IKA data can be backed up using the machine data dialog. The data are loaded automatically only if the user has copied the data with the file extension .ika1, .ika2, .ika3 from the data area **Start-up** into the data area **NC Data**.
- From SW 5: The IKA data concerned can be copied directly under **Services**.

Data access via part program

1. @ functions

The IKA data can be read or written using @ functions @30c and @40c.

Note:

You will find a detailed description of these @ functions in the Program Guide to SINUMERIK 840C.

All IKA data can be accessed using @30c and @40c.

The following IKA functions cannot be programmed with G functions. If required, these data can therefore be written in the part program with @40c.

- %IKA1, IKA configuration
  - modulo value from input A
  - offset input A
  - max. output value upper limit
  - min. output value lower limit
  - max. change of the output value
  - cubic or linear interpolation
  - weighting input A (numerator)
  - weighting input A (denominator)
- %IKA2, IKA curves
  - start pointer
  - end pointer
  - calculation of curves
- %IKA3, compensation curves
  - input quantity values
  - output quantity values

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2. Example for calculating compensation curves

```
                                  ( IKA example 1 )
                                  Machining of a contour with IKA
                                  Y[mm]=100+160/3*COS[5/7*X[mm]])
                                  from [X,Y]=[252,46.666] to [0,153.333]
                                  Caution: This example does not take the tool offset
                                  into account!
                                  0. Preparation :
N0001  @40c  K11  K2  K0             - Deactivate IKA 2
N0002  G0  X300  Y200                - Approach tool change point
N0003  R30=0  R31=0                  - Error ID = 0

                                  1. Structure of the table [ika3 data] :
N0005  @40c  K7  K1  K0              - Input quantities 1..13 :
N0010  @40c  K7  K2  K30000             Angle 0, 30, ... , 360 degrees
N0015  @40c  K7  K3  K60000             in units of 10**[-3] degrees
N0020  @40c  K7  K4  K90000
N0025  @40c  K7  K5  K120000
N0030  @40c  K7  K6  K150000
N0035  @40c  K7  K7  K180000
N0040  @40c  K7  K8  K210000
N0045  @40c  K7  K9  K240000
N0050  @40c  K7  K10  K270000
N0055  @40c  K7  K11  K300000
N0060  @40c  K7  K12  K330000
N0065  @40c  K7  K13  K360000

N0070  @40c  K8  K1  K0              - output quantities 1..13 :
N0075  @40c  K8  K2  K5000              Sine [0], ... , Sine [360 degrees]
N0080  @40c  K8  K3  K8660              in units of 10**[-4]
N0085  @40c  K8  K4  K10000             SIN=1 -> 10000=10 mm
N0090  @40c  K8  K5  K8660
N0095  @40c  K8  K6  K5000
N0100  @40c  K8  K7  K0
N0105  @40c  K8  K8  K-5000
N0110  @40c  K8  K9  K-8660
N0115  @40c  K8  K10  K-10000
N0120  @40c  K8  K11  K-8660
N0125  @40c  K8  K12  K-5000
N0130  @40c  K8  K13  K0

                                  2. Start and end pointer [ika2 data] :
N0135  @40c  K5  K1  K1              - Curve 1 uses points 1...13
N0140  @40c  K6  K1  K13

N0145  @40c  K55  K1  K-1            - Calculate curve 1
N0146  @30c  R30  K55  K1            - [a] read error byte [> R30]
N0147  @111  R30  K0  K150           - [b] case statement for R30 :
K1  K281                                Jump list for R30=1 .. 4 [error]
K2  K282                                otherwise continue [R30=0] at N150;
K3  K283                                scan [a] is repeated as long as
K4  K284                                R30 =-1 or R30=-127
K127  K-146
K-1  K-146
```


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```
                                    3. IKA configuration [ika1 data] :

N0150  @40c  K1  K2  K1               - IKA 2 uses curve 1
N0155  @40c  K40  K2  K1              - Activate extended IKA
N0160  @40c  K43  K2  K1              - Cubic interpolation on

                                      - Definition of input A :
N0165  @40c  K20  K2  K102               Type : Feedrate axis actual value
N0170  @40c  K2  K2  K1                  No. : 1 [=X]
                                      - Definition of the output :
N0175  @40c  K33  K2  K101               Type : Feedrate axis set position
N0180  @40c  K3  K2  K2                  No. : 2 [=Y]
                                      - Input B=R20 implemented as scaling
N0181  R20=1000                         with: R20 = 1000 <-> factor = 1
                                      - Definition of input B :
N0182  @40c  K26  K2  K411              Type : R parameter channel 1
N0183  @40c  K25  K2  K20               No.: 20

                                      -  Limitations :
N0185  @40c  K31  K2  K500000              Maximum traversing range + -500 mm
N0190  @40c  K32  K2  K-500000

N0195  @40c  K34  K2  K2000                Modification limitation : 2000 units/IPO
                                           cycle with IPO cycle of 16 ms : 7500 mm/min
                                      - Weighting I/O :
N0200  @40c  K18  K2  K5                   Weighting input : 5/7
N0205  @40c  K19  K2  K7

N0210  @40c  K4  K2  K16                   Weighting output : 16/3000
N0215  @40c  K30  K2  K3000                [note scaling factor R20 !]
                                           [R20=1000 produces 16/3]
                                       - Modulo function and shift :
N0220  @40c  K16  K2  K360000              Weighted input A modulo 360
N0225  @40c  K15  K2  K-90000              Shift input by -90 degrees
                                           to obtain a cosine
                                           therefore Y = Y0+16/3 * SIN[5/7*X-90]
                                                       = Y0+16/3 * COS[5/7*X]

                                    4. Approach, activation and machining :
N0235  G0  X252  Y100                  - Approach starting point: 7/5*180=252
@714
N0240  @40c  K11  K2  K1               - Activate IKA 2
N0241  G4  X1.8                        - Wait until start point is reached
N0245  G1  X0  F1000                   - Machining
@714
```


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```
                                    5. Deactivate and retract
N0250  @40c  K11  K2  K0               - Deactivate IKA 2
@714
G200  Y                                - Synchronization of actual value system
N0255  G0  Y200                        - Retract
N0260  X300
N0270  @100  K300                        Jump to end

                                    6. Errors
N0281  M00  (error 1)                  T55=1: only one pointer <> 0 !
@100  K300
N0282  M00  (error 2)                  T55=2: End pointer <= start pointer!
@100  K300
N0283  M00  (error 3)                  T55=3: Input[n+1] <= input[n] !
N0285  @30c  R31  K56  K1              - Read current point number n [> R31]
@100  K300
N0284  M00  (error 4)                  T55=4: Gradient > 1 !
N0285  @30c  R31  K56  K1              - Read current point number n [> R31]

                                    7. End
N0300  M02
```

IKA status displays in T55 and T66

Code	Text	Significance
-2	Running	Calculation running
-1	Requested	Calculation requested
0	Calculated	Curve calculated
1	0 pointer	Start or end pointer is equal to zero
2	Start > End	Start pointer is greater than stop pointer
3	Position point	The position of one point is wrong
4	Gradient point	Gradient of one point is wrong. The point is then stored in T56.
5		Both pointers in the table are zero.

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3. G functions

From IKA Stage 2, an IKA configuration can be programmed in a part program using the following G functions:

- G410 Deactivate IKA link branch
- G411 Define/delete IKA configuration
- G412 Activate/deactivate IKA link branch

If the IKA function is used in curve gearbox interpolation (CGI), it is parameterized in

- G400 Switch off GI/IKA link branch(es)
- G401 Define/delete GI/IKA configuration
- G402 Switch on/over/off GI/IKA link branch(es)
- G403 Synchronize GI/IKA link branch(es) in ascending order

This G function can only be used if gearbox interpolation has been installed via the machine data.

Note:

You will find a detailed description of the G functions listed above in the Programming Guide for SINUMERIK 840C.

Data access via MMC/data transfer

The IKA data are divided between 3 data files %IKA1, %IKA2, %IKA3. These data can be read from and written to the hard disk via the RS 232 C (V.24) interface.

Data transfer

VRS 232 C workpiece NCK

can be made automatic with the function "Control of data transfer" (DB 37).

The files to be transferred have the following format if output in punched tape format:

- Output of IKA configuration

```
%IKA1
Ny    TO = xxxxxxxx     T1=x T2=x T3=x T4=x T15=x T16=x (up to SW 3)

Ny    TO = xxxxxxxx     T1=x T2=x T3=x T4=x T15=x T16=x T17=x T18=x
                        T19=x T20=x T25=x T26=x T31=x T32=x T33=x
:                       T34=x T44=x (SW 4 and higher)
:
```

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Note:

- y=No. of the IKA configuration; max. 2 places
  x=Values
- The data set for an IKA configuration most not be larger than 255 characters.

- Output of IKA curves

```
%IKA2
Ny    T5=x T6=x (up to SW 3)

Ny    T5=x T6=x T55=x (SW 4 and higher)
:
```

Note:

y=No. of the curve; max. 2 places
x=Values

- Output of IKA points

```
%IKA3
Ny    T7=x T8=x
:
```

Note:

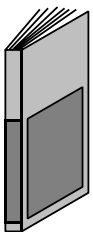
y=No. of the curve point; max. 5 places
x=Values

Data access via PLC (command channel, DB 41)

Transfer of the IKA data from the PLC via the command channel is triggered by function numbers 10 and 11. The data can be read (fct. no. 10, read IKA data) and written (fct. no. 11, write IKA data). These functions are triggered in the same way as existing command channel functions.

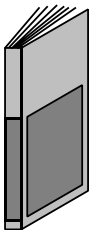
Note:

The parameters of %IKA1, %IKA2, %IKA3, of IKA Stage 2 are thus no longer supported (see Section Overview of valid IKA data).



For further details about the "Command Channel" function, please refer to the following documentation:

SINUMERIK 840C,
Interface Description, Part 1
Signals



Extended functionality via communications area (DB 48)

As from SW 6 it is possible to act upon the NCK function ”IKA” from the PLC via the extended data block DB 48. Different signals are defined for each IKA relation which are used to activate, deactivate and freeze a particular IKA relation. ”Freeze” means that the last value output from the IKA relation remains unchanged (”frozen”) until that condition (”IKA frozen”) is changed. This function makes it possible to start several IKAs simultaneously. Output signals have also been defined so that the PLC can recognize the status of every IKA. This makes it possible to respond to a particular status, for example.

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12.19.5.4 Activating IKA data

%IKA1

The IKA data of %IKA1 are active immediately.

%IKA2 und %IKA3

Changes to %IKA2 and %IKA3 must be activated separately.

Once all the IKA data have been entered in %IKA2 and %IKA3 all the compensation curves are calculated with the signal "Warm restart". When the data are loaded into the MMC on Power On, the compensation curves are calculated by the control automatically.

- From SW4 the individual curves can also be selected and calculated by operating the softkey "IKA curves".
- From IKA Stage 2, individual curves can be selected and calculated in the part program with parameter 55.

Notes:

- If an error occurs the control outputs an alarm which does not, however, cause a processing stop. An error scan must be implemented by the user (see example of calculation of compensation curves).
- If configuration curves %IKA2 and %IKA3 that are currently active are changed, traversing errors will occur until they are converted.

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12.19.5.5 Overview of valid IKA data

Definition of the individual data types:

Data type	Significance	Data No. within data type	Data type for @30c/40c or T para.	G fct. for IKA	G fct. for CGI	Only valid with IKA Stage 2
%IKA3 - IKA comp. points	Input quantity value	1 to 65536	7	-	-	
	Output quantity value	1 to 65536	8	-	-	
%IKA2- IKA curves	Start pointer	1 to 32	5	-	-	
	End pointer	1 to 32	6	-	-	
	Activation byte	1 to 32	55	-	-	x
%IKA1 - IKA configuration	Control byte 8 bit	1 to 32	0	partly with G410/G412	partly with G400/G402/ G403/PLC	
	Bit0: IKA active	1 to 32	11	partly with G410/G412	partly with G400/G402/ G403/PLC	
	Bit1: IKA direction dependent	1 to 32	12	-	-	
	Bit2: IKA negative direction	1 to 32	13	-	-	
	Bit3: IKA with comp. actual values (up to SW 3)	1 to 32	14	-	-	
	Bit4: Exp. IKA fct.	1 to 32	40	G411	G401	x
	Bit5: Position-dep. activation dir. dep.	1 to 32	41	G412	G402	x
	Bit6: Position-dep. activation overt. neg.	1 to 32	42	G412	G402	x
	Bit 7: Interpolation cubic	1 to 32	43	-	-	x
	Number of control curve	1 to 38	1	G412	G402	
	Input A (number)	1 to 32	2	G411	G401	
	Input A (type)	1 to 32	20	G411	G401	
	Offset input A	1 to 32	15	-	G403	
	Modulo value input A	1 to 32	16	-	-	
	Starting position of input A	1 to 32	17	G412	G402	x
	Weighting input A (numerator)	1 to 32	18	-	Function not available	x

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Data type	Significance	Data No. within data type	Data type for @30c/40c or T para.	G fct. for IKA	G fct. for CGI	Only valid with IKA Stage 2
%IKA1 IKA configuration	Weighting input A (denominator)	1 to 32	19	-	Function not available	x
	Input B (number)	1 to 32	25	G411	Function not available	x
	Input B (type)	1 to 32	26	G411	Function not available	x
	Output (number)	1 to 32	3	G411	G401	
	Output (type)	1 to 32	33	G411	G401	
	Weighting factor output (numerator)	1 to 32	4	G412	G402/G403	
	Weighting factor output (denominator)	1 to 32	30	G412	G402/G403	x
	Max. output value upper limit (not for compensation)	1 to 32	31	-	-	x
Unit EGF	Min. output value lower limit (not for compensation)	1 to 32	32	-	-	x
EGF	Max. change of output value (not for compensation)	1 to 32	34	-	-	x
Unit Value x EGF / IPO	Internal status of IKA (see following table)		37	-	-	x
	Value actual input A	1 to 32	21	-	-	x
	Table input value	1 to 32	22	-	-	x
	Value actual input B	1 to 32	27	-	-	x
	Actual output value	1 to 32	35	-	-	x
	Interpolat. point no.	1 to 32	36	-	-	x
	Actual switching state	1 to 32	37	-	-	x

Type definition of data type 37 "Internal condition of IKA":

Final conditions of IKA:

0: IKA deactivated
1: IKA deactivated
2: IKA deactivated in plus direction
3: IKA deactivated in minus direction

Intermediate conditions of IKA during transition to a new final condition:

4: IKA is deactivated
5: IKA is activated and deactivated
6: IKA is switched over

7: IKA is deactivated position-dependently
8: IKA is deactivated position-dependently in plus direction
9: IKA is deactivated position-dependently in minus direction

10: IKA is switched on and over position-dependently
11: IKA is switched on and over position-dependently in the plus direction
12: IKA is switched on and over position-dependently in the minus direction

13: IKA is switched over position-dependently
14: IKA is switched over position-dependently in the plus direction
15: IKA is switched over position-dependently in the minus direction

16: IKA is stopped

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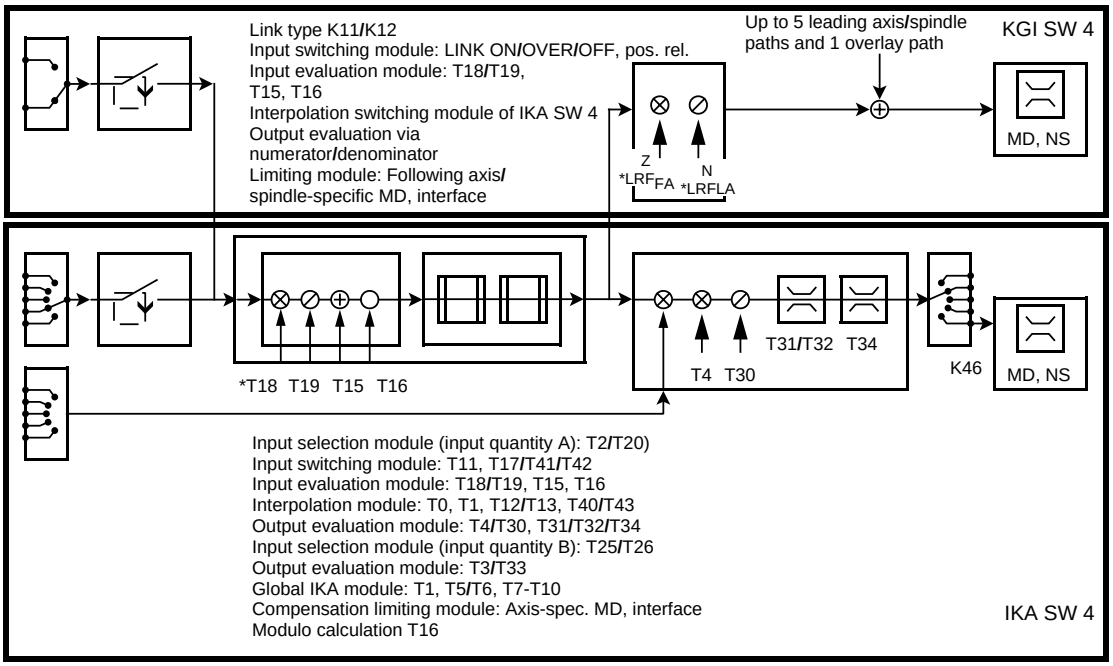
12.19.5.6 IKA calculation sequence



IKA calculation sequence

The block diagram shows the calculation sequence of the quantities involved in an IKA configuration.

In the input selection module (1), the preset quantity of input A with respect to input type and input number is activated.

In the input switching module (2), the position-independent or position-dependent activation or deactivation of an IKA configuration is performed.

If the IKA configuration is activated, input quantity A is further processed in the global IKA module (8). First of all, input quantity A is normalized with the weighting factor of input A (numerator/denominator) in the input weighting module (3). After normalization, the offset and the modulo calculation are applied. The input value for any offset and the module value must therefore refer to the normalized input quantity A.

The output quantity is determined in the interpolation module (4). The output quantity is calculated as a function of the set control curves and various control bits and forwarded to the output weighting module (5). Multiplication with the input quantity B is performed here. In input selection module (6), input quantity B is selected in accordance with the input type and number set. Moreover, further calculation of the output value is possible via the weighting factors of the output (numerator/denominator) in the output weighting module. The denominator of the output weighting can also be seen as the weighting of input quantity B.

After output weighting, the output quantity is limited with respect to position and velocity. The output selection module assigns the output values to the specified output quantity.

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If the output is assigned to the compensation value of an axis (446), the output value is limited only by the compensation limitation module (9). The limitation values are then specified in the machine data. When the limitation values are reached, this is indicated by the axis-specific interface signals.

If an IKA configuration is used as curve gear interpolation (CGI) within a gear interpolation grouping there are restrictions that can be seen from the upper part of the diagram.

The input selection module has been reduced to the option of an axis actual-value or axis setpoint coupling. Input quantity B no longer has any influence on the magnitude of the output value because the output quantity weighting is only performed via the numerator (Z) and the denominator (N) of the gear coupling factor. In a normal IKA configuration, the output value refers to the position control resolution of the output quantity, in CGI, conversion to the position control resolution of the input quantity A (leading axis, leading spindle) is performed.

The weighting factor of input A, which has no effect with CGI, also has an effect and must therefore always be set to 1.

The output selection module is no longer required because the output value is always assigned to the setpoint of an axis or spindle.

After output weighting, all coupling branches to the setpoint of the following axis/following spindle are brought together.

The following quantity is limited via the machine data of the gearbox interpolation with respect to position, velocity and acceleration of the following quantity.

Feedrate override, feedrate stop and feedrate disable do not affect following axes in the case of IKA links.

If IKA parameters change, the following axes move.

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12.19.5.7 Meaning of the data types

- **%IKA1, IKA configuration**

  Every data type can be read or written by defining the relevant type no. The control byte can be accessed byte by byte or bit by bit.

  In the part program. @30C**/**@40C are used to read and write the data. In the data file they area addressed via T parameters.

  Control byte Data type: 0 Format: 8 bit

  The control byte shows the status of the IKA configuration and defines the various function types.

  Meaning of the individual bits:

  IKA active Data type: 11 Format: 1 bit

  Bit 0=0: Deactivate IKA configuration or IKA relation inactive
  Bit 0=1: Activate IKA configuration or IKA relation active

  The bit is automatically set or reset with G functions G410**/**G412 or G402**/**G403**/**G400.

  IKA direction dependent Data type: 12 Format: 1 bit

  Bit 1=0: The effect of IKA configuration is not direction dependent
  Bit 1=1: The effect of IKA configuration is direction dependent

  IKA negative direction Data type: 13 Format: 1 bit

  Bit 2=0: IKA configuration takes effect with a positive direction of input quantity A
  Bit 2=1: IKA configuration takes effect with a negative direction of input quantity A

  Bit 3: IKA with compensated actual value (up to SW 3)
  Data type: 14 Format: 1 bit

  Bit 3=0: IKA configuration uses the uncompensated actual value
  Bit 3=1: IKA configuration uses the compensated actual value

  Correct input value (SW 3 only)

  The following effect of the IKA value must be considered. It is explained here using the example of an axis:

  A compensation**/**additional value (IKA value) calculated by a control curve, here a positive one, causes the axis to traverse in the negative direction if the axis of the input quantity is also the axis of the output quantity (e.g. application as leadscrew error compensation substitute).

  Depending on the magnitude of the compensation**/**additional value, this results in a new machine position and therefore in a new input quantity. The axis is now in a position for which another compensation**/**additional value would be measured**/**calculated in the curve measurement**/**calculation. The difference between this compensation**/**additional value and that last calculated depends on the magnitude of the last value and the gradient of the control curve between these points.

  To be able to calculate the new IKA value, it is now necessary to recalculate the last compensation**/**additional value for the actual position as the input of the control curve, i.e. the actual value is approximately compensated. The effective compensation**/**additional value is then set iteratively.

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The input quantity compensation is controlled via bit 3 of the IKA configuration.

This type of compensation is only possible in SW 3! If the compensation value is too large, the compensated axis tends to oscillate.

Extended IKA function Data type: 40 Format: 1 Bit

Bit 4=0: IKA (limited range of functions!)
Bit 4=1: IKA Stage 2 active

Note:

The bit is automatically set if the function is programmed via G401 or G411.

Position-related activation direction-dependent
Data type: 41 Format: 1 Bit

Bit 5=0: The IKA configuration is activated or deactivated direction independently with position-related activation
Bit 5=1: The IKA configuration is activated or deactivated direction dependently with position-related activation

Position-related activation overtravel direction negative
Data type: 42 Format: 1 Bit

Bit 6=0: The IKA configuration is activated in the positive travel direction
Bit 6=1: The IKA configuration is activated in the negative travel direction

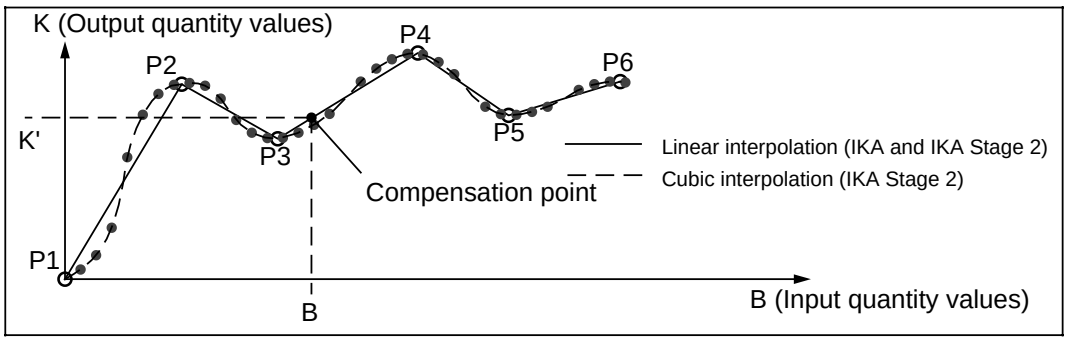
Note:

If you specify the start position and the required overtravel direction of the G412 instruction, bits 5 + 6 are automatically set. The control also only calculates the associated start position as a function of the current actual interpolation value of the input quantity.

Interpolation cubic Data type: 43 Format: 1 Bit

Bit 7=0: Linear interpolation between the interpolation values
Bit 7=1: Cubic interpolation between the interpolation values

A newly available method of IKA is the cubic interpolation between the interpolation points, i.e. a constant tangential function is applied at the transition (interpolation) points.
The cubic interpolation method therefore affords a reduction in data.



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Number of the control curve
Data type: 1

The required control curve can be selected for the IKA configuration with values 1 ... 32.

Input A (number) Data type: 2

Depending on the input quantity A type, this is either a global axis number or the number of a global or channel-specific R parameter.

Input A (type) Data type: 20

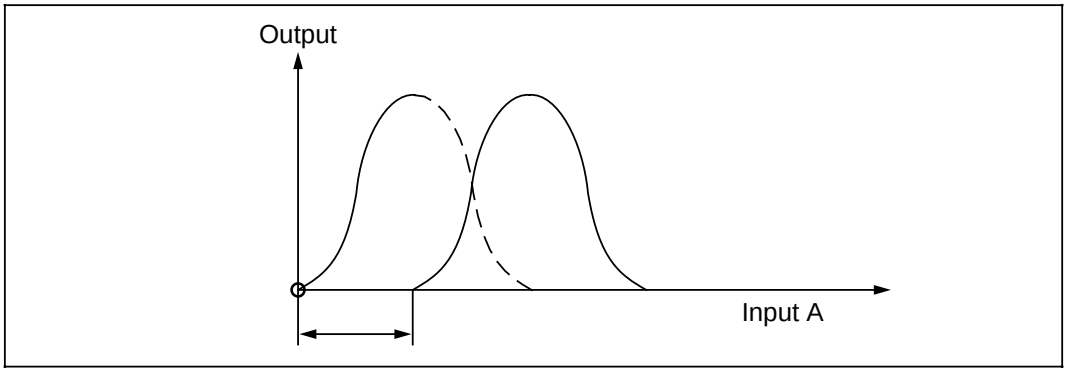
The axis type consists of a parameter group and parameter value. For a more detailed explanation see, for example, Programming Guide for SINUMERIK 840C, Section Programming cycles under @30c and @40c.

Note:

Input A is automatically preset with G function G411/G401. Display in the machine data dialog is in plaintext.

Offset input A Data type: 15 Input format: ±99 999 999

This is used to implement an offset on the compensation curve on input quantity A.



See also: Weighting of inputs depending on input and output types.

Programming with a G function is only possible with G403 in CGI. This offset value is then not displayed in this parameter.

Modulo value of input A Data type: 16 Input format: +99 999 999

Defines any modulo value for input quantity A. Compensation curves that repeat cyclically can be implemented here.

Starting position of input A Data type: 17

Defines the position of input quantity A for which the IKA configuration is to be activated or deactivated. This value always refers (even for rotary axes) to the absolute actual value.

This value should only be defined via G412.

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Weighting input A, numerator
Data type: 18 Input format: ±99 999 999

Weighting input A, denominator
Data type: 19 Input format: ±99 999 999

By entering the numerator and denominator, it is possible to stretch and compress a compensation curve. The offset of the modulo values and the start position of the IKA configuration then refer to this value.

Input B (number) Data type: 25

An axis or R parameter no, is set depending on the type of input quantity B. Input B multiplies the output. Weighting is also possible via the weighting factors of the output.

Input B (type) Data type: 26

The axis type consists of the parameter group and the parameter value. For a more detailed explanation see, for example, Programming Guide for SINUMERIK 840C, Section Programming cycles under @30c and @40c.

Note:

Input A is automatically preset with G function G411/G401. Display in the machine data dialog is in plaintext.

Output (number) Data type: 3

Depending on the type of output quantity, either the axis, R parameter or channel no. is active.

Output (type) Data type: 33

The axis type consists of the parameter group and the parameter value. For a more detailed explanation see, for example, Programming Guide for SINUMERIK 840C, Section Programming cycles under @30c and @40c.

Weighting factor output A, numerator
Data type: 4 Input format: ±99 999 999

Weighting factor output A, denominator
Data type: 30 Input format: ±99 999 999

Any multiplication factor can be generated for the output quantity by entering a numerator and denominator. Weighting of input B is also possible.

- **%IKA3, IKA compensation points**

  Input quantity value

  The input quantity value determines the compensation point on the basis axis.

  Output quantity value

  The output quantity value determines the compensation point on the relevant position of the basis axis.

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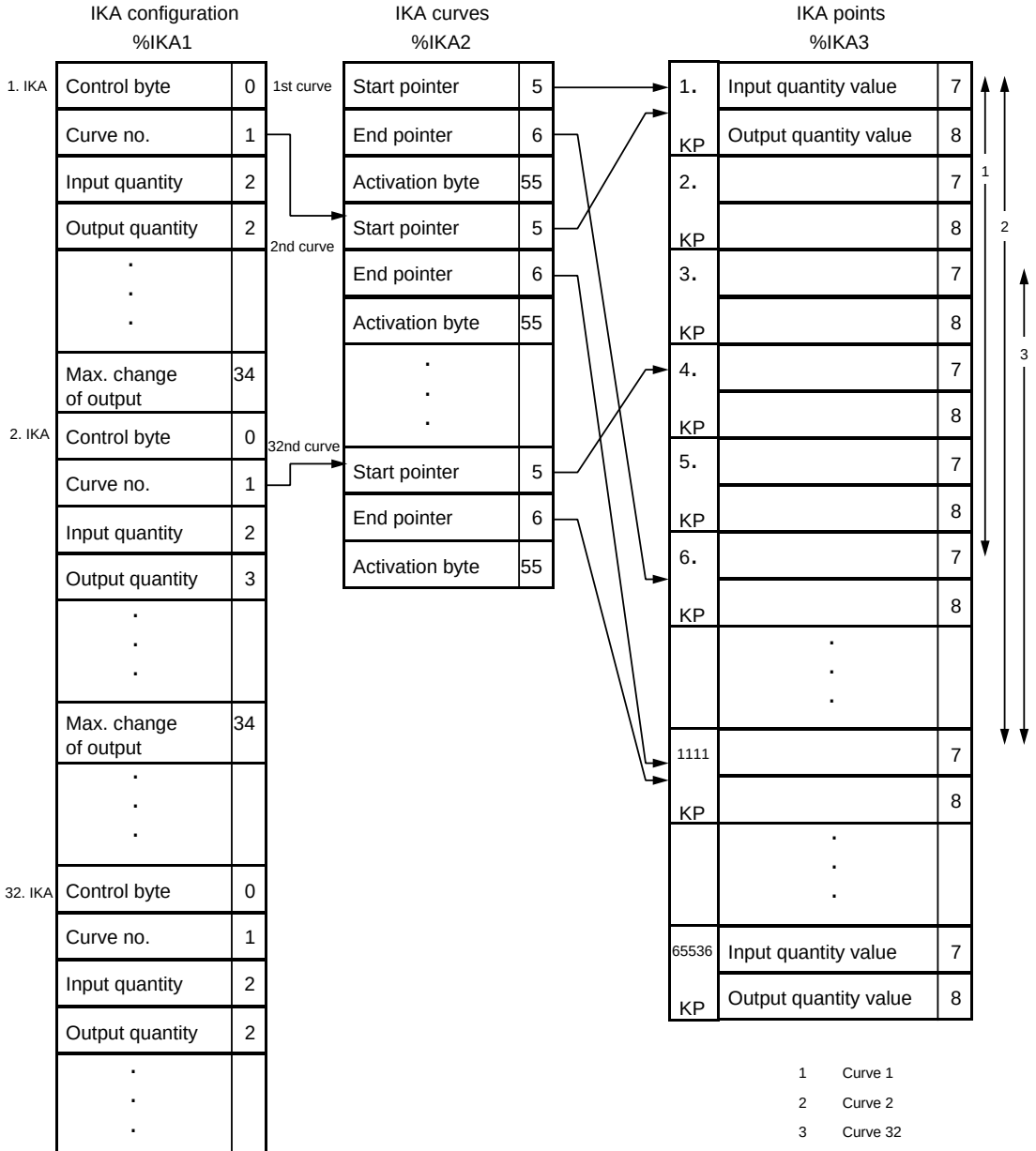
12.19.5.8 Links between IKA data areas



Note:

The IKA links are processed in descending sequence, i.e. IKA32 first, then IKA31 etc. until IKA1.

Example:

R00 is the output quantity of IKA12 and the input quantity of IKA11 and IKA13. R00 as result (output quantity) of the link of IKA12 is therefore included in the same interpolation cycle in IKA11 as input quantity. In IKA 13, however, R00 is taken into account only in the next interpolation cycle. With IK13, linking of the R parameter to an axis can result in an interpolation-cycle and speed-dependent offset.

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12.19.5.9 Viewing the IKA data during programming

The IKA data can be viewed during programming if the following conditions are fulfilled:

The IKA editor consists of list module displays used for display only, i.e. the input fields are greyed out.

- The IKA data are to be found under the workpieces (LOCAL**/**<workpiece_name>).
- The display is only possible "off-line".
- Function "new" deactivated, i.e. it is only possible to view existing data.
- Function "search" deactivated in the list module display.
- Functions "Copy to clipboard" and "Paste from clipboard" deactivated.

The softkey bar has been extended in programming by a new softkey "View IKA data".

Note:

Before pressing the softkey "View IKA data", an IKA file must be selected with the data selector, otherwise the error message "No data selected" is output.

Saving IKA data

In the MMC area Services, the IKA data are saved in directories such as NC**/**Data or LOCAL**/**<workpiece> previously selected with the data selector. The selection list for the NC source (toggle field) is extended by file types IKA1, IKA2 and IKA3, a range can be defined (from**/**to) and a PC name can be assigned.

Loading IKA data

The data are loaded from the workpiece by selecting the file with the data selector or via the job list.

12.19.5.10 Compensation beyond the working area

If the compensation position of an IKA axis lies beyond the working area (i.e. the minimum of working area limitation or SW limit switch), the axis is stopped, even if the set position still lies within the working area.
This axis stop may, in some cases, lead to "free grinding in the workpiece". The functional supplement has been created to ensure a user-configurable, automated reaction.

By means of MD bit 5198.7(=1), the interface signal DB48 DW 9 bit 0 "Compensation position beyond the working area" is enabled.
Definition: DB48 DW 9 contains signals from NCK to PLC.
The "Compensation position beyond the working area" interface signal is a group signal for all IKA "compensation" axes. The interface signal is set (=1) if the compensation position of at least one of these axes lies beyond the software limit switch or the working area limitation.
In addition, the alarm 3265 "IKA output axis not enabled" is output depending on the condition that the MD bit 5189.5 (suppression of alarm 3265) has not been set.
The interface signal is automatically reset (=0) if the compensation positions of all axes are again within the working area (e.g. retraction via JOG or compensation change via the basic axis).

Application example:

By means of this new interface signal the machine manufacturer can configure an emergency retraction via the rapid inputs. This avoids "free grinding" in the workpiece.

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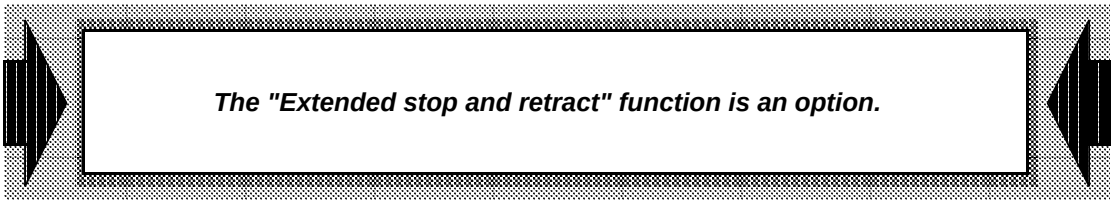
12.20 Extended stop and retract (ESR) (SW 4 and higher)



Corresponding data

NC MD 312 ... 317	Assignment of outputs of mixed I/O for retraction of a mode group
NC MD 318 ... 323	Assignment of inputs of mixed I/O for retraction of a mode group
NC MD 324	Time for interpolator-controlled continuation
NC MD 325	Maximum time for interpolator-controlled braking
NC MD 5021	Bit 0 - bit 5: Neutral position of mixed I/O outputs
NC MD 5022	Control bits for definition of stopping operation
NC MD 528*	Signal level inversion of outputs/spindle-specific
NC MD 529*	Definition of reaction/spindle-specific
NC MD 530*	Sources for retraction/spindle-specific
NC MD 588*	Signal level inversion of outputs/axis-specific
NC MD 592*	Definition of reaction/axis-specific
NC MD 596*	Sources for retraction/axis-specific
NC MD 916*	Signal level inversion of outputs/channel-specific
NC MD 918*	Definition of reaction/channel-specific
NC MD 920*	Sources for retraction/channel-specific
NC MD 922*	Effectiveness of inputs for mixed I/O and CSB
NC MD 1444*	Emergency retraction threshold

PLC interface

DB29	for axes
DB31	for spindles
DB10 ... 15	for channels

Drive machine data

Drive MD 1612	Configured switch-off reaction Power On alarms
Drive MD 1613	Configured switch-off reaction Reset alarms
Drive MD 1631	Response voltage generator axis
Drive MD 1632	Voltage range for generator control
Drive MD 1633	Switch-off reaction for generator operation
Drive MD 1634	Response threshold emergency retraction
Drive MD 1635	Minimum speed generator axis

General

- In order to provide protection for operating personnel, workpiece, tool and machine, it is possible to configure certain reactions such as the approach to a programmed retraction position, shutdown of the axes and/or output of hardware signals in response to specific errors/faults.
- Mains buffering and drive-autonomous retraction with SIMODRIVE 611D only.

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12.20.1 Functional description

The term **"Extended stop and retract"** refers to the error reactions listed below:

- Parameterization of error reaction by means of machine data and part program commands
- Monitoring sources (error identification)
- Shutdown of machine in order to prevent damage to tool or workpiece wherever possible
- Separation of tool and workpiece through traversing motions (retractions) initiated in the event of an error**/**fault

The 840C system and SW version 4 provides an extended functionality for the retraction operation. The axes/spindles (drives, motors, encoders, etc.) and the control involved in the controlled stop and retract process must all be operational: If one of these components fails, the full scope of the system reaction described below may not be available.

"**Extended stop and retract**" comprises the following functions:

- Monitoring sources (error detection)
- DC link buffering (generator operation)
- Stopping and
- Retraction

Both the sources for error detection and the reactions in the form of stop and retraction can be

- parameterized via machine data (NC and drive)
- controlled via the PLC and**/**or
- programmed by means of G commands.

Both sources and reactions can be

- internal and**/**or
- external.

12.20.2 Parameterization, control and programming

The **"Extended stop and retract"** function comprises:

1. Parameterization of the operating characteristics via machine data:

   - General machine data:
     - To enable the new operating characteristics for the stop process
     - To parameterize the times for extended stopping

   - Machine data specific to channel**/**mode group:
     - To assign the mixed I**/**O modules for the retraction operation in the form of:
       - Inputs (external sources) and
       - Outputs (external reactions).
     - Application of internal sources:
       - Mode group stop
       - EMERGENCY STOP

       which must initiate a retraction operation.
     - Definition of internal reactions to be initiated in the case of a retraction operation:
       - Alarm and mode group stop
       - Retraction operation as open-loop control function and**/**or as
       - Autonomous drive function

   - Machine data specific to axis**/**spindle:
     - To assigned the mixed I**/**O modules for the retraction operation in the form of:
       - Outputs (external reactions)

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  - Application of internal sources:
    - Emergency retraction threshold FA/FS,
    - 611D DC link voltage threshold, drive MD 1634,
    - 611D generator speed threshold, drive MD 1635

    which must initiate a retraction operation.
  - Definition of internal reactions to be initiated in the case of a retraction operation:
    - Alarm and mode group stop
    - Retraction operation as open-loop control function and/or as
    - Autonomous drive function

- Drive parameters for the "Extended stop and retract" function (611D)
  - DC link voltage threshold, drive MD 1631: If the voltage drops below this limit, a drive defined as the generator axis switches to generator mode.
  - Voltage step, drive MD 1632: This value defines the upper threshold of the two-position controller for generator operation.
  - DC link voltage threshold, drive MD 1633: If the voltage exceeds this limit value, the drive switches from generator mode back to normal operation.
  - DC link voltage threshold, drive MD 1634: If the voltage drops below this limit, emergency retraction measures can be initiated according to user specifications (via MD or programming).
  - Generator speed threshold, drive MD 1635: If the speed drops below this value, emergency retraction measures can be initiated according to user specifications (via MD or programming).

2.) The possibility of controlling the function via the PLC:

- Channel-specific
  - To PLC:
    - ESR monitoring is active
    - ESR reaction is initiated
- Axis/spindle-specific
  - From PLC:
    - Activate ESR monitoring
    - Disable ESR monitoring
    - Enable ESR reaction
  - To PLC:
    - ESR monitoring is active
    - ESR reaction is initiated
    - ESR reaction is programmed
    - 611D ZK2 messages
- If monitoring is switched on from the PLC, it can be switched off from the PLC only.
- If monitoring is switched off from the PLC, it is switched off for all channels.

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3.) The possibility of initiating or reacting via mixed I/O / CSB and high-speed data channel:

- Channel**/**mode group-specific
  - Inputs for external sources
  - Outputs for external reactions
- Axis**/**spindle-specific
  - Outputs for external reactions

4.) The possibility of programming operating characteristics via G commands (please refer to Programming Guide for exact description):

- Deactivation:

  Deactivate G420 "**Extended stop and retract**", generally or selectively for axis**/**axes and**/**or spindle.

- Activation:

  Activate G421 monitoring sources and enable reactions.

- Configuration:

  Configure generator mode (G422)
  Configure stop operation as open-loop control function (G423)
  Configure stop operation as autonomous drive function (G424)
  Configure retraction as open-loop control function (G425)
  Configure retraction as autonomous drive function (G426)

12.20.3 Monitoring sources (error detection)

Internal sources:

Examples of important internal errors are:

- ZK1 messages of 611D drive such as open cable, power section failure, etc.
- NCK alarms such as CPU failure, watchdog, emergency retraction threshold, mode group stop alarms, etc.
- PLC alarms such as CPU failure, EMERGENCY STOP, etc.

Details about individual error statuses can be found in the error descriptions.

Error sources which are directly related to the drive are explained in more detail below:

- Mains buffering and mains failure detection
- DC link overvoltage limitation by means of a pulsed resistor module
- DC link undervoltage monitoring
- DC link buffering and monitoring of generator minimum speed limit
- Communications**/**control failure
- Control**/**unit detects error**/**request and specifies "**Extended stop and retract**" as autonomous drive function

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12.20.4 Mains failure detection and mains buffering

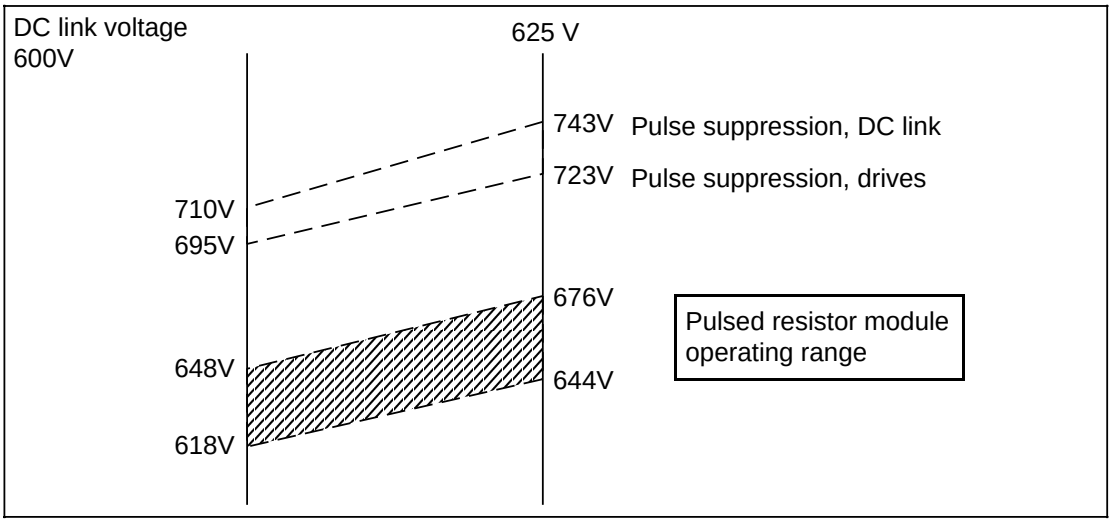
12.20.4.1 Mains failure detection

Mains failures can be detected by means of the infeed/regenerative feedback (I/RF) module when the 611 A/D drive system is used. By using terminal 73 on the I/RF module, it is possible to utilize the mains monitoring function of the connected actuator as an external source (e.g. by connecting terminal 73 to the mixed I/O or the CSB).

Under worst-case conditions, mains failure detection takes approximately 120 ms and, in the best case, only 15 ms.

12.20.4.2 DC link overvoltage limitation (611D)

The DC link is monitored for the following voltage states (see diagram).



Voltage level for DC link in 611D

The diagram shows that the pulses of the drives and the DC link are suppressed when the voltage reaches certain levels. Pulse suppression automatically causes the drives to coast to a standstill.

If this pulse suppression reaction is not desired, then the user can destroy any excess energy by using a resistor module. This module operates in the shaded range shown in the diagram and thus below the critical voltage level.

It must however be ensured that the pulse output of the resistor module is greater than the I/R output.

12.20.4.3 Mains buffering (611D only)

It is possible to compensate brief dips in the DC link voltage through configuration of drive machine data and appropriate programming by means of G commands. The possible buffering period depends on the level of energy stored by the generator used to back up the DC link and on the amount of energy required to maintain the motions currently being executed (DC link buffering and monitoring of generator minimum speed limit).

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12.20.4.4 DC link undervoltage monitoring in 611D

With the 611D package 2, the user can parameterize a new threshold for DC link voltage monitoring (drive MD 1634). The DC link voltage monitoring function via drive MD 1604, which is already available with package 1, is not relevant for the "**Extended stop and retract**" function since the drive reacts immediately with cancellation of SIMODRIVE_READY and DRIVE_READY.

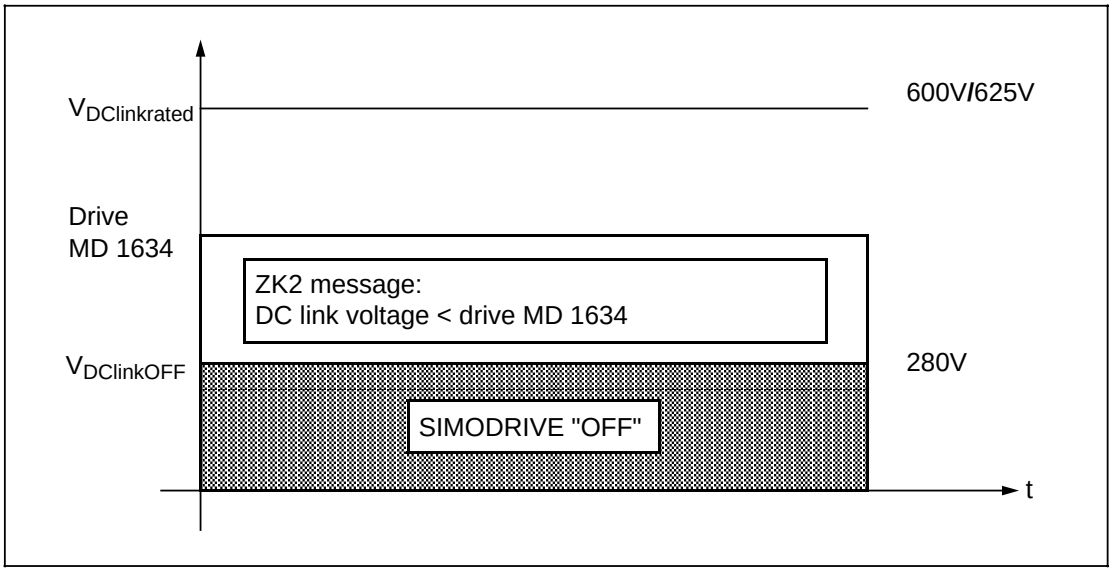
Detection of a drop in the DC link voltage to below the threshold parameterized in drive (611D) MD 1634 can be used as an internal error source (axis**/**spindle-specific NC-MD bit) for the retraction operation. In this way, it is possible to prevent the drive hardware from being shut down when the DC link voltage drops below the minimum limit (280V) before the workpiece and tool have been separated.

By setting an NC-MD bit, it is also possible to parameterize for one or several axes (meaningful for one axis per I**/**RF range) whether a retraction operation is to be initiated when the DC link voltage drops below the threshold set in drive MD 1634. If the "**Extended stop and retract**" function is parameterized and programmed, this function is then executed if it has been enabled via the PLC NS signal "Retraction enabled".

Through appropriate parameter settings in NC = MD 529* and 592*, it is possible to program either the autonomous drive or the open-loop control reaction. It is advisable to program the autonomous drive reaction if the high dynamic requirements of the drive(s) involved are such that the energy available is not sufficient to successfully separate the positive connection for "**Extended stop and retract**" as an open-loop control function (reaction and execution time too high). However, this setting has the disadvantage that interpolative retraction and stopping cannot be implemented.

The DC link can be supplied with additional energy required for "**Extended stop and retract**" by means of a parallel, regenerative braking operation:

See DC link buffering.



Monitoring of DC link voltage for violation of voltage threshold in drive MD 1634

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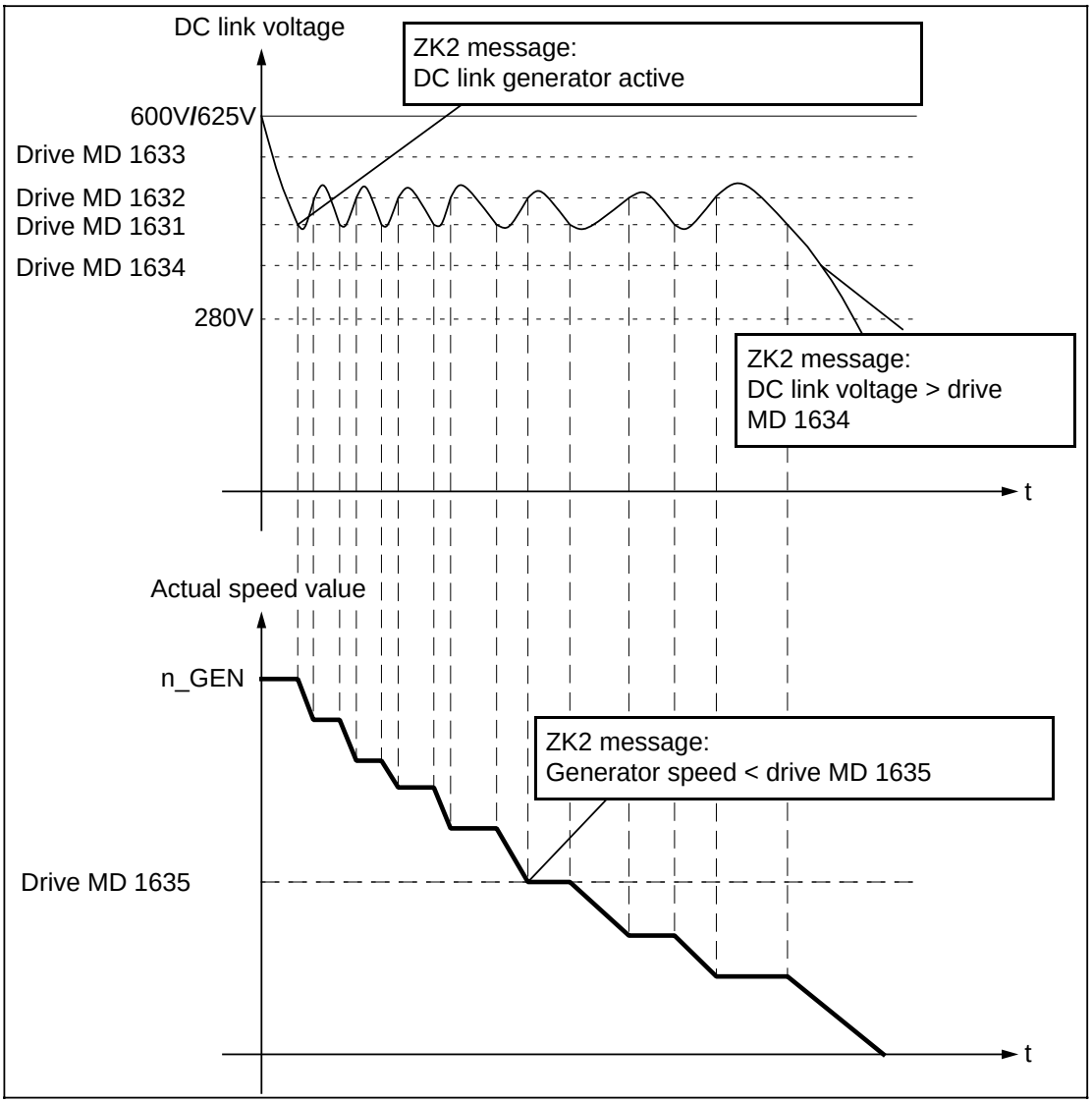
12.20.5 DC link buffering and monitoring of generator minimum speed limit

12.20.5.1 DC link buffering

An axis/spindle can buffer the DC link by means of generator-mode braking. This function can be selected through appropriate parameterization of 611D machine data and activation of generator operation by programming commands.



Generator operation

When the DC link voltage drops below the minimum threshold value set in drive MD 1631, the axis/spindle concerned switches from position-controlled or speed-controlled operation into an operating mode controlled by the DC link. When the drive is braked (through input of speed

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setpoint zero), energy is fed back to the DC link. This drive measures the DC link voltage cyclically. If the voltage increases above the values set in drive MD 1631 and 1632, the two-position controller is deactivated, i.e. the instantaneous actual speed value is input as the speed setpoint. During active generator operation, the ZK2 message "DC link generator active" (ZWK_GEN_ACTIVE) is output.

The two-position operating characteristics of the generator is specific to the machine and application.

If the voltage increases above the value set in drive MD 1633, the axis**/**spindle switches from generator mode back to speed-controlled operation unless it was operating in position-controlled mode beforehand. In this case, a drive reset is required (power ON**/**OFF).

12.20.5.2 Monitoring for generator minimum speed limit

In addition to the generator mode operating characteristics for DC link buffering purposes described above, the actual speed value of the axis**/**spindle is also monitored in generator operation for violation of a minimum speed limit which can be parameterized via a 611D MD (drive MD 1635). When the speed drops below this minimum limit, the ZK2 message "Generator speed < drive MD 1635" is output.

Analogous to the detection of violation of the DC link minimum voltage value set in drive MD 1634, this signal can also be defined as an internal error source for "**Extended stop and retract**":

See DC link undervoltage monitoring in 611D.

12.20.5.3 Communications/control failure

With the 611D package 2, a communications/control failure is detected when the NC sign of life fails to appear on the drive bus; an autonomous drive ESR is then executed if this reaction is programmed.

12.20.5.4 840C/611D detects error/request and specifies "Extended stop and retract" as autonomous drive function

When the combination 840C SW4 and 611D package 2 is available, it is possible to initiate an autonomous drive ESR when an ESR source is detected even though the control has not yet failed. It must be noted in this case that the reaction is defined depending on the source in question.

12.20.6 Stopping

The stop operation can be parameterized and programmed when SW version 4 is installed:

The following are the stop operation sources:

- Mode group stop (as well as all alarms which initiate mode group stop) and
- EMERGENCY STOP if parameterized by means of NC MD bit.

  All sources for retraction can thus also act as sources for the stop operation.

There are two categories of reaction, i.e.

- as an open-loop control function and
- as an autonomous drive function.

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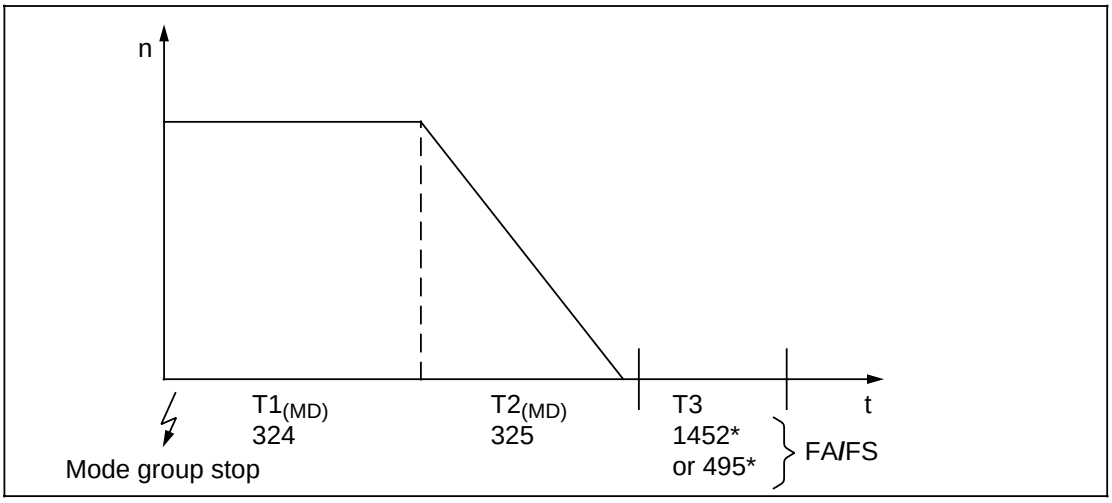
12.20.6.1 Stopping as open-loop control function

The time characteristics of this reaction type are shown in the diagram.



Parameterizable/programmable stop operation as open-loop control function

In the case of mode group stop errors, the following reactions are possible (times T1 to T3 can be parameterized via MD):

T1 Within time T1:

1.) All

- leading axes/spindles
- and all axes/spindles which are explicitly requested by means of programming, but are not leading axes or spindles as well as
- axes which interpolate with the leading axes/spindles specified above and all axes which interpolate with axes/spindles explicitly requested through programming instructions are controlled as an interpolative function, thus ensuring that the motion is continued (contour accuracy),

2.) All FA/FS remain linked,

3.) All other axes/spindles not mentioned under 1. and 2. are immediately switched to follow-up mode.

T2 Within time T2:

1.) All the above drives are braked interpolatively down to 0 as a function of acceleration

2.) All FA/FS remain linked.

These characteristics (T1 + T2) can also be activated for EMERGENCY STOP (via NC-MD 5022, bit 0).

T3: Within time T3:

All FA/FS are made to follow as a closed-loop control function (MD 1452*/495*). All other axes switch to "Follow-up" mode (MD 1224*/447*). On expiry of T3, the FA/FS are also switched to follow-up mode.

This reaction is generally initiated for linked GI groupings as well as for drives programmed by means of G functions provided that the machine data for extended stopping and for times T1 and/or T2 have been parameterized.

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Existing GI and IKA link branches with simulated leading axes**/**input quantities are not cancelled until T2 has expired.

Continued traversal as an interpolative process is desirable to suppress the brief synchronism deviation (break in speed curve) which occurs on transition to braking mode. It is particularly important to eliminate this effect during finishing cut processes.

While the traversal motion continues, the positive connection between the tool and workpiece is separated independently of the stop operation if "Retraction" is programmed and enabled.

Note:

The total time T1 + T2 + T3 should not exceed a maximum value (e.g. 1 second) for safety reasons. The user is responsible for observing this maximum value.

12.20.6.2 Stopping as autonomous drive function

- This new, extended autonomous drive stop operation is intended to ensure that the drives of a previously linked GI grouping can be stopped as simultaneously as possible if this cannot be implemented in the control system.
- The function must be enabled via a general machine data NC-MD 5022, bit 1 (extended stopping) and via a source-related machine data NC-MD 529***/**592* (channel-specific or axis/specific autonomous drive ESR).

The following reaction can be programmed:

- The speed setpoint currently active when the error occurs continues to be output for time T1 (diagram: parameterizable/programmable stop operation as open-loop control function). The purpose of this is to maintain the motion which was being executed before the failure until the positive connection has been separated or until the retraction operation initiated in parallel in other drives has been executed. This may be purposeful for all leading**/**following drives, or for linked drives, or for drives operating in a grouping.
- On expiry of time T1, all axes are stopped at the current limit through injection of a zero setpoint; pulse suppression is initiated as soon as the axes have stopped.

Note:

In contrast to stopping as an open-loop control function, it must be noted that this function affords nothing more than an autonomous drive reaction, i.e. it is not possible to control an interpolation grouping of several axes on an interpolative basis nor is it possible to control, brake or make follow an axis link on a closed-loop control basis.

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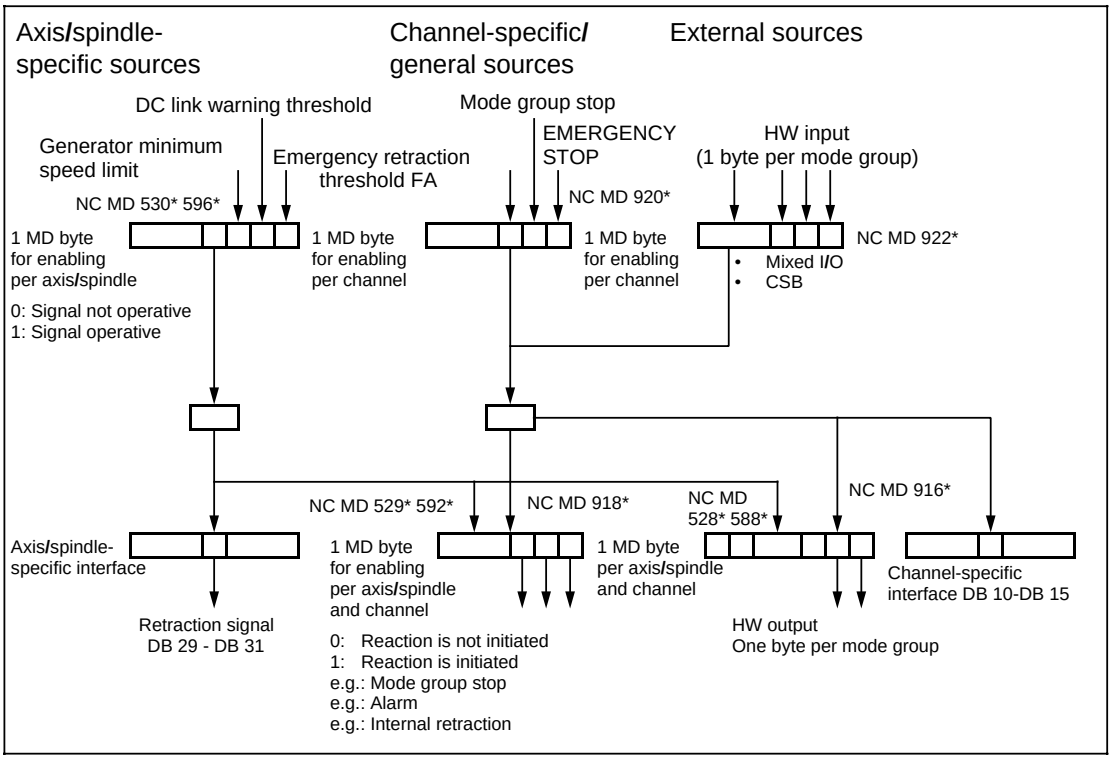
12.20.7 Retraction

The retraction motion can be parameterized and programmed.

The following diagram shows the possible sources and the associated reactions for the extended, parameterizable and open-loop controlled retraction without giving the programmable retraction motions.



Programmable retraction as open-loop control function

There are two categories of retraction, i.e.

- as an open-loop control function and
- as an autonomous drive function.

Sources

There are four source areas for the retraction process:

- Internal axis/spindle-specific sources,
- Internal sources specific to channel/mode group or general sources,
- External sources via HW inputs,
- Communications failure (autonomous drive sources which initiate generator-mode braking of the drive).

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The following individual sources are also available:

- Axis/spindle-specific sources:
  - Retraction threshold FA/FS exceeded
  - DC link voltage warning threshold
  - Generator minimum speed limit

  Activation of sources:

  The user determines which of the possible axis sources initiate a retraction and which do not in an axis-specific and spindle-specific MD byte NC MD 530* 596*.

- Sources specific to channel/mode group and general sources:
  - Mode group stop of channel mode group
  - EMERGENCY STOP

  Activation of sources:

  The user determines which sources are active and which are not in a channel-specific MD byte NC-MD 920*.

- External sources via HW inputs:

  A retraction process can be initiated from and external source (provided input is active) by means of a mode group-specific input byte of the mixed I/O or CSB (can be defined by means of MD).

  Activation of input bits:

  An MD byte NC-MD 922* is assigned to each channel; this byte is used to define which input bits are active and which are not.

  A retraction process is initiated if a low-level signal is present at an active input bit of the mixed I/O, i.e. low-active inputs; 24 V must be applied to the active inputs before the retraction is enabled.

Note:

Emergency retraction is only applied to axes that are under closed-loop control (i.e. controller enable must be set).

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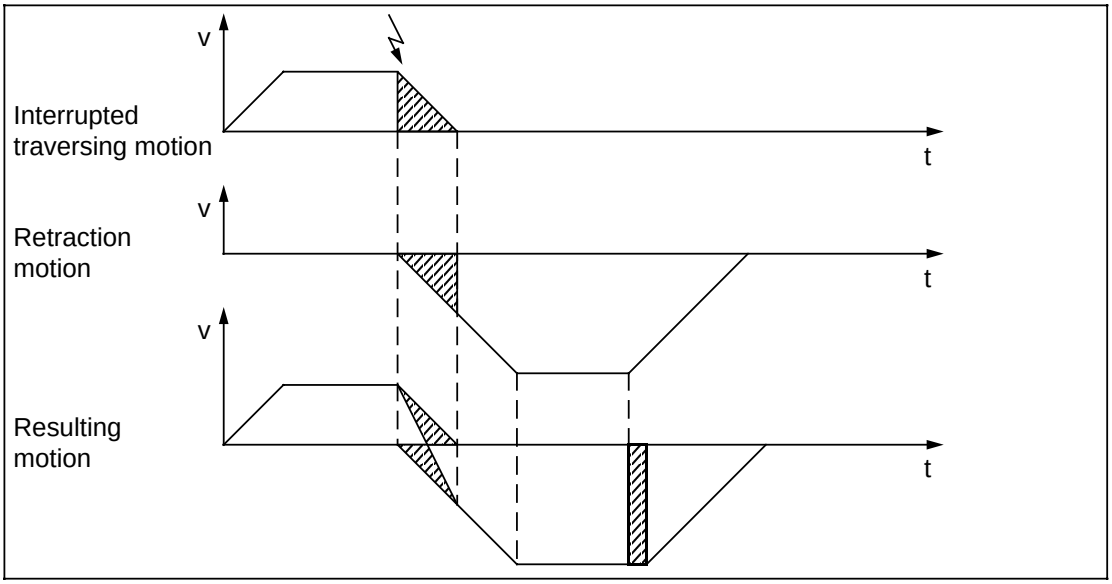
12.20.7.1 Retraction as open-loop control function

The reaction to detected retraction events can be parameterized:

- Switching of outputs on mixed I/O module
- Traversal of an internal retraction with the axes programmed for this purpose
- Output of a mode group stop alarm
- Output of PLC NS signals.

The following diagram shows the sequence of retraction motions.

In this diagram, the braking process of the current traversing motion and the acceleration process of the retraction motion are executed in parallel. In comparison to normal sequences, there are areas missing in the resulting motion and allowance must be made for these when the retraction motion is executed. This correction is made independently of the G90 or G91 characteristics of the retraction motion.



Parameterizable/programmable retraction as open-loop control function

Notes:

- The open-loop-controlled retraction process must be enabled via NC-MD 529* bit 1 and NC-MD 592* bit 2 (assignment to source).
- Up to 5 axes in the interpolation grouping and one further spindle (maximum) as well as up to 5 endlessly turning rotary axes can be programmed for the internal retraction reaction which, in the event of an error, execute a specific retraction motion.
- A retraction is executed only if the pulse enabling command from the PLC was set at the instant the error occurred. The speed controller enabling command is specified internally by the system (control to drive). The terminal connections can be provided by the user via outputs (e.g. of the mixed I/O).

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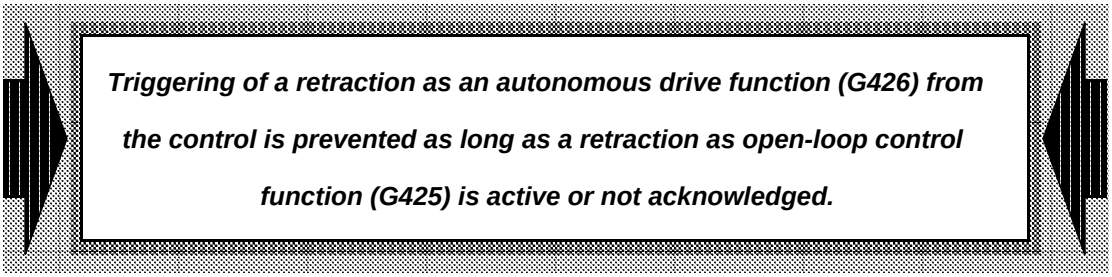
- If the function ”Consider software limit switch with controlled emergency retraction” is selected, the SW limit switch function has the same effect on emergency retraction as in the NC channels.
  Depending on the setting in machine data 5003, bit 7 ”No deceleration at limit switch”, either deceleration is performed in the emergency retraction channel or setpoint 0 is output.
  The SW prelimit switch also takes effect. The path velocity in the emergency retraction channel is set to max. the value of MD 1 ”Velocity behind SW prelimit switch”.
  The function ”Consider software limit switch with controlled emergency retraction” is activated via general machine data MD 5022 bit 5.



Individual reactions:

- Axis**/**spindle-specific reaction

  The bit "Retraction active" in set in the standard interface to the PLC for the axis or the spindle which initiates the retraction process.

- Reaction specific to channel**/**mode group

  The bit "Retraction active" is set in the standard interface to the PLC for the channel which initiates the retraction process.

- Set**/**reset HW outputs

  It is possible to define a HW output byte which is switched when retraction takes place. This byte is selected via MD NC MD 312-317 and the idle state is defined via MD NC MD 5021.

  The output bit which must be switched from the idle to the active state in the case of an error is selected via an axis**/**spindle**/**channel-specific MD byte NC-MD 916* 528* 588* (corresponding to the source).

Mode group reaction:

Possible mode group reactions are:

- Output of an alarm via MD
- Initiation of mode group stop via MD
- Programmed retraction according to part program command:
  See Programming Guide

By means of programming measures, it is possible to determine for one**/**several axes or one**/**several spindles whether and how they must execute a retraction. If a retraction condition is fulfilled and if the appropriate NC-MD bit(s) is (are) set, all programmed retraction motions are executed when the process has been enabled via the interface signal "Enable retraction" (safety function). In the event of retraction, grouped axes can be positioned incrementally or absolutely; endlessly turning rotary axes or spindles can be positioned absolutely.

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12.20.7.2 Retraction as autonomous drive function (611D)

On SW 4 and higher, axes with digital 611D drive systems can perform a retraction autonomously if the control fails (sign of life detection) or if the DC link voltage drops below a warning threshold.

The retraction motion is performed by the 611D autonomously. The retraction path and the velocity can be set in the part program.

From the beginning of the retraction phase, the drive stops its enables autonomously at the previously valid values. Emergency retraction is only performed if the pulse and interface signal "enable ESR" were set , i.e. the drive was enabled.

If the control fails, it is enough that the pulse enable is set. In this case the 611D drive system generates its own servo enable - if it is still functional. (Partial functionality for the "Retraction with clamped axes").

The external safety logic of a control and drive system combination with drive emergency retraction must be such that on failure of the control (i.e. PLC stop and NC READY failure) the drive unit is still able to move (configuration of the relevant machine safety logic).

The drive system has no reference to the NC geometry system. On the NC-side, the unit system of the motor measuring system is only known if it is used as the position measuring system.

The retraction path for the drive is set through the SERVO level with the following geometry-neutral data:

- Speed setpoint
- Travel time**/**deceleration time for braking

The drive system traverses the programmed "retraction path" with an internal time-controlled set speed.

The actual "retraction path" travelled in the event of an error depends on the current actual speed at the time the emergency retraction begins and can deviate slightly from the programmed value because the drive system does not monitor for the resulting path (no interpolation).

After this sequence of operations, a zero speed setpoint is specified for the retraction axes which are then stopped along the current limit (see autonomous drive stop operation).

The retraction motion is defined by programming:

- incremental dimension value,
- direction of traversal and
- speed setpoint (F value)

Notes:

- The autonomous drive emergency retraction is operative only if the bit "pulse suppression" is set to "off" in the drive MD 1612 and 1613.
- When emergency retraction is active, it is not possible parameterize the emergency retraction. Although the data are transferred to the drive, they are not accepted. No message is output to the user to indicate this status.
- See the SINUMERIK 840C Programming Guide for further information on programming.

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12.20.8 Configuration help for generator operation and emergency retraction

12.20.8.1 Special case voltage failure

Requirements

The generator operation and emergency retraction functions on SINUMERIK 840C require the following hardware and software:

- Hardware components:
  - SINUMERIK 840C standard hardware
  - SIMODRIVE 611D standard hardware with modified drive control loops of the type 6SN1 118-0DG... or 6SN1 118-0DH...
  - Controlled infeed/regenerative feedback module (16 kW upwards) with suitable pulse resistance module and possibly additional capacitors for the DC link.
  - Capacitor module (accessory 6FX2 006-1AA00: available as of the beginning of 1995) to back up the power supply 115-230 V AC for the central unit and operator panel or alternatively the 24 V DC power supply (available as of the 1st quarter of 1995) and possibly 24 V DC operator panel (available as of 2nd quarter 1995).
- Software components
  - System software SW 4.2
  - Generator operation option
  - Emergency retraction option (includes regenerative operation)

The following points must be noted for configuration:

1. The electronics of the drive controls must be powered from the DC link. With the infeed**/**regenerative feedback modules, the connection with the DC link must be made (see Start-up Guide 611).
2. NC and the operator panel must be backed up by suitable means, e.g.: capacitor module for 230 V power supply or accumulator for 24 V power supply.
3. The supply to the PLC peripherals must be backed up by the accumulator.

DC link backup/total energy:

The energy available in the DC link of the drive units is calculated as follows in case of power failure:

$E = 1/2 * C * (U_{Zk}^2 - U_{min}^2)$

where

E = Energy in watt seconds [Ws]
C = Total capacity of the DC link in farads [F]
U_{Zk} = Content of the drive machine data 1634
U_{min} = Lower limit for safe operation taking the motor-specific emf into account, but always above the switch-off threshold of 280 V

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Example:

C = 6000 µF (see table 16 kW infeed/regenerative feedback module) - 20%
U_{Zk} = 550 Volt (P1634)
U_{min} = 350 Volt (assumed)

E = 1/2 * 4800 µF * ((550 V)^2 - (350 V)^2) = 432 Ws

This energy is available at load for a time of:

t_{min} = E/P_{max} *

where

t_{min} = backup time in milliseconds [ms]
P_{max} = power in kilowatts [kW]
= degree of efficiency of the drive unit = 0.90

Example:

E = 432 Ws
P_{max} = 16 kW (see table for 16 kW infeed/regenerative feedback module)
= 0.90

t_{min} = 432 Ws/16 kW * 0.9 = 24.3 ms

in order to initiate the emergency retraction.

The table below shows a summary of the values for different infeed/regenerative feedback units. Nominal and minimum capacitances have been taken into account. The maximum possible capacitance (load limit) consists of the sum of the capacitances of the infeed/regenerative feedback module and the axis/spindle modules plus additional external capacitors (provided by the customer). The minimum capacitance shown in the table takes account of a component tolerance of -20% (worst case).

Infeed/regenerative feedback unit (power P_{max}) [kW]	Max. possible capacitance C_{max} [µF]	Energy content (at C_{max}) [Ws]	Energy content (at C_{min}) [Ws]	Backup time t_n at P_{max} [ms]	Backup time t_{min} at P_{max} [ms]
16	6000	540	432	30.38	24.30
36	20000	1800	1440	45.00	36.00
55	20000	1800	1440	29.46	23.56
80	20000	1800	1440	20.25	16.20
120	20000	1800	1440	13.50	10.80

Note:

In configuring the emergency retraction, a total energy must be calculated to find out if it is possible to eliminate an additional generator axis/spindle (with an appropriately dimensioned centrifugal mass).

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Option for programmable emergency retraction

The function is triggered via parameterizable sources.

The response can be drive-autonomous or open-loop controlled.

The possible responses are:

- Stopping (time-controlled continuation and braking of the axis**/**spindles relevant to the contour)
- Retraction (cancellation of the positive connection)
- Inversion of fast process outputs (e.g. fast cancellation of clampings).

The source

- Channels (mode group stop, inputs, emerg. OFF)
- Axis or spindle ($V_{dclinkmin}$, lower speed limit, emergency retraction threshold, ...)

determines the response, i.e. the source is used to decide whether the response is to be an autonomous function of the drive or a function of the control.

The response can be parameterized via machine data and configured via G functions.

Open-loop controlled stopping and retraction

If open-loop controlled stopping and retraction is to be used, the backup must be designed for at least five interpolation cycles if an additional generator is not used because all axes can be run for this time without any change.

Regenerative stopping

From the 5th IPO cycle onward, the set speeds of the configured stopping or retraction axes**/**spindles are changed. Make sure that the general control machine data "Time for interpolation-controlled continuation", NC MD 324 is set to 0. Otherwise this time must be included additively. This is only useful if the cutting conditions must be kept as constant as possible as long as the positive connection exists (parallel retraction).

After this time, the braking period begins. The braking behaviour and therefore the regenerative feedback is determined by the set acceleration ramps for axes and spindles.

As soon as the braking process begins, the energy generated is available for the retraction motion. The total energy must be calculated to ensure that the kinetic energy of the braking axis is sufficient to perform retraction.

The total energy also tells you the maximum IPO cycle that can be set to be able to perform safe retraction.

For example, if an emergency retraction must be possible without regenerative operation in a 16kW unit under maximum load and minimum DC link capacitance, the IPO cycle duration can theoretically be no greater than 4.86 ms, in which case up to 4 ms can be set.

If necessary, a more powerful NCK CPU can be used to achieve optimum conditions.

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Drive-autonomous stopping and retraction

Drive-autonomous stopping and retraction initiated by the NC must be used if a response as a function of the control (i.e. interpolation) is no longer possible, for example, if a very fast response is necessary. In this case the drive system responds within one IPO cycle by outputting a setpoint for the configured axes/spindles. Here too, a distinction is made between stopping and retraction.

After drive-autonomous stopping and retraction, a Power On reset is necessary.

Note:

If the drive bus between the NC and the drive is interrupted (loss of sign of life) stopping and retraction can only be performed as an autonomous function of the drive.

However, this does not normally occur in conjunction with a power failure.

Generator operation

Generator operation is for cases where the energy of the DC link is not sufficient for a reliable retraction (for a time of at least 5 IPO cycles). This function makes use of the kinetic energy of the spindle or axis and feeds it back into the DC link in an optimum fashion. The DC link voltage is maintained within the limits parameterized in the drive machine data using a two-step voltage controller (see Start-up Guide Section 12).

The axis**/**spindle parameterized as the generator measures the DC link voltage in "ms cycles". The DC link can therefore be backed up within a maximum of 2 ms.

The energy stored in the drive

E = 1**/**2 * * 2
with
= total mass moment of inertia of the drive
= angular velocity at the time of switchover to regenerative operation

is fed back with a degree of efficiency of approx. 90%.

For generator operation, especially on large machines with high-power infeed**/**regenerative feedback units (55, 80, 120 kW) it is advisable to use a separate drive with a flywheel that must only put in the friction losses once it has reached maximum velocity.

Of course, any drive on the machine can be used for this function as long as it is not directly involved in controlled stopping or retraction.

Axes that are involved in gear couplings must be maintained are not suitable.

Note:

A minimum speed limit of the generator can also be a source of emergency retraction response. This is useful if short interruptions in the voltage must be backed up in regenerative operation.

Other comments:

Suitably rated pulse resistance modules must be used to prevent the DC link from becoming too great when braking begins (stopping and retraction either as a function of the control or as an autonomous function of the drive) and the drive responding with pulse suppression causing uncontrolled coasting.

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12.20.8.2 Activating autonomous drive emergency retraction in case of PLC failure or 5 V undervoltage (as from SW 6.3)

No NCK failure, activation only when in operative mode, no run up in the general reset mode

Activating

Clearing for activation of the autonomous drive emergency retraction is implemented according to the function via the following MD bits:

NC MD	Bit No.							
	7	6	5	4	3	2	1	0
5022	Delay of the NC ready signal for 1 IPO cycle in case of PLC failure or 5 V under-voltage		5 V under-voltage	Retraction in case of PLC failure				

5022.4=1 Clearing for activation of the autonomous drive emergency retraction in case of PLC failure

5022.5=1 Clearing for activation of the autonomous drive emergency retraction in case of 5 V undervoltage

5022.7=1 Delay of the NC ready signal for 1 IPO cycle in case of PLC failure of 5 V undervoltage

5022.7=0 No delay of the NC ready signal for 1 IPO cycle in case of PLC failure or 5 V undervoltage

Default setting of bit is 0.

Reactions

Display of the applicable alarm on (POWER ON), stopping the NCK CPU and execution of the autonomous drive emergency retraction.

After POWER ON, the NCK instantly runs in normal operational mode instead of the then startup mode.

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12.21 Simultaneous axes

12.21.1 Corresponding data

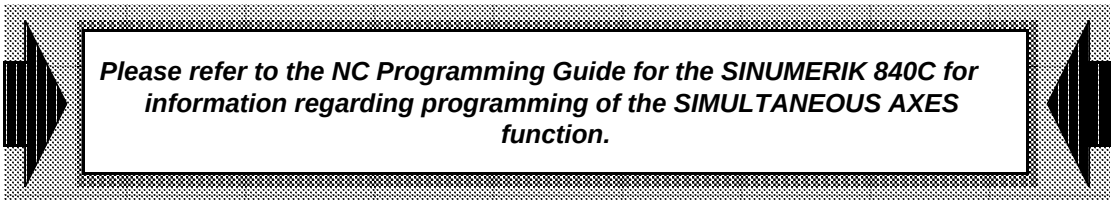
- NC MD 5004 bit 0,1 1st or 2nd handwheel connected
- SD 564* Handwheel pulse evaluation
- DB32 DWk+1 bit 0,1 1st or 2nd handwheel active for the relevant axis

General

Simultaneous axes are axes which can be traversed at a separately programmed velocity independently of other axes. A total of 5 simultaneous axes can be programmed and traversed either individually or in addition to up to 5 further interpolative axes in a block of the part program. Every positioning axis can be programmed and traversed with a separate, axis-specific feed. A block change does not take place until all simultaneous axes and all other axes programmed in this block have reached their end point.

Only real axes can be used as simultaneous axes. An axis is defined block-by-block as a positioning axis during programming, i.e. in the next block, it can be traversed interpolatively again with other axes.

The feedrate of the simultaneous axes with block end behaviour is weighted with the channel-specific override.



12.21.2 Handwheel for simultaneous axes in automatic mode

Simultaneous axes can be traversed by means of the handwheel in automatic mode. This handwheel overlay is enabled by the G function G27. G27 is a block-related function and operates on a block-by-block basis.

All axial limitations (SW/HW limit switches, SW prelimit switch, working area limitation) remain operative when the handwheel overlay function is active.

Handwheel pulses generated are ignored under the following conditions:

- Override 0%
- No handwheel enable from PLC
- No feed enable from PLC
- Velocity overlay (when v = 0 is reached)

Two different overlays can be programmed:

- Velocity overlay
  The programmed position is reached sooner or later by means of the handwheel overlay, i.e. the velocity is manually increased or decreased depending on the direction of rotation. The direction, however, remains unchanged; the velocity can at most be reduced to v = 0.
- Path overlay
  The programmed position can be reached only manually through rotation of the handwheel. The direction of rotation determines the traversing direction for the programmed axis. It is possible to traverse in the opposite direction to that which is programmed, but it is not possible to traverse beyond the end position programmed. Once the programmed end position has been reached, a block change takes place and the axis can be traversed by handwheel only by applying a G27 function again. The active block can be aborted by means of axial deletion of distance to go (@736). The actual value display of the traversing axes is continuously updated.

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Please refer to the NC Programming Guide for the SINUMERIK 840C for information regarding programming of the HANDWHEEL OVERLAY OF SIMULTANEOUS AXES IN AUTOMATIC MODE function.

Starting up the function

An option bit is not required for the function. It is merely necessary to specify the connected handwheels in NC MD 5004. The handwheel to be used must then be activated via DB32 DWk+1. It is permissible for both handwheels to be active simultaneously in one block.

The weighting factor (applicable to both handwheels) is defined by setting data 564*.

Setting data 564*	Bit0=1:	1 increment per handwheel pulse
	Bit1=1:	10 increments per handwheel pulse
	Bit2=1:	100 increments per handwheel pulse
	Bit3=1:	1000 increments per handwheel pulse
	Bit4=1:	10000 increments per handwheel pulse
	Only one weighting bit may be set!	

A monitoring function, which is dependent on the display resolution and the handwheel pulse evaluation, is activated to ensure that the path to be traversed with one handwheel pulse does not exceed 1 mm and is not less than the input resolution.

Note:

The weighting factor can be displayed via the LEDs of the increment keys on the machine control panel of the PLC.

Deletion of distance-to-go with simultaneous axes

The command @736 makes it possible to delete the distance to go on an axis-specific basis within an NC block as a function of a signal change at an external input. The two measuring inputs of the Central Service Board or the 16 digital inputs of the mixed I/O module (max. 2 permitted per SINUMERIK 840C) can be used as external inputs. When @736 is programmed, the corresponding input signal is interrogated by the NC cyclically in the interpolation cycle and, in the case of an active signal level, initiates deletion of distance to go. The input signal must remain at the active level for at least two IPO cycles.

If several input signals are to act on one axis, then it must be ensured that all inputs are set to the same input byte of the mixed I/O module.

An incremental axis position, which is programmed after the block with the "Delete distance-to-go", refers to the position of the point of interruption defined by the occurrence of the external signal.

Please refer to the NC Programming Guide for the SINUMERIK 840C for information regarding programming of the DELETION OF DISTANCE-TO-GO WITH SIMULTANEOUS AXES (@736) function.

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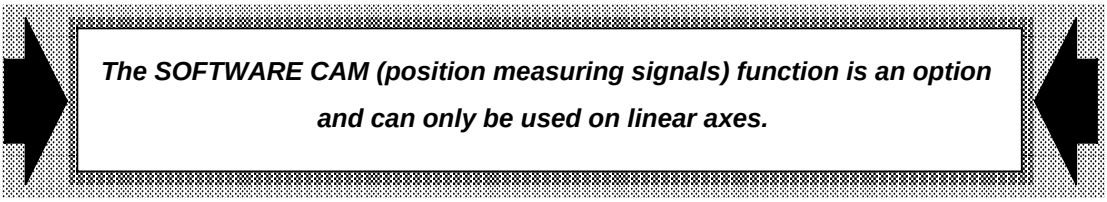
12.22 Software cam (position measuring signals)



12.22.1 Corresponding data

NC MD 310	Assignment cam output byte to synchr. user INTERF (in preparation)
NC MD 311	Assignment cam output byte to MIXED I/O bytes
SD 7000-7007	Cam positions of cam pairs
DB48 DR0.6	Activate cam/axis assignment
DB48 DR1.6	Cam/axis assignment activated
DB48 DR0.7	Transfer of cam values
DB48 DR1.7	Cam values transferred
DB48 DR1.5	NC changes cam values
DB32 DL121+m	Cam signals of axis
DB32 DL123+m	Cam pair for axis active

Software cam (position measuring signals) option

12.22.2 Functional description

The "software cam" function generates position measuring signals and can be parameterized via setting and machine data. The setting data contain the axis positions of the individual cams and organized in a cam value block. The cams are always assigned to the axis in pairs, each consisting of a positive and a negative cam.

The positive and negative cams simulate an operating cam of infinite length which is activated at a defined position (cam position) in a certain approach direction when the axis reaches the cam position.

The status of the cams, the cam signals, are transferred to DB32 DL121+m in the IPO cycle and/or output additionally via the output bytes of the MIXED I/O (assignment in NC MD 311).

The software cam function is fully operational and can be activated in all operating modes after the appropriate axes have approached the reference point. It remains active even after RESET or EMERGENCY STOP.

Cam pair and cam range

A cam pair consists of a positive and a negative cam. The axis range assigned to the positive cam is greater than its cam position and the axis range assigned to the negative cam smaller than its cam position.

The axis range assigned to the cam is referred to as the "cam range".

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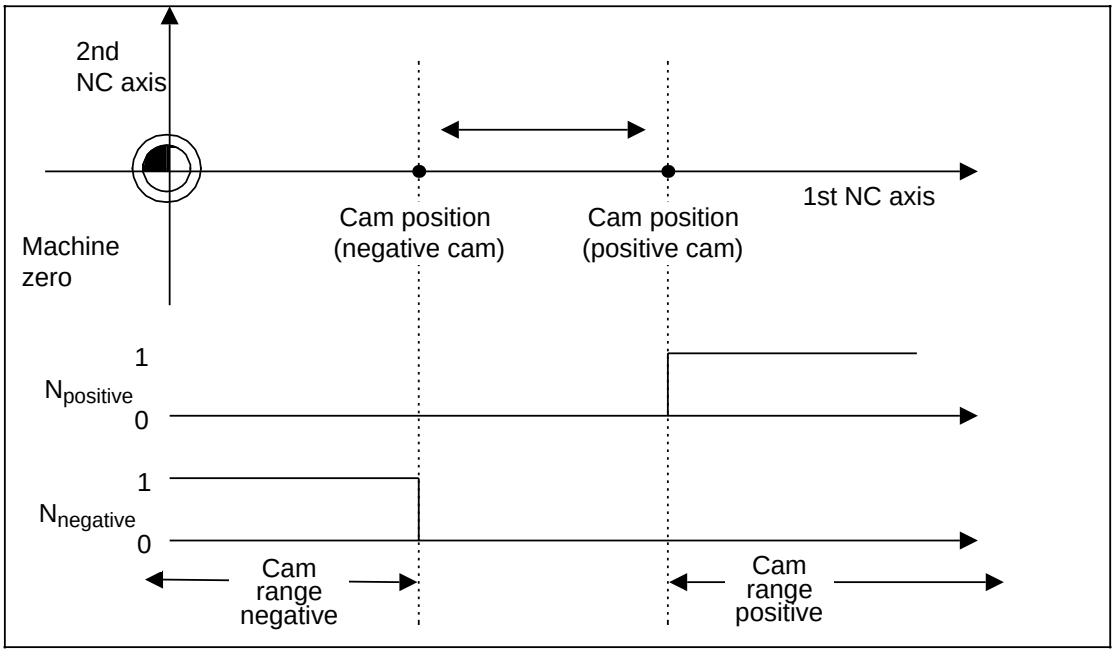
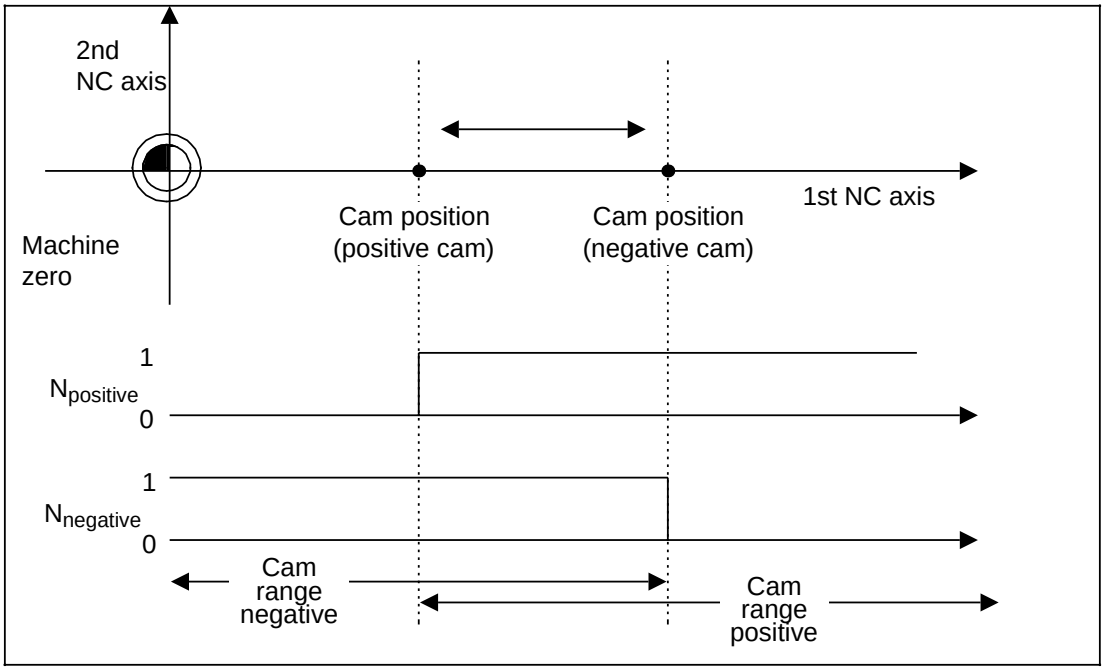


Negative cam < positive cam



Positive cam < negative cam

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Cam values

All cam values are contained in the setting data 7000 to 7007. This range is referred to as the cam value block and includes the positions of eight cams which are divided into four cam pairs.

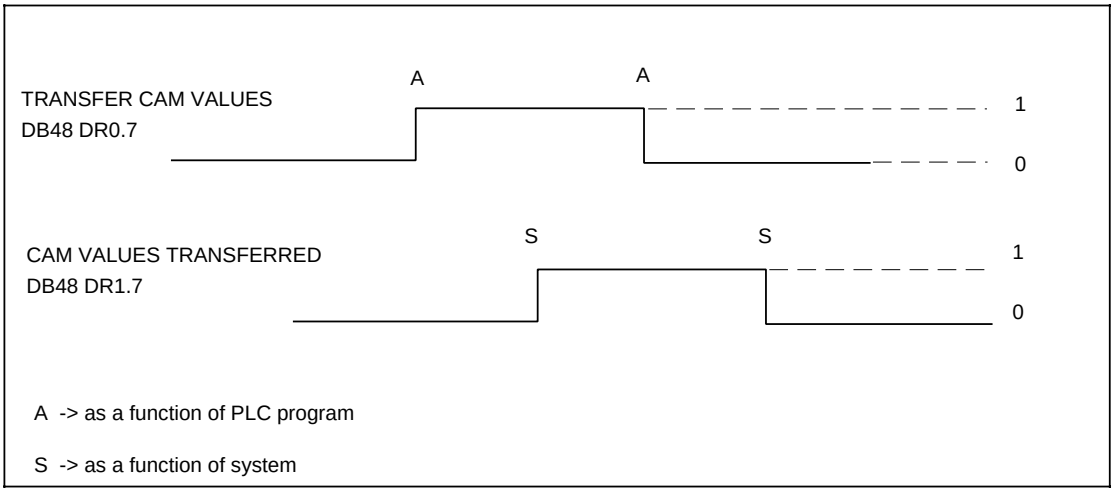
Position negative cam 1	SD 7000	Pair of cams 1	Cam value block
Position positive cam 1	SD 7001		
Position negative cam 2	SD 7002	Pair of cams 2	
Position positive cam 2	SD 7003		
Position negative cam 3	SD 7004	Pair of cams 3	
Position positive cam 3	SD 7005		
Position negative cam 4	SD 7006	Pair of cams 4	
Position positive cam 4	SD 7007		

The cam positions must refer to the relevant machine system, in either metric system or inches. They are input into the machine-related actual value system. No check is performed to ensure that the cam positions do not exceed the maximum traversing range.

In axis follow-up mode, the actual positions are used as cam signals. The setpoint is used in the case of position-controlled axes.

The cam values can be entered in the setting data display "Position measuring signals" or written and read by means of a @-function. The cam positions can be read in the PLC program and changed from the PLC program by means of PLC interfaces FB61 and FB62. The user can monitor write access to the cam value block through appropriate setting of DB48 DR1, bit 5.

The changed cam positions are not activated until a 0/1 signal edge change in the TRANSFER CAM VALUES signal (DB 48 DR0.7). As an acknowledgement of transfer, the user receives the CAM VALUES TRANSFERRED signal (DB 48 DR1.7). He must then reset bit DB48 DR0.7.



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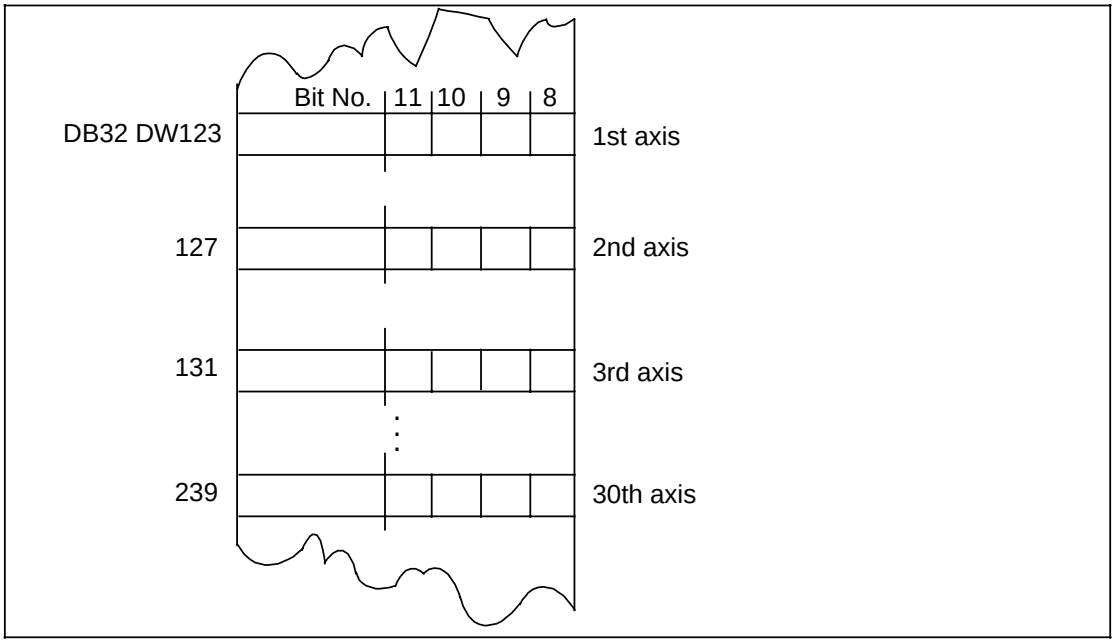
Assignment between cam pairs and axes

The cam pairs are assigned via the NC/PLC interface to specific axes as follows:



Bit 11	Bit 10	Bit 9	Bit 8	Function
0	0	0	0	"Cam pairs" function inactive
0	0	0	1	Cam pair 1 active
0	0	1	0	Cam pair 2 active
0	1	0	0	Cam pair 3 active
1	0	0	0	Cam pair 4 active

The changed cam assignments are not transferred to the NC until a 0/1 signal edge change in the ACTIVATE CAM/AXIS ASSIGNMENT signal (DB 48 DR0.6). As an acknowledgement of transfer, the user receives the CAM/AXIS ASSIGNMENT ACTIVATED signal (DB 48 DR1.6). He must then reset the signal DB48 DR0.6.

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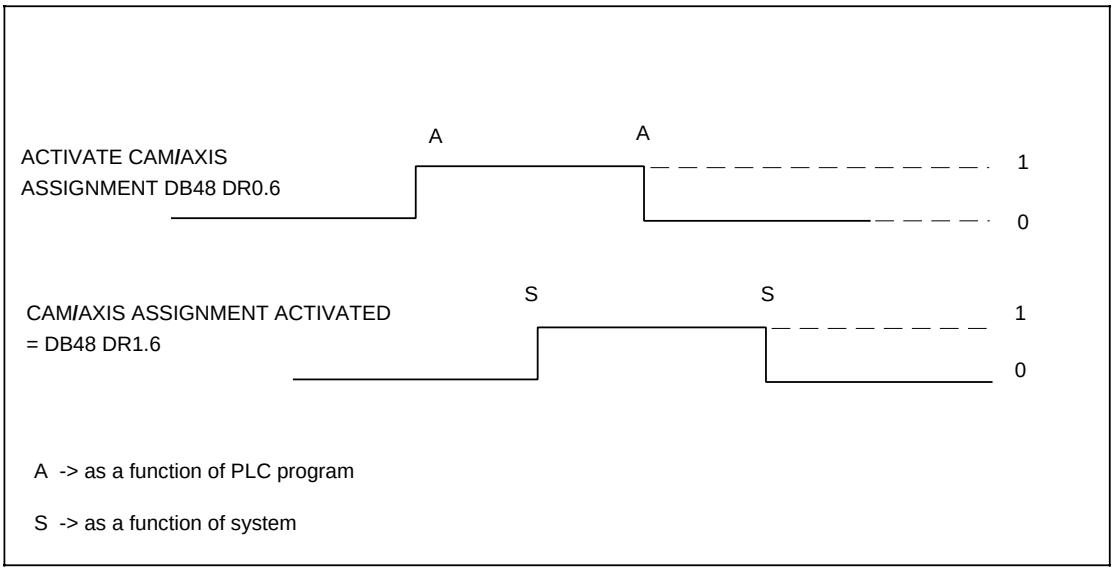

Notes:

- A cam pair can be only ever be assigned to one NC axis at a time.
- Several pairs of cams can be activated for one axis.
- Cam signals are not output until the axes have been referenced.
- Cams must not be activated until axes have been referenced.

Output of cam signals

The cam signals are transferred in the IPO cycle to the axis-specific interface DB32 DW121+m, bits 8 to 15.

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Signals from axis								
Byte no.	15	14	13	12	11	10	9	8
	Bit No.							
	7	6	5	4	3	2	1	0
Axis1 DL 121	Cam 4+	Cam 4–	Cam 3+	Cam 3–	Cam 2+	Cam 2–	Cam 1+	Cam 1–
Axis1 DR 121								
Axis2 DL 125	Cam 4+	Cam 4–	Cam 3+	Cam 3–	Cam 2+	Cam 2–	Cam 1+	Cam 1–
Axis2 DR 125								
⋮								
Axis30 DL 237	Cam 4+	Cam 4–	Cam 3+	Cam 3–	Cam 2+	Cam 2–	Cam 1+	Cam 1–
Axis30 DR 237								

The user can also output the cam signals in the IPO cycle via a digital output byte of the MIXED I/O. The cam signals are assigned to a MIXED I/O output byte via NC MD 311.

MIXED I/O								
Byte No.	Bit No.							
	7	6	5	4	3	2	1	0
1 or 2	Cam 4+	Cam 4–	Cam 3+	Cam 3–	Cam 2+	Cam 2–	Cam 1+	Cam 1–

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12.23 Actual-value system for workpiece

12.23.1 Corresponding data

- SD 5001 bit 0 (Actual-value system for workpiece)
- NC MD 5153 bit1 (Reset position 6th G group)
- NC MD 140* (Basic setting 6th G group)
- NC MD 142* (Basic setting of tool offset block)
- NC MD 548*, 550*, 552* (Address name)

The "Actual-value system for workpiece" function is a grinding function; it can, however, also be used for other technologies.

General

The function is parameterized via setting and machine data. When the function is active, the zero offsets (ZOs) selected in the program and the tool offset block (TO) are retained even after program end (M02/M30) or in the reset state. The variable basic setting of the ZOs (G54 - G57) and the active TO (D number 1 - D819) after M02/M30 is meaningful only in an actual-value system for workpieces.

12.23.2 Reference systems

It is possible to select between a machine-related and a workpiece-related actual-value display for grinding processes.

In the machine-related actual-value system, no account is taken of any ZOs or TOs in the display of axis actual values. The displayed position values refer to the machine reference point or to the control zero (see diagram, M corresponds to the machine reference point).

In contrast, when a ZO (G53 - G59) or TO (D0 - D819) is selected in a workpiece-related actual-value system (designated as W1 or W2 in the diagram), the display immediately takes account of offset and compensation values. With an active ZO (G54), the display for X and Y changes from X = 500 to 250 (Pxw1) and Y = 100 to 250 (Pyw1).

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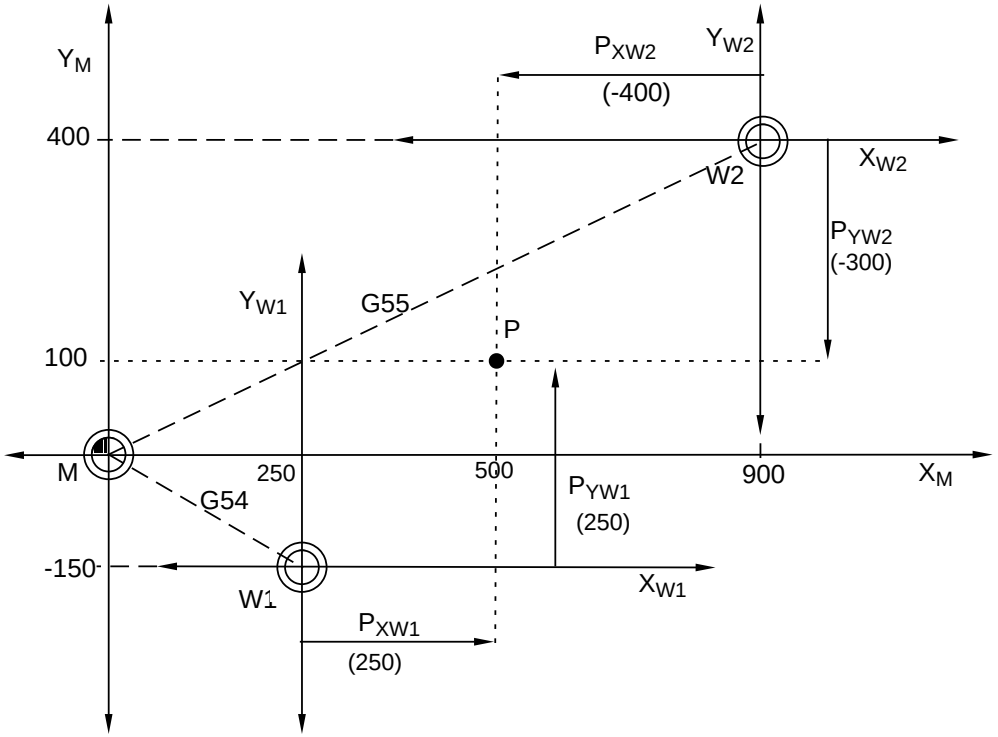

M - Machine reference point (coordinates: X_M and Y_M)

W1 - Workpiece reference point (coordinates: X_{W1} and Y_{W1})

W2 - Workpiece reference point (coordinates: X_{W2} and Y_{W2})

Diagram showing reference systems

12.23.3 Functional description

The "Actual-value system for workpiece" function can be parameterized via setting and machine data. The function is activated with SD 5001 bit 0 = 1.

The actual-value system for workpiece function has the following features:

- The basic setting of the valid ZOs (G54 - G57) and TOs (D0 - 819) after power on are defined in MD 140* and 142* on a channel-specific basis.
- After NC start, MD 110*, 112* and D0 are selected as standard. If MD 5153.1 = 1, then the last selected ZO group, TO and level remain active even after NC start.
- The actual values for all axes of the active channel are displayed according to the sum of all ZOs and the active TO.
- In this case, the reference system-based display of axis positions is implemented such that the actual values of all axes are displayed independently of any programmed axis motion after the ZO or TO has been changed. This also applies to the "Workpiece-related reading of actual values" function (@ 360).

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- At the end of a program (or after reset), the last active ZO group (G54 - G57) and TO (D0 - D819) are retained. The actual-value display is merely adjusted by the programmable offsets (G58 and G59).
- When the function is deactivated (SD 5001, bit 0 = 0), all actual values displays are updated according to actual-value representation for the machine.

12.23.4 Example of function

For reasons of simplicity, this example refers only to two axes of the 1st channel. In the example, the X axis is the abscissa and the Y axis the ordinate (see MD 1100, 5480, 5500 and 5520).

Default settings:

```
SD      5001.0 =  1      ; "Actual-value display for workpiece" function active
NC MD   5153.1 =  0      ; After NC start, reset position ZO from MD 1120 = G54 and TO
                           = D0 active.
NC MD   1100   =  17     ; Plane G17 (X abscissa and Y ordinate) has been selected in the
                           1st channel to define the reference for tool offsets during
                           machining.
NC MD   5480   =  0000   ; (address name X abscissa)
NC MD   5500   =  0001   ; (address name Y ordinate)
NC MD   5520   =  0010   ; (address name Z co-ordinate), the plane names of the co-ordinate
                           system are assigned to the axes listed above in the 1st channel.
```

Zero offset	G54 (coarse)	G54 (fine)	G55 (coarse)	G55 (fine)	G56 (coarse)	G56 (fine)
X axis	-54.0	0	-0.55	-55.0	0	0
Y axis	-54.0	0	-0.55	-55.0	0	0

Table: ZO data referring to example

Active TO = D3 (type = 1, a tool with 2 length compensations and tool nose radius compensation)

L1 Geometry	P2=-90	L2 Geometry	P3=-180
L1 Wear	P5=-9	L2 Wear	P6=-18
L1 Basis	P8=-1	L2 Basis	P8=-2

Note regarding tool compensation:

L1 always refers to the ordinate and L2 to the abscissa of the co-ordinate system. The assignment between the TO and the axes can be changed in the NC program by means of plane selection.

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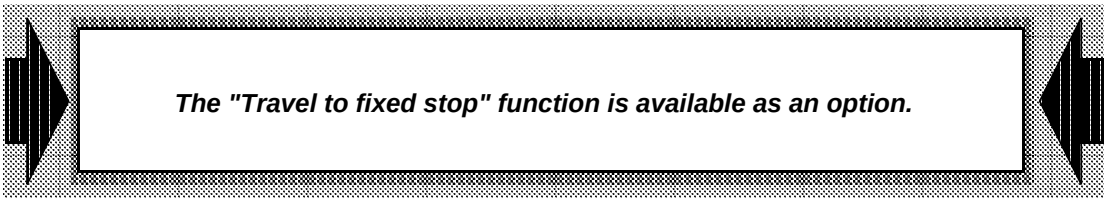
12.24 Travel to fixed stop



12.24.1 Corresponding data

- NC MD 1804* bit 3 Clamping tolerance monitoring active
  bit 4 Sensor signal PLC for travel to fixed stop
  bit 5 Axis can travel to fixed stop
- NC MD 1284* Clamping tolerance for travel to fixed stop
- NC MD 1280* Following error excess value threshold for travel to fixed stop
- NC MD 1144* Switchover current setpoint
- SD 320* Clamping torque for travel to fixed stop
- Travel to fixed stop option
- DB 32 DL x+2 bit 0 Acknowledgement for travel to fixed stop signal
- DB32 DL x+2 bit 1 Acknowledgement for travel to fixed stop reached signal
- DB 32 DL x+2 bit 2 Sensor signal for travel to fixed stop reached signal
- DB 32 DR x bit 6 Travel to fixed stop active
- DB 32 DR x bit 7 Fixed stop reached

Note:

The axis position can be monitored in the "Fixed stop reached" state by means of NC MD 1804* bit 3 "Clamping tolerance monitoring active" and NC MD 1284* "Clamping tolerance".

12.24.2 Functional description

The "Travel to fixed stop" function allows defined forces to be generated for the purpose of clamping workpieces, tools, etc. The function can be used for both axes and spindles.

It can be selected and deselected via G commands G221/G220 or the command channel.

The fixed stop must be situated between the start and target positions of the axis/spindle when the function is selected or deselected.

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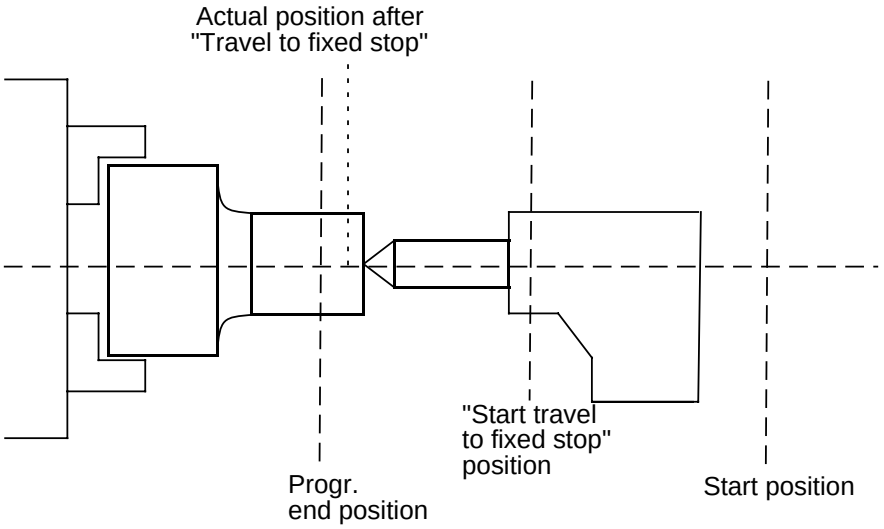
The operating principle is explained below on the basis of an example (showing sleeve being pressed onto workpiece).



Selection

The axis traverses at the programmed velocity towards to the programmed position, commencing at the start position. The axis behaves like a normal NC axis during this process.

The current limitation on the actuator is now activated.

As soon as the axis presses against the mechanical fixed stop (workpiece), the control on the drive will attempt to increase the torque by raising the current setpoint. This, however, has already been limited to a specific value beforehand (NC MD 1144*, Switchover current setpoint).

The "Fixed stop reached" state can be detected by two different methods, depending on the setting in NC MD 1804*.3 "Sensor signal PLC for travel to fixed stop".

NC MD 1804*.3 = 1	External sensor sends "Fixed stop reached" signal to NC via the PLC.
NC MD 1804*.3 = 0	The "Fixed stop reached" state is established when the following error has exceeded the value set in NC MD 1280* "Following error threshold for travel to fixed stop".

Once the "Fixed stop reached" state has been detected by the NC, the distance to go is deleted and the axis switched to follow-up mode.

If the programmed end position is reached before the "Fixed stop reached" state is detected, the alarm "Fixed stop not reached" is output.

The NC performs a block change, but leaves a setpoint applied to the drive actuator so that the clamping torque is effective.

The clamping torque can be changed while "Fixed stop" is active via programming G222 axis > P... or through a direct input in the SE data display "Travel to fixed stop".

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Deselection

The NC detects that the function has been deselected through the programming of G220. In this case, the interface signals "Travel to fixed stop active" and "Fixed stop reached" are reset.

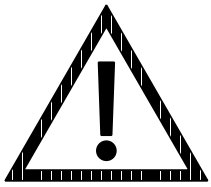
The axis switches to position control.

If a traversing motion is programmed in the deselection block, it must be noted that the end position of the axis deviates slightly from the programmed position. The setpoint and actual positions can be made to coincide through renewed programming of the axis.

Notes:

As soon the "Travel to fixed stop" function has been activated for an axis/spindle, the axis/spindle can not be included in any interpolation grouping (2D/3D interpolation, ELG, synchronous spindle, etc.) until the function has been deselected again.

Spindles must be switched to C-axis mode before the function is selected; they are treated in the same way as rotary axes by the NC.



CAUTION

The "Travel to fixed stop" function remains active even after RESET. It is not deactivated on the drive side until an EMERGENCY STOP command is issued. It must be ensured the no dangerous machine situations can occur after the function has been deactivated by EMERGENCY STOP.

12.24.3 Travel to fixed stop with analog drives

The following drive actuators can be used in conjunction with the "Travel to fixed stop" function:

- SIMODRIVE 611A feed drives for axes. No particular hardware or software versions of this system are required in this case.
- SIMODRIVE 611A MSD or SIMODRIVE 660 for spindles. Please note: It must be possible to deactivate the actuator alarm F11 (Speed controller at limit) in these actuators.

12.24.4 Travel to fixed stop with fixed clamping torque (torque limitation via terminal 96)

This function can be implemented for

- axes in combination with the SIMODRIVE 611A drive actuator and for
- spindles with actuators of type SIMODRIVE 611A MSD or SIMODRIVE 660.

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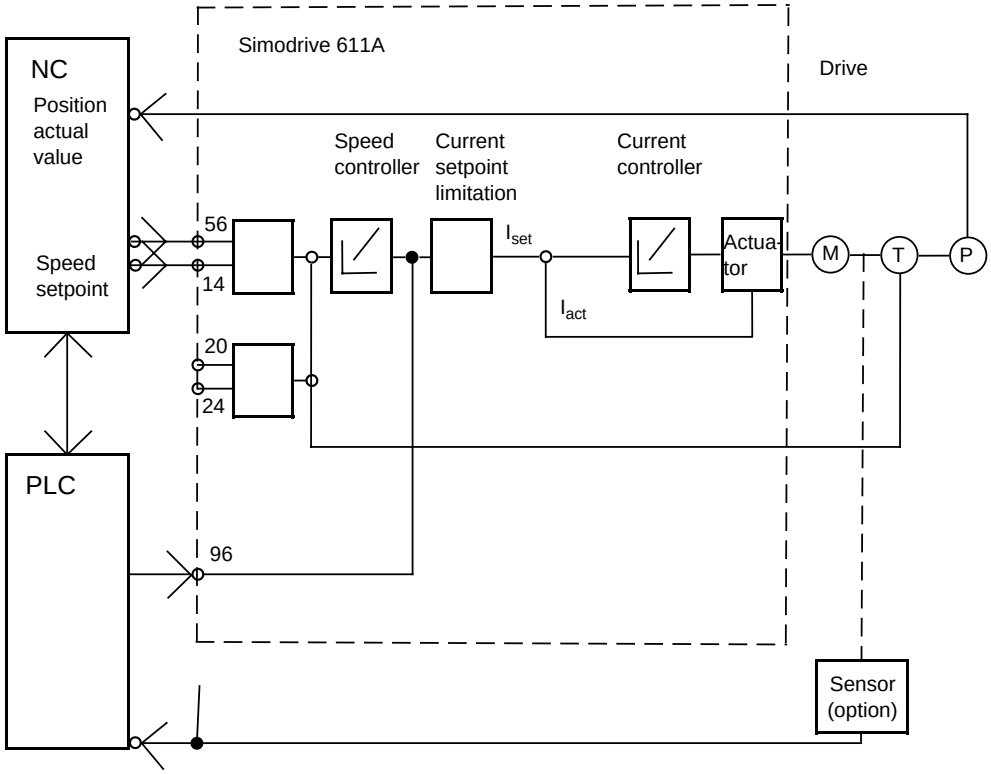
12.24.4.1 SIMODRIVE 611A

In this system, a fixed current limitation is specified via a resistor circuit (or via R12) in the drive actuator. This current limit is then addressed by the control via a PLC output (which acts on terminal 96 of the actuator) as soon as the function is activated. It can thus be ensured that a fixed clamping torque is available at the axis.

Setpoints can be input via terminals 56/14 or 24/20.

Hardware connections:



Functional sequence with analog drives

The NC detects selection of function G221 (via G function or command channel) during block processing and informs the PLC that the function has been selected via the interface signal TRAVEL TO FIXED STOP ACTIVE.

The PLC must then activate the current limitation in the actuator (terminal 96) and transmit an edge signal ACKNOWLEDGEMENT TRAVEL TO FIXED STOP ACTIVE to the NC.

The axis then approaches the target position at the programmed velocity.

As soon as the axis reaches the fixed stop, the following error increases. As a result of the increase in the following error above the threshold set in NC MD 1280* or owing to the input signal of a sensor (which is passed on to the PLC-NC interface), the control detects that the fixed stop has been reached.

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The NC setpoint interface then outputs a voltage value according to the setting in NC MD 1144* Switchover current setpoint; however, the current limitation in the actuator becomes operative as a result of the activation of terminal 96.
The NC outputs the interface signal FIXED STOP REACHED to the PLC.

The NC consequently deletes the remaining distance to go and switches the axis to follow-up mode.

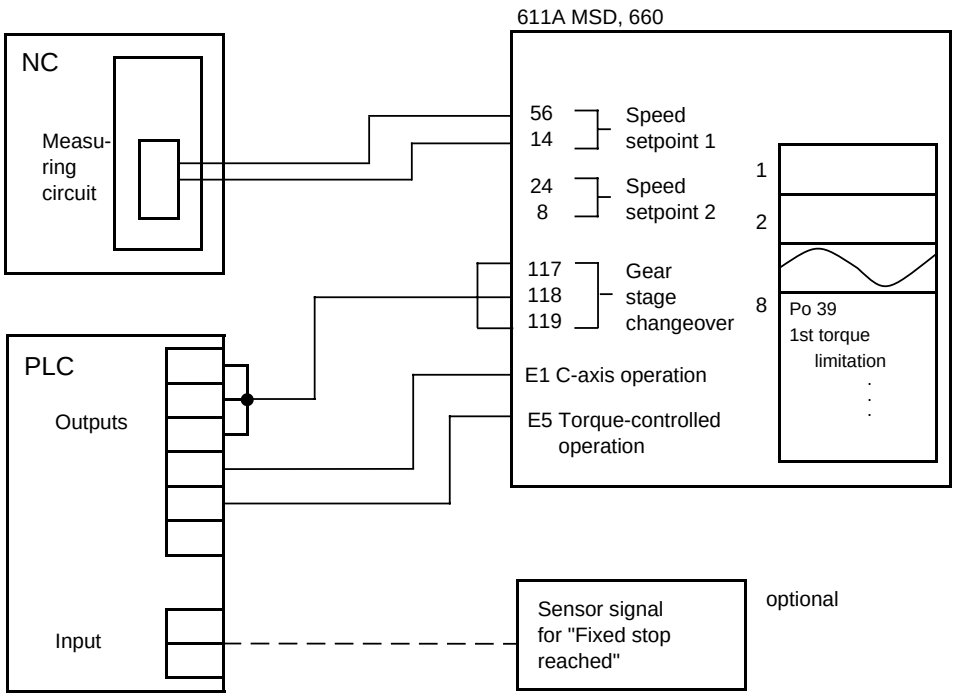
The PLC sends an edge signal ACKNOWLEDGEMENT FIXED STOP REACHED to the NC.

A block change is then performed. The current setpoint, and thus also the clamping torque, remain applied.

12.24.4.2 SIMODRIVE 611A MSD or SIMODRIVE 660

With these systems, a torque limitation is entered in a free gear stage in the actuator. When the function is selected, the PLC activates the free gear stage, thus making the torque limitation operative. Setpoints must be input via terminals 56/14.

Hardware connections:



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Functional sequence

The control must switch the spindle to C-axis operation before the function is selected. It does this by activating terminal E1 (C-axis operation) of the drive actuator.

The NC detects selection of function G221 (via G function or command channel) during block processing and informs the PLC that the function has been selected via the interface signal TRAVEL TO FIXED STOP ACTIVE.

The PLC then activates the free gear stage, in which the torque limitation is operative, via terminals 117, 118 and 119 and outputs the interface signal ACKNOWLEDGEMENT TRAVEL TO FIXED STOP ACTIVE to the NC.

The rotary axis then starts to traverse at the programmed velocity.

As soon as the C axis has reached the fixed stop, the following error increases. As a result of the increase in the following error above the threshold set in NC MD 1280* or owing to the input signal of a sensor (which is passed on to the PLC-NC interface), the control detects that the fixed stop has been reached.

The NC setpoint interface then begins to output the current setpoint (NC MD 1144*).

The NC outputs the interface signal FIXED STOP REACHED to the PLC.

The PLC then activates terminal E5 of the actuator, thus effecting a switchover from speed-controlled to torque-controlled operation. After a time period of > 80 ms, the PLC switches off the torque limitation (by selecting the preceding gear stage).

In addition, the PLC also sends an edge signal ACKNOWLEDGEMENT FIXED STOP REACHED to the NC.

The NC subsequently deletes the remaining distance to go and switches the axis to the ”travel to fixed stop active” status.

The axis setpoint output now outputs the current setpoint in accordance with the specified torque (SD 320*).

A block change is then performed. The current setpoint, and thus also the clamping torque, remain applied.

12.24.5 Travel to fixed stop with programmable clamping torque (switchover of drive actuator to current-controlled operation)

This function can be implemented for

- axes in combination with the SIMODRIVE 611A drive actuator and for
- spindles with actuators of type SIMODRIVE 611A MSD or SIMODRIVE 660.

12.24.5.1 SIMODRIVE 611A

In this case, the drive actuator is switched to current-controlled operation by the PLC as soon as the fixed stop is reached. When terminal 22 is activated, the voltage level applied to terminals 20**/**24 is no longer applied as the speed setpoint, but as the current setpoint. In this way, a variable clamping torque can be specified.

Setpoints must be input via terminals 24**/**20.

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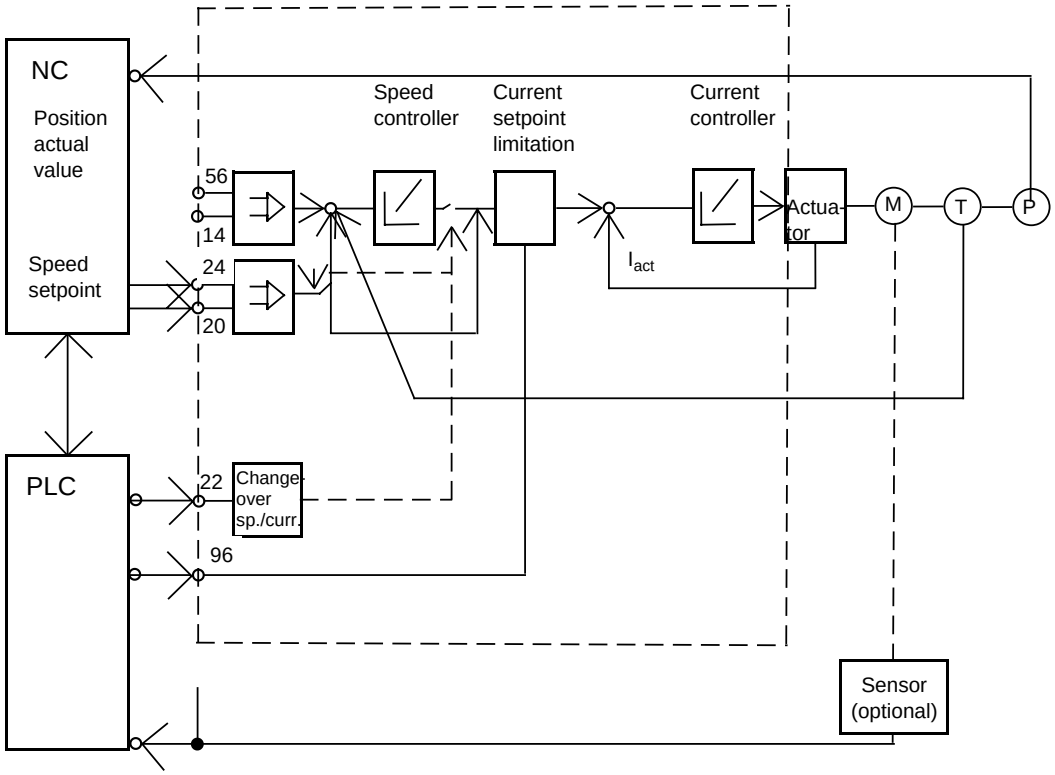
Hardware connections:



Functional sequence

The NC detects selection of function G221 (via G function or command channel) during block processing and informs the PLC that the function has been selected via the interface signal TRAVEL TO FIXED STOP ACTIVE.

The PLC must then activate the current limitation in the actuator (terminal 96) and transmit an edge signal ACKNOWLEDGEMENT TRAVEL TO FIXED STOP ACTIVE to the NC.

The axis then approaches the target position at the programmed velocity.

As soon as the axis reaches the fixed stop, the following error increases. As a result of the increase in the following error above the threshold set in NC MD 1280* or owing to the input signal of a sensor (which is passed on to the PLC-NC interface), the control detects that the fixed stop has been reached.

The NC setpoint interface then begins to output the current setpoint defined in NC MD 1144*.

The NC outputs the interface signal FIXED STOP REACHED to the PLC.

The PLC then activates terminal 22 of the actuator, thus effecting a switchover from speed-controlled to current-controlled operation. After a time period of > 10 ms, the PLC switches off the current limitation (terminal 96). In addition, the PLC also sends an edge signal ACKNOWLEDGEMENT FIXED STOP REACHED to the NC.

The NC subsequently deletes the remaining distance to go and switches the axis to follow-up mode.

The axis setpoint output now outputs the current setpoint in accordance with the specified torque (SD 320*).

A block change is then performed. The current setpoint, and thus also the clamping torque, remain applied.

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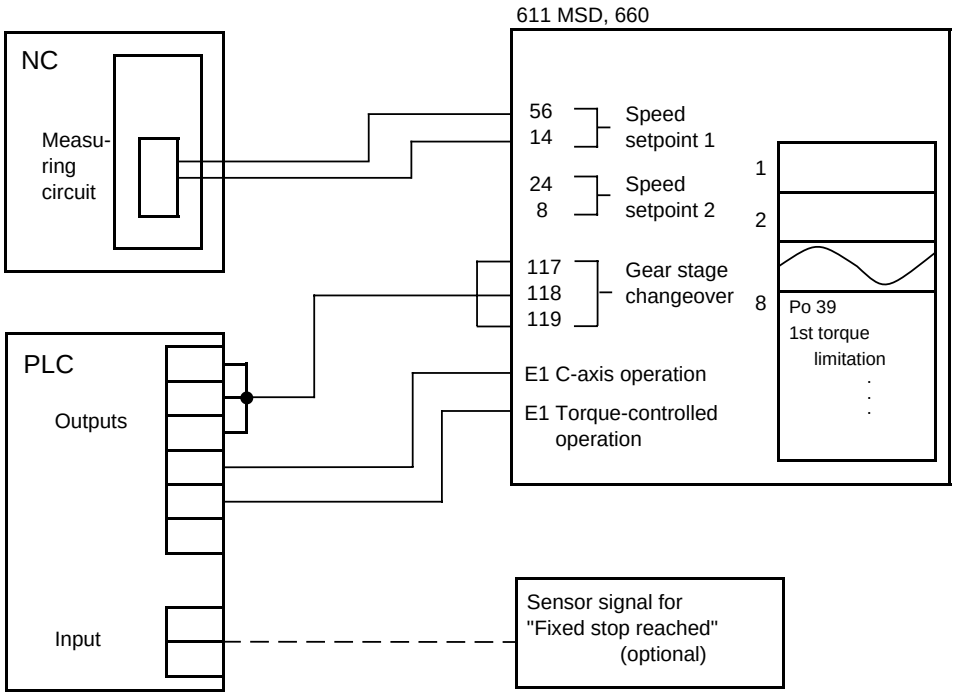
12.24.5.2 SIMODRIVE 611A MSD or SIMODRIVE 660

With these systems, the drive is switched over from torque-limited operation to torque-controlled operation after the fixed stop is reached. In this way, a torque of any desired value (0.1 to 99.9% of max. torque) can be specified via the setpoint interface.

Setpoints must be input via terminals 56/14.

Hardware connections:



Functional sequence

The control must switch the spindle to C-axis operation before the function is selected. It does this by activating terminal E1 (C-axis operation) of the drive actuator.

The NC detects selection of function G221 (via G function or command channel) during block processing and informs the PLC that the function has been selected via the interface signal TRAVEL TO FIXED STOP ACTIVE.

The PLC then activates the free gear stage, in which the torque limitation is operative, via terminals 117, 118 and 119 and outputs the interface signal ACKNOWLEDGEMENT TRAVEL TO FIXED STOP ACTIVE to the NC.

The rotary axis then starts to traverse at the programmed velocity.

As soon as the C axis has reached the fixed stop, the following error increases. As a result of the increase in the following error above the threshold set in NC MD 1280* or owing to the input signal of a sensor (which is passed on to the PLC-NC interface), the control detects that the fixed stop has been reached.

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The NC setpoint interface then begins to output the current setpoint defined in NC MD 1144*.

The NC outputs the interface signal FIXED STOP REACHED to the PLC.

The PLC then activates terminal E5 of the actuator, thus effecting a switchover from speed-controlled to torque-controlled operation. After a time period of > 80 ms, the PLC switches off the torque limitation (by selecting the preceding gear stage). In addition, the PLC also sends an edge signal ACKNOWLEDGEMENT FIXED STOP REACHED to the NC.

The NC subsequently deletes the remaining distance to go and switches the C-axis to follow-up mode.

The C-axis setpoint output now outputs the current setpoint in accordance with the specified torque (SD 320*).

A block change is then performed. The current setpoint, and thus also the clamping torque, remain applied.

12.24.6 Deselection of the function

The NC detects that the function has been deselected on the basis of G220 and inputs a "0" current setpoint, i.e. it no longer specifies a clamping torque.

It resets the interface signals TRAVEL TO FIXED STOP ACTIVE and FIXED STOP REACHED, cancels follow-up mode and the read-in enable command.

The PLC must then switch the drive to speed-controlled operation. In addition, any current limitation which may still be applied must be deactivated (terminal 96 with SIMODRIVE 611A, gear stage selection with SIMODRIVE 611A MSD or 660).

If a traversing motion is programmed in the deselection block, then the motion will be executed.

The NC issues the read-in enable command again and performs a block change.

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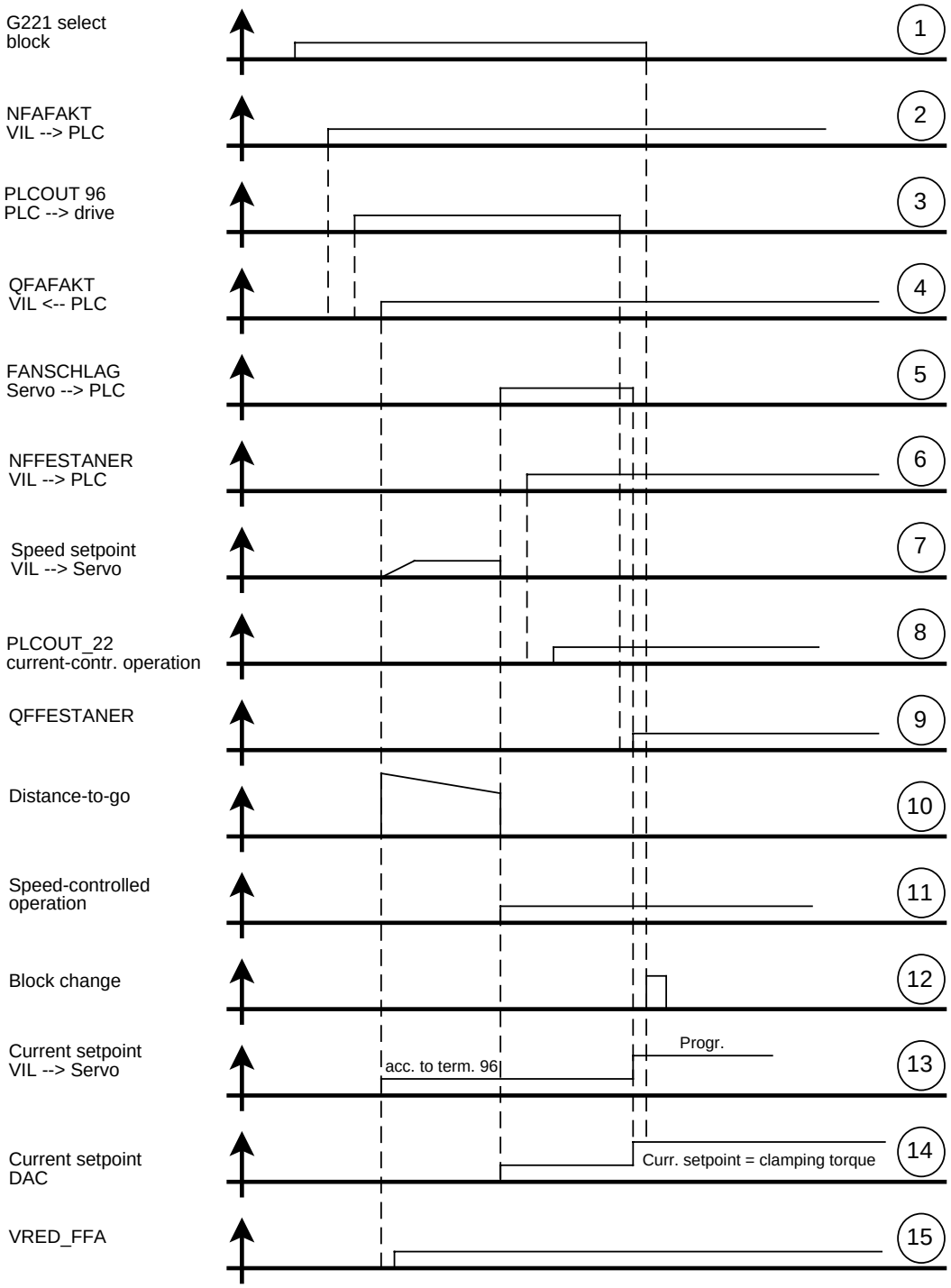
12.24.7 Diagrams for selection/deselection of travel to fixed stop

12.24.7.1 Selection of travel to fixed stop (fixed stop is reached) ANALOG

Travel to fixed stop selection (Fixed stop is reached)



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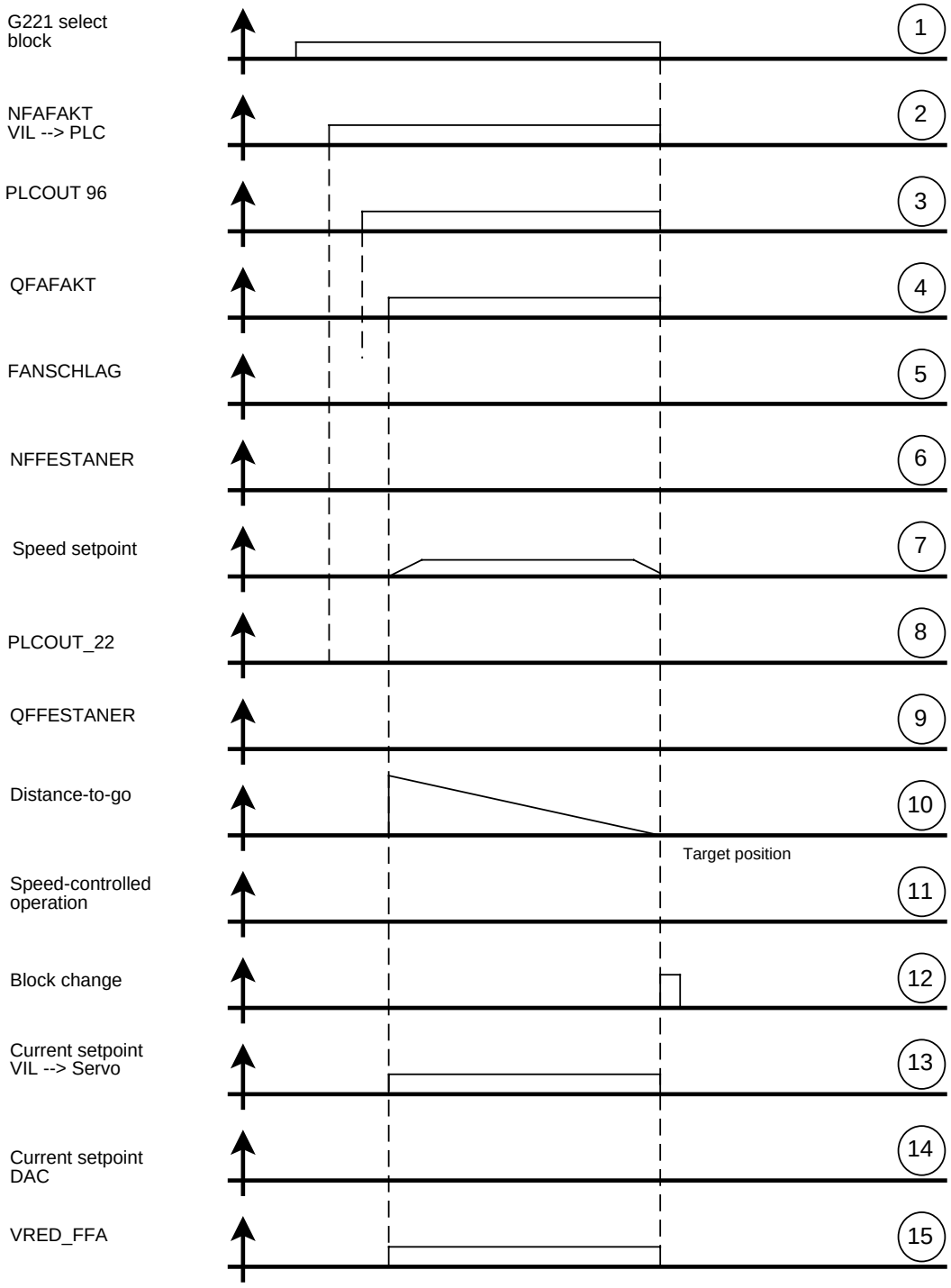
12.24.7.2 Selection of travel to fixed stop (fixed stop is not reached)

Timing of travel to fixed stop selection



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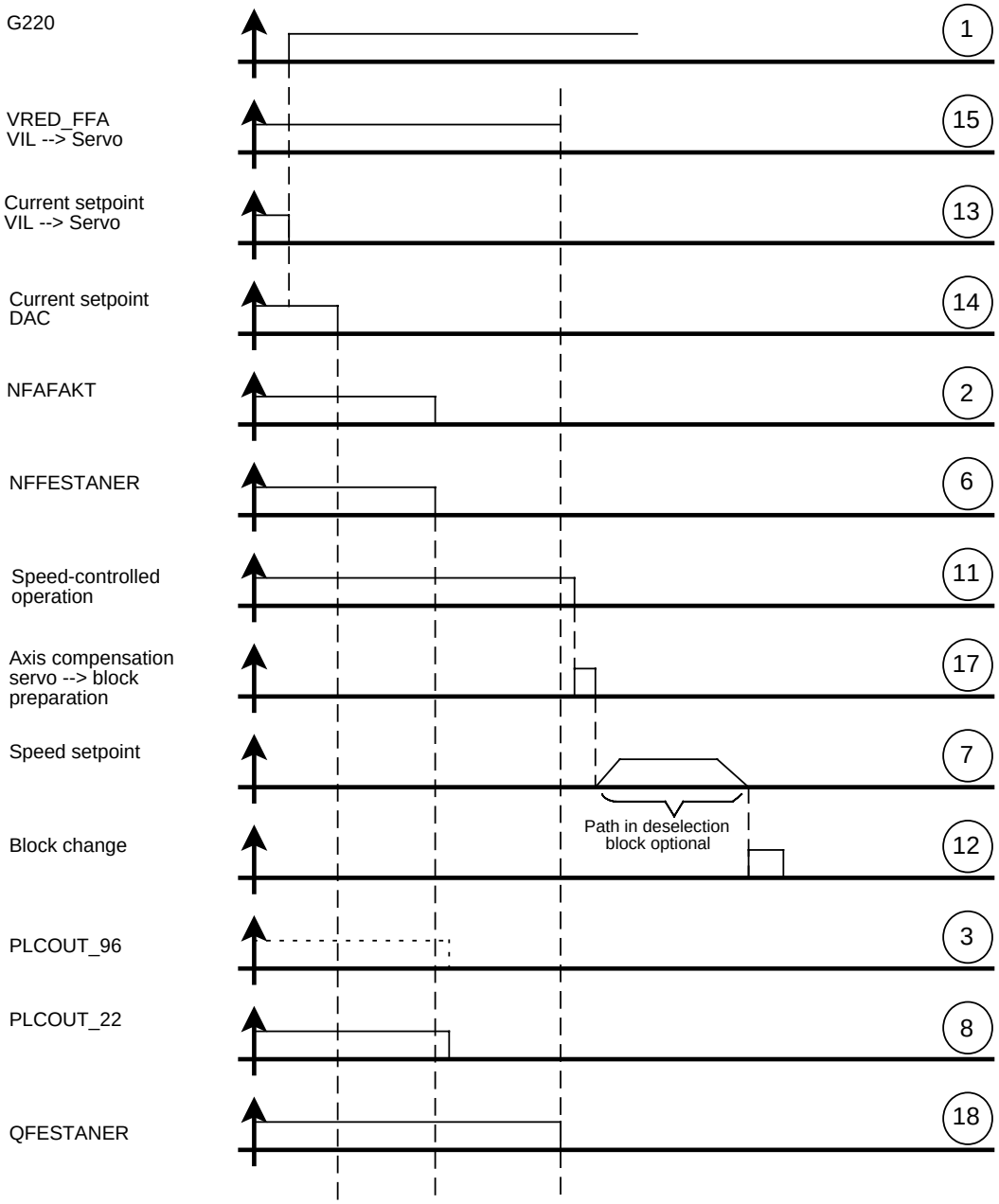
12.24.7.3 Deselection of travel to fixed stop

Timing of travel to fixed stop deselection



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12.24.7.4 Meaning of signals

1.	G220	Deselection block for travel to fixed stop
1.	G221	Selection block for travel to fixed stop
2.	NFAFAKT	Interface signal "Travel to fixed stop" active
3.	PLCOUT 96	PLC output which is connected to term. 96 (611 FD) or gear stage changeover (611 MSD, 660). The MSD have 1-3 terminals available for gear stage changeover.
4.	QFAFAKT	PLC acknowledgement for the interface signal "Travel to fixed stop active"
5.	FANSCHLAG	Servo signal to VIL: "Fixed stop reached".
6.	NFESTANER	Interface signal "Fixed stop reached
7.	Speed setpoint	
8.	PLCOUT 22	PLC output for switchover to current-controlled operation. This output is connected to term. 22 (611).
9.	QFESTANER	PLC acknowledgement for interface signal "Fixed stop reached"
10.	Distance-to-go	Initiation of deletion of distance-to-go
11.	Speed-controlled operation	Separate position control loop and switch the axis internally to follow-up mode (principle of operation as for spindle mode).
12.	Block change	A block change is initiated on termination of "Travel to fixed stop" function.
13.	Current setpoint	Current setpoint transfer between VIL and servo
14.	Current setpoint DAC	Current setpoint output via measuring circuit
15.	VRED_FFA	The "Travel to fixed stop active" signal informs the servo that "Travel to fixed stop" is active
16.	S_FANSCHLAG	Sensor signal "Fixed stop reached" from VIL: to servo

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12.24.7.5 Travel to fixed stop with digital drives (SIMODRIVE 611D MSD/FDD)

The functional sequence for digital drives is basically the same as that for analog drives.

However, digital drives do not have external terminal wiring or any resistor circuitry in the drive. The handling of PLC signals is also simpler in digital drive systems.

Functional sequence

The NC detects selection of function G221 (via G function or command channel) during block processing and informs the PLC that the function has been selected via the interface signal TRAVEL TO FIXED STOP ACTIVE. At the same time, the current limitation is activated at a value corresponding to that set in NC MD 1144* (switchover current setpoint).

The axis then approaches the target position at the programmed velocity.

As soon as the axis has reached the fixed stop, the following error increases. As a result of the increase in the following error above the threshold set in NC MD 1280* or owing to the input signal of a sensor (which is passed on to the PLC-NC interface), the control detects that the fixed stop has been reached.

The NC setpoint interface then specifies a clamping torque according to the programmed (P...) or the value set in SD 320*.

The NC outputs the interface signal FIXED STOP REACHED to the PLC.

The NC subsequently deletes the remaining distance-to-go and switches the axis to the ”travel to fixed stop active” status.

A block change is then performed. The current setpoint, and thus also the clamping torque, remain applied.

Note:

Spindles must be switched to C-axis mode before the travel to fixed stop function is selected.

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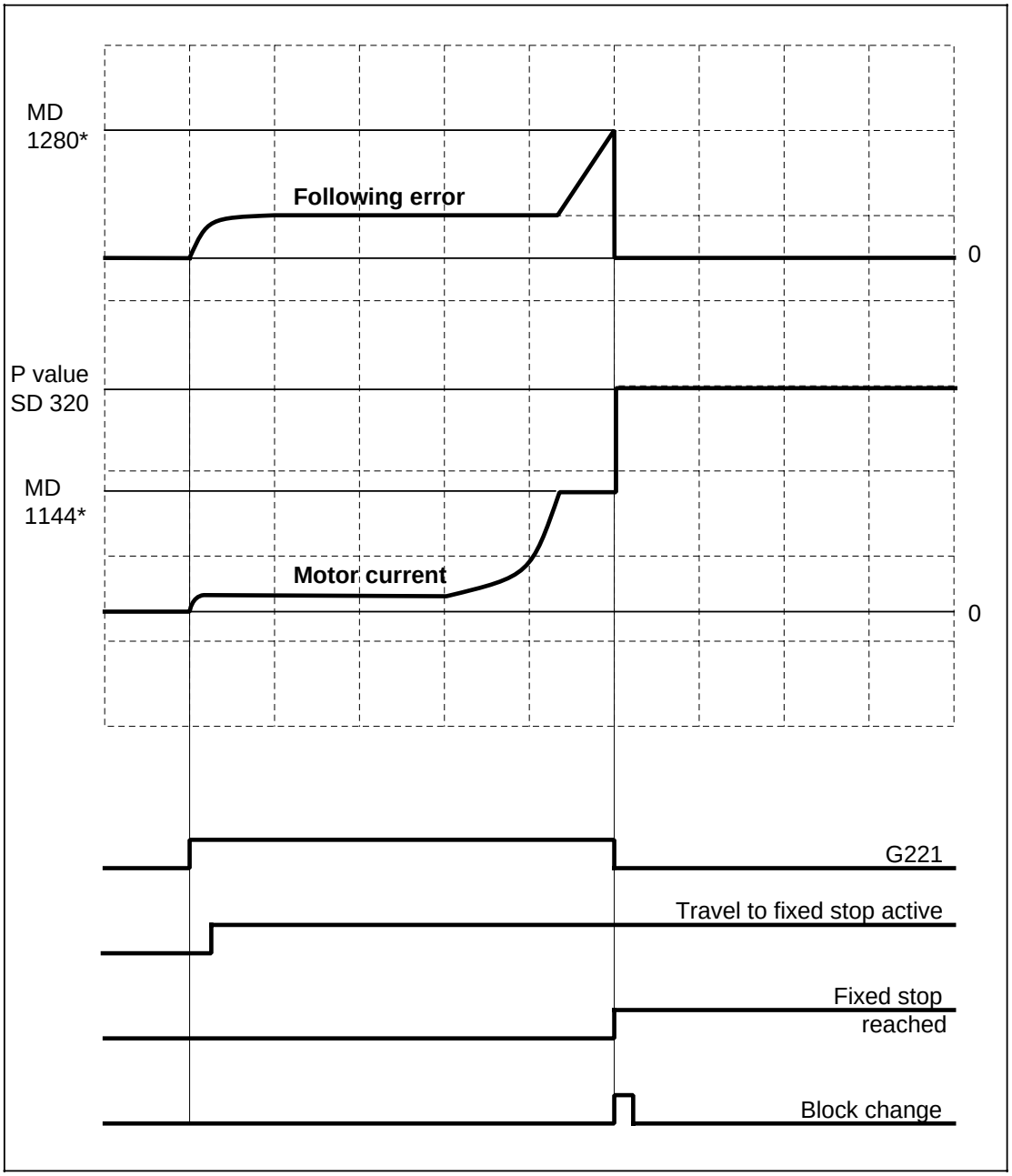
Diagram of 611D



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12.25 Flexible memory configuration (SW 4 and higher)

12.25.1 Corresponding data

Machine data

- NC MD 60000 Size of UMS memory
- NC MD 60001 Size of part program memory
- NC MD 60002 Number of IKA points
- NC MD 60003 Memory for drive software for MSD
- NC MD 60004 Memory for drive software for FDD
- NC MD 60005 Number of tools
- NC MD 60006 Number of TO parameters per tool
- NC MD 60007 Number of channel-specific R parameters
- NC MD 60008 Number of central R parameters
- NC MD 60009 Unassigned residual memory, D-RAM
- NC MD 60010 Unassigned residual memory, S-RAM
- NC MD 60011 NC module memory configuration
- NC MD 6100* Number of block buffers in block memory in channels 1 to 6
- NC MD 6200* Number of axis-specific measured values for the "Extended measurement" function
- NC MD 60013 Memory for real axes (as from SW 5)
- NC MD 61020 Memory for ”Extended overstore” (as from SW 5) to 61025

General

The "**Flexible memory configuration**" function allows the user to influence the memory page allocation for:

- **User data**
  - Part program data
  - UMS data
  - IKA data
  - R parameters
  - TO data
  - Data for real axes
  - Data for extended overstore
- **Drive software**

  In the case of analog drive systems, the memory space reserved for digital drive software can be used to store user data.
- **Number of axis-specific measured values:**

  For the "Extended measurement" function.
- **Number of block buffers in block memory:**

  Depending on the capacity utilization of individual channels, it is possible to define on a channel-specific basis the maximum permissible number of part program blocks which may be pre-decoded during processing.

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With the new functionality of the flexible memory configuration, the user is now in a position to configure the memory such that it is ideally suited to the field of application of his machine tool; this functionality is available for every HW variant of the NC-CPU. The following characteristics can be optionally defined:

- Part program memory > 1 MB
- UMS memory > 512 KB
- Number of IKA points > 16000
- Number of measured values (axis-specific) > 0
- Memory for real axes
- Memory for extended overstore.

Furthermore, when the customer upgrades his system by replacing the 386 NC-CPU module with a 486 SW NC-CPU module (which must feature an integrated 611D connection if he wishes to connect a digital drive), he can decide whether he needs memory space for the drive software. If he does not intend to connect a digital drive, this memory space can be utilized for user data.

The same degree of freedom applies to the number of tools and R parameters to be used, i.e. customers who require fewer tools, but use a large number of R parameters (or vice versa), can determine the amount of memory space required for these data to suit his particular application.

When NC machine tools are used, one or two channels are often used as machining channels while the remaining channels are used "only" for auxiliary functions. By increasing the number of block buffers in the block memory in the machining channels, it is possible to make these channels "faster", i.e. it is possible to set the number of part program blocks which can be pre-decoded during processing of a long traversing block. These pre-decoded blocks can then be inserted in the processing sequence in the IPO cycle if required.

12.25.2 System features, boundary conditions

Compatibility

1024 KB = 1 MB (NC module with 4 MB memory) or 3072 KB = 3 MB (with 8 MB memory configuration) are available for the data of the UMS, IKA, part programs and drive and for the measured-value data. In addition to this storage, approximately 40 KB of memory are available for the block buffers which are stored on a channel-specific basis, i.e. an additional 240 KB memory capacity. Approximately **1/5 MB** of memory is available for configuration purposes. The drive software for digital drives occupies a total of 388 KB (194 KB for MSD and 194 KB for FDD).

Users with a SINUMERIK 840C and SW version 1-3 who utilize the maximum data quantities for the UMS, part program and IKA data and thus require a total of 1.75 MB (1 MB part program data , 512 KB UMS data and 256 KB IKA data), must take into account that the memory capacity is restricted to 1 MB in the case of NC modules with 4 MB storage.

When the software is upgraded from SW version 4 to the next higher version, it may be impossible to transfer the "old" **NCMEMCFG** data. If, for example, the size of a block buffer has increased and the total memory capacity available with the old SW version has been used up, then the memory space available would no longer be sufficient. In this case, the only possible solution is to reduce the user data area (e.g. decrease part program memory).

MD 13 (= number of TO parameters) has the same meaning as MD 60006. To ensure that these MDs remain consistent, the contents of MD 60006 is copied over into MD 13 of the NCK during control power-up. In this way, it can be ensured, for example, that cycles which may evaluate MD 13 are processed correctly.

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12.25.3 Functional description

Assignment of data to memory areas

The data are stored partly in the static RAM and partly in the dynamic RAM. Now that the "**Flexible memory configuration**" function has been introduced, the assignment of data to SRAM/DRAM memory space is as follows:

Data type	Memory area
• UMS data • Part programs • IKA data • Measured value data • Drive SW • Block buffers • Real axes • Extended overstore	DRAM with approx. 1**/**5 MB
• R parameters • TO data	SRAM with 64 KB

12.25.4 Memory configuration on control power-up

The memory is configured when:

- Control is switched off
- Forced booting of NCK
- Selection of "**Reconfig. memory**" SK in MDD!

The memory configuration data are stored in a similar way, for example, to the ASM file, on the disk in the Siemens or user branch in directory NC**/**data in the TEA1 file **NCMEMCFG**. The data are stored in punch tape format in the same way as, for example, the standard MDs.

N60000 = 64*)
N60001 = 176*)
N60002 = 4000
N60003 = 0
N60004 = 0
N60005 = 819
N60006 = 10
N60007 = 700
N60008 = 600
N60009 = 0
N60010 = 0
N60011 = 0
N60013 = 15

N61000 = 23
N61001 = 23
N61002 = 23
N61003 = 23
N61004 = 23
N61005 = 23
N61020 = 1
N61021 = 1
N61022 = 0
to61025

N62000 = 0
N62001 = 0
N62002 = 0
N62003 = 0
:
:
:
N62028 = 0
N62029 = 0

The default setting of MD 60009 to 60011 is zero because it is not possible to make allowance for the memory configuration of the various NC modules in this case.

The Siemens values for the memory configuration allow for the size of the Siemens ASM file and define a standard memory configuration which is based on the NC module with 4MB storage capacity and assumes that no digital drives are connected:

---

*) *MD 60000 and 60001 are weighted by the factor 4 KB (= 4096). Internal values of 64 and 176 therefore correspond to 256 KB and 704 KB respectively.*

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DRAM:

704 KB		for part program memory
64 KB		for IKA data (corresponds to 4000 IKA points)
256 KB		for UMS
approx. 40 KB		for block buffers for one channel (corresponds to 23 block buffers per channel)
0 KB		for buffering of measured values (new "**Extended measurement**" function)
approx.100 KB		for extended overstore in 2 channels
0 KB		for drive SW (MSD)
0 KB		for drive SW (FDD)
0 KB		for additional real axes
1364 KB	**=**	**Total memory requirements**

SRAM:

19 KB		for R parameters (corresponds to 700 channel-spec. and 600 central R parameters)
32 KB		for TO data (corresponds to 819 tools with 10 parameters)
51 KB	**=**	**Total memory requirements**

The values entered in the Siemens **NCMEMCFG** file guarantee that the control starts during the initial start-up phase and can be operated.

If a 386 NC-CPU module is replaced by a 486 SX NC-CPU module, it is advisable to use the same memory configuration in the new module.

The initial start-up procedure is as follows:

The rotary switch on the CSB module is set to start-up position and the control switched on. The control reaches cyclic operation within the start-up mode. The data contained in file **NCMEMCFG** are transferred to the NC-MD during power-up.

The currently valid memory configuration can now be examined in an MDD display. This display is selected by means of softkeys **Data area/Start-up/Machine data/NC-MD/ETC key/Memory configuration**. The user data can be displayed in the appropriate memory areas by means of softkeys **DRAM data** or **SRAM data**. "Online" data can be read, but not written. If an attempt is made to change online data, the message "**No input authorization**" is output.

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The user can now configure the NC memory according to his requirements by following the procedure described below:

Select softkey "**File functions**" to call display 1:

Machine	Parameter	Program.		Services	Diagnosis	
						04:45
Start-up/Machine data/Standard data						
Name		Type				
<online>		TEA1				
NCMEMCFG		TEA1				
Start-up/Machine data/Standard data						
Name		Type	Length		Date	
Edit	Preset					

Fig. 1

Select softkey "**Preset**" to copy file **NCMEMCFG** over into the user data area (file name remains unchanged!).

By selecting softkey "**Edit**", you can now call the **NCMEMCFG** file in the user area in order to edit it and to change the configuration values according to your requirements**. Changes may only be made in General reset mode**. By selecting the edit function, you call displays 2, 3 and 4.

The MDD performs a plausibility check on the entered data. If a value which is lower/higher than the minimum/maximum permissible limit is entered, the error message "**Values only from ... to ...**" is output.

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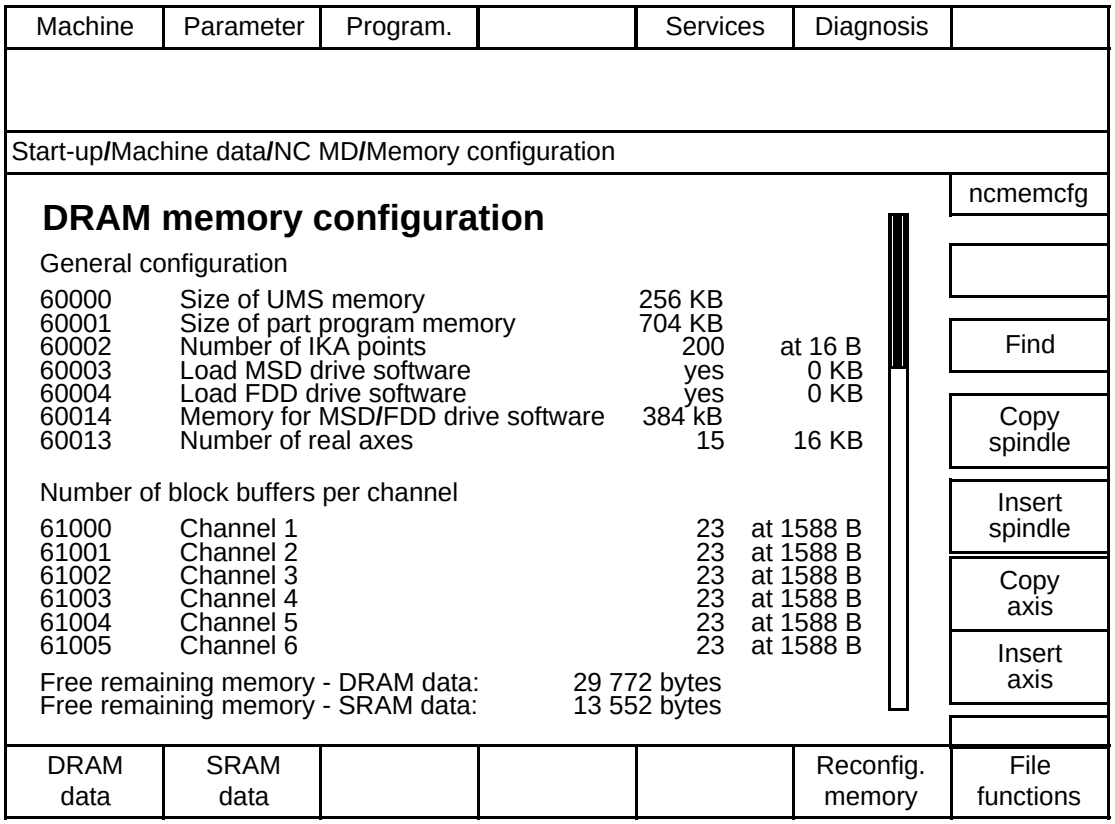

Fig. 2

To ensure that this plausibility check works, the MDD fetches various information such as

- memory requirements for one block buffer (may vary depending on SW version installed)
- size of configurable DRAM memory, etc.

from the NC when display 2 is selected.

This information is required in order to calculate the free remaining memory and to monitor the values entered in displays 2, 3 and 4.

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Machine	Parameter	Program.		Services	Diagnosis	

Start-up/machine data/NC MD/memory configuration

ncmemcfg

DRAM memory configuration

Number of meas. value buffers

62000	Axis 1	0	at 4 B
62001	Axis 2	0	at 4 B
62002	Axis 3	0	at 4 B
62003	Axis 4	0	at 4 B
⋮	⋮	⋮	
62028	Axis 29	0	at 4 B
62029	Axis 30	0	at 4 B

Free remaining memory - DRAM data: 0 bytes
Free remaining memory - SRAM data:

Find

DRAM data	SRAM data				Reconfig. memory	File functions

Fig. 3

Machine	Parameter	Program.		Services	Diagnosis	

Start-up/machine data/NC MD/memory configuration

ncmemcfg

SRAM memory configuration

General data II

60005	Number of tools	819	at 4 B
60006	Number of parameters per tool	10	at 4 B
60007	No. of chan.-specific R parameters	700	at 4 B
60008	Number central R parameters	600	at 4 B

Free remaining memory - DRAM data: 29 772 bytes
Free remaining memory - SRAM data: 13 552 bytes

Note:

Changes of the SRAM memory configuration require execution of "Format user data"!

Find

DRAM data	SRAM data				Reconfig. memory	File functions

Fig. 4

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The set configuration is activated through selection of softkey "**Reconfig. memory**". The activation command is rejected if

- the NC is not in general reset mode. In this case, the dialog box "**Only possible in reset**" appears which is acknowledged with "**ok**". The user can switch to general reset mode and select softkey "**Reconfig. memory**" again (the set data are not lost when the user switches to general reset mode).
- the set configuration would require more memory than is actually available. The dialog box "**Insufficient memory space**" then appears which is acknowledged with "**ok**". The user can correct his memory configuration.

The softkey "**Reconfig. memory**" initiates an NCK reset and the NCK system program and, in some cases, the customer UMS are re-booted. If it is detected that the memory required exceeds the actual memory available (in particular, when the real size of the UMS is taken into account) when the MD are checked again, then no UMS boot operation takes place and the dialog box "**UMS too large UMS not loaded**" is displayed.

The NC updates the "online" machine data 60009, 60010, and 60011 at this point in time.

If the number of R parameters or TO parameters has been changed, then "**Format user data**" must be executed in general reset mode.

If the user does not wish a UMS load operation, then he must set MD 60000 to zero. The entry "UMS 512" in the file "Master control**/**Config." has no meaning with SW version 4 and higher.

NC machine data:

MD 60009 to 60011 are not evaluated by the NC and are used only for display purposes.

The machine data in the "Start-up**/**Data" directory can be read out as usual via the computer link or V24 or read in to the control. When the user reads in the new MD, however, he must remember that these MD, which can also be examined online with the aid of MDD, need not necessarily have anything to do with the actual memory configuration. **The memory configuration is determined solely by the file NCMEMCFG on the disk.**

The file **NCMEMCFG** can be read in and out via the V24 by means of the MMC services. By selecting the softkey sequence **Services/Data output**, the user can call the display in which all accessible directories are displayed. He can then call the **NC/DATA** directory by moving the cursor and selecting the input key. This directory contains the **NCMEMCFG** file.

Loading the drive SW up to SW 5:

The default setting of "0" for MD 60003 and 60004 means that no memory capacity is reserved for the drive SW during initial start-up after the system has been upgraded with SW 4. When digital drives are started up, however, memory space must be reserved explicitly for the drive software.

A default setting of "0" offers the following advantages when the system is upgraded:

- If a module with 386 CPU is installed, then the user does not need to change the MD mentioned above. With a default setting of "1", the user would be forced to reconfigure the memory.
- If a module with 486 CPU is installed, but no digital drives connected, then the MD mentioned above remain unchanged.

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- If a module with 486 CPU is installed and digital drives are connected, the MD mentioned above must be set to "1".

Loading the drive software as from SW 6

General notes:

Up to SW 5 the drive software (MSD and FDD) is loaded from the MMC hard disk into the NCK user memory in its entirety while the control powers up and is then transferred to the drive when the drive powers up. For this, the use must make 192 Kbytes of NCK memory available per package.

As from SW 6 this memory is not large enough for the drive software. There are two ways of loading the drive software.

1. Increase the size of the NCK user memory for MSD/FDD
Advantage: Fast loading of the drive software
Disadvantage: Larger user memory requirement

2. Retroload the drive software from the hard disk in packages
Advantage: No additional user memory requirement
Disadvantage: Longer power-up times

The available memory is set via NC-MD 60016. The drive software memory requirement can be increased from 288 Kbytes to 384 Kbytes for more recent software versions. If less memory is made available than is needed for the drive software, the missing software is retroloaded from the hard disk, thus increasing the time which the control takes to power up.

No.	Number of drive packages	Memory required	Corr. to MD 60014	Power-up time increased
1	1 (MSD or FDD)	192 K	2	yes
2	1 (MSD or FDD)	288 K	3	no
3	2 (MSD or FDD)	192 K	2	yes, considerably
4	2 (MSD or FDD)	384 K	4	yes
5	2 (MSD or FDD)	576 K	6	no

Lines 1 and 4 give settings that are compatible with 840C SW 3 and 5. They result in a (slight) increase in the power-up time without requiring more user memory.

Lines 2 and 5 show the recommended settings for 840C SW 6. Here, more user memory is required but power-up is quickest with these settings.

Line 3 shows a setting that requires less user memory than SW 3-5. However, here the power-up time of the control has increased considerably.

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Loading the UMS

Now that the "**Flexible memory configuration**" function has been introduced, the user can prevent loading of the UMS by setting NC-MD 60000 in file **NCMEMCFG** to zero.

With previous SW versions, the UMS analysis is initiated after UMS loading; this analysis function outputs alarm 91 "**ID number in UMS header incorrect**" if it detects an error in the UMS. This check function is not performed if UMS loading has been disabled (MD 60000 = 0). There are two causes of errors which may be detected in the UMS header:

- A faulty UMS has been loaded.
- The user intended to load a UMS (MD 60000 not equal to zero), but the memory reserved for this purpose is smaller than the UMS to be loaded. In such cases, no UMS loading takes place (zeros are set in the memory).

The alarm text "**ID number in UMS header incorrect**" is changed to "**UMS not valid**" so that it is applicable to both these different error causes.

Restriction relating to R parameters

Channel-specific R parameters must be assigned numbers within the range used to date [0.699] for compatibility reasons which means that there cannot be more than 700 channel-specific R parameters. However, a smaller number of these parameters can be selected. This restriction does not apply to central R parameters (number range used to date [700, 1299]). It is permissible to program more than 1299 central R parameters.

However, if the selected number of R parameters is lower than the default setting (700 channel-specific and 600 central R parameters) or if the R parameter setting is set to zero, **the Siemens standard cycles cannot be processed** (see Programming Guide).

With this increase in the number of central R parameters, these new R parameters can be used in part programs (e.g. X = R3000). If the same part program is processed on another control which has a different configuration of the R parameter memory and does not contain this R3000 parameter, processing of the part program is interrupted and the alarm "**General programming error**" output.

Block buffer

The selected number of block buffers determines the maximum number of part program blocks which can be pre-decoded during processing. This number may have a direct effect on the block change times. In the case of part programs with a large number of blocks and short axis traversing paths (and high feedrate), it is meaningful to set a large number of block buffers. In contrast, it is not meaningful to select a large number of block buffers for part programs with long axis traversing paths (and low feedrate), particularly as timing problems relating to "Refresh" occur when a large number of block buffers is programmed. Refresh of a block buffer takes approximately 2 ms with the NC module with 80386 CPU 20 MHz and the standard M configuration. The entire SSV is refreshed when single blocks are processed, i.e. when 600 block buffers are programmed, there is a 1.2 second delay before the next single block can be processed.

When a SINUMERIK 840C system or a SW upgrade is purchased, the number of channels for a specific machine tool has already been decided, i.e. this is the maximum number of channels which can be used on this machine tool. At least 21 block buffers must be reserved for each of these channels. The Siemens configuration file **NCMEMCFG** works on the assumption that all 6 channels will be activated, i.e. that 23 block buffers are assigned to each of the 6 channels. The user can set the number of block buffers for unused channels to zero and thus gain approximately 76 KB memory for each channel.

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However, the block buffer number may be set to zero only for those channels which will never be activated for the machine tool in question. It is not possible for the NC-SW to perform a check during power-up of the number of defined channels or of the number of block buffers defined in these channels by the user since a valid MD block may not be available at the time the test is carried out.

However, if an existing channel (MD 100*) is programmed as having 0 block buffers, alarm 50 "**Not enough memory for block buffer**" (as from SW 5: Error in flexible memory configuration) is output during power-up on transition to cyclic operation.

Extended overstore

As from SW5.5, the function "Extended overstore" is enabled in the "Flexible memory configuration". The file can be edited via **the MDD menu tree Startup/Machine data/NC machine data/ETC/flex. memory conf**.
The function can be switched on or off in the channel-specific toggle field "Data for extended overstore". No memory is reserved, if the function is switched over for a channel, for which no block buffers have been defined.
As a default, the function is switched on for channels 1 and 2 and switched off for channels 3 to 6.

Memory for real axes

If the user defines more than 15 axes (default value), the system reserves a memory space of approx. 16 KB per axis. The memory is enabled via the machine data "Memory for real axes" (MD 60013), which is stored in the "ncmemcfg" file. This file can be edited via the MDD menu tree **Machine data/NC machine data/ETC/flex. memory conf**. If the user has defined more real axes than memory is available, alarm 71 is displayed. The number of axes, for which memory is available, is indicated ot the SERVO on transmission of the axis-independent data.

Dialog box messages

Description of error reactions

Errors which are indicated by MMC:

- Dialog box "**Standard memory configuration error in configuration file**" is output if the NC detects that the memory cannot be configured with the values entered in the memory configuration MD.
- Dialog box "**UMS too large UMS not loaded**" is output if the user attempts to load a UMS (MD 60000 not set to zero) which is too large for the memory space available (i.e. value in MD 60000 is lower than actual UMS size).
- Dialog box "**Only possible in reset**" is output if an attempt is made to reconfigure the NC memory by means of softkey "**Reconfig. memory**" when the NC is not in general reset mode.
- Dialog box "**Insufficient memory space**" is output if softkey "**Reconfig. memory**" is selected and the free remaining memory is negative.
- Dialog text "**Values only from ... to ...**" is output in the MDD display if an attempt is made to enter a value which is not within the permissible [minimum, maximum] value range.
- Dialog text "**No input authorization**" appears in the MDD display it an attempt is made to change machine data in file **NCMEMCFG** in the Siemens branch or **online**.

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- For switched-off channels, the interactive message **"No memory available for function"** is output for the number of "Extended overstore". Selection from PLC is rejected with the **error number 144**.

12.26 BERO interface (SW 4 and higher)

BERO encoders can now be connected to the 611D and to the PCA measuring circuit. The user can select in machine data which signal is to act as the trigger for zero mark synchronization.

Axis:

MD 1820*, bit 2 "Ext. zero mark 1st MS"
MD 1820*, bit 4 "Ext. zero mark 2nd MS"

Spindle:

MD 522*, bit 0 "Ext. zero mark"

The actual value system is updated in response to the switching edge of the BERO signal. The switching edge depends on the rotation of direction of the encoder:

Position direction of rotation: Positive switching edge
Negative direction of rotation: Negative switching edge

The following have been introduced to provide switching hysteresis compensation:

MD 3096* - 3124* "Zero mark compensation positive" (axis),
MD 2416* - 2433* "Zero mark compensation positive" (spindle) and
MD 3128* - 3156* "Zero mark compensation negative" (axis),
MD 2434* - 2441* "Zero mark compensation negative" (spindle).

These MD are stored in the parameter set group "Ratios", i.e. they can be set per gear speed. They are activated only when the extended parameter set switchover function is selected.

No check is performed to ascertain whether the external hardware (BERO and cabling) required for external zero mark hardware is present or operational (e.g. open cable).

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12.27 Parameter set switchover

The Parameter set switchover function

is as option (SW 4 and higher).

The parameter set switchover function allows parameters of various NC control areas (position control, actual value detection) or of the drive to be switched over simultaneously and with minimum delay.

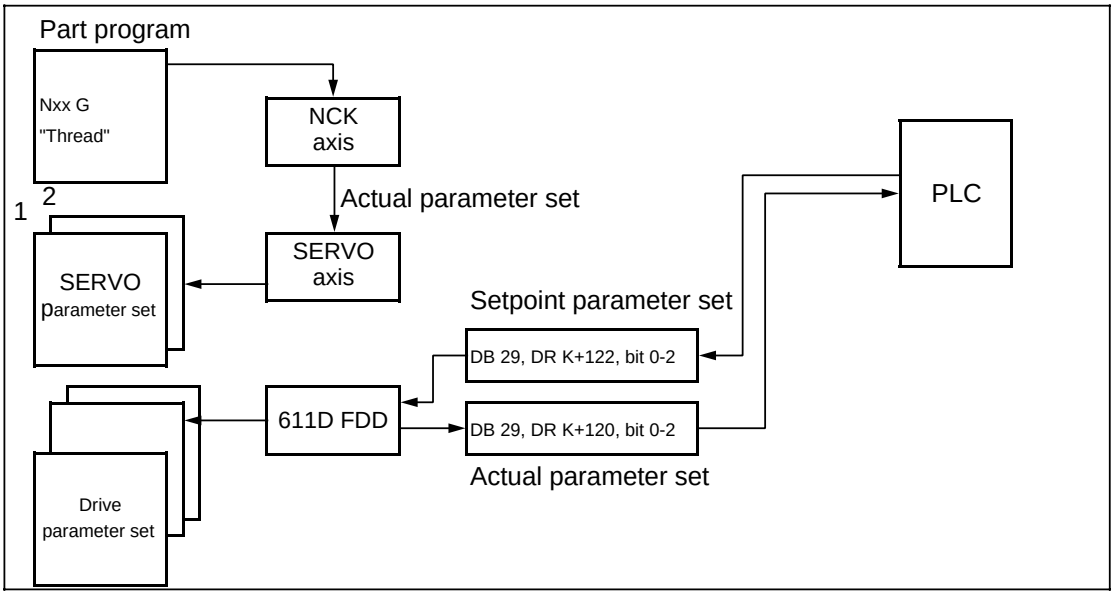
12.27.1 Parameter set switchover (up to SW 3)

Axis parameter sets (NCK/SERVO)

Two parameter sets (PaSe) are available for the position control area in feed axes.

	Axis parameter	
	1stPaSe	2ndPaSe
Parameter	MD	
Servo gain factor	252*	1320*
Feed forward control factor	312*	1260*
Time const. symm. filter	392*	1324*

The switchover is executed implicitly when G functions for thread functions (G33, G34, G35, G36, G63) are selected. There is no way in which the user can directly initiate the switchover process.



Gear stages/parameter set switchover for axes with 840 C and SW 3

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Spindle parameter sets (NCK/SERVO)

8 parameter sets have been provided to date for spindles. A mechanical gear stage is generally linked to these parameter sets, but is not a mandatory requirement.

	Gear-stage-depend. parameters					Effective in: SERVO / NCK		
	1stPaSe	2ndPaSe	3rdPaSe	4thPaSe	5thPaSe	6thPaSe	7thPaSe	8thPaSe
Parameter	MD							
Maximum speed	403*	404*	405*	406*	407*	408*	409*	410*
Minimum speed	411*	412*	413*	414*	415*	416*	417*	418*
Accel. time pos. const. w/o position controller	419*	420*	421*	422*	423*	424*	425*	426*
Creep speed	427*	428*	429*	430*	431*	432*	433*	434*
Servo gain factor	435*	436*	437*	438*	439*	440*	441*	442*
Accel. time pos. const. with position controller	478*	479*	480*	481*	482*	483*	484*	485*

(PaSe=parameter set)

The switchover is implemented by means of the "Actual gear stage" control bits in the cyclical, spindle-specific PLC interface (DB 31, DR K + 1, bits 0 - 2), i.e. the user can directly select the active parameters via the PLC program.

In addition, the user also has an automatic gear stage selection function at his disposal which works in the following way:

Speed ranges are defined by means of MD 403* - 410* and MD 411* - 418*. When a speed is programmed by means of an S value, a setpoint gear stage (SGS) is output to the PLC which is capable of evaluating it. After execution of the gear change, the setpoint gear stage can be acknowledged through setting of the actual gear stage (AGS) and cancellation of the "Change gear" signal (DB 31, DR K, bit 7).

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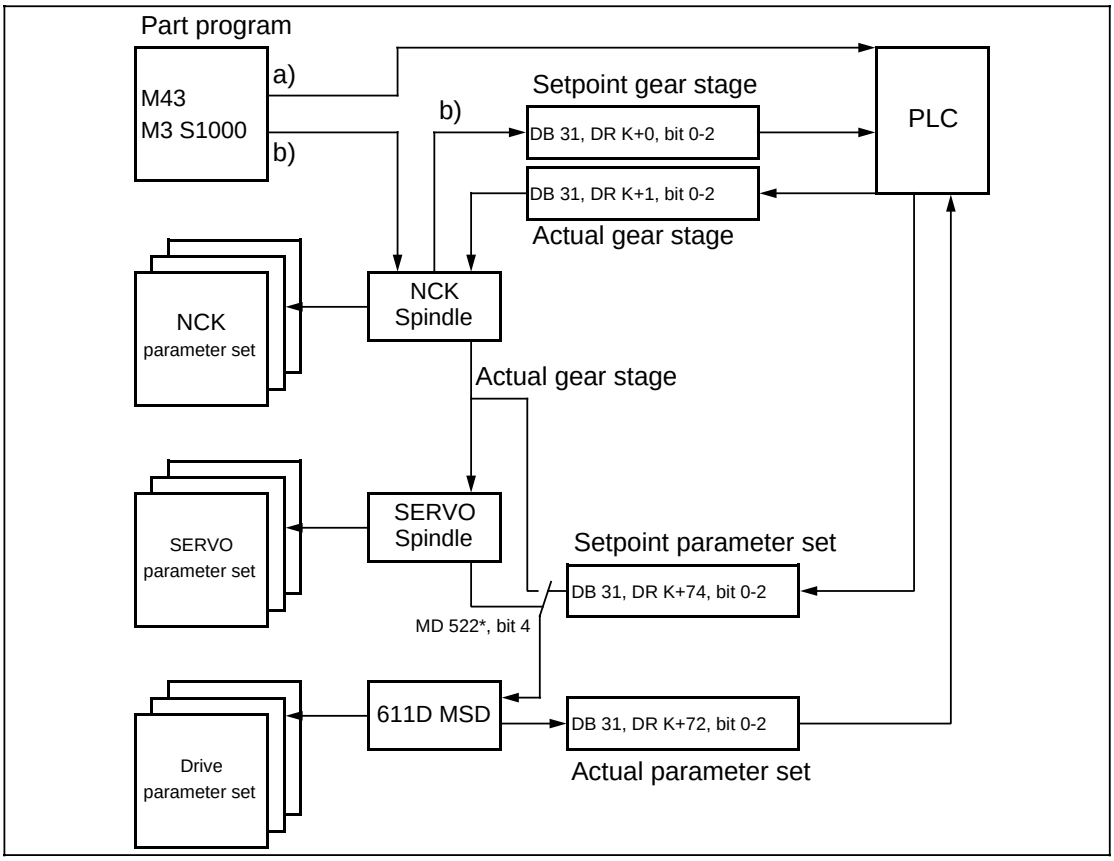

a) Spindle gear stage selection through user M function to PLC (M43 in example)

b) Gear stage selection through programming of S value (semi-automatic)

FDD parameter sets (611D)

There is no selection of parameter sets available for feed drives. The PLC control and status signals (DB 29, DW K + 122, bits 0 - 2; DB 29, DW K + 120, bits 0 - 2) have no effect, but are still transferred.

MSD parameter sets (611D)

A selection of eight parameter sets is available for a main spindle drive via the PLC control signals DB31, DW K + 74, bits 0 - 2. The active parameter set is displayed via status signals DB 31, DW K + 72, bits 0 - 2. The MSD parameter set and NCK gear stages can be linked by means of bit 4 in MD 522*. If the bit is reset, then the MSD parameter set is switched over with the NCK actual gear stage. In this case, control bits DW K + 74 have no effect.

NC MD 522 *. 4 is active only with 523 *. 0 ”Extended parameter set switchover”.

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12.27.2 Parameter set switchover with SW 4 and higher (option)

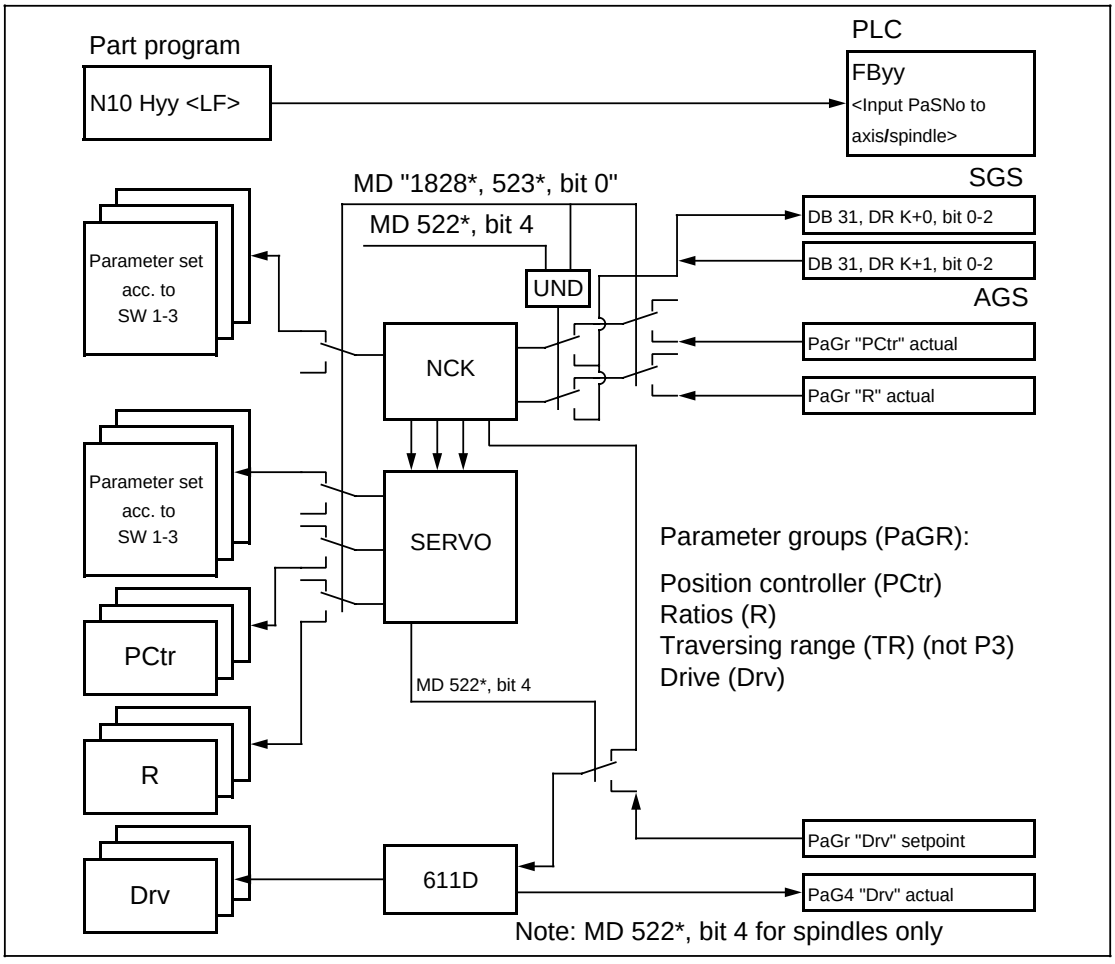
The parameters to be switched over are divided into 3 parameter groups (PaGr) in the control. The individual parameter groups are switched over independently of one another. Each parameter group contains 8 identically formatted parameter sets (PaSe). A specific parameter set within a PaGr can be selected by specifying a parameter set number (PaSNo) from the PLC.

Owing to the grouping of parameters according to type and the fact that they can be switched over independently, the system is highly flexible in terms of configuration and adaptation of the control to the mechanical features, dynamic response and geometry of the machine

The extended parameter set switchover must be enabled explicitly via MD 1828*, bit 0 (axes) or MD 523*, bit 0 (spindles).

The switchover mechanisms for axes and spindles available to date which are described above remain fully functional.

The automatisms used to date (Spindle: Switchover via S program commands; axis: Switchover through G program commands) remain operative even when the extended parameter set switchover is enabled. They are, however, converted to the new parameter groups, i.e. where previously all parameters were switched over with the gear change, a switchover request (new setpoint gear stage = new parameter set numbers) is now set for all parameter groups which contain these parameters.



Extended parameter set switchover with H function and PLC FB (SW 4 and higher)

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"Position control" parameter group

The structure of the "Position control" parameter group is identical for axes and spindles.

This parameter group contains the parameters "Servo gain (Kv) factor", "Feedforward control factor" and "Time constant symmetrizing filter" which were previously switched over for axes by means of thread functions. With software versions up to SW 3, switchover from parameter set number 1 to parameter set number 2 is implemented automatically for the thread function. This functionality is not affected by selection of the extended parameter set switchover.

The parameters in the "Position control (PCtr)" group are listed below. When the extended parameter set switchover function is selected via MD bits, all the parameters in this group can be switched over.

"Position controller" group	Axis							
	1stPaSe	2ndPaSe	3rdPaSe	4thPaSe	5thPaSe	6thPaSe	7thPaSe	8thPaSe
Parameter	MD							
Servo gain (Kv) factor	252*	1320*	1220*	1308*	1312*	1316*	1328*	1332*
Speed feedfor. contr. factor	312*	1260*	1140*	1184*	1188*	1192*	1196*	1392*
D comp. feedfor. ctrl factor	1124*	1156*	1160*	1164*	1168*	1172*	1176*	1180*
Time const. symm. filter	392*	1324*	1460*	1464*	1468*	1472*	1476*	1480*
Time const. setpoint filter	1272*	1484*	1488*	1492*	1496*	1500*	1504*	1508*
SERVO maximum speed	256*	1512*	1516*	1520*	1524*	1528*	1532*	1536*
Exact stop limit "coarse"	204*	1540*	1544*	1548*	1552*	1556*	1560*	1564*
Exact stop limit "fine"	208*	1568*	1572*	1576*	1580*	1584*	1588*	1592*
Zero speed control	212*	1596*	1600*	1604*	1608*	1612*	1616*	1620*
Electr. weight comp.	1292*	3188*	3192*	3196*	3200*	3204*	3208*	3212*
Kv factor AGR	1420*	1624*	1628*	1632*	1636*	1640*	1644*	1648*
I component AGR	1424*	1652*	1656*	1660*	1664*	1668*	1672*	1676*
D component AGR	1428*	1680*	1684*	1688*	1692*	1696*	1700*	1704*
Time const. parallel model	1432*	1708*	1712*	1716*	1720*	1724*	1728*	1732*
Time const. setp. filter K4 link branch	3300*	3304*	3308*	3312*	3316*	3320*	3324*	3328*
Synchronism "coarse"	1440*	3244*	3248*	3252*	3256*	3260*	3264*	3268*
Synchronism "fine	1436*	3216*	3220*	3224*	3228*	3232*	3236*	3240*
Alarm lim. velocity	1736*	1740*	1744*	1748*	1752*	1756*	1760*	1764*
Alarm lim. acceleration	1768*	1772*	1776*	1780*	1784*	1788*	1792*	1796*
Emerg. retract. threshold	1444*	3272*	3276*	3280*	3284*	3288*	3292*	3296*
Jerk (as from SW 6)	3332*	3336*	3340*	3344*	3348*	3352*	3356*	3360*
Acceleration (as from SW 6)	276*	3364*	3368*	3372*	3376*	3380*	3384*	3388*
Maximum velocity (as from SW 6)	280*	3392*	3396*	3400*	3404*	3408*	3412*	3416*

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"Position controller" group	Spindle							
	1stPaSe	2ndPaSe	3rdPaSe	4thPaSe	5thPaSe	6thPaSe	7thPaSe	8thPaSe
Parameter	MD							
Servo gain (Kv) factor	435*	436*	437*	438*	439*	440*	441*	442*
Speed feedfor. contr. factor	465*	2442*	2443*	2444*	2445*	2446*	2447*	2448*
D comp. feedfor. ctrl factor	2449*	2450*	2451*	2452*	2453*	2454*	2455*	2456*
Time const. symm. filter	467*	2457*	2458*	2459*	2460*	2461*	2462*	2463*
Time const. setpoint filter	486*	2464*	2465*	2466*	2467*	2468*	2469*	2470*
SERVO maximum speed	403*	404*	405*	406*	407*	408*	409*	410*
Accel. time const. w. PCtr	478*	479*	480*	481*	482*	483*	484*	485*
Accel. adapt. limit	2471*	2472*	2473*	2474*	2475*	2476*	2477*	2478*
Accel. adapt. factor	2479*	2480*	2481*	2482*	2483*	2484*	2485*	2486*
Exact stop limit "fine"	443*	2487*	2488*	2489*	2490*	2491*	2492*	2493*
Kv factor AGR	487*	2494*	2495*	2496*	2497*	2498*	2499*	2500*
I component AGR	488*	2501*	2502*	2503*	2504*	2505*	2506*	2507*
D component AGR	489*	2508*	2509*	2510*	2511*	2512*	2513*	2514*
Time const. parallel model	490*	2515*	2516*	2517*	2518*	2519*	2520*	2521*
Time const. setp. filter K4 link branch	2567*	2568*	2569*	2570*	2571*	2572*	2573*	2574*
Synchronism "coarse"	492*	2553*	2554*	2555*	2556*	2557*	2558*	2559*
Synchronism "fine	491*	2546*	2547*	2548*	2549*	2550*	2551*	2552*
Alarm lim. velocity	2522*	2523*	2524*	2525*	2526*	2527*	2528*	2529*
Alarm lim. acceleration	2530*	2531*	2532*	2533*	2534*	2535*	2536*	2537*
Emerg. retract. threshold	493*	2560*	2561*	2562*	2563*	2564*	2565*	2566*
Accel. time const. w/o PCtr	419*	420*	421*	422*	423*	424*	425*	426*
Minimum speed	411*	412*	413*	414*	415*	416*	417*	418*
Creep speed M19	427*	428*	429*	430*	431*	432*	433*	434*

Parameter set update in channels (as from SW 6.1):

The machine data for velocity, acceleration and jerk (parameter-dependent from SW 6) are calculated during block processing in automatic mode. The blocks are processed prior to the traversing movement. When switching over a parameter set, the new parameter set will not be activated for the pre-calculated blocks (for the machine data mentioned). Therefore, a @714 must be provided for in the program or an NC Stop/NC Start is required for switching over these data.

The NC Start/Stop can be triggered automatically by the NC. This function must be selected for each channel via the machine data:

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"Ratio" parameter group

The "Ratio (R)" parameter group contains the following parameters:

	Axis							
	1stPaSe	2ndPaSe	3rdPaSe	4thPaSe	5thPaSe	6thPaSe	7thPaSe	8thPaSe
Parameter	MD							
Number of teeth, motor	3032*	3036*	3040*	3044*	3048*	3052*	3056*	3060*
Number of teeth, spindle	3064*	3068*	3072*	3076*	3080*	3084*	3088*	3092*
Zero mark compensation +	3096*	3100*	3104*	3108*	3112*	3116*	3120*	3124*
Zero mark compensation -	3128*	3132*	3136*	3140*	3144*	3148*	3152*	3156*
Backlash compensation	220*	3160*	3164*	3168*	3172*	3176*	3180*	3184*

This parameter set acts only on the first measuring system (mounting on motor side), i.e. a variable gear ratio may be required. The second measuring system in normally a direct measuring system (mounting on load side). Between this measuring system and the movements to be measured, there is normally a fixed gear ratio which can be taken into account, as with previous software versions, by means of pulse/path evaluation.

	Spindle							
	1stPaSe	2ndPaSe	3rdPaSe	4thPaSe	5thPaSe	6thPaSe	7thPaSe	8thPaSe
Parameter	MD							
Number of teeth, motor	2400*	2401*	2402*	2403*	2404*	2405*	2406*	2407*
Number of teeth, spindle	2408*	2409*	2410*	2411*	2412*	2413*	2414*	2415*
Zero mark compensation +	2416*	2417*	2418*	2419*	2430*	2431*	2432*	2433*
Zero mark compensation -	2434*	2435*	2436*	2437*	2438*	2439*	2440*	2441*

If the function "Extended parameter set switchover" is not active, then the following value settings are fixed, i.e. the values given above are irrelevant:

Axis:
3032* ... 3060* = 1 (Number of teeth, motor)
3064* ... 3092* = 1 (Number of teeth, spindle)
3096* ... 3124* = 0 (Zero mark compensation +)
3128* ... 3156* = 0 (Zero mark compensation -)
3160* ... 3184* = MD 220* (backlash compensation)
The backlash compensation value of the 1st parameter set is activated in all parameter sets.

Spindle:
2400* ... 2407* = 1 (Number of teeth, motor)
2408* ... 2415* = 1 (Number of teeth, spindle)
2416* ... 2433* = 0 (Zero mark compensation +)
2434* ... 2441* = 0 (Zero mark compensation -)

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- The function is disabled for measuring systems with distance-coded zero marks, i.e. a gear ratio other than 1:1 must not be set for such axes. Incorrect MD settings generate the alarm "Parameterization error NC-MD" and service alarm 312.
- In the case of axes, the gear ratio acts on the actual values from the 1st measuring system.
- In the case of spindles/C axes, different gear ratios can be set for both operating modes, even if only one encoder is defined. When the operating mode is switched over, the gear ratio is automatically adapted.
- When the gear ratio changes after a parameter set switchover, the signal "Axis referenced" or "Spindle synchronized" is reset (Note: A check is made to ascertain whether the individual values for "Number of teeth, motor" and "Number of teeth, spindle" are the same, i.e. internally, a gear ratio of 1:1 is not the same as a ratio of 2:2. This only applies to the treatment of status signal "Axis referenced"/"Spindle synchronized" and has no effect on actual value evaluation).

  The status signals are also reset when the backlash compensation value is changed (by means of parameter set switchover or MD change).

Drive parameter group

With SIMODRIVE 611A systems, parameter sets are switched over by means of terminals which can be switched externally. The parameter sets (speed controller parameters, filter settings, current and power limits, etc.) can be specified directly via the PLC-NCK interface with SIMODRIVE 611D systems.

The switchover of a parameter set from a certain parameter group can be initiated, for example, from the part program by means of an auxiliary function. This function is detected by the PLC which subsequently passes the parameter set number to the NCK interface and activates it.

12.27.3 Switchover

Switchover between parameter sets is implemented via the PLC interface:

Axis:	Parameter group "Position control"	:DB 32, DW K+123, bits 0, 1, 2
	Parameter group "Ratio"	:DB 32, DW K+123, bits 3, 4, 5
	Parameter group "Drive 611D"	:DB 29, DW K+122, bits 0-1, 2
Spindle:	Parameter group "Position control"	:DB 31, DW K+51, bits 0-1, 2
	Parameter group "Ratio"	:DB 31, DW K+51, bits 3-4, 5
	Parameter group "Drive 611D"	:DB 31, DW K+74, bits 0-1, 2

To ensure that switchover for the spindle is implemented by means of these interface signals, MD 522*, bit 4 "Switch over parameter groups separately" must be set. In this case, the interface signals for the actual gear stage (DB 31, DW K + 1, bits 0 - 2) are without meaning. The display of the actual gear stage in the service display continues to be updated according to the interface signals, but does not otherwise have any effect.

If the MD bit is not set, then the PLC signals for the actual gear stage are used.

In the case of spindles**/**C axes, the switchover behaviour of the spindle and the C axis is influenced by MD bit 522*, bit 4, "Switch over parameter groups separately". "Separate switchover" is a fixed setting for normal axes. It is possible to influence C axes via the spindle MD bit such that all parameter groups ("Position controller", "Ratio" and "Drive) are switched over together via the interface of the "Position controller" parameter group.

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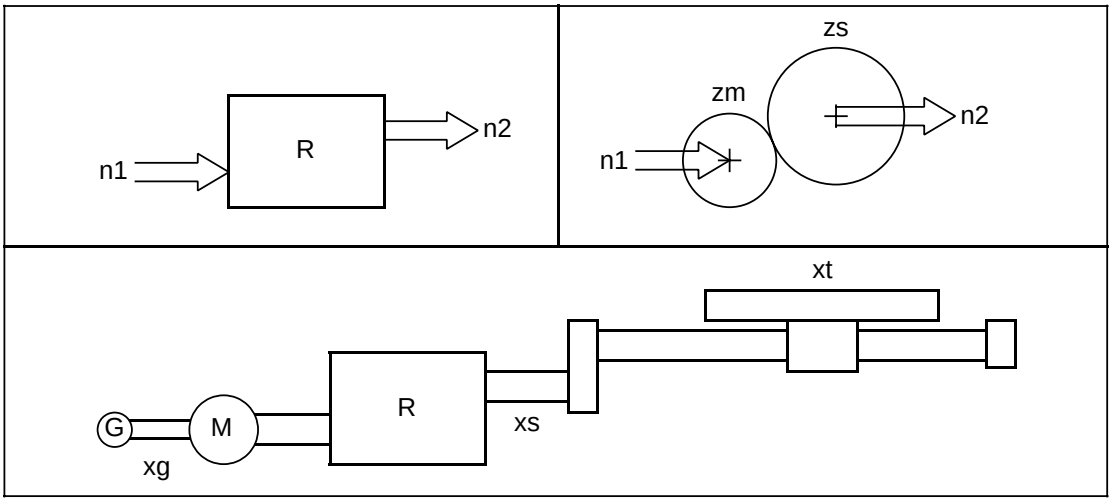
In addition to variable increment evaluation, a gear ratio can be activated additionally via parameters "Number of teeth, motor" and "Number of teeth, spindle". This is necessary when gear ratios change as a result of gear changes (with indirect actual value sensing).



Gear ratios, numbers of teeth, paths

The gear ratio specifies the speed ratio between the drive and output ends:

$$R = \frac{n1}{n2} = \frac{zs}{zm}$$

n1 = Drive speed
n2 = Output speed
zs = Output (spindle) number of teeth
zm = Drive (spindle) number of teeth

The ratio between the numbers of teeth (can be directly entered in new machine data) is always inversely proportional to the ratio between the speeds.

The path on the workpiece side is thus calculated as follows:

$$xt = xs * h$$

or

$$xt = xg * h * \frac{zm}{zs}$$

xt =Workpiece path
xs =Spindle path
xg =Motor path
h =Spindle pitch

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12.27.4 Diagnosis

The currently effective parameter sets in the various parameter groups are displayed in the NC service display for axes**/**spindles in the individual displays.

Structure of service displays:

Service Axes Individual display	Axis:	1
Following error		
Absolute actual value		
Absolute setpoint		
Abs. compensation value		
Speed setpoint	(0.01 %)	
Part actual value		
Part setpoint		
Contour deviation		
Synchronism error		
Parameter set position control		
Parameter set ratio		
Service number		

Service Spindle Individual display	Spindle:	1
Speed setpoint	(0.01 %)	
Progr. speed setpoint	(rev**/**min)	
Current speed setpoint	(rev**/**min)	
Actual speed value	(rev**/**min)	
Position setpoint	(degrees)	
Actual position value	(degrees)	
Following error		
Synchronism error		
Override	(%)	
Current gear stage		
Parameter set position control		
Parameter set ratio		
Service number		

The current parameter set numbers of the two parameter groups "Position control" and "Ratio" are output in the services displays "Axis individual" and "Spindle individual". The following applies to spindles: When the extended parameter set swithover function and "Switch over parameter groups together" setting (MD 522*, bit 4 = 0) are selected, the "Actual gear stage" display is irrelevant; parameter group switchover is executed entirely via the interface for the "Position controller" parameter group.

When a gear ratio is incorrectly parameterized, the alarm "Parameterization error NC-MD" is generated and the associated new service number is output in the service display:

312 = Incorrect gear ratio entered for a parameter set (number of teeth, motor or spindle = 0).
Gear ratio other than 1:1 specified for an axis with distance-coded measuring system.

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12.27.5 Operator inputs

The operator inputs the machine data for the parameter sets under DIAGNOSIS**/**START-UP**/**MACHINE DATA**/**NCK-MACHINE DATA**/**AXIS or SPINDLE where the new MD are arranged under the existing parameter set data.

12.27.6 Power ON, system start, power OFF, restart

During control power-up, the values from the 1st parameter set remain active until the PLC interface has been supplied with valid values.

Subsequent inputs of parameter sets are unaffected by channel reset, mode group reset and restart operations.

NCK power ON**/**OFF invalidates these settings, the values of the 1st parameter set are activated again.

The selected parameter set number for the parameter group "Drive" remains valid even when the digital drive is switched off, i.e. when the drive is switched on again, it receives the same, cyclically transmitted PaSNo.

12.27.7 Compatibility

If the "Extended parameter set switchover" function is not activated in MD 1828*, bit 0 (axis) or MD 523*, bit 0 (spindle), then the old functionality (prior to SW 4) regarding traversing limits, tapping, gear stage switchover and drives parameters is applicable. The associated MD of the extended parameter sets are not activated.

The following boundary conditions apply when this function is activated:

Spindle:

Software version 4 is compatible with previous versions in terms of spindle gear stage switchover functionality. Parameters which could not be switched over with SW versions up to and including SW 3 must be set to the appropriate value of the first parameter set when SW version 4 is installed.

Axis:

The operating principle of the "Tapping without compensating chuck" function is compatible to that applied in SW 3. Parameters in the 2nd set of parameter group "Position control" which cannot be switched over with SW version 3 must be set to the same values as those in the 1st set of this parameter group.

Drive:

If a drive is assigned more than once, then the parameter set number of the currently active axis/spindle, which also supplies the setpoint, is valid in each case. The current parameter set remains valid provided no controller enabling command is applied.

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12.28 High-speed data channels

The "High-speed data channels" function

is an option (SW 4 and higher).

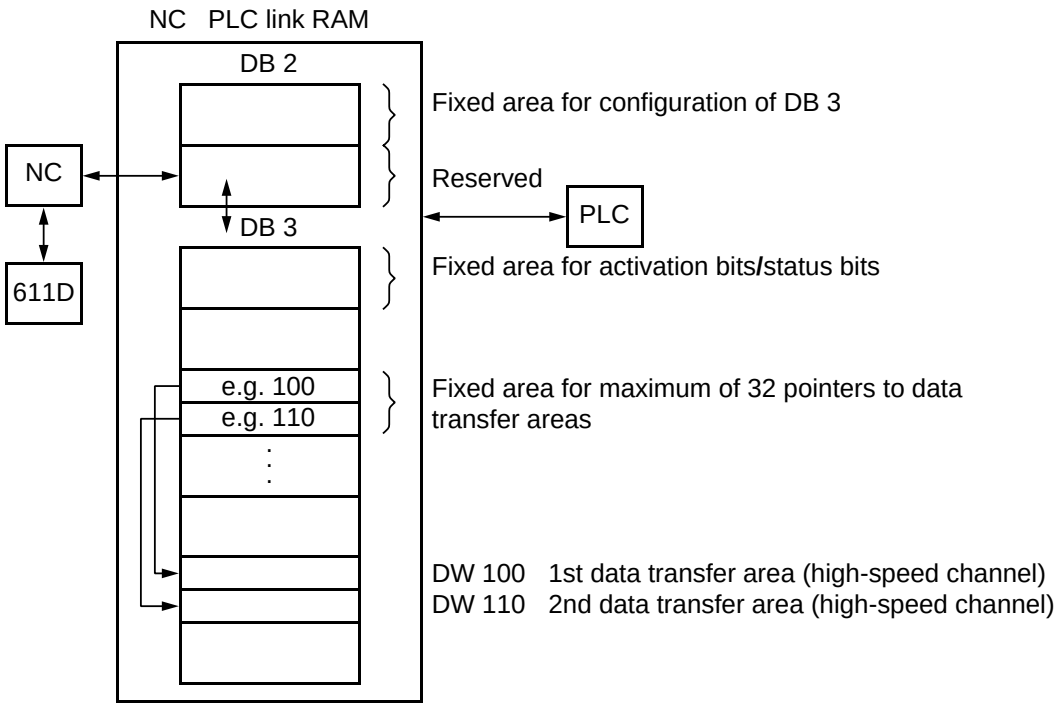
12.28.1 Corresponding data

- Option 6FC5 150-0AS40-0AA0
- Data block DB2 (configuring DB)
- Data block DB 3 (data transmission areas)

12.28.2 Functional description

With the "High-speed data channels" function, signals from SIMODRIVE 611D SERVO digital drives as well as signals from an NCK I/O module are exchanged cyclically with the PLC user program.

With SW versions up to and including SW 3, analog values are read in via analog modules in the PLC area.



Functional structure of high-speed data channels

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- It is possible to define in the PLC user program which data are to be transferred via a maximum of 32 high-speed data channels.
- The minimum updating rate of these high-speed channels is identical to the set interpolation cycle (in NC), but can be set to a high multiple of the interpolation cycle for each individual channel in order to minimize unnecessary operating time loading of the NC.
- The user has the option of processing the updating rate in an interrupt- or time-controlled DB (DB 3) in the PLC.
- A special "configuring channel" is provided to allow the high-speed data channels to be configured (DB 2) in terms of the type and direction of the data to be transferred during operation.
- Configuring measures can be taken to determine whether values should always be updated or whether they should be updated only after the last value to be entered in the high-speed channel has been read by the partner (NC or PLC) (channel operation with acknowledgement). As from SW 4, several data channels can be controlled simultaneously (”Synchronous data channels”).
- New configurations or re-configurations of this type are not processed in the interpolation cycle, but in the 40 ms reference.
- **Only one** high-speed channel can ever be configured via the configuring channel.
- On successful completion of the configuration, the data channels can be activated individually or jointly. All activated data channels become active immediately (i.e. in the next IPO cycle at the latest) and simultaneously.
- Each individual high-speed data channel is capable of transferring a maximum of one 32-bit value (the data length is specific to data group and data type). Since the processor is not capable of writing/reading 32-bit data to/from the link RAM with one single access operation, access must be co-ordinated between the NC and PLC by means of semaphores in order to prevent incorrect data from being read. These semaphores are used by the PLC only when 32-bit values are transferred by means of a high-speed channel, but not for 8-bit or 16-bit data (in order to save program run times). The PLC user should always use semaphores in order to guarantee programming consistency on the PLC side and to eliminate programming errors in the user program. The assignment between semaphores and high-speed data channels is 0:1, i.e. semaphore 0 controls the data exchange via the 1st high-speed channel, semaphore 31 controls the data exchange via the 32nd high-speed channel and so on. The log for configuration and use of the high-speed data channels is established and is not assisted by function macros provided by Siemens. It is the particular responsibility of the PLC user to make sure that semaphores are always used.
- Since the NC interpolation cycle is not synchronized with PLC processing blocks, it cannot be guaranteed that values read in a PLC processing block, which have been supplied by several channels, all originate from the same IPO cycle.

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12.28.3 Configuration

In order to avoid complicated programming involving pointers and lengthy run times in the PLC user program, the configuring channel and data transfer areas are stored in different data blocks: A "Configuring DB" with 32 DW (DB2) and "High-speed data channels" with 256 (DB 3) are set up in the link RAM; these blocks act as the communications link between the NC and PLC.

Configuring channel in DB 2

Block of 11 DW in DB 2 by means of which one data transfer area in each case can be set in DB 3 (unambiguous definition of data to be transferred). Regardless of how many transfer areas are present in DB 3, there is only on configuring channel in DB2; several data transfer areas must be configured one after another.

Contents of DB 3:

- **Data transfer areas**

  A data transfer area is an element of the interface DB 3 which allows certain data to be exchanged between the NC and PLC. The type and meaning of the data are defined in the configuration.

- **High-speed data channels**

  A high-speed channel is a certain type of data transfer area; its format and processing mode can be specified. The length of a high-speed data channel is dependent on the type of data to be transferred. These channels are accessed directly by the PLC user program, thus allowing the cycle time (e.g. access to an alarm OB) of the updating function to be controlled by the user. The maximum data exchange rate between the NC and this interface corresponds to the interpolation cycle.

- **Function identifier**

  Designation for a certain type of data transmission. The "High-speed data channels" are defined here.

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12.28.4 Format of interface data blocks

DB 2 configuring DB								
Byte No.	15	14	13	12	11	10	9	8
	Bit No.							
	7	6	5	4	3	2	1	0
DL 0	with acknowldg.	Read/ write	Operating mode					STROBE
DR 0	Error code from NC							
DL 1	Job No. from PLC							
DR 1	No. of data transfer area							
DL 2	NC updating rate							
DR 2	Function identifier							
DL 3	Configuring parameter 1 LOW							
DR 3	Configuring parameter 1 HIGH							
DL 4	Configuring parameter 2 LOW							
DR 4	Configuring parameter 2 HIGH							
DL 5	Configuring parameter 3 LOW							
DR 5	Configuring parameter 3 HIGH							
DL 6	Configuring parameter 4 LOW							
DR 6	Configuring parameter 4 HIGH							
DL 7	Reserved							
DR 7	Reserved							
⋮				⋮				⋮
DL 10	Reserved							
DR 10	Reserved							

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DL 0 bit 8 "Strobe":

Strobe for activation of configuring channel. Set by PLC user and reset by NCK after acceptance (or rejection with error code) of configuration.

DL 0 bit 14 "Read/write":

Definition of transmission direction: 0 = PLC reads, 1 = PLC writes.

DL0 bit 15 "With acknowledgement":

If this bit is set, the writer (NCK or PLC) may not enter a new value until the last value to be entered has been fetched by the reader (PLC or NCK). When a high-speed data channel is operated "with acknowledgement", no semaphores are required to ensure consistent data transmission; control bit "new value" in the data transfer area (see DB 3) performs the requisite synchronization.

DR 0 Error code of NC:

Error code	Description
80H	Function identifier incorrect
40H	Configuring parameter 1 incorrect
41H	Configuring parameter 2 incorrect
42H	Configuring parameter 3 incorrect
43H	Configuring parameter 4 incorrect
20H	No. of data transfer area incorrect/pointer to data transfer area incorrect
10H	Write not permissible
11H	Impermissible operating mode in DL 0
01H	Too many data channels configured
02H	Option not activated
03H	Wrong update rate

If a fault occurs, the configuration is rejected. The corresponding data transfer area is no longer processed by the NC, until there is a reconfiguration.

DL 1 "Job number":

Since the configuration for a number of data transfer areas is defined via one channel only and consecutively for the areas concerned, there is no longer any assignment between the currently supplied data and their meaning in the interface DB 3. The user must manage this correlation himself outside the interface DB 3. To facilitate diagnosis, the PLC user can assign a job number when he configures a data transfer area; if the configuration is successful, this number is signalled back by the NC in the appropriate data transfer area in DB 3.

DR 1 "No. of data transfer area":

The data transfer areas are numbered consecutively, starting with 1, in the interface DB3.

DL 2 "Updating rate":

The rate at which this channel is processed by the NC, i.e. after how many IPO cycles, can be set here. 1 means that the channel is processed in every IPO cycle.

DR 2 "Function identifier" (for a description see Section "Overview of function identifiers and configuring data (DB 2, DR 2 ... DR 6)"

DL 3 DRG configuring parameters 1 .. 4 (for a description see Section "Overview of function identifiers and configuring data (DB 2, DR 2 ... DR 6)"

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DB 3 data transfer areas

DB 3 data transfer areas								
Byte No.	15	14	13	12	11	10	9	8
	Bit No.							
	7	6	5	4	3	2	1	0
DL 0	Activation bits from PLC							
	Data channel 8	Data channel 7	Data channel 6	Data channel 5	Data channel 4	Data channel 3	Data channel 2	Data channel 1
DR 0	Activation bits from PLC							
	Data channel 16	Data channel 15	Data channel 14	Data channel 13	Data channel 12	Data channel 11	Data channel 10	Data channel 9
DL 1	Activation bits from PLC							
	Data channel 24	Data channel 23	Data channel 22	Data channel 21	Data channel 20	Data channel 19	Data channel 18	Data channel 17
DR 1	Activation bits from PLC							
	Data channel 32	Data channel 31	Data channel 30	Data channel 29	Data channel 28	Data channel 27	Data channel 26	Data channel 25
DL 2	Status bits from NC "Data channel configuration valid"							
	Data channel 8	Data channel 7	Data channel 6	Data channel 5	Data channel 4	Data channel 3	Data channel 2	Data channel 1
DR 2	Status bits from NC "Data channel configuration valid"							
	Data channel 16	Data channel 15	Data channel 14	Data channel 13	Data channel 12	Data channel 11	Data channel 10	Data channel 9
DL 3	Status bits from NC "Data channel configuration valid"							
	Data channel 24	Data channel 23	Data channel 22	Data channel 21	Data channel 20	Data channel 19	Data channel 18	Data channel 17
DR 3	Status bits from NC "Data channel configuration valid"							
	Data channel 32	Data channel 31	Data channel 30	Data channel 29	Data channel 28	Data channel 27	Data channel 26	Data channel 25
DW 4	Reserved							
⋮				⋮				⋮
DW 13	Reserved							
DL 14	Pointer to data area 1 (=No. of data word) (DW "X")							
DR 14	Pointer to data area 2 (=No. of data word)							
⋮				⋮				⋮
DL 29	Pointer to data area 31 (=No. of data word)							
DR 29	Pointer to data area 32 (=No. of data word)							
DL 30								
DR 30								
DL x	Job No. (acknowledgement from NC)							
DR x	Control bits							
	Error in NC data write operation	Error in NC data read operation				Synchronous data channel	"New value" write NC data	"New value" read NC data
DL x+1	VALUE							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DR x+1	VALUE							
	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
DL x+2	VALUE							
	Bit 23	Bit 22	Bit 21	Bit 20	Bit 19	Bit 18	Bit 17	Bit 16
DR x+2	VALUE							
	Bit 31	Bit 30	Bit 29	Bit 28	Bit 27	Bit 26	Bit 25	Bit 24
DR 12	Synchronous data channels							
	Res.	Res.	Res.	Res.	Res.	Res.	"New value" write NC data	"New value" read NC data

x = Data transfer area nos. 1 to 32 via pointers (DW 14 to 29)

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Activation bits (PLC NC):

Each of the 32 bits represents a data transfer area, bit 0 = data transfer area 1. Data transfer areas which have already been configured can be activated (bit x = 1) or deactivated (bit x = 0) with this signal. The activation signals are evaluated in every IPO cycle by the NC. Any attempt to activate incorrectly configured areas is ignored without comment by the NC. The NC indicates which data transfer areas are correctly configured in status bits (DL 2 to DR 3) (bit 1 = 1 means: The data transfer area is correctly configured and can be activated).

Format of a data transfer area of "High-speed data channel type":

Job No. (acknowledgement from NC)	DL
Control bits	DR x
Value (bits 0 - 7)	DL x+1
Value (bits 8 - 15)	DR x+1
Value (bits 16 - 23)	DL x+2
Value (bits 24 - 31)	DR x+2

Control bits:

Error in NC data write operation	Error in NC data read operation				Synchronous data channel	New value for NCK data write	New value for NCK data read

Error in NC data write/read operation

Set by NC if it has not been possible to read/write a value. Possible causes:

- Permissible value range exceeded.
- Drive not ready

New value for NC data read:

Indicates that the date value has been newly entered by the NCK. If the data transfer area has been configured "with acknowledgement", then the NC enters data here only if this bit is not set. "New value for NC data read" must in this case be reset by the PLC user after the data have been ready so that the "writer" can enter new values again.

New value for NC data write:

Indicates that the data value has been newly entered by the PLC user. The NC accepts data only if this bit is set. "New value for NC data write" must be set by the PLC user after the data have been written so that the NC can read the new values.

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12.28.5 Configuration of a high-speed data channel

Step 1: Reset activation signal in DB 3.

Step 2: Divide up DB 3 appropriately for all data transfer areas used. Program pointers for the data transfer areas accordingly.

Step 3: Enter job number in configuring channel, enter number of data transfer area, enter function identifier and configuring parameters, set bits for read**/**write operations and acknowledgement bit if appropriate. Set strobe.

Step 4: Wait for NC to reset strobe.

Step 5: Evaluate any error message from NC.

Step 6: If no error message is output, the high-speed data channel can now be activated (enter value to be written, if any, beforehand).

12.28.6 Fast synchronous data channel

With the function ”Synchronous data channel” it is possible to access several NCK data (access via several ”fast data channels”) ”simultaneously” (i.e. all data refer to one IPO cycle). Synchronous data channels are always operated ”with acknowledgment”, irrespective of their configuration (DB 2 DL 0 bit 7).

The way the data channel is configured has not changed. The activation bits (DB 3 DW 0-1) must be set.
Setting the data-channel-specific bit ”Synchronous data channel” (DB 3, DRx, bit 2) makes the data channel a ”synchronous data channel”. The data channel is then no longer controlled via the data-channel-specific bits ”New values, read NC data” and ”New values, write NC data” (DB3, DRx, bit 0 and bit1) but via the synchronous data channel bits ”New values, read NC data” and ”New values, write NC data” (DB3, DR12, bit 0 and bit 1). As all the synchronous data channels are controlled by these bits, all data channels are activated simultaneously.

With a synchronous ”**Read NC data**” the PLC requests the data from the NCK by resetting bit ”New values, read NC data” (DB3, DR12, bit 0). Once the NCK has read all data it signals this to the PLC by setting this bit.

With a synchronous ”**Write NC data**” the PLC initiates writing by setting bit ”New values, write NC data” (DB3, DR12, bit 1). Once the NCK has written all data this is signaled to the PLC by resetting this bit.

Notes:

- The function ”Synchronous data channel” is only available for function identifiers 02 (digital I**/**O in NCK) and 03 (NCK data). With function identifier 01 (drive data and servo data) bit ”Synchronous data channel” is ignored.
- Synchronous data channels can be converted to ”normal” data channels at any time by resetting bit ”Synchronous data channel”. They are then operated with or without acknowledgment depending on the configuration.
- The data-channel-specific bits ”New values, read NC data” and ”New values, write NC data” (DB3, DRx, bit 0 and bit 1) are not processed by the NC when synchronous data channels are set (i.e. the status of these bits is irrelevant).

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12.28.7 Use of a high-speed data channel

Case 1: Write with acknowledgement,
configure high-speed data channel,
cyclical from now on:
If "New value for NC data write" is not set, enter value to be written, set "New value for NC data write".

Case 2: Write without acknowledgement,
configure high-speed data channel,
cyclical from now on:
Set semaphores, enter value to be written, set "New value for NC data write, enable semaphores.

Caution:

The signal "New value" must be set for the NC even though the data channel is operating without acknowledgement. The NC reads data only if new data have been entered in order to eliminate unnecessary link RAM access operations by the NCK (operating time).

Case 3: Read with acknowledgement,
configure high-speed data channel,
cyclical from now on:
If "New value for NC data read" is set, read value, reset "New value for NC data read".

Case 4: Read without acknowledgement,
configure high-speed data channel,
cyclical from now on:
If "New value for NC data read" is set, set semaphores, read value, reset "New value for NC data read".
Enable semaphores.

Note:

"New value for NC data read" need not be evaluated at this point.

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12.28.8 Overview of function identifiers and configuring parameters (DB 2, DR 2 ... DR 6)

Permissible function identifiers and associated configuring parameters:

Function identifier	Explanation	Max. permissible number	Parameter 1	Parameter 2	Parameter 3	Parameter 4
01	Drive data	32	Data group 21H	Data type	Signal number	Axis/spindle number
01	Servo data	32	Data group 26H	Data type	Signal number	Axis/spindle number
02	Digital I/O in NCK	32	0	Data designation	0	0
03 (SW 5 and higher)	NCK data	32	0	Signal number	Axis No.	Channel/IKA No.

Explanation of drive data:

Function identifier	Explanation	Max. permissible number	Parameter 1	Parameter 2	Parameter 3	Parameter 4
01	Drive data	32	Data group 21H	Data type	Signal number	Axis/spindle number

Data group	21H
Data type	0 - 7 (parameter set number)
Signal number	0 -19999 (possible inputs: see table below)
Axis/spindle/drive number	Addressing types: a) With drive number 0 – 0FH: 0: Global 1–15: Drive 1 to 15 b) With axis/spindle number 100H – 131H 100H – 127H: Axis 0 - 39 (0 - 29 possible) 128H – 131H: Spindle 40 - 49 (40 - 45 possible, spindle 1 - 6)

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Signal number	Meaning	Data format	Unit	Attribute
11009	Capacity utilization	U (Unsigned 16 Bit)	7FFFH=100%	Read
11010	Torque setpoint	S (Signed 16 Bit)	4000H=100% Drive MD 1725	Read
11011	Active power	S (Signed 16 Bit)	0.01 KW (=10 W)	Read
11012	Smoothed current actual value (iq)	S (Signed 16 Bit)	4000 H =100% Drive MD 1107	Read
11013	Motor speed actual value	SL (Signed Long 32 Bit)	400000 H =100% Drive MD 1401	Read

Explanation of servo data:

Function identifier	Explanation	Max. permissible number	Parameter 1	Parameter 2	Parameter 3	Parameter 4
01	Servo data	32	Data group 21H	Data type	Signal number	Axis/spindle number

Data group	26H
Data type	0
Signal number	0 -1000 (possible inputs: see table below)
Axis/spindle/drive number	Addressing types: • Axis/spindle number 100H – 127H: Axis 100H – 127H Axis 0 - 39 (0- 29 possible) 128H – 131H: Spindle 40 - 49 (40 - 45 possible, spindle 1 - 6)

Signal number	Meaning	Data format 1)	Unit	Attribute
	AXIS/SPINDLE			Read
1	Following error	SL	UMS	Read
2	Absolute position setpoint	SL	UMS	Read
3	Speed setpoint	SL	0.01 % of max. load speed 3)	Read
4	Part actual value (active)	SL	0.01 % of max. load speed 3)	Read

1) Data format SL.. Signed Long (32 bit)

2) Unit UMS ... Units Machine system

(0, 1) RPM ... Revolutions / minute, load-related

0.1 rpm when MD bit 520 bit 3 =1*

1 rpm when MD bit 520 bit 3 = 0*

3) Load speed: 400000H corresponds to 0.01% of the max. load speed

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Signal number	Meaning	Data format 1)	Unit	Attribute
5	Part setpoint	SL	0.01 % of max. load speed 3)	Read
6	Synchronism deviation	SL	UMS	Read
7	Angular offset (mech. coupling)	SL	UMS	Read
8	Absolute position actual value (without modulo compensation)	SL	UMS	Read
9	Part actual value 1st measuring system	SL	0.01 % of max. load speed 3)	Read
10	Part actual value 2nd measuring system	SL	0.01 % of max. load speed 3)	Read
	AXIS			
100	Contour deviation	SL	UMS	Read
101	Abs. compensation value	SL	UMS	Read
	SPINDLE			
200	Current speed setpoint (before ramp generator)	SL	(0.1) RPM	Read
201	Speed setpoint (ramp generator output)	SL	(0.1) RPM	Read
202	Speed actual value	SL	(0.1) RPM	Read

Explanation of digital I/O in NCK:

Function identifier	Explanation	Max. permissible number	Parameter 1	Parameter 2	Parameter 3	Parameter 4
01	Digital I/O in NCK	32	Data group 21H	Data type	Signal number	Axis/spindle number

The digital I/O peripherals (e.g. 6 digital inputs of Central Service Board or maximum 2 mixed I/O modules with 2 input and output bytes each) can also be used to a limited extent in the NCK area.

The status of these inputs/outputs can be read from the PLC by means of the high-speed data channels. However, the outputs cannot be written from the PLC!

---

1) Data format SL.. Signed Long (32 bit)

2) Unit UMS ... Units Machine system

(0, 1) RPM ... Revolutions / minute, load-related

0.1 rpm when MD bit 520 bit 3 =1*

1 rpm when MD bit 520 bit 3 = 0*

3) Load speed: 400000H corresponds to 0.01% of the max. load speed

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The data to be read are selected via configuring parameter 2. The following table shows the available data options:

Configuring parameter 2	Addressed data
10	Outputs of mixed I/O modules in NCK (4 bytes)
111	Inputs of first mixed I/O module in NCK (2 bytes)
112	Inputs of second mixed I/O module in NCK (2 bytes)
180	Inputs of Central Service Board (6 bits)
90	Special signals from NC to PLC
190	Special signals from PLC to NC (Note: The PLC can only write these data!)

Special signals; NC PLC

The user specifies in NC-MD 312-317 the location to which the NC should signal that an emergency retraction has been initiated by a channel or axis, i.e. whether the NC outputs this status information to a mixed I/O module or supplies it in the form of a special signal for the PLC (MD 312-317 must then be set to a value between 91 and 94).

Special signals: PLC NC

The user also specifies in NC-MD 318-323 the location from which the NC accepts the command to initiate emergency retraction (a value of between 91 and 94 indicates the special signals from the PLC should be accepted).

Initialization/power-up/reaction to errors

The contents of the two data blocks DB2 and DB3 are erased by the NC software after NCK power ON. The NC also erases all 32 semaphores in the link RAM to the PLC during power-up. The high-speed data channels do not remain active after mains on/off since the data in the NC are stored in the dynamic RAM. In addition, the NC-internal pointers must be re-calculated after every power-up since, for example, changes to internal address lists may have occurred as a result of the cancellation of axes by means of a power ON operation. The PLC user program must re-configure the high-speed data channels after every link bus reset (i.e. also after NCK power ON initiated by means of operator input or PLC cold restart). Since the PLC generally executes a warm restart rather than a cold restart, it must be noted that the user program operates with incorrect values (0) for a maximum of one cycle after a power ON operation. The contents of the two data blocks are erased before the NC and PLC system software is synchronized. Since the configuration of the high-speed data channels involves several cycles, it must be not be defined in OB20.

It is advisable to use OB20 to divide up the high-speed data channels (see also application example).

In the case of failure of the PLC sign-of-life monitoring function (alarm 43 "PLC-CPU not ready"), the NC stops writing values into the link RAM. In the case of drive failure, drive data read via the high-speed data channel are invalid (error identifier in data channel). The PLC can detect a drive failure by monitoring the "Drive ready" signal. When the drive is connected (again), the read drive data become valid again (NC resets error bit on next transmission of data).

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Explanation of NCK data (SW 5 and higher)

Function identifier	Explanation	Max. permissible number	Parameter 1	Parameter 2	Parameter 3	Parameter 4
03 (SW 5 and higher)	NCK data	32	0	Signal number	Axis number	Channel/IKA number

Signal number	**Name of the NCK signal**	**Axis no.**	**Channel/ IKA no.**	**Unit 1)**
1	Axial feedrate	1 - 30		2(exp - 1) GEO*U/SP
2	Path feedrate	--		2(exp - 17) GEO*U/SP
3	Path distance-to-go	--		2(exp - 1) GEO*U
4	IKA input quantity A (type 21)	--		--
5	IKA input quantity B (type 27)	--		--
6	IKA output quantity (type 35)	--		--
7	IKA compensation value	1 - 30		LR
8	IKA intermediate point number (type 35)	--		--
9	IKA table input A (type 22)	--		--
10	Axis setpoint	1 - 30		LR
11	Number of predecoded blocks	--		--
12	CPU use	--		--

Configuration in PLC DB 2 is performed with the function identifier 03 and configuration parameter 1=0.

This **reading process** can be executed either with or without acknowledgement. Operation with acknowledgement means the next value is read only when the communication partner has read the value.

In operation without acknowledgement, the values to be entered are refreshed in the timebase as configured in DB2 in the parameter "Refresh rate".

---

1) Unit GEO... geometry resolution
U... Unit
SP... Scan period
LR... Position control resolution

2) The data CPU use is displayed with double precision.

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Example:

Parameterization of DB 2 for reading without acknowledgement of the signal path feedrate (signal No. = 2) in the 3rd channel is as follows:

Byte no.	Content	Meaning
DL 0	0x01	Operation without acknowledgement/reading/set strobe
DR 0	--	Error code from NC (output parameter)
DL 1	0x13	Job number of PLC
DR 1	0x01	No. of the data transfer area
DL 2	0x10	Refresh rate NC
DR 2	0x03	Function ID of the service function
DL 3	0x00	Configuration parameter 1 LOW
DR 3	0x00	Configuration parameter 1 HIGH
DL 4	0x02	Configuration parameter 2 LOW = Signal No.
DR 4	0x00	Configuration parameter 2 HIGH = Signal No.
DL 5	0x00	Configuration parameter 3 LOW = Axis No.
DR 5	0x00	Configuration parameter 3 HIGH = Axis No.
DL 6	0x03	Configuration parameter 4 LOW = Channel/IKA No.
DR 6	0x00	Configuration parameter 4 HIGH = Channel/IKA No.

Writing these signals from the PLC is not permitted. If an attempt is made to perform a write access, the error code 41 "**Configuration parameter 2 incorrect**" is indicated in DB 2 DR 0.

Examples for "Servo Trace" or high-speed data channel

The following abbreviations are used:

MW = Measured value, i.e. the measured value that can be read off in the trace curve or the data transfer range of the "high-speed data channel" received on the PLC side.

RW = Real value, i.e. the measured value converted into the physical quantity. Usually, this physical quantity has the same unit as in the part program, e.g. mm/min for the feedrate. This unit is indicated in square brackets.

IT=Interpolation cycle [ms]

EF=Input resolution, corresponds to MD 5002.4-7

LF=Position controller resolution, corresponds to MD 18000.0-3

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Axial feed:

Formula for servo trace: RW=MW*120000*LF/IT [mm/min]
Formula for high-speed data channel: RW=MW*60000*LF/IT [mm/min]

Example: G91 G94 F1000 Z10 X10
In servo trace:

Read-off	MW=	1885	in Z axis
with	LF =	$0.5*10^{-4}$ [mm]	in Z axis
and	IT =	16 [ms]	
results in	RW=	$1885*120000*(0.5*10^{-4})$/16 [mm/min]	
i.e.	RW=	707 [mm/min]	

The same feedrate results in the X axis. Both together have therefore a path feedrate of SQRT ($707^2 + 707^2$) = 1000 [mm/min] as programmed.

Note: "Channel/IKA no." is not relevant in the servo trace screen!

Path feedrate:

Formula for servo trace: RW=MW*60000*EF/IT [mm/min]
Formula for high-speed data channel: RW=MW*30000*EF/IT [mm/min]

Example: G91 G94 F1000 Z10 X10
In servo trace:

Read-off	MW=	266.5
with	EF =	10^{-3} [mm]
and	IT =	16 [ms]
results in	RW=	$266.5*60000*(10^{-3})$/16 [mm/min]
i.e.	RW=	999 [mm/min]

Distance to go on path:

Formula for servo trace: RW=MW*EF [mm]
Formula for high-speed data channel: RW=MW*EF/2 [mm]

IKA input quantity value A:

Important: The IKA No. selected in the servo trace screen must be larger by 1 than the desired IKA No (applies for SW 5.1 and 5.2).

If the input quantity is a position, the following applies:

Formula for servo trace RW=MW*EF [mm]
Formula for high-speed data channel: RW=MW*EF/2 [mm]

If the input quantity is an R parameter, the following applies:

Formula for servo trace RW=MW
Formula for high-speed data channel: RW=MW/2

IKA input quantity value B:

Important: The IKA No. selected in the servo trace screen must be larger by 1 than the desired IKA No (applies for SW 5.1 and 5.2).

If the input quantity is a position, the following applies:

Formula for servo trace RW=MW*EF [mm]
Formula for high-speed data channel: RW=MW*EF/2 [mm]

If the input quantity is an R parameter, the following applies:

Formula for servo trace RW=MW
Formula for high-speed data channel: RW=MW/2

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IKA output quantity value:

Important: The IKA No. selected in the servo trace screen must be larger by 1 than the desired IKA No (applies for SW 5.1 and 5.2).

If the output quantity is a position, the following applies:

Formula for servo trace	RW=MW*EF [mm]
Formula for high-speed data channel:	RW=MW*EF**/**2 [mm]

If the output quantity is an R parameter, the following applies:

Formula for servo trace	RW=MW
Formula for high-speed data channel:	RW=MW**/**2

Absolute compensation value (IKA + TK):

Caution: A relevant value is generated only if "Axis compensation value" has been selected in the IKA configuration screen under "Type output quantity".

Formula for servo trace	RW=MW	[Dimension as indicated]
Formula for high-speed data channel:	RW=MW*LF	[mm]

Current compensation point: SINUMERIK 840C T/M

Formula for servo trace	RW=MW
Formula for high-speed data channel:	RW=MW**/**2

The output compensation point is the smaller one of the two including the current position.

IKA table input A:

Formula for servo trace	RW=MW*LF [mm]
Formula for high-speed data channel:	RW=MW*LF*2 [mm]

Axis setpoint value:

Formula for servo trace	RW=MW*2*EF**/**LF [mm]	The value is incorrectly converted internally. ERROR!!!
	Example:	EF=10E-3mm LF=0.5*10E-4mm setpoint value = 20 mm, value in servo trace = 2mm!!!
Formula for high-speed data channel:	RW=MW*EF**/**2 [mm]	

Number of predecoded blocks:

Formula for servo trace	RW=MW
Formula for high-speed data channel:	RW=MW

CPU utilization:

Formula for servo trace	RW=MW	[Dimension as indicated]
Formula for high-speed data channel:	RW=MW**/**2	[%]

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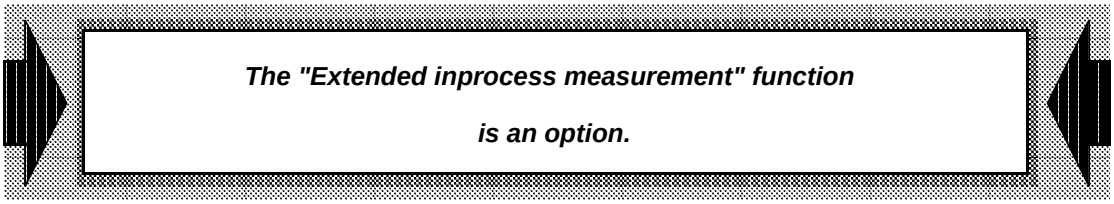
12.29 Extension of inprocess measurement (SW 4 and higher)



Extended measurement (as from SW 6)

General

The new ”extended in-process measurement” function allows for the simultaneous processing of any number of measured values on a maximum of 5 axes and for sequential recording and storing in the R parameter field.

For detailed information about the programming syntax please refer to the SINUMERIK 840C documentation: Programming Guide, section 8.19.5 Extended measurement (G720/G72/G722).

12.29.1 Functional description

The following functions are available for extended in-process measurement:

1. Measurements only within the programmed traversing movement of the measuring block:

   G720:
   Measurement is stopped when the programmed number of measurements has been completed. The programmed traversing movement is discontinued through internal delete distance-to-go and a block change is executed.

   Example:
   N100 G91 C1=90 F3 G720 MT=1 MF=-1 X1=Z1=Y MS=1099 MS=1199 MS=1299 MA=100

   G721:
   The programmed traverse path is traveled independent of measuring. At the end of the programmed traversing movement measuring is discontinued even if the programmed number of measurements has not been completed and a block change is executed.

   Example:
   N100 G91 C1=90 F3 G721 MT=1 MF=1 X1=Z1=Y MS=1099 MS=1199 MS=1299 MA=100

2. Measurements parallel to traversing movements across block limits

   G722:
   A traversing movement may be but must not be programmed within the measuring block. A block change will follow either immediately or at the end of the programmed traversing movement. Measuring is stopped when the programmed number of measurements has been completed. This has no influence on traversing movements.

   Example:
   N100 G91 C1=90 F3 G722 MT=1 MF=-1 X1=Z1=Y MS=1099 MS=1199 MS=1299 MA=100 N110 G91 C1=90 F3

   or

   N100 G722 MT=1 MF=-1 X1=Z1=Y MS=1099 MS=1199 MS=1299 MA=100
   N110 G91 C1=90 F3
   N120 G91 C1=-90 F3

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Measuring block parameter:

MT = Measuring sensor input
Depending on the hardware, inputs 1 or 2 can be measuring sensor inputs. Sensor input one 1 is effective on all measuring circuit hardware (detailed description in section 12.29.2, Hardware - secondary conditions for measuring).

Example:

MT=1	Activation of measuring sensor input 1
MT=2	Activation of measuring sensor input 2
MT=R<No.>	Activation of the measuring sensor input which is stored in the R parameter under its number

MF=Measuring system edge
The measuring system edge specifies on which edge of the measuring sensor signal the measured value of the axes should be recorded.

Example:

MF=1	Measured value recording at positive edge
MF=-1	Measured value recording at negative edge (effective with all measuring circuit hardware
MF=2	Measured value recording of each edge change beginning with the first positive edge
MF=-2	Measured value recording of each edge change beginning with the first negative edge
MF=R<No.>	Measured value recording depending on the contents of the R parameter

Measuring axes

Measured values can be recorded simultaneously for a maximum of 5 axes. Axis programming can be carried out directly or indirectly.

Example:

X1=Y1=Z1=C1=C2=	Measuring axes are the specified axes
@441 <No.>	Measuring axis is the axis specified by a global axis

MS=Start parameter
The start parameter is the R parameter as from which measuring data are stored for the respective axis. **At least one start parameter has to be specified. With multiple measuring axes and one start parameter the control automatically recalculates the other start parameters according to the number of measured values. Individual start parameters can also be specified for each measuring axis.** The 1st programmed start parameter must **therefore** be assigned to the 1st measuring axis, the 2nd programmed start parameter to the 2nd measuring axis etc.

The number of actual measurements is entered in the R parameter specified by the start parameter. The measured values are then listed in ascending order in the following R parameters.

Example:

MS=1099	Start parameter is the R parameter R1099
MS=R<No.>	Start parameter is the R parameter the number of which is recorded in the specified R parameter

Structure of the R parameter field

R<Start parameter>	Number of actual measurements
R<Start parameter+1>	1st measured value
R<Start parameter+2>	2nd measured value
	. .
	. .
R<Start parameter+No. of measured values>	last measured value

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MA=No. of measured values
The number of measured values indicates the number of measurements to be recorded for a complete measuring sequence. The required number of R parameters per measuring axis is derived from the number of measured values:

Required R parameters per measuring axis = number of measured values +1 (see also MS = Start parameter)

Measured values:

The measured values refer to the respective axis-specific position control resolution of the assigned measuring axis with regards to their unit.

Linear axes:

For linear axes, the absolute actual value of the axis is stored as a measured value in the R parameters.

Rotary axes:

For rotary axes, the absolute actual value of modulo 360 degrees is stored as measured value in the R parameters.

Measuring cut off frequency:

One measured value can be recorded for every position controller cycle (in [ms]). The inverse value of the position controller cycle (in [kHz])is therefore the limit frequency which still ensures a safe measured value recording.

Measured value buffer:

Since the recording of measured values is executed in the position controller cycle and since measured value data can only be transferred to the R parameters in the interpolation cycle, it is therefore necessary for each measuring axis to have its own measured value buffer available (MD 6200*, see the functional description: flexible memory management). The number of measured value memory locations per measuring axis should be at least the same as the ratio of interpolation cycle to position controller cycle.

Example:

Interpolation cycle =8 ms
Position controller cycle =2 ms

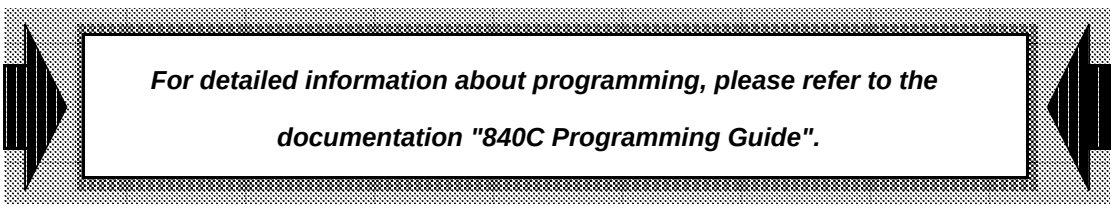
$$\text{No. of meas. value memory locations per meas. axis} = \frac{\text{Interpol. cycle [ms]}}{\text{Pos. contr. cycle [ms]}} = \frac{8\ \text{ms}}{2\ \text{ms}} = 4$$

Repeated measuring

Since measuring with G722 is carried out parallel to other part program processing (traversing blocks) the situation could arise that further measuring with G720, G721 or G722 is requested before the measuring initiated by the G722 block has ended. Differentiate between the following two cases.

Case 1: An axis already programmed in the G722 block is reprogrammed. The measuring initiated in the G722 block for the axis in question is then interrupted without error message. The axis will become measuring axis within the new measuring block.

Case 2: An axis not yet programmed in the G722 block is programmed. The measuring process initiated in the G722 block continues irrespectively.



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12.29.2 General hardware conditions for "Extended measurement"

"Extended measurement" G720/1 can be programmed for every measuring circuit variant:

- Standard measuring circuit with SPC 6FC5 111 0BA0.-0AA0,
- Standard measuring circuit with PCA 6FC5 111 0BA0.-0AA0,
- HMS measuring circuit 6FC5 111 0BA..-0AA0 and
- SIMODRIVE 611D modules with indirect**/**direct measuring channel.

The variation in hardware properties gives rise to the following boundary conditions which must be noted when the function is programmed to avoid output of RESET alarms.

SPC(214) and HMS measuring circuit (6FX1121-4BA02, 6FX1121-4BA01):

- Only one probe input can be active, the negative signal edge is always evaluated. "Extended measurement" **G720/1** can be performed only with the first probe input, the second probe input is ignored. (This restriction does not apply to "Inprocess measurement" 720 with which both probes can be activated alternately, but is necessary for the extended function to ensure an unambiguous assignment of probe inputs, even for SIMODRIVE 611D mixed operation).
- Response to probe "bouncing":

  In the case of multiple edges (probe "bouncing") within one position controller cycle, the measured value is read from the measuring circuit belonging to the last edge.
- When programming the measuring edge, switch S4 on the CSB module must be taken into account. Depending on switch S4, this module can invert the signal of the probe.

PCA measuring circuit (successor to SPC214, 6FX1121-4BA03):

- Only one measuring probe can be active. The PCA measuring circuit can react in the position controller cycle to the following edge sequences: "rising**/**rising", "falling**/**falling" or "alternately rising**/**falling falling**/**rising".

  In contrast to the SPC measuring circuit, evaluation of the second probe input is supported as an alternative for the PCA (measuring probe inputs can be switched over).

  Only one measuring edge per position controller cycle can be sensed (either positive or negative). For alternating measuring edges, therefore, the PCA measuring circuit module is reprogrammed internally (software function) to the next probe edge in the next position controller cycle after every new measured value is received. When "alternating measuring edges" is programmed, the user must ensure that the measuring frequency is smaller than the position control frequency.
- Response to probe "bouncing":

  In the case of multiple edges (probe "bouncing") within one position controller cycle, the measured value belonging to the first edge is always read out.

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SIMODRIVE 611D:

- 611D measuring circuits can evaluate both measuring probes alternatively; they can also react to the following signal edge sequences: "rising**/**rising", "falling**/**falling" or "alternately rising**/**falling".

  In this case, the minimum permissible time interval between two measured values corresponds to one position controller cycle, i.e. if values are measured at short intervals, measured data will be lost. Within this position control cycle, one rising edge and one falling edge of each probe can be evaluated.

- Response to probe "bouncing":

  In the case of multiple edges (probe "bouncing") within one position controller cycle, the measured value belonging to the first edge is always read out.

Mixed operation:

If various measuring circuit variants are used, then the following applies to the available measuring functionality:

Measuring circuit variants used			Measuring functionality as for
SPC**/**HMS	PCA	SIMODRIVE 611D	SPC**/**HMS
–	PCA	SIMODRIVE 611D	PCA
SPC**/**HMS	–	SIMODRIVE 611D	SPC**/**HMS
SPC**/**HMS	PCA	–	SPC**/**HMS

Measuring circuit switchover:

Any attempt to switch over the active measuring system (switchover of first**/**second measuring system by PLC signal DB 32, DL k + 2, bit) while measurement is in progress likewise leads to abortion of the G720**/**G721 block with output of a RESET alarm.

Reactions to disturbances/errors relating to "Extended measurement"

Through evaluation of the actual number of measured values in the start address for the R parameter field of each axis involved, a part program cycle can detect in the case of abortion or at a block end whether the measurement (actual number = programmed number) was complete in each axis.

The decoding function detects the following G720**/**G721 programming errors:

- Specification of non-existent R parameter ranges
- Specification of overlapping R parameter ranges (in the same block)
- Specification of non-existent axes
- Programmed number of measured value = number of measurements to be taken * number of axes in a G720**/**G721 block does not fit into the available R parameter range
- Incomplete data

Alarm 3006 "Incorrect block structure" is output in response to one of the above errors.

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No check is made to ascertain whether R parameters which are also required by other functions are being overwritten. Which R parameters within the available parameter range are used is left to the discretion of the user.

If the programmed G720**/**G721 variant (probe selection, edge selection, etc.) is not supported by the measuring circuit hardware, the axis-specific RESET alarm 1076* "Hardware measurement" is output.

The following steps can be taken to avoid this problem:

- When taking measurements with the second probe (MT = 2), program PCA and**/**or 611D axes only.
- In mixed operation 611D**/**PCA with SPC**/**HMS, program "first probe input" (MT = 1) and "negative edge" (MF = 1) only.

Alarm 1076* is also output if the active measuring system is switched over when measurements are in progress.

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12.30 Master/slave for drives, SW 4.4 and higher, option

The function master/slave for drives consists of the options:

- Master/slave basic package (speed setpoint coupling without torque compensation)
- Master/slave torque compensation control (master/slave operation)

The master/slave basic package and the torque compensation control is described below. The torque compensation control function is based on the basic package.

12.30.1 Corresponding data

Data for the basic package

NC MD 523*	
NC MD 1336*	
NC MD 1812*	Bit 4
	Bit 7
NC MD 2700*	

Interface	DB 31
Interface	DB 32
Alarm	1012*
Alarm	1056*
Alarm	2019*
Alarm	2086*

Additional data for torque compensation control

NC MD 1288*	
NC MD 1340*	
NC MD 1384*	
NC MD 1812*	Bit 5
	Bit 6
NC MD 2701*	
NC MD 2702*	
NC-MD 2703*	
NC-MD 2704*	

General notes

"Master/slave operation" is required for the following applications to which different principles apply:

- **For power gain:**

  In this case, two or more drives are securely coupled to an output shaft mechanically (e.g. to the main machining spindle). This application is defined when a machine is planned and cannot be changed during operation or only with difficulty. Master/slave operation remains unchanged during the entire operating time of the machine (**power-on** functionality).

- **For supporting a mechanical coupling:**

  To support the control in the "temporary mechanical coupling" of two (or more) drives, e.g. synchronous spindle operation during a parting operation or mechanical coupling of two normally independent machine tables by means of bolts, clamps and the like. This application is activated and deactivated during operation and is only active while there is a "mechanical coupling" (**on-line** functionality).

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12.30.2 Difference to synchronous spindle/GI

Unlike the synchronous spindle or GI, master/slave operation is no substitute for a mechanical link but can only support torque distribution where a mechanical coupling exists. Master/slave operation is not advisable where there is no fixed mechanical coupling because then there can be no torque distribution over a common mechanical link.

While master/slave operation can provide a speed and/or torque coupling of several drives, GI and synchronous spindle operation are used to implement positional coupling of several drives. The functions GI and synchronous spindle provide a position reference between the leading and the following drives and monitor it. Without compensation controllers, the leading and following axes involved are each responsible for executing motions that do not violate the contour.

If master/slave operation is activated (leading axis LA = master, following axis FA = slave), the position reference between the leading and the following axes is lost if they are not mechanically coupled.

There is no position difference control, only coupling at the speed/torque level.

12.30.3 Function description

The control structure of master/slave operation is shown in the following diagram: the speed setpoint N_{set} of the master is output directly to the slave. For clarity's sake, only one slave is shown. If there are several slave drives they all receive the speed setpoint of the master. Cascading (where a master in speed setpoint coupling is itself a slave) is not permissible. Any existing position control of the slaves is automatically deactivated. When the speed setpoint of the master is transferred, internal normalization to the same **load speed** is performed. This makes different motor speeds of master and slave possible.

In addition, it is possible to use a torque compensation controller for better torque distribution (especially during acceleration). However, this requires a SIMODRIVE 611D because with analog drives, the torque setpoints are not available in the position control.

The outputs and inputs of the torque compensation controller can be connected as required. In the simplest case, as shown in the diagram, the torque setpoints of the **master** and slave are used as input variables (if there are several slaves: star-shaped configuration) and the output is injected with reversed polarity as an additional speed setpoint to the master **and** to the slave. If there are several slave drives it is possible to use the torque setpoint of a further **slave** as an input instead of the master torque setpoint. This slave is then the master of the torque compensation control (chain structure).

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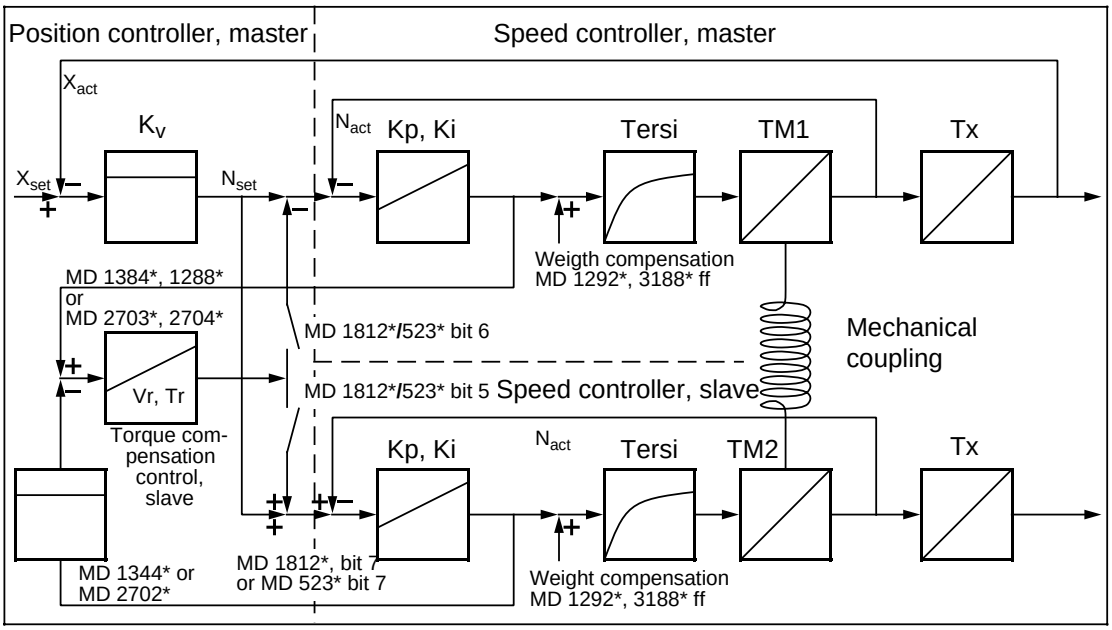
The output can now be injected either **only** to the slave or **only** to the master of the torque compensation control (see switch in the diagram).



Structure of master/slave with torque compensation control

Static pretensioning torques can be set on the master and the slave with electrical weight compensation (MD 1292*, MD3188*) of the parameter set. This torque is not eliminated by the torque compensation controller. There is no equivalent machine data for spindles.

Setting the speed control parameters

The installation of the speed control loop described in Section 9.1.3 is performed separately for the master and the slave drives. If all drives are mechanically coupled all the time, the drives not involved must be disabled, e.g. via terminal 663. These drives then also rotate as inertial masses. If the mechanical coupling is made via a wormgear it might be advisable to operate all axes not involved by actual-value coupling via an ELG grouping.

The speed control gains that can be achieved are adapted via the ratios of the moments of inertia.

Example:

Master/slave grouping with three drives

Drive 1: J_{to}= 50 · 10^{-4} kgm^2; K_P= 6 Nms/rad, T_N=10ms; K_P/J_{to}=1200
Drive 2: J_{to}= 100 · 10^{-4} kgm^2; K_P= 10 Nms/rad, T_N=10ms; K_P/J_{to}=1000
Drive 3: J_{to}= 200 · 10^{-4} kgm^2; K_P= 20 Nms/rad, T_N=10ms; K_P/J_{to}=1000

The smallest factor K_P/J_{to} now determines the further adaptation of the speed control gain.

rive 1: $K_{P_{new}} = J_{to} \cdot \left(\frac{K_P}{J_{to}}\right)_{min} = 50 \cdot 10^{-4}\text{kgm}^2 \cdot 1000 = 5$ Nms/rad
Drive 2: $K_{P_{new}}$=10 Nms/rad
Drive 3: $K_{P_{new}}$=20 Nms/rad

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Parameterization with the NC machine data

The slave is parameterized via the NC machine data. This is only a short list with a few notes relevant to the function:

Basic package

MD axis**/**MD spindle
MD 1336***/**2700*
MD 1812*, bit 4**/***523* bit 4:
MD 1812*, bit 7**/***523* bit 7:

Additional MDs for torque compensation control

MD axis**/**MD spindle
MD 1340***/**2701*
MD 1344***/**2702*
MD 1384***/**2703*
MD 1288***/**2704*
MD 1812*, bit 5**/***523* bit 5:
MD 1812*, bit 6**/***523* bit 6:

With MD 1344***/**2702*, the input quantities of the torque compensation control are weighted to permit a parameterizable torque distribution over both drives.

The most uniform torque distribution even during acceleration is obtained if the torque compensation controller does not have to intervene in the command behaviour. If identical motors are used with identical drive parameterization and they all have to output the identical torque, the standard parameterization of 500‰ is the best setting. This is also recommended where master**/**slave operation gives the best results.

If the motors are different, the user can decide whether both motors are to output the same torque or whether the torques are to be distributed according to the moments of inertia or rated torques. Distribution according to the moments of inertia of the motors is recommended with the aim of achieving the same ramp-up time for both drives.

The standard parameterization of 500‰ results in a distribution according to values in **drive machine data** 1725 (normalization of the torque setpoint interface) for both axes. For another distribution, the MD 1344***/**2702* must be calculated according to the following formula:

$$\text{NC MD 1344*/2702*} = \frac{M_{desired_{slave}}}{M_{desired_{slave}} + M_{desired_{master}} * \frac{MD1725_{slave}}{MD1725_{master}}} \cdot 1000‰$$

$M_{desired}$ is the ideal torque distribution between master and slave.

The torque compensation control can be connected as required via MD 1340***/**2701* and 1812***/**523*. If MD 1336* and 1340* are set differently it is possible to implement a chained multi-slave structure. However, it is up to the user to make sensible parameterization. In the system software a check is only made that the drive in question can provide its torque setpoint (SIMODRIVE 611D).

The control output parameterized in bits 5 and 6 of the axial MD 1812* acts either on the master or the slave. With the default setting 0 in these bits, the switches in the diagram are open.

With bit 7 in MD 1812***/**523*, it is possible to take account of different ways of connecting the slave drive to the common output without having to change the polarity of the control and the direction of travel of each axis. All the relevant signs of the slave are inverted.

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12.30.4 Activating/deactivating the master/slave torque compensation control

Master/slave operation is activated and deactivated via the PLC signals in the DB32 or DB31 of the slave in question. In this way, it is possible to achieve both power-on functionality and switchability using the PLC user program.

Alternatively, it is possible to configure slave operation to take effect straight after power-on with bit 4 of MD 1812*/523*. This setting is only intended for the power gain application described above. This mode can only be deactivated by reparameterization of the bits followed by Power Off.

The feedback signal "Slave operation active" is placed in status word DB31/DB32 for spindle or axis. A traverse command for a slave axis causes an alarm. After deactivation of slave operation, it is possible to traverse the axis again (in the part program: matching the actual position with G200).

With the exception of the function generator operation on the SIMODRIVE 611D, the slave follows all motions of the master drive with speed coupling. For the master, it is therefore still possible to select all modes. The **switchover to slave mode** via the PLC signal is only possible in certain modes. These are the main modes:

- Control mode
- (C)-axis mode
- (C)-axis mode with GI
- Synchronous spindle following mode

Switchover is not allowed in:

- Oscillating mode
- Positioning mode (M19)
- Function generator mode
- During motion to a fixed stop.

In the last modes, a request for slave operation by the PLC signal is ignored. The request is ignored and the status bit "Slave operation active" is not set.

In the opposite case, the same procedure is followed, i.e. the mode master/slave first selected is retained. A function generator start is rejected. A request to travel to fixed stop and a mode change of the slave to reciprocation or position mode causes alarm 1056* and 2086*.

A mode change to spindle/C-axis mode is permissible, the user must make sure that the various machine data and PLC control signals are active.

If traversing to a fixed stop is selected in the master, it is necessary to ensure that the torque compensation controller sets the torque of the slave such that it maintains the parameterized torque ratio with the master statically, but that the slave is able to output much higher torques dynamically. However, this is only possible if the output of the torque compensation controller is set to the output of the slave (Bit 5 in MD 1812*/523*=1).

If a GI coupling of the two axes exists in addition to master/slave operation, synchronism monitoring remains active. The position reference can thus be checked by the user. The same applies to synchronous spindle operation. If correctly configured, switchover between following axis/following spindle operation and slave operation is performed smoothly until the synchronism error is eliminated.

If master/slave torque compensation control is active, the compensation controller must be deactivated because synchronism deviations cannot be eliminated. An integral-action in the compensation controller would then drift away and cause synchronism errors when the gear coupling is reactivated (master/slave deactivation).

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For the master, function generator operation is also permitted in the SERVO and in the SIMODRIVE 611D (start-up functions). Measurement of the position control loop (SERVO) is made with the speed and torque coupling active. With measurement functions in the SIMODRIVE 611D (speed and current control loop), however, only the torque compensation controller is active. Its output must therefore be connected to the slave (bit 5 of MD 1812*/523* = 1), if measurement is performed with offset > 0.

As an alternative to the start-up functions, it is possible to deactivate the slave operation as well and configure a GI actual-value coupling instead. The function generator operation is also permitted for GI leading axes.

12.30.5 Response in the event of an error

In error states (alarms with request for "correction") in the master and/or slave, both drives must be deactivated together otherwise one of them might attempt to output all the required torque by itself. In this case, distortion or torsion in the workpiece would be avoidable. The drives are shut down via SERVO-internal communication in the IPO cycle.

The way in which deactivation is performed can be determined by the user using the familiar delay times:

If torqueless operation is to be activated immediately, the "OFF delay for servo enable" (MD 156) and "Delay servo enable" (MD 1224*) must be set to 0. The global MD 156 only applies if the axial MD 1224* is 0 and must therefore be set to 0. In this case, the servo enables of the drive are cancelled immediately. To prevent the drive performing regenerative braking, the drive machine data 1404 must be set to 0. The axis then coasts to rest.

If active braking is only to begin after a certain delay (with the torque of the still intact slaves or of the master), this time must be parameterized to be the same for all slaves and for the master in MD 1224*. It is up to the user to do this.

On spindles there is an option of braking the speed setpoint via a ramp and then disabling the controller. Here too, the user must parameterize identically for all spindles of a master/slave grouping.

Note:

"Extended stopping and retracting" (ESR), if programmed, cannot be taken into account for the reason described above as soon as one axis of a master/slave grouping fails. The following table shows an overview of the alarm responses:

Error occurs:	1.) Normal functionality without ESR	2.) ESR active for master and slave
Master:	Immediate initiation of follow-up control with the parameterized stopping times	Immediate initiation of follow-up control with the parameterized stopping times
Slave:	Immediate initiation of follow-up control with the parameterized stopping times	Immediate initiation of follow-up control with the parameterized stopping times
Other axis in the mode group:	Immediate initiation of follow-up control with the parameterized stopping times	Master + slave: configured ESR, master/slave is **retained**.

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So that all axes of a master**/**slave grouping exit the follow-up control at the same time, they must be reset internally at the same moment. For this reason, all axes of a master**/**slave grouping must be defined in the same mode group.

Incorrect parameterization of the master**/**slave torque compensation control causes the alarm 1012***/**2019* "Parameterization error NC-MD" and the service number 330.

Change from SW 5, position-controlled follow-up in the event of an error

SW 5 gives the user the option of setting bit 3 in MD 1812* (or 523* for spindles) to initiate switchover to position-controlled follow-up for following axes (FA) in the event of an error. This function must not be used if the master is also the leading axis for the slave because this creates an unstable control loop.

Error occurred during:	1.) Normal functionality without ESR	2.) ESR not active, axes are FA and MD 1812*, bit 3=1	3.a) ESR active, axes are not FA or MD 1812*, bit 3 = 0	3.b) ESR active, axes are FA and MD 1812*, bit 3=1
Master	Immediate initiation of follow-up with parameterized stopping times	Transition to controlled follow-up	Immediate initiation of follow-up with parameterized stopping times	Transition to controlled follow-up
Slave	Immediate initiation of follow-up with parameterized stopping times	Transition to controlled follow-up	Immediate initiation of follow-up with parameterized stopping times	Transition to controlled follow-up
Other axes in mode group	Immediate initiation of follow-up with parameterized stopping times	Transition to controlled follow-up	Master + slave: Configured ESR, no transition to controlled follow-up, master**/**slave **remains** intact	Master + slave: Configured ESR, no transition to controlled follow-up, master**/**slave **remains** intact

The axis for which the error occurred must always be followed up immediately.

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12.30.6 Effects on existing functions

Master**/**slave operation does not cause any function restrictions in the **master** except for the alarm handling described in the previous section. For the **slave**, the following changes must be taken into account because speed**/**torque coupling is used instead of NC-controlled motion setpoints:

- Zero-speed and contour monitoring are deactivated.
- The PLC status information traverse command +**/**- is not updated.
- In the NC service display, only the absolute actual position, the speed setpoint (0.01%) and the partial actual value need be correctly updated. If the slave drive is a GI following axis or a following spindle the error synchronism is also updated. Other information such as the following error are modelled or generated from the NC setpoint that is not relevant to the real motion of the axis**/**spindle.
- In slave operation, no compensations should be active. The individual effects are:
  – Quadrant error compensation: the correction value from the master is transferred to the slave via the speed setpoint coupling. The compensation value of the slave is not used.
  – Tacho compensation: the tacho compensation is deactivated internally.
  – Leadscrew error compensation, interpolatory compensation with absolute values: This actual value is still corrected but not used for control.
  – Backlash compensation corrects the actual value in accordance with the setpoint from the NCK and is therefore automatically inactive. Depending on the traverse motion of the master, the actual position is therefore incorrect by the amount of the backlash. After the backlash compensation has been written, the interface signal "Reference point reached" is cleared.
  – Semi-automatic drift compensation: In slave operation, the drift is always calculated with respect to 0. This function must not be activated by the user during slave operation.
- A mode change might possibly not be performed (see Section ”Activation**/**Deactivation”).
- The ramp function generator rapid stop function from the PLC in the slave is ignored in the speed setpoint. The ramp function generator rapid stop function from PLC in the master causes rapid stop of the slaves via the speed setpoint coupling. The PLC signal in the **Master of the torque compensation controller, MD 1340*/2701*** is decisive for deactivation of the torque compensation controller. This might be another slave in a chain configuration (see Section ”Function description”). It is therefore advisable to activate the ramp function generator rapid stop signal from the PLC (DB29, DB31) for all axes**/**spindles of a master**/**slave grouping simultaneously.

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12.31 Dynamic SW limit switches for following axes

12.31.1 Corresponding data

- MD 560*, bit 1 Dyn. SW limit switches for following axes
- MD 560*, bit 5 Software limit switches active
- MD 3932* Deadtime compensation for dyn. SW limit switches
- MD 3936* Minimum reduction factor for dyn. SW limit switches
- DB32 DR[K], bit 3 Axis is in reduction range
- DB32 DR[K+1], bit 2 Dynamic SW limit switch monitoring passive
- DB10 ... 15, DR0. bit 0 Path speed of channel not reduced

General

- **Behaviour of following axis without monitoring**

  If a gear interpolation is active in the SINUMERIK 840C, then the software limit switch for the following axis is monitored only when the actual position is exceeded. If the following axis crosses the limit switch, a servo alarm (148* to 152*) is output and the axis grouping braked. In this case, the axis travels a long distance passed the limit switch depending on its speed.

- **Behaviour of following axis with monitoring**

  The purpose of the function is to monitor the position of the following axis continuously and, if required, to reduce the path speed of the channels in the mode group such that the following axis travels only a short distance past the switch. The axis grouping is not separated.

12.31.2 Description of function

- **Sequence**

  The SW limit switches for following axes are monitored only if

  – MD 560*, bit 1 = 1 "Dyn. SW limit switches for following axes"
  – MD 560*, bit 5 = 1 "Software limit switches active"
  – Axis is referenced
  – Axis is following axis when gear interpolation is active
  – C axis in C axis mode, not spindle mode
  – PLC signal to axis, bit 2 = 0: "Dynamic SW limit switch monitoring passive"
  – PLC signal to channel, bit 0 = 0: "Path speed of channel not reduced"

  The axis-specific PLC signal "Dynamic SW limit switch monitoring passive" allows the user to switch the monitoring function on and off. The signal to channel "Path speed of channel not reduced" determines whether the path speed of the channel is reduced.

- **Reduction range**

  A braking path is calculated for each following axis from the max. velocity V_{max} and the max. acceleration A_{max} in the machine data. This braking path represents an area in front of the software limit switches that is referred to as "reduction range" below. The reduction range is always re-calculated after the machine data have been changed.

$$\text{Reduction range} \quad (V_{max} * V_{max}) \,/\, 2 * A_{max}$$

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The reduction range represents a safety area. As soon as the following axis is positioned in the reduction range, the path speed of the channels is reduced. Since the speed set for the following axis in the next IPO cycle is not known, the path speed of the channels must be restricted by means of the reduction range for safety reasons.

- **Deadtime compensation**

  The setpoint position of the following axis is checked in every IPO cycle to establish whether it is within the reduction range. The system is designed such that several IPO cycles elapse before changes to the setpoints of a leading axis are output to the setpoint controller of the following axis. To compensate this deadtime, the setpoint position is corrected by the predicted path. The deadtime and thus also the compensation value are dependent on the gear interpolation link type. The deadtime is 2 IPO cycles for the setpoint link. A deadtime of 5.5 IPO cycles is recommended for the actual value link.

- **Calculation of reduction factor**

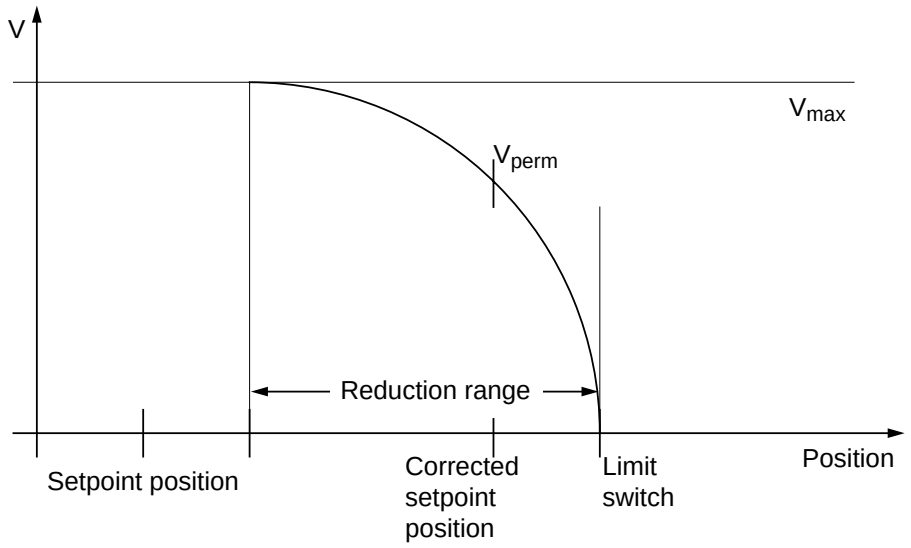
  The distance between the deadtime-compensated setpoint position and the active limitations is calculated. The active limitations are the innermost limit values as defined by the working field boundary and the selected SW limit switch. If the distance **d** is smaller than the reduction range, the braking operation must be initiated. For this purpose, a permissible velocity value V_{perm} calculated from the distance to the SW limit switch and the max. acceleration value A_{max}.

$$V_{perm} = \sqrt{2 * d * A_{max}}$$

  A reduction factor is calculated from V_{perm} and V_{max} and transmitted to the mode group channels. In a similar way to an override, the reduction factor is included in the path velocity calculation in all mode group channels.

$$\text{Reduction factor} = V_{perm} / V_{max} * 100$$

  Diagram showing reduction range in front of a limit switch:



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It is possible to define for each individual channel whether or not its path speed must be reduced by means of the PLC signal to channel "Do not reduce channel".

If a following axis is positioned within the reduction range, then the appropriate interface signal: "Axis is in reduction range" is set. The PLC can transmit a message in response to the output signals.

The display of the reduction factor and feed override * reduction factor can be configured on the NC workstation WS800A. The reduced path feed of the channels is displayed in the AUTOMATIC basic screen.

The minimum limit of the reduction factor corresponds to the value in MD 3936*. The SW limit switch is approached with this minimum reduction factor. If the switch is reached, the channels are braked at the max. acceleration rate and the reset alarm 148*/152* "SW limit switch plus/minus" is output. The machining operation is halted. The axis is now positioned behind the limit switch. The axis grouping remains intact.

MD 3936* "Minimum reduction factor" makes it possible to limit the distance traversed by the axis passed the SW limit switch. 1 % corresponds to 100.

The following **start-up** procedure is recommended:

– Set "Min. reduction factor" to 1 %
– Traverse following axis at max. speed with monitoring of SW limit switch active
– If the distance by which the axis traverses past the SW limit switch is too large, then the reduction factor must be decreased.

- **Retraction**

  Retraction is possible only in the direction opposite to traversing. On the return path up to the SW limit switch, the minimum reduction factor stored in MD 3936* is applied. From this point onwards, the reduction factor is calculated in exactly the same way as for travel towards to the SW limit switch, i.e. the reduction range is also effective when the axis is moving away from the limit switch.

- **Movements near the SW limit switch**

  The reduction factor always causes a reduction in the path speed when the following axis is within the reduction range, even if it has not crossed the SW limit switch.

- **G33 thread cutting**

  If the following axis enters the reduction range during thread cutting, then the spindle speed is braked causing a dynamic lead error. The alarm "Stop during thread cutting" is output.

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12.32 Collision monitoring (as from SW 6)

12.32.1 General description

The ”Collision monitoring” function prevents collision of moving and stationary parts of the machine.

A protection zone (abbreviation SR) can be defined for a machine part requiring protection. The distance between protection zones is calculated in IPO cycles. If two protection zones come close, the axes involved are braked to zero speed.

For technical reasons, it is impossible to guarantee that the distance between the protection zones is equal to 0 mm when the axes are stopped. The where will necessarily be a small overlap between the protection zones (less than 1 mm). We therefore recommend that you do not dimension the protection zones exactly round the machine parts but allow a safety zone of approximately 1-2 mm.

12.32.2 Defining a protection zone

The protection zones in collision monitoring are defined as cuboids. Starting from a machine reference point M for stationary of F for moving protection zones, the protection zone reference point P1 is defined. The protection zone coordinate system with its coordinates X, Y, and Z which is parallel with the axes of the machine coordinate system is in the protection zone reference point P1.

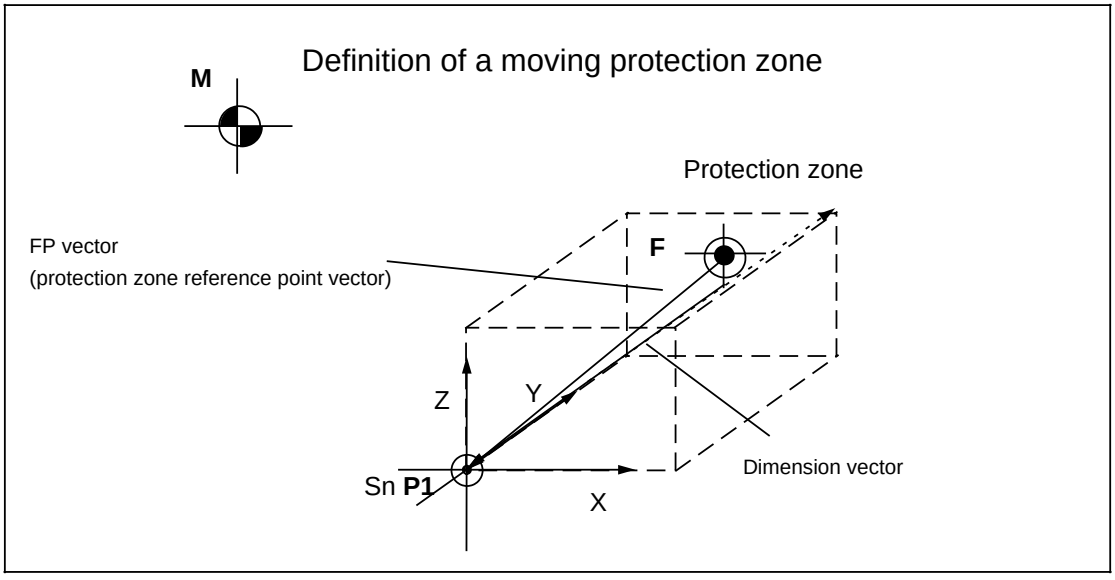
The dimensions of the protection zone must be specified as sections on the positive coordinates X, Y and Z of the protection zone coordinate system.

In the event of an error, alarm 111 ”Error in collision monitoring data” is output with the code:

04=protection zone dimensions missing

or

05=negative protection zone dimensions.



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It is also possible to define protection zones in two dimensions.
Two-dimensional protection zones that must be monitored mutually, must be defined in the same plane.

In the event of an error, alarm 111 ”Error in collision monitoring data” is output with the code

96=protection zones not defined in the same plane.

In the 3rd coordinate, the dimension of two-dimensional protection zones is assumed to be +/- infinite.

Protection-zone-specific machine data
FPI vector (protection zone reference point vector)

X coordinate:	MD 3812*
Y coordinate:	MD 3816*
Z coordinate:	MD 3820*

Dimension vector

X coordinate:	MD 3824*
Y coordinate:	MD 3838*
Z coordinate:	MD 3832*

12.32.3 Activation of collision monitoring of a protection zone

Collision monitoring is activated for each individual protection zone in machine data 3876* ”Protection zone exists”.

Because of the specific machine geometry, it might be necessary to model the geometric space that a machine part requiring protection occupies more precisely than is possible with a single protection zone.

To achieve a better approximation of the protection zone to the geometry of the machine part, it is possible to define several protection zones that describe the machine part section by section.

Because mutual monitoring of these spaces is not necessary, it can be deactivated for each protection zone in machine data 3880*-38921* ”No monitoring with reference to SR”. It is necessary to deactivate monitoring in the machine data of both protection zones.

In the event of an error alarm 111 ”Error in collision monitoring data” is output with code

03=Error in monitoring reference.

No monitoring with reference to SR

Protection zone exists:	MD 3876*.0

Do not monitor protection zone

SR1-SR8:	MD 3880*.0-7
SR9-SR16:	MD 3884*.0-7
SR17-SR24:	MD 3888*.0-7
SR25-SR32:	MD 3892*.0-7

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12.32.4 The motion axes of a protection zone

If a protection zone is to be able to follow a moving machine part, e.g. a tool slide, the real machine axes that move the machine part must assigned to the protection zone. These axes are the motion axes of the protection zone.

The axes must exist and be in the same mode group.

In the event of an error, alarm 111 ”Error in collision monitoring data” is output with the code

01=motion axis does not exist

or

02=motion axis not in the same mode group.

Protection-zone-specific machine data

X coordinate:	MD 3800*
Y coordinate:	MD 3804*
Z coordinate:	MD 3808*

12.32.5 Machine coordinate systems

To permit mutual monitoring of protection zones that are in different machine coordinate systems within a machine tool, the two coordinate systems must be transformed into a common coordinate system (monitoring coordinate system). The common coordinate system can be any machine coordinate system.

(Collision monitoring only works with the machine coordinate systems that are not rotated with respect to one another but only translated and**/**or mirrored.)

Each protection zone must therefore be assigned to a machine coordinate system by machine data.

Protection-zone-specific machine data

Machine coordinate system: MD 3840*

General machine data

Offset vector **2nd** machine coordinate system

X coordinate:	MD 337
Y coordinate:	MD 338
Z coordinate:	MD 339

Mirroring vector **2nd** machine coordinate system

(X, Y, Z):	gen. MD 5026, 0-2

Offset vector **3rd** machine coordinate system

X coordinate:	MD 340
Y coordinate:	MD 341
Z coordinate:	MD 342

Mirroring vector **3rd** machine coordinate system

(X, Y, Z):	gen. MD 5027, 0-2

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Offset vector **4th** machine coordinate system
X coordinate: MD 343
Y coordinate: MD 344
Z coordinate: MD 345

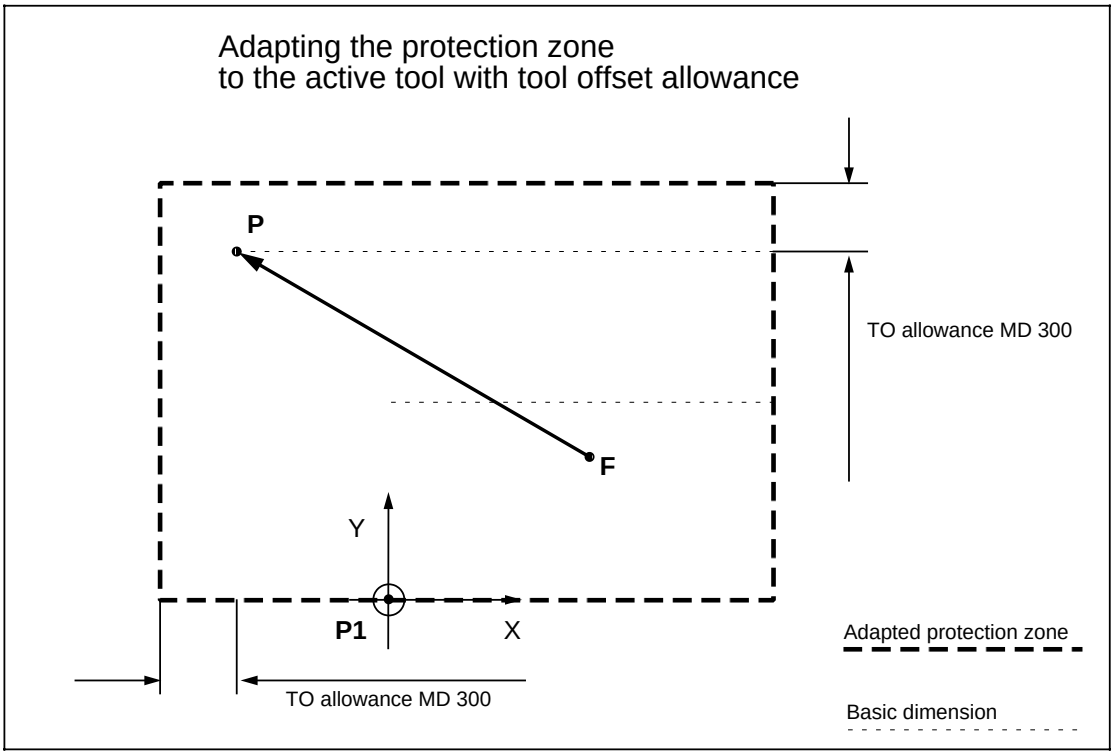
Mirroring vector **4th** machine coordinate system
(X, Y, Z): gen. MD 5028, 0-2

12.32.6 Adaptation of the protection zone to the active tool

The size of protection zone can automatically be adapted to the active tool of an NC channel.

If the tool tip **P** protrudes out of the protection zone defined in the machine data the protection zone is adapted in accordance with the tool offset data. If is adapted in such a way that the protection zone is enlarged on the basis of the basic dimensions defined in the machine data such that tool nose **P** is on the boundary of the protection zone.

With the general machine data MD 300* ”TO allowance” it is possible to enlarge the protection zone till further. The tool offset allowance is calculated into all the coordinates in which the tool offset value is not equal.



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The axes in which the tool offset in the NC channel is calculated and that of the protection zone coordinate that is to be adapted to it are assigned to one another in the axis-specific machine data MD 3938*.

Gen. machine data
TO allowance: MD 300

Axis-specific machine data
Coord. assignment: MD 3948*

12.32.7 Activating machine space adaptation

Because the active tool offset is defined within an NC channel, but a protection zone cannot be assigned permanently to an NC channel, this assignment must be made to depend on the machining situation using a G function.

G181 S<protection zone number>

The protection zone designator S and the ***<protection zone number>*** must be programmed immediately after the G function.

The G function is modal so that changes in the D number are automatically calculated.

To achieve collision monitoring without any delay in protection zone adaptation to the tool offset values, all relevant data must be specified in the part program block on tool change.

Example:

N100 **T<tool location No.> D<tool No.> G180<protection zone No.>**

Each channel can change the assignment of the channel to the protection zone and therefore protection zone adaptation at any time.

The tool offset number D0, Program end and RESET all have no effect on protection zone adaptation. Protection zone adaptation is only deactivated by the G function:

G180 S<protection zone No.>

The protection zone designator **S** and the ***<protection zone No.>*** must be programmed immediately after the G function.

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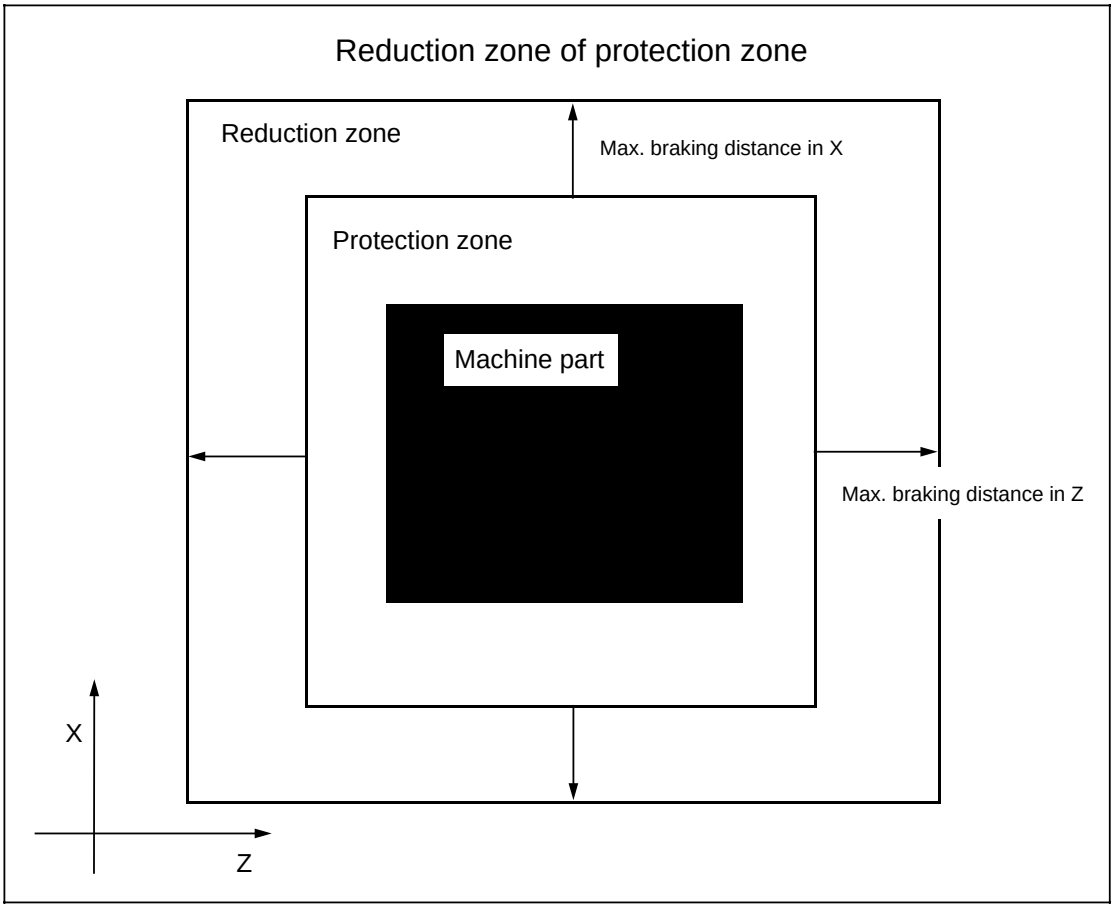
12.32.8 Reduction zone of a protection zone

Each coordinate of a protection zone that is assigned a motion axis has a reduction zone in this coordinate. The reduction zone is the distance around the protection zone within which it is only possible to traverse with a speed proportional to the distance from the protection zone.

The size of the reduction zone is equal to the maximum braking distance of the motion axis of the coordinate.



For each motion axis for which a reduction factor of less than 100% results, this is displayed in the axis-specific interface.

Formulas

Calculation of the max. braking distance of an axis

Max. velocity of the motion axis V_{max} in m/s
Max. acceleration of the motion axis a_{max} in m/s2

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Calculation of the number of acceleration steps to brake from V_{max} to 0 using a_{max}:

$$m = \frac{v_{max}}{a_{max}}$$; Integer component of the division

$$m_{remainder} = \frac{v_{max}}{a_{max}}$$; Remainder of the division

Calculation of the max. braking distance

$$S_{brake_max} = \frac{m \cdot (m-1)}{2} \cdot a_{max} + m_{remainder} \cdot a_{max} \cdot m$$

Axis-specific interface
Axis in reduction in reduction zone: DB32, DR k, bit 3

12.32.9 Reduction factor

The reduction factor is an internal override value which is added to the set path velocity of all channels of the mode group in which the motion axes of the protection zone are located.

It is calculated as a percentage representing the proportion of the distance between two protection zones.

Formulas

Calculation of the reduction factor of the protection zone S1 with respect to a second protection zone S2:

$$\text{Re } dfac_{S1} = \sqrt{\frac{S_{S1S2}}{S_{brake_maxS1} + S_{brake_maxS2}}} \cdot 100\%$$

with S_{S1S2}=distance between the two protection zones S1 and S2

Minimum reduction factor

If two protection zones collide the result is a reduction of 0%. This would prevent retraction from this situation. The axis-specific machine data ”Minimum reduction factor” can be used to set a lower limit for the reduction factor. It is then possible to retract the protection zones at the resulting velocity.

In the event of a collision the protection zone boundary is crossed with the velocity resulting from the minimum reduction factor. For this reason, the minimum reduction factor which depends on the maximum velocity of the axis must be selected to be as small as possible (1%).

Axis-specific machine data
Minimum reduction factor: MD 3936*

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12.32.10 Dead-time compensation

Because of the internal structure of the software, dead-time compensation must be performed for all motion axes functioning as ELG following axes. The dead time to be compensated is specified in the axis-specific machine data.

Dead times:

ELG following axes with setpoint coupling: 2 IPO cycles
ELG following axes with actual value coupling: 5.5 IPO cycles

Axis-specific machine data
Dead-time compensation value: MD 3932*

12.32.11 Protection zone collision

Because the internal traverse enable for the motion axes involved can only be canceled with a protection zone distance of zero, it is possible that the two protection zones might overlap as the result of a collision. The overlap is larger:

- the larger the IPO sampling time
- the larger the maximum velocity
- the larger the maximum reduction factor
- the smaller the acceleration
- the smaller the maximum jerk

It is therefore advisable not to fit the protection zones **exactly** round the machine parts to be protected.

By selecting appropriate values for the above parameters, especially the minimum reduction factor, it is advisable to achieve an overlap of less than 1 mm in any case.

Formulas

Calculation of jerk r, acceleration a and velocity v with respect to the path per IPO cycle.

$$r\left[\frac{mm}{T_{IPO}^3}\right] = r\left[\frac{m}{s^3}\right] \cdot \left[\frac{T_{IPO}^3\,[ms]}{10^6}\right]$$

$$a\left[\frac{mm}{T_{IPO}^2}\right] = a\left[\frac{m}{s^2}\right] \cdot \left[\frac{T_{IPO}^2\,[ms]}{1000}\right]$$

$$v\left[\frac{mm}{T_{IPO}}\right] = v\left[\frac{m}{min}\right] \cdot \left[\frac{T_{IPO}\,[ms]}{60}\right]$$

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12.32.12 Collision alarms

When two protection zones collide, the axis-specific alarm ”Protection zone collision plus**/**minus” is output for all the motion axes of the protection zones specifying the direction. After that, traversal of the motion axes in the direction of the collision is disabled until the axis-specific collision alarms have been acknowledged (retract from protection zones).

To retract in the opposite direction it is possible to traverse with the velocity resulting from the set velocity and the minimum reduction factor.

The collision of protection zones is displayed for each protection zone in the PLC interface DB48.

Axis-specific alarms
Protection zone collision plus: Alarm 1368*
Protection zone collision minus: Alarm 1372*

PLC interface
Protection zone collision: DB48, DW5 and DW7, bit 0 - bit 15

12.32.13 Deselection of collision of monitoring of a protection zone

Via PLC interface DB48 it is possible to deactivate monitoring of a protection zone. For safety reasons, the interface signal is LOW active.

PLC interface
Collision monitoring OFF: DB48, DW4 and DW6, bits 0 - bit 15 in each case.

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12.32.14 Example on a double-slide turning machine

On the example of a double-slide turning machine, let us look at the configuration of collision monitoring with a total of five protection zones.

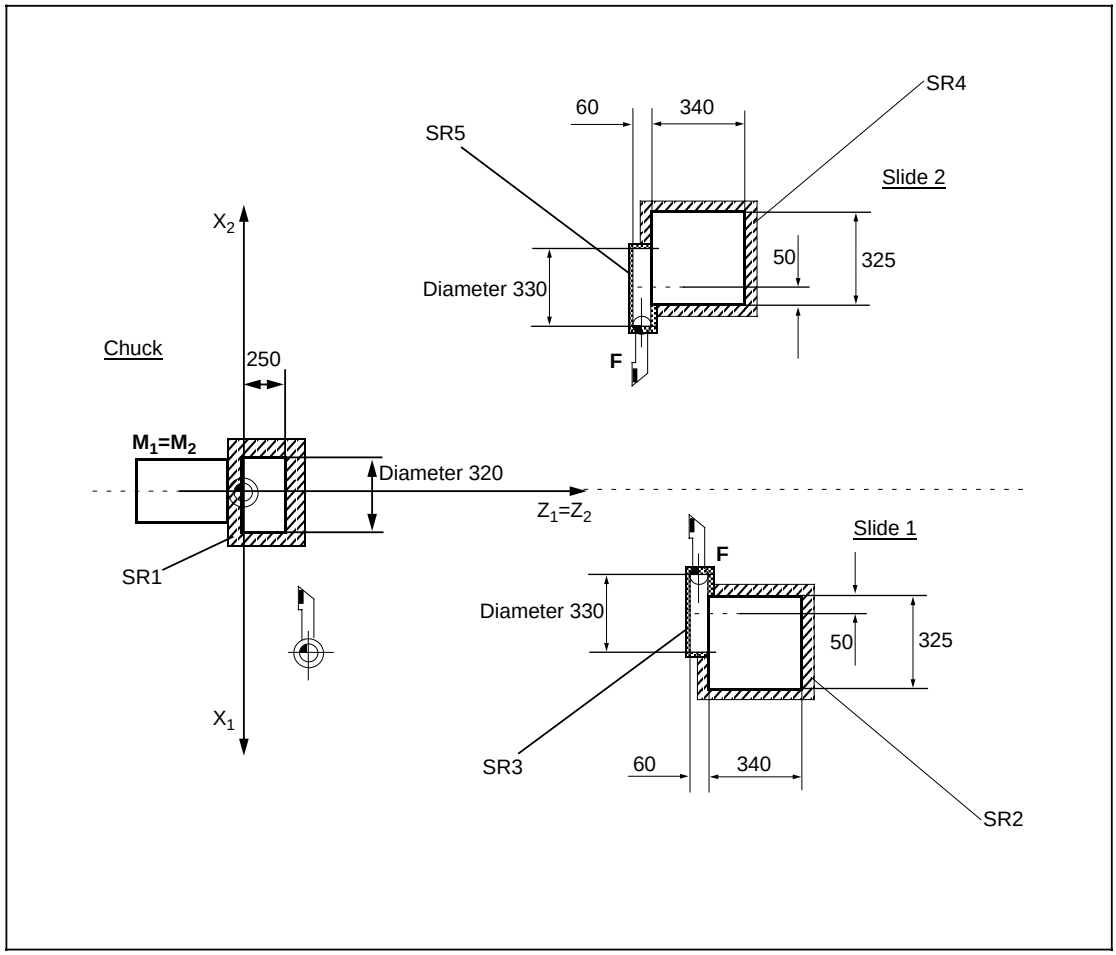
The input resolution is: 10^{-3} mm

The safety distance of a protection zone around the machine part is defined as 2 mm.

Slide 1 is moved through axes X1 (=1st axis) and Z1 (=2nd axis).
Slide 2 is moved through axes X2 (=3rd axis) and Z2 (=4th axis).

Slide 1 machines in front of, slide 2 behind the turning center. This results in two coordinate systems with the respective machine zeros M1 and M2 (M1=M2).

The X coordinate of the 2nd machine coordinate system is mirrored with respect to the X coordinate of the 1st machine coordinate system.



The collision machine data resulting from the dimensions in the example are listed on the following pages.

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- **Protection zone 1: Spindle chuck**

Protection zone data VALUES

Motion axes
X coordinate: MD 38000 = 0
Y coordinate: MD 38040 = 0
Z coordinate: MD 38080 = 0

FP1 vector
X coordinate: MD 38120 = -162
Y coordinate: MD 38160 = 0
Z coordinate: MD 38200 = -2

Dimension vector
X coordinate: MD 38240 = 324
Y coordinate: MD 38280 = 0
Z coordinate: MD 38320 = 254

Machine coordinate system
Number: MD 38400 = 1

Protection zone data BITS
Protection zone exists
SR exist.: MD 38760.0 = 1

Monitoring reference OFF
SR 1 - 8: MD 38800.0-7 = 00000000
SR 9 - 16: MD 38840.0-7 = 00000000
SR 17 - 20: MD 38880.0-7 = 00000000
SR 21 - 32: MD 38920.0-7 = 00000000

- **Protection zone 2: Slide 1**

Protection zone data VALUES

Motion axes
X coordinate: MD 38001 = X1
Y coordinate: MD 38041 = 0
Z coordinate: MD 38081 = Z1

FP1 vector
X coordinate: MD 38121 = 113
Y coordinate: MD 38161 = 0
Z coordinate: MD 38201 = 28

Dimension vector
X coordinate: MD 38241 = 329
Y coordinate: MD 38281 = 0
Z coordinate: MD 38321 = 344

Machine coordinate system
Number: MD 38401 = 1

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Protection zone data BITS
Protection zone exists
SR exist.: MD 38761.0 = 1

Monitoring reference OFF
SR 1 - 8: MD 38801.0-7 = 00000100
SR 9 - 16: MD 38841.0-7 = 00000000
SR 17 - 20: MD 38881.0-7 = 00000000
SR 21 - 32: MD 38921.0-7 = 00000000

Protection zone 3: Turret of slide 1

Protection zone data VALUES

Motion axes
X coordinate: MD 38002 = X1
Y coordinate: MD 38042 = 0
Z coordinate: MD 38082 = Z1

FP1 vector
X coordinate: MD 38122 = -32
Y coordinate: MD 38162 = 0
Z coordinate: MD 38202 = -332

Dimension vector
X coordinate: MD 38242 = 64
Y coordinate: MD 38282 = 0
Z coordinate: MD 38322 = 334

Machine coordinate system
Number: MD 38402 = 1

Protection zone data BITS
Protection zone exists
SR exist.: MD 38762.0 = 1

Monitoring reference OFF
SR 1 - 8: MD 38802.0-7 = 00000010
SR 9 - 16: MD 38842.0-7 = 00000000
SR 17 - 20: MD 38882.0-7 = 00000000
SR 21 - 32: MD 38922.0-7 = 00000000

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Protection zone 4: Slide 2

Protection zone data VALUES

Motion axes
X coordinate: MD 38003 = X2
Y coordinate: MD 38043 = 0
Z coordinate: MD 38083 = Z2

FP1 vector
X coordinate: MD 38123 = 113
Y coordinate: MD 38163 = 0
Z coordinate: MD 38203 = 28

Dimension vector
X coordinate: MD 38243 = 329
Y coordinate: MD 38283 = 0
Z coordinate: MD 38323 = 344

Machine coordinate system
Number: MD 38403 = 2

Protection zone data BITS
Protection zone exists
SR exist.: MD 38763.0 = 1

Monitoring reference OFF
SR 1 - 8: MD 38803.0-7 = 00010000
SR 9 - 16: MD 38843.0-7 = 00000000
SR 17 - 20: MD 38883.0-7 = 00000000
SR 21 - 32: MD 38923.0-7 = 00000000

Protection zone 5: Turret of slide 2

Protection zone data VALUES

Motion axes
X coordinate: MD 38004 = X2
Y coordinate: MD 38044 = -
Z coordinate: MD 38084 = Z2

FP1 vector
X coordinate: MD 38124 = -32
Y coordinate: MD 38164 = 0
Z coordinate: MD 38204 = -332

Dimension vector
X coordinate: MD 38244 = 64
Y coordinate: MD 38284 = 0
Z coordinate: MD 38324 = 334

Machine coordinate system
Number: MD 38404 = 2

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Protection zone data BITS
Protection zone exists
SR exist.: MD 38764.0 = 1

Monitoring reference OFF
SR 1 - 8: MD 38804.0-7 = 00001000
SR 9 - 16: MD 38844.0-7 = 00000000
SR 17 - 20: MD 38884.0-7 = 00000000
SR 21 - 32: MD 38924.0-7 = 00000000

Machine coordinate system

Machine coord. systems VALUES

Offset vector 2nd machine coordinate system
X coordinate: MD 337 = 0
Y coordinate: MD 338 = 0
Z coordinate: MD 339 = 0

Machine coord. systems BITS
Mirroring vector 2nd mach. coord. system
(X,Y,Z): MD5026.0 - 2 = 001

Axis-specific data
Coord. assignment of mach. data
1st axis MD 39480 = Abscissa
2nd axis MD 39481 = Applicate
3rd axis MD 39482 = Abscissa
4th axis MD 39483 = Applicate

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12.32.15 Collision monitoring (as from SW 6.3)

12.32.15.1 Additive protection zone adjustment via setting data

The additive protection zone adjustment is activated by the MD 3876* bit 1 specific to protection zones.

In order to be able to adjust a protection zone to dynamically changing machine geometries, the main dimensions of a protection zone (MD 3812*, 3814*, 3816*) are adjustable via instantly effective setting data bits.

There are two setting data bits per protection zone coordinate, one for each coordinate direction. The setting date is added to the main dimension of the protection zone and consequently enlarges the protection zone for the respective coordinate direction.

Consideration of the ”additive protection zone adjustment” takes place before the ”automatic protection zone adjustment to the active tool” (as from SW 6.1). If the current tool assigned to the protection zone still projects from the protection zone after the additive protection zone adjustment, then this adjustment is implemented automatically. If after the additive protection zone adjustment the tool is within the protection zone, no further adjustment incurs.

The values for the coordinates of the additive protection zone adjustment are to be entered in the setting data bit 800*, 804*, 808*, 812*, 816* and 820*.

Setting data specific to the protection zone can be written with @411.

12.32.15.2 Collision monitoring without reduction zone

The implemented safety concept will influence the entire mode group of the motion axes of the two protection zones by way of reduction factor of the collision monitoring on the approach to these two protection zones.

If two protection zones are positioned next to one another in such a way that their distance from one another is smaller than their deceleration distance then this will influence the traversing velocity of the entire mode group. In certain instances, this may be undesirable, e.g. if the corresponding machine parts (second slide, quill, steady) are to be ”parked” only temporarily to provide sufficient space around the workpiece during a machining situation. To switch off protection zone monitoring in this case is not a satisfactory solution since collision monitoring should be active during the entire machining period.

With the function ”Collision monitoring without reduction zone”, each protection zone can be individually extracted from the reduction factor calculation, i.e. its deceleration range with regard to collision monitoring will turn towards 0.

However, this will have the result that only from the moment of collision of two protection zones, for which this function is active, the respective mode groups will be influenced. The axes will then be brought to zero speed via **set value 0** instead of via the configured maximum accelerations.

The function is selected via the PLC interface DB 48, DW 74 and 76.

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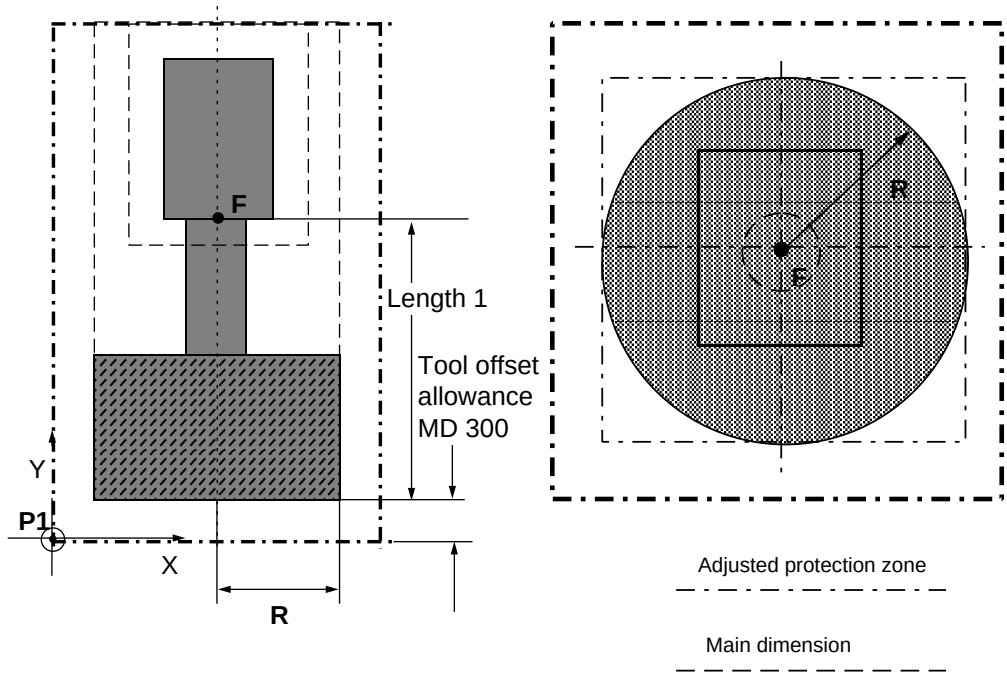
12.32.15.3 Automatic protection zone adjustment for tool types > = 20 (as from SW 6.3)

The automatic protection zone adjustment function for the active tool is extended to tool types > = 20.
The automatic protection zone adjustment is activated not only up to the tool tip but it now also encompasses the tool in all of its dimensions.

Adjustment of the protection zone to the active tool for tool types > = 20



The ”protection zone adjustment active” signal is set in the PLC interface DB 48, DW 75 and DW 77 when the protection zone dimensions are set larger than those specified in the machine data. Protection zone adjustment may have been implemented via automatic protection zone adjustment to the active tool (G181 and D number) and/or via the protection zone specific setting data for the additive protection zone adjustment. Differentiation is not possible at the PLC interface.

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12.33 Description of function of current and speed setpoint filters

12.33.1 Introduction

Owing to the complexity of setpoint filter applications, it is not possible to describe their scope of application in general terms at this point. The following section does, however, specify the criteria for selecting and parameterizing such filters.
We would recommend our drive system training courses to those interested in understanding the full range of possible applications for setpoint filters on mechanically critical machines.

Note

The sequence of operations for this function is described in Sections 9.1 and 9.2 in this documentation.

General application criteria

Filters are used

- to smooth the response curve
- to dampen mechanical resonance and
- to symmetrize axes with different dynamic response characteristics, especially in the case of interpolating axes.

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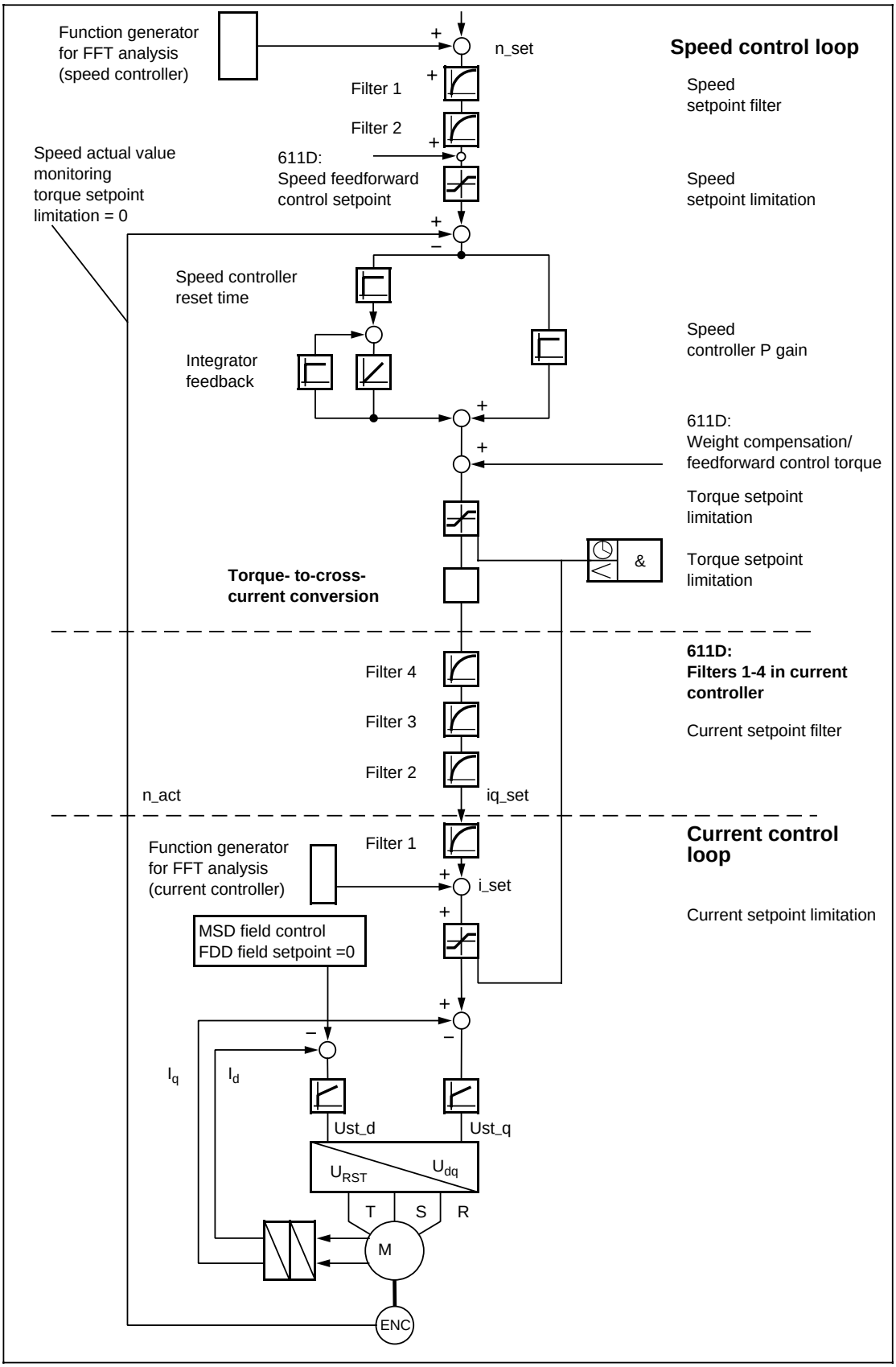

Fig. 12-1 Overview of speed and current control loops

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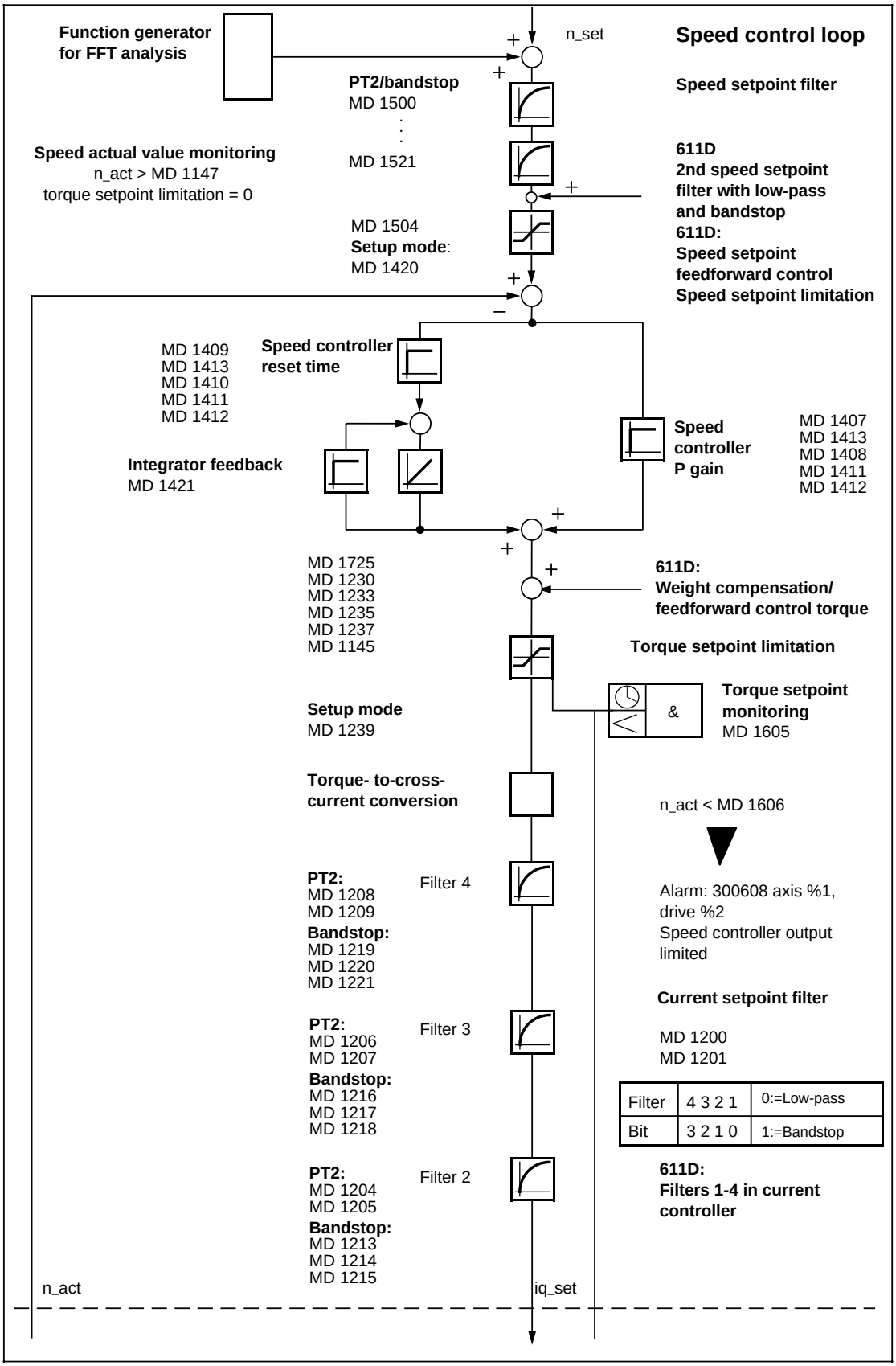

Fig. 12-2 Overview of speed control loop

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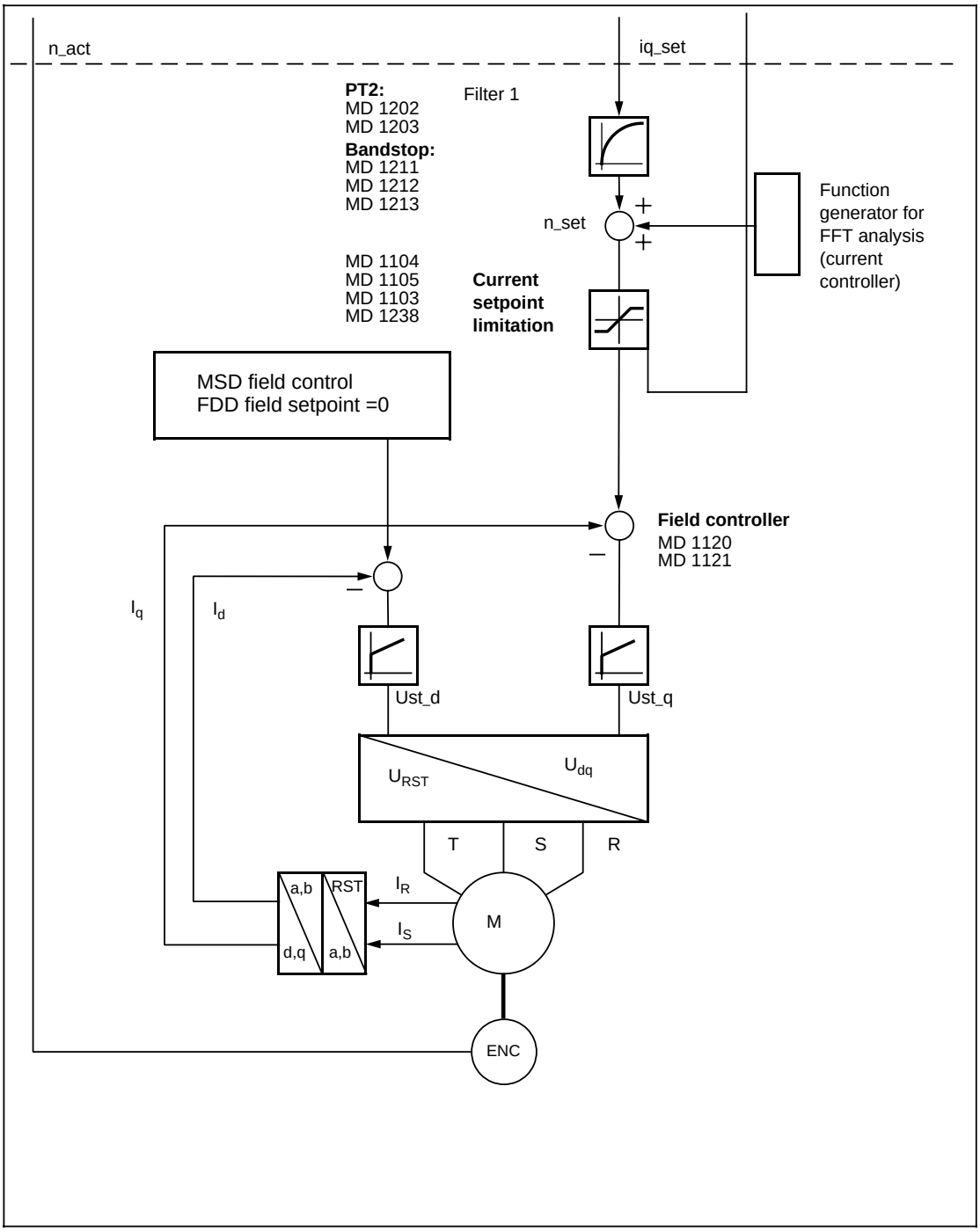

Fig. 12-3 Overview of current control loop

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12.33.1.1 Fourier analysis

The integrated Fourier analysis function provides you with a particularly effective tool for optimizing the speed controller. It allows you to assess the speed control settings and the mechanical properties of the machine.

To reach the Fourier analysis (frequency response method), please select Startup Drive servo startup Startup function .

The frequency response method supplies exact and reproducible results even with very low test signal amplitudes. You can adapt the measurement parameters to the individual application.

The results of the Fourier analysis are displayed in a Bode diagram. A Bode diagram consists of two graphs, i.e. the amplitude response curve and the phase response curve.

The phase is at 0 in the lower frequency range. It rotates to negative phase angles as the frequency increases. If the phase angle exceeds I180°I, the graph representation is reversed, i.e. it jumps from –180° to180° or from 180° to–180°.

12.33.1.2 Measurement range (bandwidth), measurement time

The bandwidth is calculated as follows on the SINUMERIK 840C/611D:

$$\text{Max. bandwidth} = \frac{1}{2 \times \text{speed controller clock cycle}}$$

The bandwidths are as follows depending on the speed controller clock cycle:

- Clock cycle= 62.5µs Bandwidth = 8 kHz.
- Clock cycle= 125µs Bandwidth = 4 kHz.
- Clock cycle= 250µs Bandwidth = 2 kHz.
- Clock cycle= 500µs Bandwidth = 1 kHz.

Owing to the short measurement times, traversing distances of a few mm are sufficient for the required response measurement. The measurement time is calculated as follows:

$$\text{Measurement time[s]} = \frac{512 \times \text{No. of averaging operations}}{\text{Bandwidth [Hz]}} + \text{settling time}$$

The measurement time is 6.5 seconds with 20 averaging operations. With an offset of 5 rev/min, a traversing range of less than 0.55 revolutions is required for the measurement.

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12.33.1.3 Measurement procedure

In order to optimize a cascaded closed-loop control structure (current, speed, position control loops), it is necessary to start with the innermost (lowest level) control loop, i.e. the current control loop. This is set optimally by means of operator command "**Calculate controller data**" and need not be optimized again by the user.

The speed controller is also preset by means of command **Calculate controller data**. This is a rough setting for the motor under no-load conditions and does not take account of mechanical components mounted on the motor.

Amplitude and offset settings

All measurements are carried out during the execution of an offset motion of a few (approximately 1 - 10) revolutions per minute on which a test signal amplitude (noise) of one to three revolutions is superimposed. The offset should always be greater (factor 2- 3) than the amplitude. At very low values, backlash or static friction may result in different results to those measured at higher traversing speeds. Very high amplitude values falsify the measurement results or may result in damage to mechanical components.

If you obtain very noisy results, you should increase the number of averaging operations or the amplitude. The accuracy increases in proportion to the selected number of averaging operations.

12.33.2 Optimization of speed controller

The following rules apply to optimization of the speed controller:

- The amplitude must equal 0 dB over the widest possible fundamental frequency range. The fundamental frequency range is the operating range up to the controller stability limit.
- Increase the P gain if the amplitude does not reach the 0 dB line.
- Decrease the P gain if the amplitude rises above the 0 dB line.
- A few dB above the ideal setting (max. 1 - 3 dB) are permissible.

The reference values for the speed controller frequency response can be defined as follows:

- Fundamental frequency range
  Approx. 200 Hz – 300 Hz
- Controller stability limit
  – 3dB attenuation in amplitude
  – 180˚ phase crossover
  Typical values for 611D without built-on mechanical components are:
  Speed controller: T = 62.5µs approx. 0.9 kHz
  T = 125µs approx. 0.5 kHz

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12.33.2.1 Machine data

MD 1001: Speed controller clock cycle
MD 1004: Configuration control structure
MD 1406: Speed controller type
MD 1407: P gain speed controller
MD 1408: P gain upper adaptation speed
MD 1409: Reset time speed controller
MD 1410: Reset time upper adaptation speed
MD 1411: Lower adaptation speed
MD 1412: Upper adaptation speed
MD 1413: Select adaptation speed controller
MD 1414: Natural frequency reference model speed
MD 1415: Damping reference model speed
MD 1416: Symmetrizing reference model speed
MD 1421: Time constant integrator feedback
MD 1665: Long-time factor IPO/NCONT cycle for ramp generator

12.33.2.2 Optimization of proportional gain of speed controller

The proportional gain is optimized as the first step in optimizing the speed controller. For this purpose, MD 1409: Reset time speed controller is set to 500 ms, effectively deactivating the integral-action component. The proportional component is then incremented until resonance points in the system are reached (motor begins to whistle). The P gain which is determined by this method must then be multiplied by a factor of 0.5. The product is then the start value for the first frequency response measurement.

12.33.2.3 Optimization of integral-action component (reset time) of speed controller

After the proportional gain has been determined, the reset time of the speed controller is decreased until the amplitude response begins to rise above the 0 dB line. An increase over the line of 3 dB is generally permitted. A value of < 20 ms is the target guide value for the reset time.

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12.33.3 Current setpoint filter

Current setpoint filters (low-pass or bandstop) are used to adapt the speed controller to the machinery to be controlled.

The amplitude of the speed controller frequency response should remain at 0 dB over the entire fundamental frequency range.

Note

The frequency response analysis of the **current controller** does not include the current setpoint filters. The effects of the filters can be detected only in the frequency response of the **speed controller**.

The following measures should be taken when filters are used.

- Record reference frequency response of speed control loop
- Determine points of resonance according to:
  No. of resonance points
  – Individual pronounced resonance points
  – Resonance bundles

  Position of resonance points
  – Fundamental frequency range
  – Controller stability limit
  – Frequency range above controller stability limit

  Properties
  – Distribution of resonance (dependent on traversing speed or direction)
  – Mechanical resonance or excessively high controller settings
  – Reflected resonance
  – Amplitude and phase margins

Note

- Reduce resonance caused by excessively high controller setting by adjusting controller parameters.
- Use filters only in the case of purely mechanical resonance. If it is possible to attribute resonance to specific mechanical components of the machine (load vibration, coupling, etc.), modifications to the machine construction should also be considered.

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12.33.3.1 Machine data

MD 1200: Number of current setpoint filters
MD 1201: Type of current setpoint filter
MD 1202: Natural frequency current setpoint filter 1
MD 1203: Damping current setpoint filter 1
MD 1204: Natural frequency current setpoint filter 2
MD 1205: Damping current setpoint filter 2
MD 1206: Natural frequency current setpoint filter 3
MD 1207: Damping current setpoint filter 3
MD 1208: Natural frequency current setpoint filter 4
MD 1209: Damping current setpoint filter 4
MD 1210: Blocking frequency current setpoint filter 1
MD 1211: Bandwidth current setpoint filter 1
MD 1212: Blocking frequency current setpoint filter 1
MD 1213: Counter bandwidth current setpint filter 2
MD 1214: Bandwidth current setpoint filter 2
MD 1215: Blocking frequency current setpoint filter 2
MD 1216: Counter bandwidth current setpint filter 3
MD 1217: Bandwidth current setpoint filter 3
MD 1218: Blocking frequency current setpoint filter 3
MD 1219: Counter bandwidth current setpint filter 4
MD 1220: Bandwidth current setpoint filter 4
MD 1221: Blocking frequency current setpoint filter 4

MD 1201: Type of current setpoint filter

1st filter	Bit 0	0	Low-pass (see MD 1202/1203)
		1	Bandstop (see MD 1210/1211/1212)
2nd filter	Bit 1	0	Low-pass (see MD 1204/1205)
		1	Bandstop (see MD 1213/1214/1215)
3rd filter	Bit 2	0	Low-pass (see MD 1206/1207)
		1	Bandstop (see MD 1216/1217/1218)
4th filter	Bit 3	0	Low-pass (see MD 1208/1209)
		1	Bandstop (see MD 1219/1220/1221)

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Possible filter combinations

Filter 4	Filter 3	Filter 2	Filter 1	MD 1201
PT2	PT2	PT2	PT2 = 0	0000
PT2	PT2	PT2	BS = 1	0001
PT2	PT2	BS	PT2	0010
PT2	PT2	BS	BS	0011
PT2	BS	PT2	PT2	0100
PT2	BS	PT2	BS	0101
PT2	BS	BS	PT2	0110
PT2	BS	BS	BS	0111
BS	PT2	PT2	PT2	1000
BS	PT2	PT2	BS	1001
BS	PT2	BS	PT2	1010
BS	PT2	BS	BS	1011
BS	BS	PT2	PT2	1101
BS	BS	PT2	BS	1101
BS	BS	BS	PT2	1110
BS	BS	BS	BS	1111

Note

Filter 1 is configured as a low-pass filter as standard.

12.33.3.2 Scope of application of low pass as current setpoint filter

Low-pass filters must be dimensioned such that resonance is kept reliably low while the filter effect on the fundamental frequency range is minimized.

Filter in the case of resonance in the fundamental frequency range

Resonance in the fundamental frequency range can normally be restricted by means of control parameters.

Note

Smoothing filters have a negative phase rotation (low-pass generally, bandstop for f < fs, fs = blocking frequency). This phase rotation can reduce the stability margin of the fundamental frequency range.

When a filter is used, therefore, the objective must be to obtain the optimum from

- desired damping action and
- minimum possible filter effects on the fundamental frequency range.

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Filter in the case of resonance at and above the controller stability limit

Low-pass

– With resonance bundle
– Distribution of resonance phenomena (dependent on traversing direction, speed)

Low-pass as current setpoint filter

A low-pass filter is the better solution in cases where a peak occurs in the amplitude response that is not linked to a fixed frequency, but wanders under different conditions. With a **low-pass** filter, the signal above the entered natural frequency is damped. Reduced damping results in less phase rotation below the natural frequency and thus to a greater phase margin.

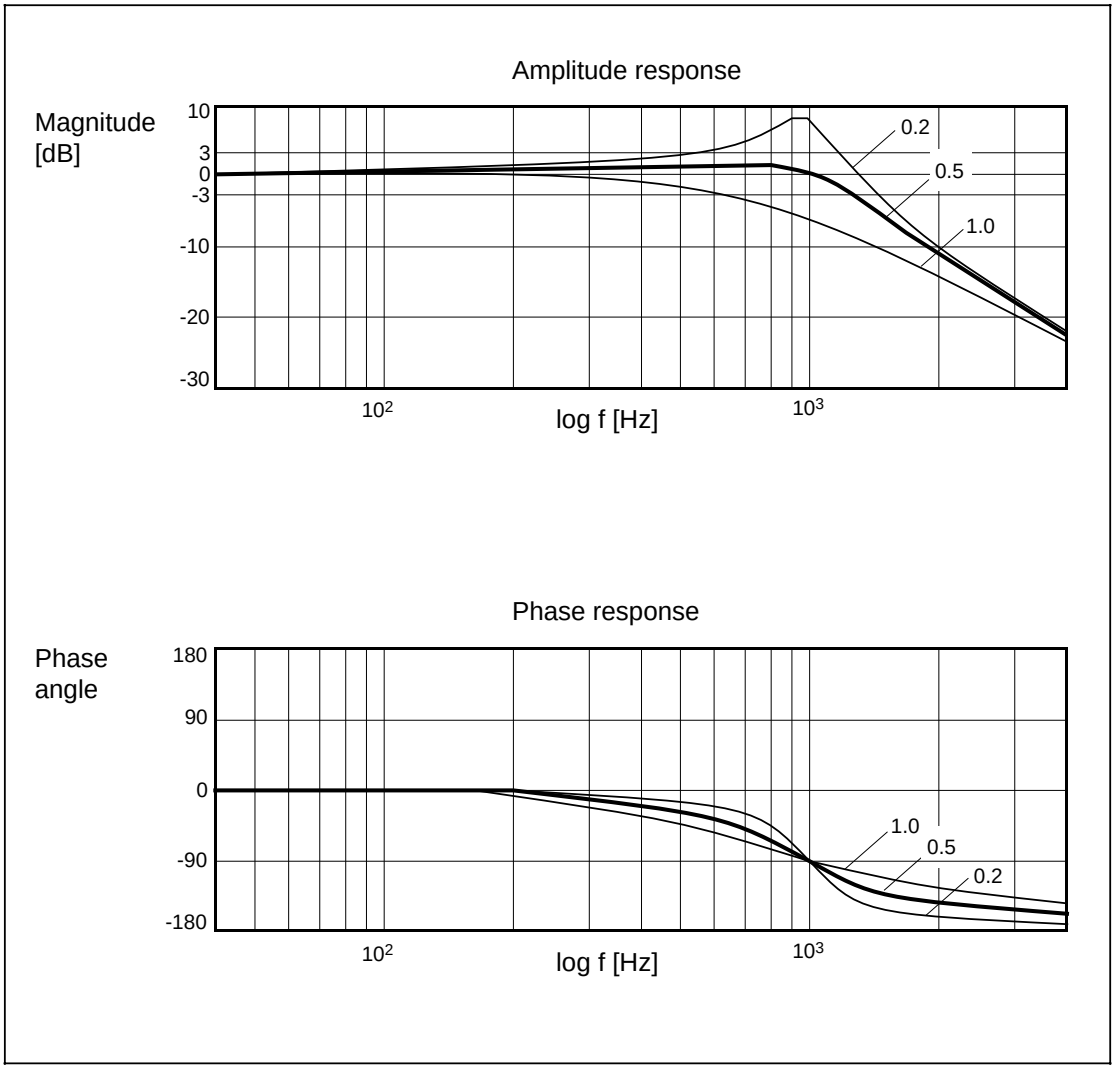

Fig. 12-4 Low-pass behaviour at natural frequency of 1000 Hz and variation in damping of 0.2, 0.5 and 1.0

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12.33.3.3 Scope of application of bandstops as current setpoint filter

Bandstop filters must be dimensioned such that resonance is kept reliably low while the filter effect on the fundamental frequency range is minimized.

Filter in the case of resonance in the fundamental frequency range

Resonance in the fundamental frequency range can normally be restricted by means of control parameters.

Filter in the case of resonance at and above the controller stability limit

Bandstop as current setpoint filter

Bandstops generally provide improved damping with the same phase rotation.

– Suitable in cases of pronounced mechanical resonance (peaks), no distribution of resonance phenomena.

– Blocking filters at frequencies above the controller stability limit may eliminate interference resonance in the fundamental frequency range.

A **bandstop** is used when a narrow, pointed peak exceeds the 0 dB line in the amplitude response at a fixed frequency (above the fundamental frequency range of the speed controller). This causes a clearly audible whistling noise in the drive train.

Depending on requirements, the bandstop can be set in two configurations.

- Simple bandstop with

  Blocking frequency: MD 1210 (filter 1), MD 1213 (filter 2), MD 1216 (filter 3), MD 1219 (filter 4)

  Bandwidth: MD 1211, MD 1214, MD 1217, MD 1220

- Bandstop with adjustable damping of amplitude response plus counter bandwidth: MD 1212, MD 1215, MD 1518, MD 1512

Note

The bandstop frequency of a current setpoint filter must be lower than the Shannon frequency (parameterization error). The bandstop frequency for filter 1 (MD 1210), filter 2 (MD 1213), filter 3 (MD 1216) and filter 4 (MD 1219) must be lower than the reciprocal of two current controller clock cycles.

$$\text{MD 1210, MD 1213, MD 1216, MD 1219} < \frac{1}{2 \times \text{MD 1000}}$$

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Examples of frequency responses

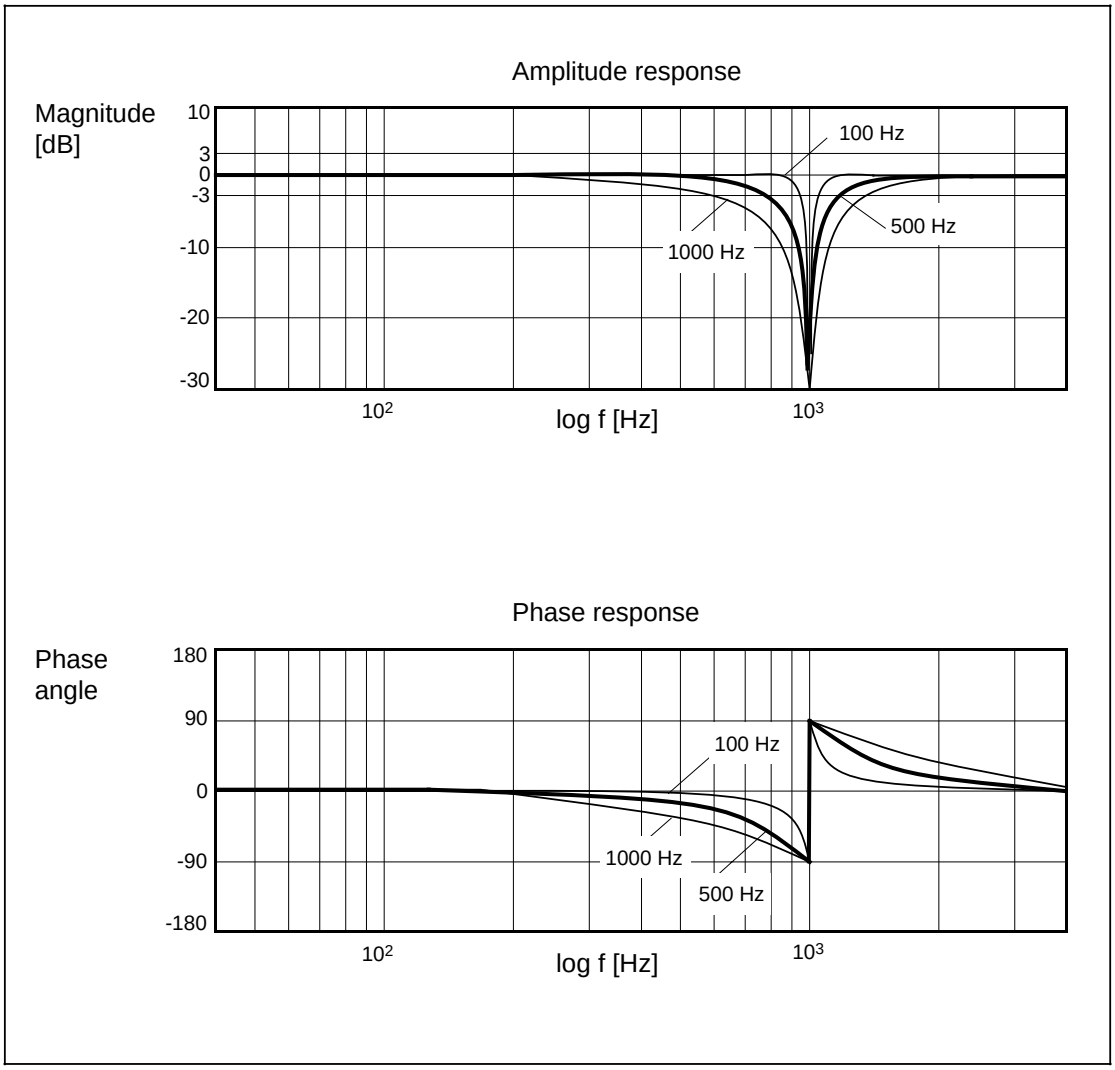

Fig. 12-5 Frequency response of undamped bandstop with blocking frequency of 1000 Hz and bandwidth variations of 100 Hz, 500 Hz and 1000 Hz.
The bandwidth is the difference between two frequencies with amplitude attenuation of 3 dB.

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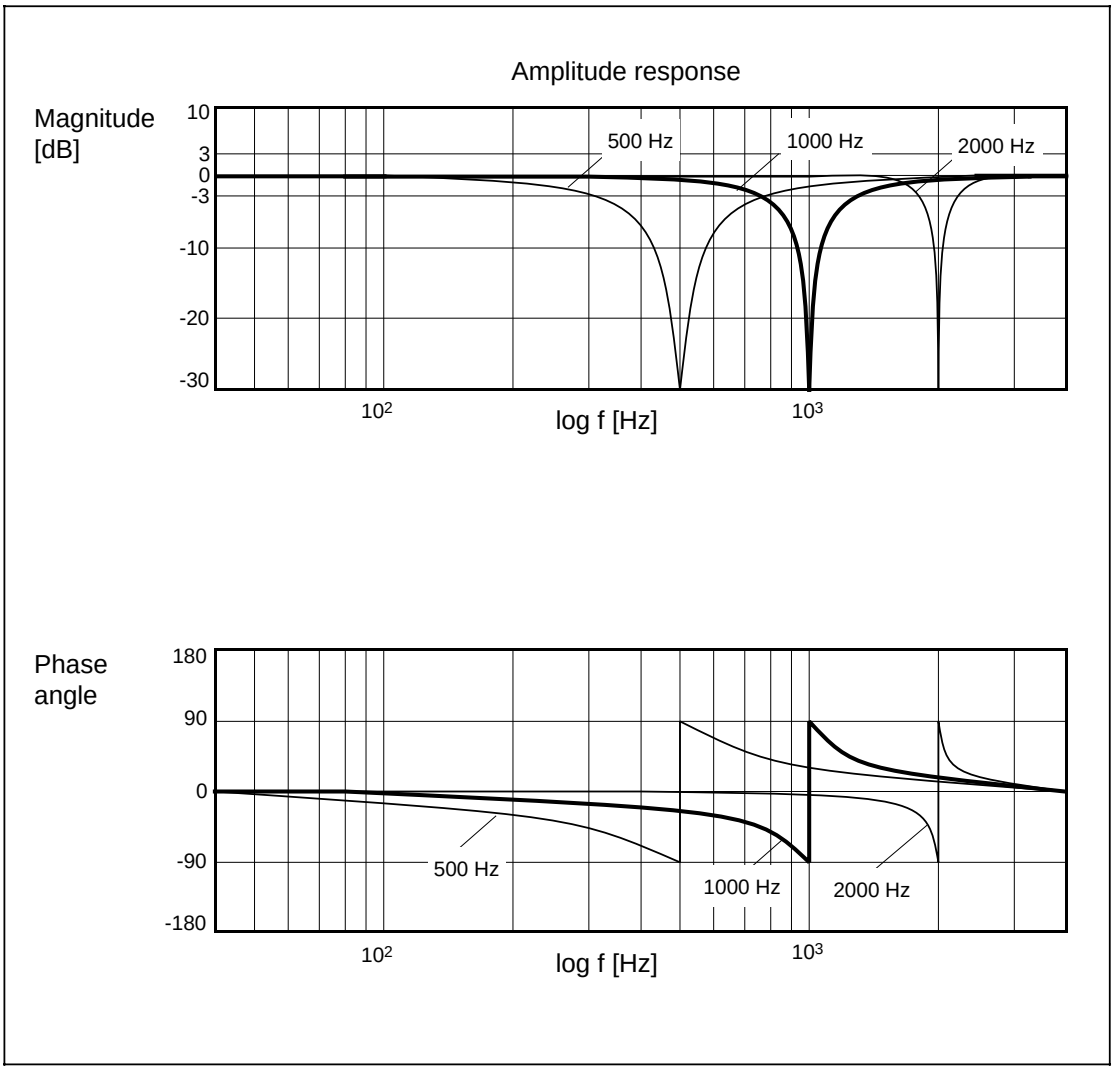

Fig. 12-6 Frequency response of undamped bandstop with a bandwidth of 500 Hz and blocking frequency variations of 500 Hz, 1000 Hz and 2000 Hz.

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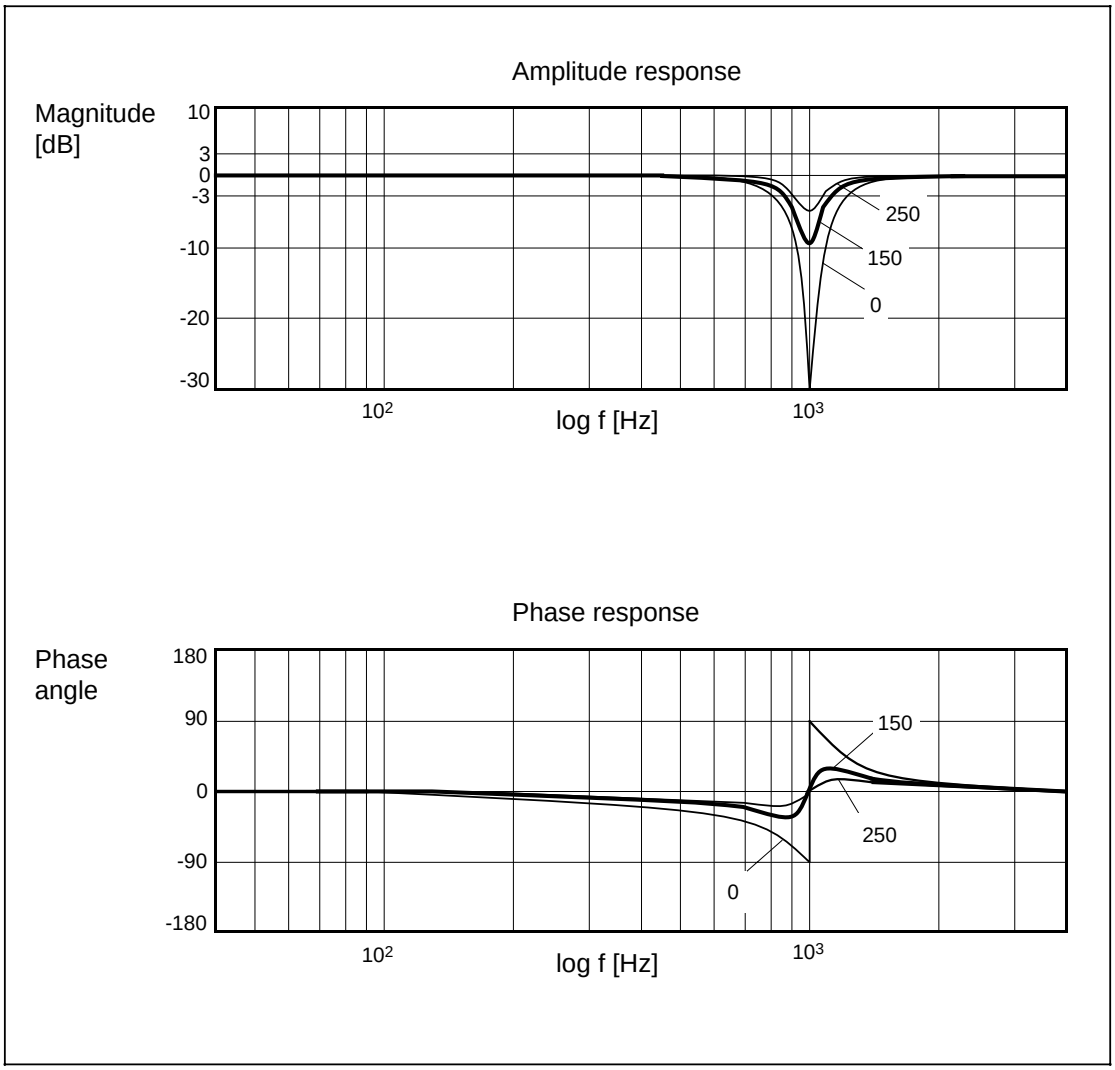

Fig. 12-7 Bandstop performance with bandwidth of 500 Hz, blocking frequency of 1000 Hz and variation in counter bandwidth of 0, 150 and 250 Hz.

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Example of bandstop filter application

The example below explains the basic procedure for applying one or several current setpoint filters.

Peaks have been measured at 900 Hz and 1200 Hz.
Bandstop filters must be used to dampen both resonant frequencies. The speed controller can then be set more finely to improve the inadequate dynamic response of the drive.

- Default settings
  Filter 1 (activated as standard)
  Low pass with fe 2000 Hz and
  d 0.7
  Reduction of amplitude response well above the fundamental frequency range, minimization of effects of torque control loop on speed control loop.
- Filters 2 and 3 must be parameterized as the bandstop.
  MD 1200: Number of current setpoint filters = 3
  MD 1201: Type of current setpoint filter = 6
- Enter frequency.
  Filter 2:
  MD 1213: Blocking frequency current setpoint filter 2 = 900 Hz
  Filter 3:
  MD 1216: Blocking frequency current setpoint filter 3 = 1200 Hz
- Enter bandwidth.
  Half the measured resonant frequency is recommended as a guide value for the bandwidth to be entered.
  Filter 2:
  MD 1213**/**2 = 900 Hz**/** 2 = 450 Hz
  MD 1214: Bandwidth current setpoint filter 1 = 450 Hz
  Filter 2:
  MD 1216**/**2 = 1200 Hz**/** 2 = 600 Hz
  MD 1217: Bandwidth current setpoint filter 2 = 600 Hz
- Enter counter bandwidth
  Filter 2:
  MD 1215: Counter bandwidth current setpoint filter 1 = 0.0 (default)
  Filter 3:
  MD 1218: Counter bandwidth current setpoint filter 2 = 0.0 (default)

After the filters have been activated, the speed control loop is measured again. The measurement result indicates whether and to what extent the resonance has been dampened as a result of the filters. If the signals are now below the 0 dB line, the speed controller parameters can be adjusted again.

If the measurement results are unsatisfactory, an attempt can be made to improve the effect of the filters by varying the filter bandwidth (filter 2 MD 1214, filter 3 MD 1217).

Criteria for filter setting:

- Minimum additive phase rotation as a result of "Bandwidth" parameter. Filter effects on fundamental frequency range are thus minimized.
- Maximum damping effect as a result of pole point compensation (reduce amplitude peak to between 0 and approximately +3 dB).

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12.33.4 Speed-dependent current setpoint filter

A speed-dependent current setpoint filter (torque setpoint smoothing) allows the user to reduce the speed ripple at higher speeds (MSD + FDD).

12.33.4.1 Machine data

MD 1245: Threshold speed-dependent torque setpoint smoothing
MD 1246: Hysteresis speed-dependent torque setpoint smoothing

12.33.4.2 Description

If the threshold value is set to 0, then the filter remains active as a low-pass over the entire speed range. When other values are set, the settings in

MD 1245: Threshold speed-dependent torque setpoint smoothing and
MD 1246: Hysteresis speed-dependent torque setpoint smoothing

are used to calculate two switchover speeds:

$n_{upper} = n_{threshold} + n_{hysteresis} =$ MD 1245 + MD 1246

$n_{lower} = n_{threshold} - n_{hysteresis} =$ MD 1245 – MD 1246

The low-pass function is activated then the absolute actual speed value exceeds the value n_{upper} ($|n_{act}| \geq n_{upper}$). Vice versa, the low-pass function is deactivated when the absolute actual speed value drops below n_{lower} ($|n_{act}| < n_{lower}$).

If the hysteresis is set to zero, then the two switchover speeds are identical.

Note

The speed threshold is effective only when filter 2 is configured as a low pass. This machine data has no effect on the closed-loop control.

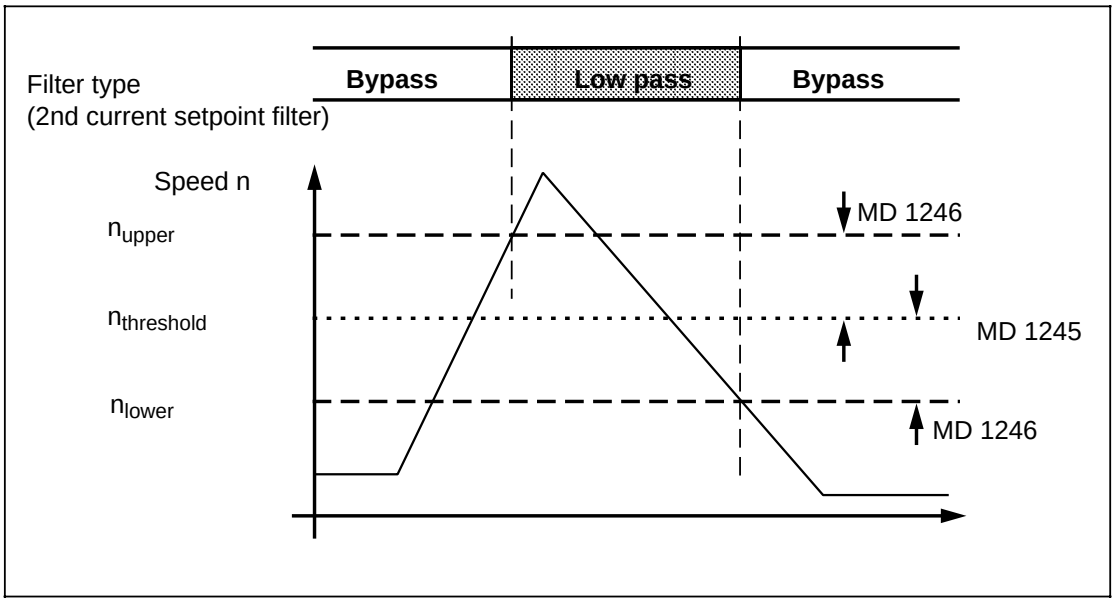

Fig. 12-8 Threshold of speed-dependent torque setpoint smoothing

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12.33.5 Speed setpoint filter

Speed setpoint filters are used to dampen mechanical resonant frequencies in the position control loop. Bandstops and low passes (PT2/PT1) can both be used as speed setpoint filters. The tasks of the filter are as follows:

- Adapt the position controller to machinery to be controlled (e.g. table resonance)
- Symmetrize different axis dynamic responses in the case of interpolating axes.

Note

The frequency response analysis of the speed controller includes the filters.

The structure of the position control loop must be taken into account when the speed setpoint filter is dimensioned.
- Position control to direct measuring system, i.e. load resonance directly in control loop.
- Position control to motor measuring system, i.e. load resonance only indirectly via motor to control loop.

12.33.5.1 Machine data

MD 1500: Number of speed setpoint filters
MD 1501: Type of speed setpoint filter
MD 1502: Time constant speed setpoint filter 1
MD 1503: Time constant speed setpoint filter 2
MD 1506: Natural frequency speed setpoint filter 1
MD 1507: Damping speed setpoint filter 1
MD 1508: Natural frequency speed setpoint filter 2
MD 1509: Damping speed setpoint filter 2
MD 1514: Blocking frequency speed setpoint filter 1
MD 1515: Bandwidth speed setpoint filter 1
MD 1516: Bandwidth counter speed setpoint filter 1
MD 1517: Type speed setpoint filter
MD 1518: Bandwidth speed setpoint filter 2
MD 1519: Bandwidth counter speed setpoint filter 2
MD 1520: Natural frequency bandstop speed setpoint filter 1
MD 1521: Natural frequency bandstop speed setpoint filter 2

MD 1501: Type speed setpoint filter

Low pass/ bandstop	1st filter	Bit 0	0	Low pass (see MD 1502/1506/1507)
			1	Bandstop (see MD 1514/1515/1516)
	2nd filter	Bit 1	0	Low pass (see MD 1502/1508/1509)
			1	Bandstop (see MD 1517/1518/1519)
PT2/PT1 with low pass	1st filter	Bit 8	0	PT2 low pass (see MD 1506/1507)
			1	PT1 low pass (see MD 1502)
	2nd filter	Bit 9	0	PT2 low pass (see MD 1508/1509)
			1	PT1 low pass (see MD 1503)

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Speed setpoint filter combinations

Filter 2	Filter 1	MD 1501
PT1	PT1	300
PT1	PT2	200
PT1	BS	201
PT2	PT1	100
PT2	PT2	000
PT2	BS	001
BS	PT1	102
BS	PT2	002
BS	BS	003

12.33.5.2 Bandstops and low passes as speed setpoint filter

Bandstop

Depending on requirements, the "Bandstop" function can be set in three configurations:
- Simple bandstop. MD 1514/MD 1517 and MD 1515**/**MD 1518.
- Bandstop with adjustable damping of amplitude response plus MD 1516/MD 1519.
- Bandstop with adjustable damping of amplitude response and increase/decrease in amplitude response above blocking frequency plus MD 1520/MD 1519.

Note

The sampling frequency of the control (MD 1001) sets an upper limit to the blocking frequency input (parameterization error).

$$\text{MD 1514} < \frac{1}{2 \times T_{sampl}} = \frac{1}{2 \times \text{MD 1001}}$$

$$\text{MD 1001} = T_{sampl} = \begin{bmatrix} 62.5\ \mu s \\ 125.0\ \mu s \end{bmatrix} \Rightarrow \text{MD 1514} < \begin{bmatrix} 8000\ Hz \\ 4000\ Hz \end{bmatrix}$$

Low pass

In the case of rigid mechanical components, the k_v (servo gain) factor and dynamic response of the subordinate speed control loop (incl. filter time constants and position controller deadtimes) are indirectly proportional for the purpose of optimizing the position control loop.

If the k_v (servo gain) factor setting is limited to lower values due to elastic mechanical components (table frequencies), it is possible to use the filter time constant (as a component of the subordinate dynamic response) as an additional degree of freedom to the servo gain factor to dampen resonance without impairing the dynamic response of the position controller.

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$$k_{vmax} = \frac{1}{2(T_{ers,n} + T_{n,w,gl} + T_{tot,LR} + T_{abt,LR})}$$

$T_{ers,n}$ = Equivalent time of closed speed control loop
$T_{n,w,gl}$ = Equivalent time of speed setpoint filter
$T_{tot,LR}$ = Deadtime position/speed control loop (1 x T_{LR})
$T_{abt,LR}$ = Sampling of position actual value (0.5 x T_{LR})
LR = Position controller

Another application for the low-pass function as a speed setpoint filter is the interpolation of speed setpoint steps. The speed setpoints are output by the NC in the position controller clock cycle. This can be set to a much higher value than the speed controller clock cycle.

Note

Speed setpoint filters can be used in interpolating axis groupings to compensate the different dynamic responses in the speed control loops of individual axes.

The total equivalent time constant (= equivalent time constant of speed control loop + equivalent time constant of speed setpoint filter) must be set such that it is the same for all mutually interpolating axes.

The input of damping values close the minimum input limit causes overshoots in the time range up to a factor of 2. This effect is raised to a power in the case of 2 configured low-pass filters with the same setting parameters. These filters still have a linear response in low-level signal operation. In high-level signal operation, the filter states may be limited in some cases by the maximum numerical formats (as defined by the processor register width). The filter characteristic becomes non-linear for a brief period. Overshoots or unstable reactions do not occur.

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Example of speed setpoint bandstop

fz	: Blocking frequency	MD 1514/MD 1517
DZ	: Damping numerator	
fbz = 2 x Dz x fz	: Bandwidth numerator	MD 1515/MD 1518
Dn	: Damping denominator	
fbn = 2 x Dz x fn	: Bandwidth denominator	MD 1516/MD 1519
fn = MD 1520(%) x fz	: Bandstop natural frequency	MD 1520/MD 1521

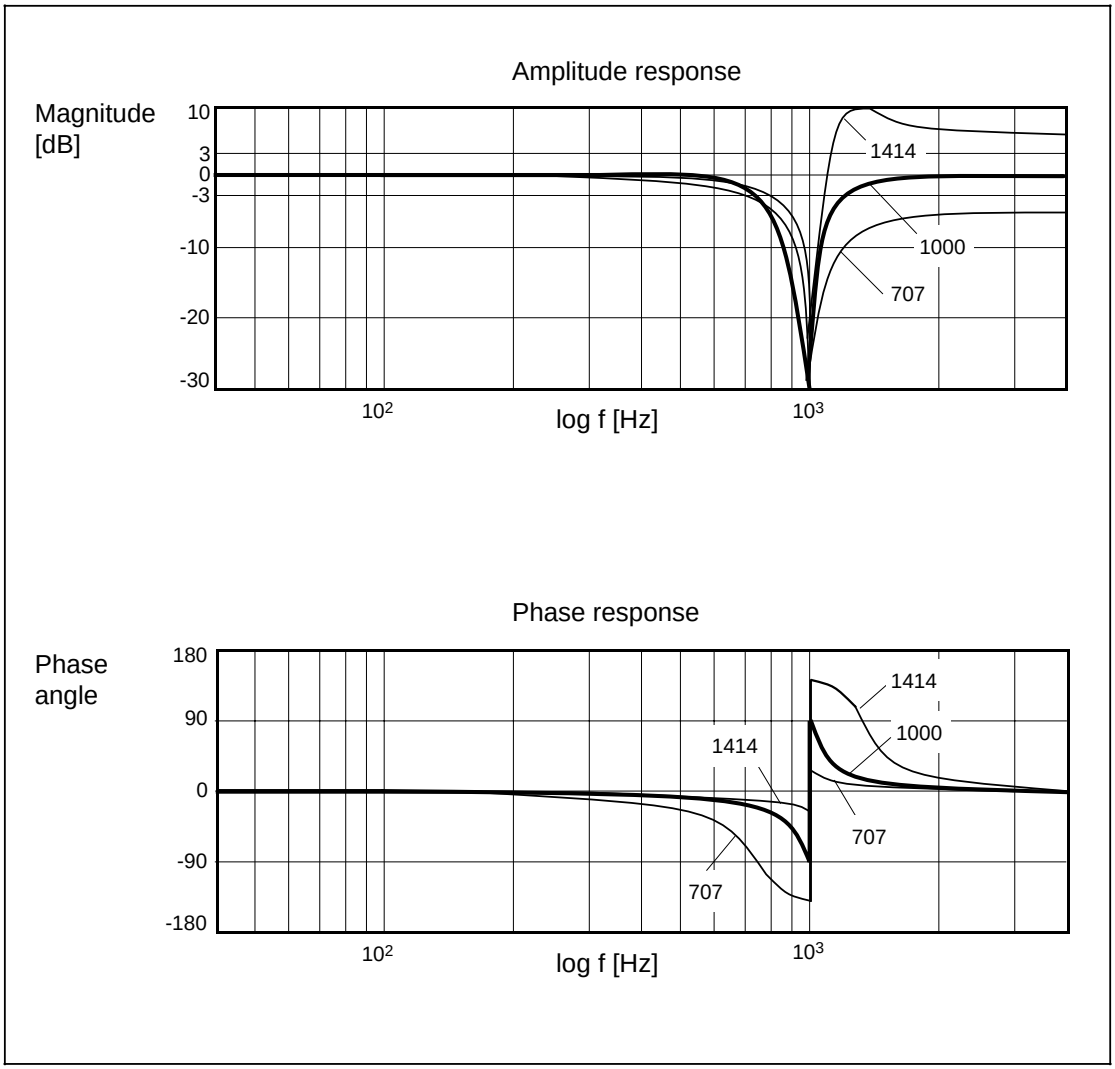

Fig. 12-9 Frequency response of general bandstop with blocking frequency f_z = 1000 Hz, bandwidth f_{Bn} = 500 Hz, counter bandwidth f_{Bz} = 0 Hz and variation in natural frequency f_n = 707, 1000 and 1414 Hz.

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12.34 Actual value passive monitoring axis (as from SW 6.3)

12.34.1 General

Special technological demands require the actual value of a measuring circuit at the same time in several axes. This entails that a measuring circuit is read out for the second time from a passive monitoring axis. For this reason, passive monitoring axes have the same drive measuring module numbers.

12.34.2 Parameterization

NC machine data 1832* bit 1 activates the release of the measuring circuit for multiple assignment (bit 2 in the 2nd measuring system) in the 1st measuring system. Bit 3 defines in the 1st measuring system the axis as principal axis or as actual value passive monitoring axis (bit 4 in the 2nd measuring system). If bit 3 or 4 is set on an axis, then the following restrictions apply to that measuring system.

12.34.3 Restrictions

Principal axis:	No functional restrictions
Actual value passive monitoring axis:	Referencing, ”in-process measuring”, ”extended measuring” and EnDat absolute encoder are not permitted.
Remedy for actual value passive monitoring axis:	Referencing is achieved by setting a reference dimension (set actual value). The actual value is read from the principal axis, e.g. over high-speed PLC data channel.
	Use of the measuring function directly on the principal axis.

12.34.4 Alarm messages

The following alarm messages may occur in this context:

Alarm message 1080*	”Hardware referencing on passive monitoring axis” by invalid use of referencing
Alarm message 1076*	”Hardware measuring” by invalid use of measuring
Alarm message 1012*	”Parameterization error NC MD” by more than one parameterized principal axis per measuring circuit

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12.34.5 Parameterization examples

Example 1, incremental encoder:

The 2nd measuring system of the 4th and the 1st measuring system of the 3rd axis monitor the measuring circuit of the 1st measuring system of the 1st axis.

1st axis:	Principal axis (monitored axis)	MD 18320.3=0
	1st measuring system released for monitoring	MD 18320.1=1
	no absolute encoder	MD 18080.0=0
3rd axis:	Monitoring axis	MD 18322.3=1
	1st measuring system released for monitoring	MD 18322.1=1
	no absolute encoder	MD 18082.0=0
4th axis:	Monitoring axis	MD 18323.4=1
	2nd measuring system released for monitoring	MD 18323.2=1
	no absolute encoder	MD 18083.0=0

Example 2, EnDat absolute encoder

The 2nd measuring system of the 3rd axis monitors the measuring circuit of the 1st measuring system of the 2nd axis. There, an EnDat absolute encoder is connected.

2nd axis:	Principal axis (monitored axis)	MD 18321.3=0
	1st measuring system released for monitoring	MD 18321.1=1
	EnDat encoder	MD 18080.0=1
3rd axis:	Monitoring axis	MD 18322.4=1
	2nd measuring system released for monitoring	MD 18322.2=1
	no EnDat encoder	MD 18082.0=0

Note on EnDat encoders:

Only the incremental encoder part may be used for the monitoring axis.

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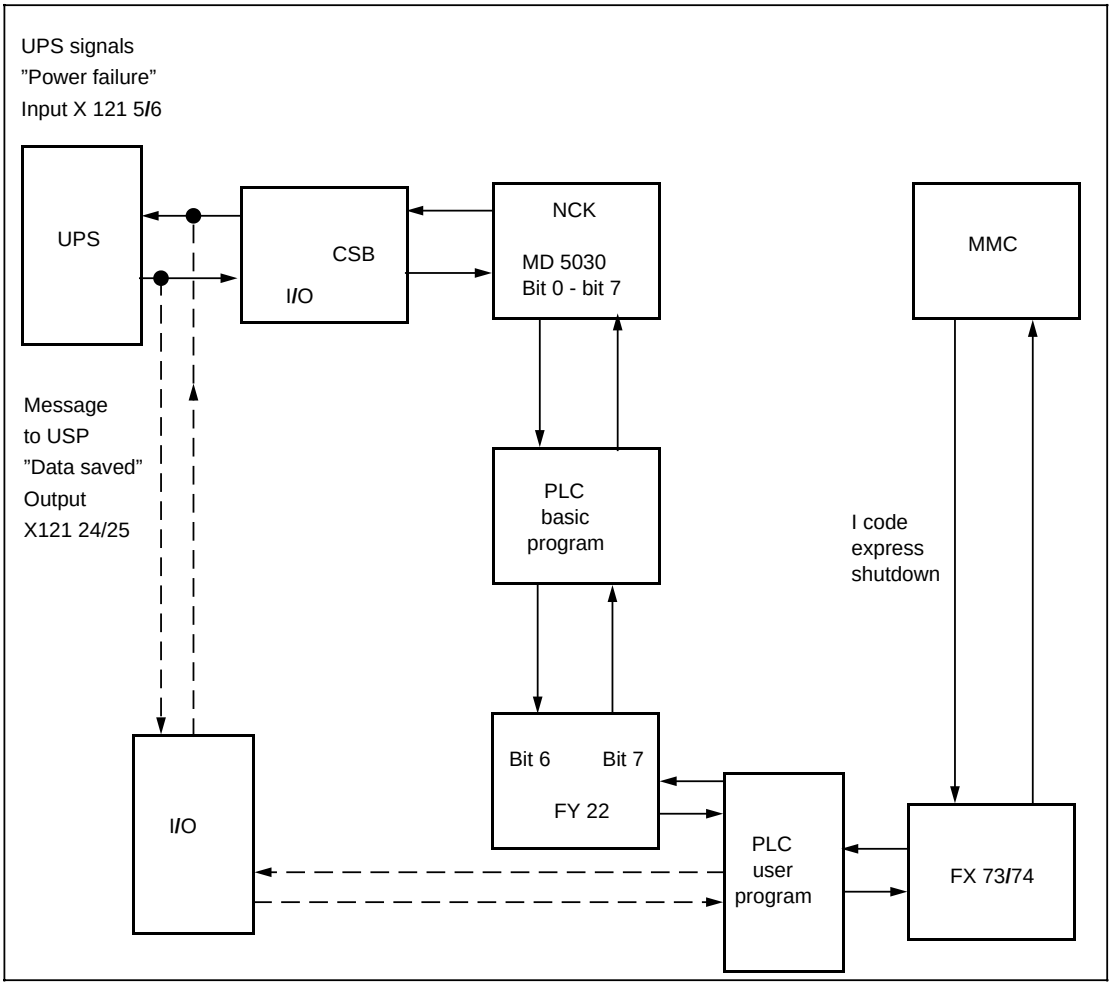
12.35 Uninterruptible power supply (UPS) (as from SW 6.3) (Express shutdown)

General

When the 840 C control is not purposely, i.e. properly ramped down but instead just turned off, general problems can occur in the operating system. E.g. opened data files may not be closed properly leading to inventory data inconsistencies. In a worst case scenario, the file system of the hard disk could become inconsistent during a momentary write access to the hard disk. The danger in such cases is that the MMC may not be able to boot at the next POWER ON.

With the help of a standard UPS (approx. 300 W) it is possible to switch off or ramp down (express shutdown) the NC in a controlled manner.

Express shutdown function diagram



Configuration of the express shutdown

Configuration options as follows:

———— Connection via special I/O on the central service board (CSB)
– – – – – – Connection via PLC inputs/outputs

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Interfaces

The PLC user program has available the UPS signals in FY 22 bit 6 and bit 7. The signal ”Power failure” (FY 22 bit 6=1) in the PLC user program can cause an ”Express shutdown” on the MMC.
After implementing ”Express shutdown”, the signal ”Data saved” (flag byte 22 bit 7=1) can be set in the PLC user program. This signal then travels via the NCK to the CSB output X121 5/6 (see the following example).

Activating ”Power failure” signal

The CSB module has a choice of 24 V inputs, from 0 to 7. These signals are activated in the MD 5030 bits 0 to 7. When using the X121 pin 24/25 the signal ”Power failure” must be released via MD 5030 bit 5.

Note:

The CSB inputs may also be used for other functions. But there is no monitoring of multiple assignment on the NC part. This must be considered during configuration.

Information on the CSB can be found in section 2.3.6.2 Interface description, Part 2; Connector requirements.

”Data saved” signal to UPS

The ”Data saved” signal can be applied to the CSB output plug X 121 as floating contact assembly on pin 5 and pin 6.

Connection of UPS via CSB

Prerequisite for this functionality is a CSB module with order number 6FC5 114-0AA02-0AA2.

On earlier releases of the CSB module, alarm 3113 (”Error by access to mixed I/O or CSB”) was activated when a bit was set simultaneous in the NC MD 5030. The UPS message signals for ”Power failure” (X121 24/25) and ”Data saved” (X121 5/6) are connected to the X121 plug of the CSB module itself.

For more details see section Cable distributor CSB in the Interface description, Part 2.

Connection of UPS via PLC I/O

The UPS message signal ”Power failure” is sent via a user specified and selectable PLC input to the PLC user program.

For further procedure see section ”Express shutdown”.

Express shutdown

Initiation of the ”Express shutdown” is carried out from the PLC user program. To do so, the user must adequately feed the FX 73 module and send an I code data package to the MMC. When all of the applications signed on in the ”Express shutdown” have acknowledged, the system generates an acknowledgements package to the PLC. See the following example.

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Example ”Express shutdown”

Notes

1. A detailed description of the I codes as well as the FX73/74 is contained in the Win-OEM document.
   Only the I code 042F (Express shutdown) is currently implemented for the FlexOS control.
   The use of the FX73 and FX74 is limited to this one function.
2. Acknowledgement bytes (3x FY)
   The error numbers are contained in the Win-OEM document (FX73/74).
   The following setting up applies:

1st byte	Error bit x.0 If the bit is ”0”, then the other two bytes are valid. To start with, evaluation of this bit (Error Yes**/**No) in the user program will suffice.
2nd byte	Coupling error (while accessing the mailbox)
3rd byte	User error (incorrect parameterization, incorrect user data, etc.)

3. Express shutdown
   Described in the Win-OEM documentation.
   Take note of the fact that (contrary to the description) the low and the high byte are to be swapped on the I code and the control flag!
4. OEM information bit (FX74 OEM-EMPF)
   The PLC MD 137 is monitored for a valid input only by the system (<25 / >254).
   Permitted are according to the Win-OEM documentation (FX74) FW 25 ... 198.
   If another FW is entered (e.g. 220) there will be no error message.
   ”Express shutdown” is implemented, the I code, however, will not be acknowledged!

Structure of the user data blocks for the OEM-SEND (FX73)

DW x	Length of package (ideally reserve with 10 i.e. length: 10 DW). The FX does no explicitly check the package length. A value of > 1 and < 30 must be entered.	Format: KF
DW x+1	Task sender "0201H" - PLC	Format: KH
DW x+2	Task receiver "0319" - mailbox MMC	Format: KH
DW x+3	Task data structure always enter ”1”	Format: KH
DW x+4	Task number "5F02H"	Format: KH
DW x+5	I code "2F04H" (express shutdown)	Format: KH
DW x+6	Control flag "0090H"	Format: KH

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Structure of target data block (MMC feedback)

DW x	Package length "4"	Format: KF
DW x+1	Task sender "0319H"	Format: KH
DW x+2	Task receiver "0201H"	Format: KH
DW x+3	Task data structure "1"	Format: KH
DW x+4	Task number "0"	Format: KH
DW x+5	I code "2F04H"	Format: KH
DW x+6	Control flag "0094H"	Format: KH

Parameterization of FX73 and FX74

FX73

DBTY	---	Module type (DB/DX) Variable assignment: FW240	Format: KC
DBNR	---	Module no. Variable assignment: FW242 If the variable is assigned, ”0” must be entered here.	Format: KF
DWNR	---	No. of 1st DW of user data blocks Variable assignment: FW244	Format: KF
QTTG	---	Acknowledgement of FX Indication of 1st FY (a total of 3 bytes) Variable assignment: FW246	Format: KF

FX74

DBTY	---	Module type (DB/DX) Variable assignment: FW240	Format: KC
DBNR	---	Module no. Variable assignment: FW 242 If the variable is assigned, ”0” must be entered here.	Format: KF
DWNR	---	No. of the 1st DW of user data blocks Variable assignment: FW244	Format: KF
OEMN	---	No. of mailbox containing the information. Corresponds to signals of the OEM information bit (PLC MD 137) Thus: ”0” or ”1” Variable assignment: FW246	Format: KF
QTTG	---	Acknowledgement of the FX Indication of 1st FY (a total of 3 bytes) Variable assignment: FW248	Format: KF

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Example: PLC program for the initiation of an ”Express shutdown”

```
A       DB255          User DB

L       KF 10          Package length
T       DW 10

L       KH 0201        Sender (PLC)
T       DW 11

L       KH 0319        Receiver (MBX)
T       DW 12

L       KH 001         Task data structure
T       DW 13

L       KH 5F02        Task number
T       DW 14

L       KH 2F04        I code
T       DW 15

L       KH 0090        Control flag
T       DW 16

BA      FX73
        OEM-SEND
DBTY    KC   DB
DBNR    KF   255
DWNR    KF   10
QTTG    KF   192
.
.
.                      Scanning of the OEM information bit (PLC-MD 137).
                       Only once bit ”0” or ”1” has been set, then data
                       (acknowledgement) are present in the mailbox.
                       In this dependency the FX74 is called up.

BA      FX74
        OEM-EMPF
DBTY    KC   DB
DBNR    KF   255
DWNR    KF   20
OEMN    KF   0
QTTG    KF   195
```

Data received:
(as acknowledgement, ”Express shutdown” implemented, the I code is returned)

DB 255

```
DW20    KH =   0004    Package length
DW21    KH =   0319    Sender (MBX)
DW22    KH =   0201    Receiver (PLC)
DW23    KH =   0001    Task data structure
DW24    KH =   0000    Task number
DW25    KH =   2F04    I code
DW26    KH =   0094    Control flag
```


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12.36 Inch/metric switchover function (as from SW 6.3)

12.36.1 General

Use the softkey function to switch the measuring system from inch to metric and vice versa. The function ”Inch/metric switchover” has two features:

1: Inch/metric switchover function

2: Metric/inch switchover function

12.36.2 Functional description

- The conversion can be configured by the user.
- Manual readjustment of the calculated data is possible.
- No password is required for the switchover.
- A password is required for the conversion since the machine data dialog (MDD) must be started.

12.36.3 System data

When switching over the measuring system, all measurements in length will automatically be converted into the new measuring system. This includes:

Zero offsets

Tool offsets P2-P9

Working area limitation

Dry run feedrate

Scale center

Protection zone

Position switching signals

Preset

DRF

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12.36.4 Inch/metric switchover function

Regarding NCK under section Parameter, Setting data there is a softkey reading ”Inch/metric switchover” which, when pressed, sends an I code to the MMC application Services which then fades in the following sub-dialog window (as a safety confirmation) if the corresponding files exist (necessary to load to the NCK). If in fact the files do not exist, an error message is generated advising that the files must first be created in the MDD (machine data dialog).

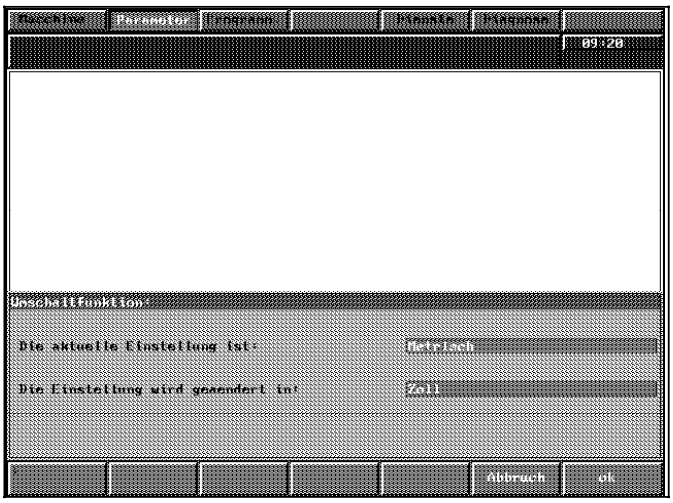

Fig.: Switchover function

Here in the sub-dialog, the user can switch back and forth between the inch and metric setting. The display shows the current setting and indicates the new setting. The text for the output fields can be configured by the user (see section Configurability of the switchover). The dialog can be stopped by pressing the Recall key.

The following actions are executed when the user presses the softkey ”OK”:

1. The converted data files the names of which are listed in the configuration file (CONFIG) are sent to the NCK via data transfer.
2. After a successfully completed loading process the services send the I code as task to the NCK which then converts the TOA and ZOA data according to a specified calculation method. The conversion can be controlled via a parameter value and the direction of conversion in the configuration data file.
3. When the NCK has completed the conversion of the TOA and ZOA data, the services activate a ”Power ON reset” signal provided that this function was defined in the configuration.

The switchover is activated by the NCK via an I code and ends with the acknowledgement of this I code except for when it is followed by a required Power ON. Since it cannot be permitted that machine data are changed during a given process, it is necessary that the NCK makes certain that the I code is sent only in a specific status of all channels and that this status be continued until the end of the switchover function.

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12.36.5 Inch/metric conversion function

When the data required for loading the switchover do not yet exist, the user must change to the MMC application MDD to initiate the conversion process. The initiation of the conversion process is described below.

Select the display using the softkeys for Diagnosis, Machine data, File functions.

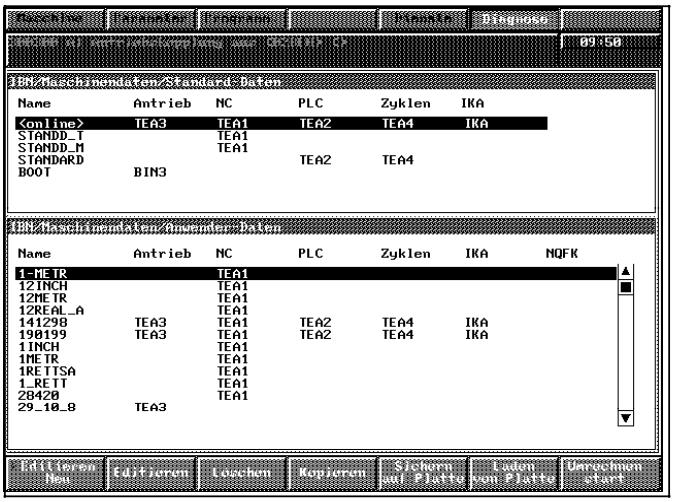

Fig.: Conversion function in the MDD

Pay attention to the following during the conversion process:

- Select a data block with the data selector from the user branch.
- Only offline data can be used, other data are rejected by an error message. If there are no offline data linked, first save online data in a file of their own.
- Rounding errors may occur through multiple conversions i.e. when converted from ”metric” to ”inch” and then back from ”inch” to ”metric”.

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When the softkey ”Conversion start” is pressed another sub-dialog appears denoting the conversion direction.

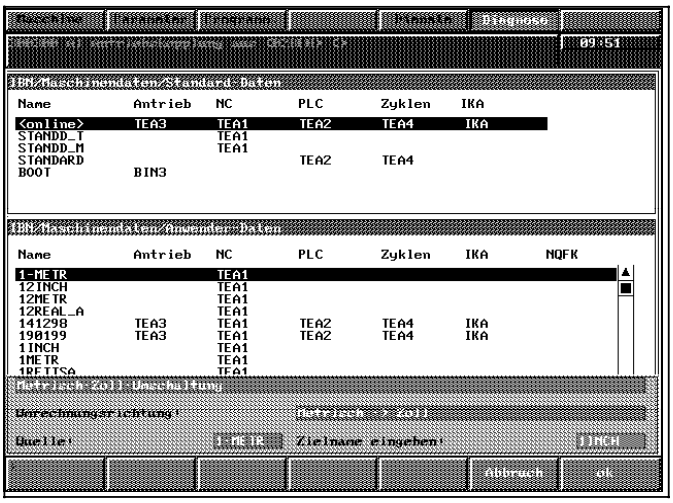

Fig.: Sub-dialog in the MDD

Sequence for the softkey function ”Conversion start” on ”OK” in detail:

1. Copying the data from the source machine data block (source data objects as selected above) to the data block of the target file whereby only the data TEA1, TEA2 and TEA4 are considered. The TEA3 and IKA data are not copied.
2. Checking with user if the inch/metric data (target data) are already available.
3. Only the machine data valid for the respective zone are filtered out from the target file, converted and stored in the destination file. The target file again contains the complete data. A target file is created for each zone.
4. The machine data to be converted can be configured by the user according to a list
5. Automatic identification of the conversion direction (inch to metric or vice versa) is carried out via the reference date (MD can be configured). Rejection of the process results if data are not complete. Therefore, only complete data blocks are accepted.

Source and target name are automatically recorded in the ”CONFIG” file. These data recorded in the ”CONFIG” file are loaded to the NCK when the softkey ”Switchover function” (see NC parameter) is pressed.

The machine data – further optimized online and manually – can be stored in the target files (converted data) via the already present functionality ”Save on disk”. The user is responsible for selecting the correct data block.

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12.36.6 Deleting the conversion data

The machine data (destination files) previously created during the conversion can be deleted with the help of the softkey ”Delete”. The selection of the objects to be deleted (inch**/**metric) is made with the data selector.

12.36.7 Error handling

Some basic errors are detected not only before the conversion but also before the switchover by a syntax analysis of the configuration file (CONFIG) and indicated on the user interface. A master control event box is then shown in which the faulty line number (if the error can be attributed to a line) and an explanatory error text is then read out. A list of all possible errors that can arise during reading in of the configuration file is listed in the appendix.

The configuration file is interpreted during conversion and switchover while the list of descriptions is only necessary during conversion.

A syntax test is carried out in the list of descriptions and incurring errors are signalled to the user interface.

The following is an example of an error that can incur when in TEA1 the entry ”n” for general machine data has been omitted. The log file shows the error as follows:

```
...
Error 5: Format error in data list
Line 2 file/mmc.001/user.005/mdas.140/list.142
Unexpectedly found: <<End-of-line>>
Expected would be at this point:
Handling type (n, a, s, k, ...)
```

When an error incurs, the values in the target files have already been partially converted, but due to this error the entire data block becomes useless.

The last line in the log file tells if the conversion was successful. Example of a conversion free from errors:

```
...
Updating target file XXX
```

Example of a faulty conversion:

```
...
32 errors -- target file XXX NOT updated
```

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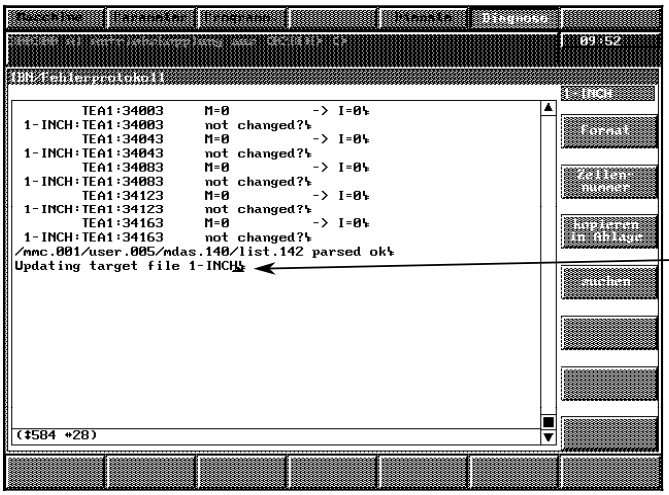
The entry XXX in the log file is the name of the target file i.e. the name of the destination data block.



Check of the last line for errors

12.36.8 Configurability of the conversion

The user can control the conversion via the ASCII lists. There is a central configuration file (CONFIG) and a common list of descriptions file (LIST) for all groups (TEA1, TEA2, TEA4).

The selection of the configuration file and the list of descriptions is carried out via the softkeys Diagnosis, PC data, Conversion data.

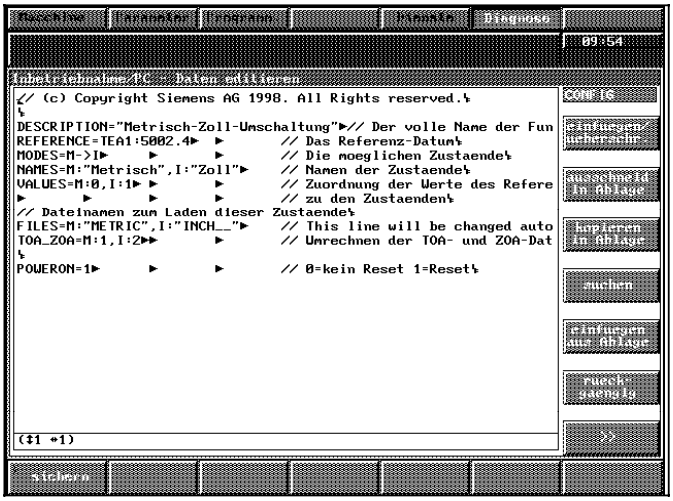


Fig.: Configuration file (CONFIG)

The line ”FILES=” is written by the internal conversion routine i.e. the name of the source file and the name of the target file are recorded there. These files are required for the switchover.

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Structure, syntax and the meaning of key words in the file CONFIG[1] as follows:

Syntax: Parameter=value [//Comment][2]

Parameter	Value (entry example)	Max. number	Meaning
DESCRIPTION	”Long text name”	76	Full name of switchover function[3]. This text appears in the MMC dialog box for the conversion function in the MDD.
REFERENCE	TEA1:5002.4		The reference date helps to decide which mode is set. The groups TEA1, TEA2 and TEA4 are permitted. Each machine date of these groups can be selected except for the channel specific TEA4 data. The selection of a bit is optional. Only bit 0 to 7 can be selected. Selection of a bit group (e.g. 5002.4-7) is not possible. Specification of a decimal digit (e.g. 3840**/**2) is not possible. The bit specification must follow the number without blank space.
MODES	X Y	1 per mode	Definition of the code letters for the modes. In the form of code letters, capital letters are exactly one character long and separated by commas. Presently at least 2, at maximum 2 modes possible The calculation is also defined here: from X Y. By reversing the conversion direction this line must be changed accordingly, i.e. Y X The arrow ( ) signifies the conversion direction.
NAMES	X:"Name X", "Y:"Name Y"	19	Status texts. Definition of a text for each mode. These text lines appear in the MMC dialog box for the conversion function in the MDD.

1) The format is line-related, column-free, tabs can be used instead of blanks.

2) Comments: They are valid from the double slash // until the end of the line.

3) Text constants: with double quotation marks ”...” are optional.

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Parameter	Value (entry example)	Max. number	Meaning
VALUES	X:2, Y:5	One assign-ment per mode	Assignment of the reference date values. The reference date value must be defined for each mode by which this mode should be recognized. Only decimal values are allowed. For bits only values 0 and 1 are permitted.
FILES	X:"FILES_X", Y:"FILES_Y"		File name (name of machine data block) which refers to the respective status (e.g. the METRIC file for metric etc.). A maximum of 7 characters are permitted. The reserved names such as BOOT, STANDARD STANDD_M, etc. must not be used. The line with the code word FILES is also written. Here, the source name and the target name from the MDD are stored.
TOA_ZOA	X:#, Y:#		This parameter is transmitted directly to the NCK (in I code). Here, parameter # means: #=0 Do not carry out conversion on the NCK side. #=1 Metric conversion of TOA and ZOA data on the NCK side #=2 Inch conversion of TOA and ZOA data on the NCK side Default setting=M:1, I:2 The following settings are also possible: M:1:, I:1, or M:2, I:2 and M:0, I:0
POWERON	#		Power On Reset Then the parameter # means: #=0: No reset #=1: Reset The parameter is valid in both statuses Default setting=1

Remark:

The indicated parameters are mandatory parameters except for the parameters TOA_ZOA and POWERON. The order of entry as in the table above is applicable.

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12.36.9 List of descriptions

This file describes the conversion. The syntax used and described as follows has been kept in terms as general as possible to also allow other conversions, i.e. it is the responsibility of the user to change the file in such a way that the most different conversion algorithms can be implemented.

Various types of machine data are grouped in sections which are introduced under a heading as known from the 840C-MDD list block:

TEA1	**n**	for general machine data
TEA1	**a**	for axis-specific NC machine data
TEA4	**k**	for channel-specific cycles machine data
TEA2	**n**	for PLC machine data
IKA1	**ibz**	for IKA configuration
IKA2	**ifk**	for IKA configuration
IKA3	**ipk**	for IKA points

Under the list of descriptions, only the above-mentioned types of data are permissible and valid for conversion. At least one section has to be quoted with a machine data. The sequence of the sections is immaterial. Comments can be added to the file (introduced by a double slash = //) then the rest of the line is ignored right to the end of the line. By entering space lines the list can be structured. Blank spaces are also possible.

There are basically two types of conversion instructions:

- Direct assignment
  A fixed value is specified for each of the two modes and entered into the machine data.
  The type of the value has to suit the type of data of the machine data.
  Always indicate both values.
  The value of the original data record is normally checked to avoid errors.
  A string of bits is started with 0b...

- Linear formula
  The new value is calculated from the old value.
  The formula can also be used in reverse, however, it must not contain a decimal fraction as factor and offset.

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Example of a list of descriptions file LIST:

```
// Conversion of 03.99
// first
TEA1 n
5002.4-7      I=0b1101      M=0b0100
3969.0        I=1           M=0
1             I=M · 0.3937+0.01
3             I=M · 0.3937+0.01
6             I=M · 0.3937+0.01
7             I=M · 0.3937+0.01
9             I=M · 0.3937+0.01
10            M=I · 2.94 – 0.01

// now the axis-specific machine data
TEA1 a
18000.4-7     I=0b1101      M=0b0100
2240          I=M · 0.3937+0.01

// now the channel-specific cycles machine data
TEA4 k
5             I=M · 25.4
400           I=7.2         M=3.1

// End of file
```

The conversion list acts like a filter which is placed between the target file and the source file filtering out all machine data listed in the list. These data are converted according to the conversion regulations installed in the list. All machine data from each area not contained in the list are taken over unchanged (i.e. 1 to 1) from the source file to the target file.

Special treatment of machine data

In general, in the case of axis-specific and channel-specific machine data, only the specific base number has to be quoted since the internal loop automatically increases the respective number for the data. This will lead to the state that conversion is valid for all data. However, this is not always wanted under certain circumstances. A remedial measure would be the following circumvention.

a) Example of a special treatment in the case of axis-specific machine data:

```
// Conversion
//
// Special treatment of one axis (e.g. 2nd axis)
TEA1 a
2800          I=M · 0.3937
// Special treatment of 2nd axis
2801          M=I · 10
// continue as normal from here ...
2802          I=M · 0.3937

// End of file
```

By explicitly quoting the data for the 2nd axis, conversion of the 2nd axis is different from all other axis. It follows that data for the 3rd axis must also be quoted in the list otherwise conversion is carried out as e.g. in the case of the 2nd axis.

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b) Example of a special treatment in the case of axis-specific machine data:

```
// Conversion
//
// Special treatment of one axis (e.g. 2nd axis)
TEA1 n      // !!!TRICK 17!!!
2800        I=M · 0.3937
2801        M=I · 10
2802        I=M · 0.3937

// End of file
```

Section ”TEA1 n” (marked as TRICK) in example b) prevents the internal loop from being executed, therefore allowing the conversion of each machine data individually.

General notes

- What will **not** be converted

  Tool offsets P10-P32
  Cycle data (e.g. measuring cycles)
  IKA data
  GI data
  Inc-Var

- Rounding errors when converting

  Most data to be converted are in FLP10 format and have to be converted into FXP4 format. Then data have to be converted using factor 25.4 or 1/25.4 with the following conversion into the original FLP10 format. This may lead to rounding errors which will become greater if more conversions are carried out.

- Overflows when converting

  Overflows can incur when converting data e.g. work area limitation 9,999.9999 inch 253,999.974 mm. Input limit is 99,999.999 mm. Alarm is given and the maximum value is stored, i.e. when next converting from the metric system to inch the work area limitation would be at 3937.0078 inch and – apart from rounding errors – would remain there even after further conversions.

- Tool offsets in the case of rotary axes

  All tool offsets are converted. The user must himself ensure that tool offsets for rotary axes are reconverted into ”degrees”.

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- Power failure during conversion

  After restarting conversion is continued without conversion errors or alarm messages from the point where the interruption occurred.

- Locking during switch-over

  Before initiating the conversion ensure that the control is in the reset mode and remain there during the conversion process (NC start disable, feed stop and spindle stop).

- Upward compatibility

  It must be ensured that new or enlarged setting data, machine data etc. can be included for conversion purposes.

- Checking for conversions not carried out

  Checks must be carried out by the user whether a metric program runs on a metric machine (starting cycle).

- Graphic simulation

  There is no checking of the consistency of machine data, setting data and the simulating program.

END OF SECTION

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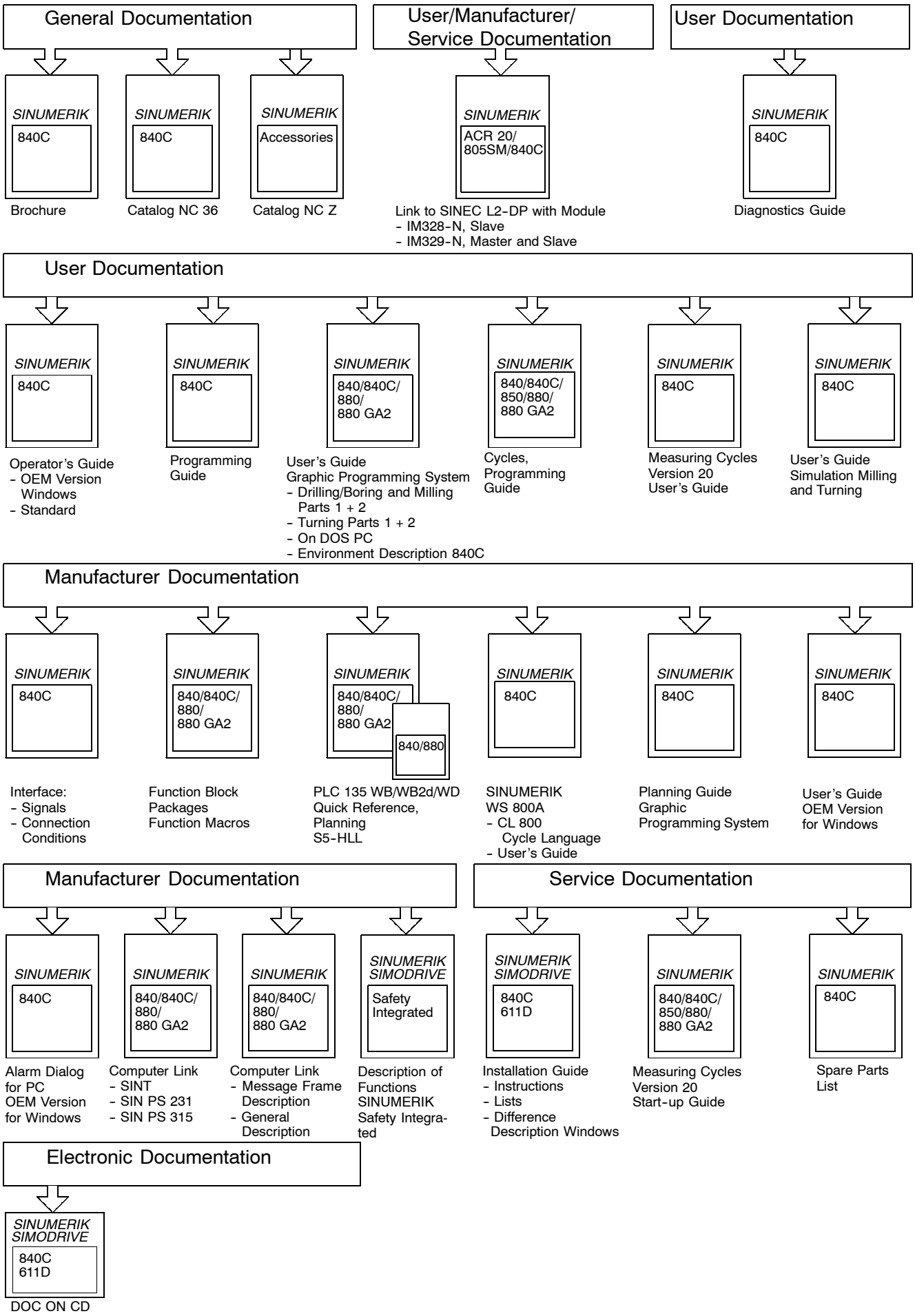
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