SINUMERIK 805
Software Version 4
Installation Instructions

Installation Guide 05.93 Edition

Service Documentation

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Installation Instructions

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Service Documentation

May 1993 Edition

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.

Status code in ”Remarks” *column*:

A . . . New documentation
B . . . Unrevised reprint with new Order No.
C . . . Revised edition with new status
If factual changes have been made on a page since the last edition, this is indicated by a new edition coding in the header on that page.

Edition	Order No.	Remarks
06.90	6ZB5 410-0CX02-0AA0	**A**
01.91	6ZB5 410-0CX02-0AA1	**C**
11.91	6ZB5 410-0CX02-0AA2	**C**
05.93	6ZB5 410-0CX02-0AA3	**C**

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.

This publication was produced on the Siemens 5800 Office System.
Subject to change without prior notice.

Preliminary Remarks

General Remarks

This manual contains the information required by the personnel responsible for installation and service of the control.

This documentation is directed at qualified technical personnel who have been specifically trained in or possess the requisite knowledge of instrumentation and control technology, referred to in the following as automation technology.

Familiarity with and technically correct observation of the safety instructions and warnings are essential for safe installation and start-up as well as for safety during operation and maintenance of the product. Only qualified personnel are in a position to correctly interpret and implement the safety instructions and warnings described in general terms in the documentation.

Technical Comments

There are two hardware versions of the SINUMERIK 805:

Version 1 (up to software version 2.2)
Version 2 (from software version 3.1)

This manual describes both versions.
Differences between them are always indicated.

This documentation is valid for software version 4

Safety Guidelines

	WARNING
	When electrical devices are in operation, certain parts of them are inevitably subjected to hazardous voltages. **Improper** interference with the device/system or failure to observe the warning advice can result in serious physical injury or material damage. Only appropriately **trained personnel** familiar with the assembly, installation, starting up or operation of the product are permitted to interfere with this device/system.

Qualified personnel

	WARNING
	As far as the safety advice (contained in the documentation or as a sticker on the product) is concerned, ”qualified personnel” refers to persons who, for instance: • have received training or instruction and authorization to energize and deenergize, earth and tag electric circuits and devices according to established safety practices. • have received training or instruction according to established safety practices in the care, use and repair of appropriate safety equipment. • have received training or instruction in working with electrostatically sensitive components or modules. • have been instructed as operators to work with automation technology equipment and are familiar with the contents in the Operator's and/or Programming Guide referring to operation.

When planning, installing, starting up and operating the control, the personnel concerned must be familiar with the documentation relevant to their jobs.

Notes on danger

The following notes are provided for your personal safety and to protect the product described here or connected devices and machines against damage.

Safety advice and warnings intended to avert danger to human life and health and to avoid material damage are highlighted in this Manual by the terms defined here. The terms have the following meanings in the context of this Manual and the remarks on the product itself:

DANGER

As far as this Manual and the warning advice on the products themselves are concerned, ”danger” refers to instances where death, serious physical injury or considerable material damage **will** result, if proper precautions are not taken.

WARNING

As far as this Manual and the warning advice on the products themselves are concerned, ”warning” refers to instances where death, serious physical injury or considerable material damage **can** result if proper precautions are not taken.

CAUTION

As far as this Manual and the warning advice on the products themselves are concerned, ”caution” refers to instances where slight physical injury or material damage **can** result if proper precautions are not taken.

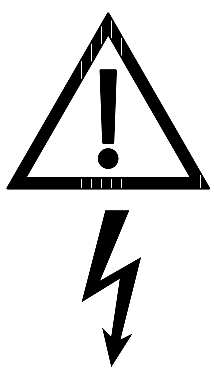
”Note” refers to important items of information about the product or the part of the Manual to which particular attention must be paid.

Proper Usage

- The equipment/system or the system components may only be used for the applications described in the catalog or the technical description, and only in combination with the equipment, components and devices of other manufacturers as far as this is recommended or permitted by Siemens.
- The product described has been developed, manufactured, tested and the documentation compiled in keeping with the relevant safety standards. Consequently, if the described handling instructions and safety guidelines described for planning, installation, proper operation and maintenance are adhered to, the product, under normal conditions, will not be a source of danger to property or life.

Active and passive faults in an automation system

- Depending on the type of automation system, both **active** and **passive** faults can be **dangerous**. In a drive control, for example, the active fault is generally dangerous because it results in the drive being switched on without authorization. By contrast, a passive fault can prevent a dangerous state of operation from being reported in the case of a signalling function.
- This distinction of possible faults and their task-specific characterization as dangerous or harmless is important for all safety considerations concerning the delivered product.



WARNING

Wherever faults in the automation equipment can cause substantial material damage or even physical injury, i.e. wherever dangerous faults can arise, additional external measures must be introduced or equipment must be provided to ensure or force safe operating conditions even if a fault occurs (e.g. by means of independent limit monitors, mechanical interlocks etc.).

Note on configuring the product

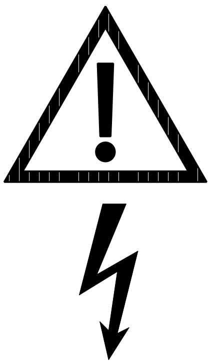
These notes are intended to serve as a guideline for avoiding dangers when integrating this product in its environment since the product is generally used as part of a greater system or plant.

The following facts are of particular importance

Even if a maximum of safety has been incorporated in the design of automation equipment, e.g. by the use of multiple channels, it is still essential meticulously to follow the instructions given in the documentation because incorrect handling can make ineffective any measures that have been provided to prevent the occurrence of dangerous faults and additional hazards can result.

Additional notes

If measuring or testing work is required on an active piece of equipment, the stipulations and implementation instructions of the VBG 4.0 accident prevention regulation, in particular §8 ”Permissible differences when working on active parts”, must be observed. Suitable electrical tools must be used.
NB: The above applies in the Federal Republic of Germany. Check with your area office for local regulations.



WARNING

- Repairs to equipment supplied by us must be made only by the **Siemens customer service** or by **repair services authorized by Siemens**. When replacing parts or components, use only those parts contained in the spare parts list. Unauthorized opening and inexpert repairs can cause death or serious physical injury as well as considerable material damage.
- Always pull out the mains connector or open the disconnecting switch before opeing the device.
- Use only the specified types when renewing fuses.
- Do not throw batteries into fires and do not solder on the cell casing owing to the risk of explosion (max. temperature 100 °C). Do not open and do not recharge lithium batteries or batteries containing mercury. Use only the same types when replacing.
- All types of batteries must be disposed of as special waste.
- When using monitors:
  Improper intervention, in particular changes to the high voltage or installation of a different type of picture tube, can lead to intensified X-rays. Equipment modified in this way no longer complies with the approval and must not be used.

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1 Preconditions and Visual Inspection

1.1 Preconditions for installation

- The electrical and mechanical configuration of the machine must be complete and the axes prepared for operation (obtain confirmation from the customer).

- The customer PLC program must be operational and, as far as possible, pretested.

- The measuring systems must be installed and wired as far as the SINUMERIK 805 control (visual check).

  If the customer has fitted ***adapter plugs*** in the measuring circuit leads, check proper connection, strain relief and, above all, provision of prescribed shielding.

- The cables to the machine must be connected. The cable shields must be run to the control neutral point as stated in the Interface Description.

  Flexible ***earth wires*** installed (visual check):
  – Earth bar in SINUMERIK 805 interface units: 10 mm^2
  – Earth bar in machine column interface unit: 10 mm^2

- Support provided by customer personnel for work in interface unit, on machine, for machine operation and as regards the PLC program compiled by the customer.

  Recommendation:
  Limit the travel ranges (greater clearance distances) by displacing the end stop (EMERGENCY STOP cam).

- The machine data specified for the machine must be available.

- Test tapes for checking the machine-specific functions must be available.

1.2 Preliminary remarks

Synthetic or rubber soles and, in particular, synthetic flooring and carpets, may produce static charges of several kV in human beings. Integrated circuits are sensitive to high-voltage discharges of this type. For this reason, never touch printed conductors or components without first discharging your body on an earthed part of the system.

The control must always be disconnected before removing or inserting modules and power supply cables.

Attention must be paid to static charging even when the control is disconnected, to prevent short-circuiting across the V_{CC} RAM printed conductors. Otherwise data in a buffered CMOS RAM memories may be corrupted or printed conductors may burn out.

MOS Caution! Observe safety regulations!

MOS Caution! Observe safety regulations!

MOS is a technology used to produce highly integrated digital circuits. "MOS" is an acronym of Metal Oxide Silicon. Its principle advantages are:

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

Identification on packaging **MOS**

Identification on printed circuit board **M O S**

CAUTION

CAUTION

The printed circuit board (PCB) is equipped with MOS chips. To prevent these chips being destroyed, equipotential bonding is needed before installing the PCB. Take the PCB with conductive foam plastic out of the packaging and touch an earth part of the system with your hand. Do note touch the printed conductors and components!

Note:
Refer to the note in the packaging!

Additional notes:

Do not open the special packaging unnecessarily.
Store only in the black (conductive) foam plastic.
Do not bring into contact with plastic materials (risk of static charging).
Disconnect power supply before installing and removing.

1.3 Visual inspection of system

1.3.1 Earthing

Proper earthing to divert external faults is essential for troublefree operation. Make sure that the earth wires are not kinked and have the required cross-section (also see Instruction Manual).

1.3.2 Position encoders

Special attention must be paid to proper installation of the linear measuring systems (air gap etc.) and rotary measuring systems (coupling etc.); also refer to the Heidenhain installation and adjustment instructions. Check proper wiring and secure location of the connectors. Other makes of measuring system may result in inaccuracies and surface quality problems beyond our control.

1.3.3 Cable laying

The power and control cables must be isolated as far as possible. Avoid earth loops because these or non-regulation earthing may generate a ripple voltage affecting the speed controller set value. In such cases, smooth running is no longer possible at very low speeds.

Check for kinks (fibre-optic cables).
Make sure that the cables are properly installed and not trailing.

1.4 Shielding

The overall shields of all cables running to or from the control must be earthed at the control via the connectors (see Interface Description Part 2 - Cables and Devices).

1.5 Operator panel, screen

Check that the keys, lamps, symbols and screen are in proper working order.

1.6 Overall condition

Make sure that the modules and cover plates are properly secured and that the connectors are screwed to the devices (earth connection).

Accessory pack:
Check that the log book and complete parts list are present.
(The parts list is included with the original delivery note for insertion in the log book).

When renewing modules or in the event of faults, check the proper location and seating of all ICs inserted in sockets.

Check jumper assignment on the modules.

1.6.1 Battery in central controller

The battery holder is located in the central controller on the right. To avoid the loss of stored data, the battery holder must be removed when renewing the battery only with the control switched on. The battery voltage is continuously monitored. If the voltage drops below 2.9V, Alarm 1 (battery fault) is displayed (also see Section 3.1.6).

1.6.2 Cables

Check all cables with reference to the Interface Description (Part 2 Connection Conditions). This applies especially to cables produced by customer. A random check must be made on at least one connector (note conductive elastomer connections in particular). In the event of non-compliance with our directives, inform the responsible sales point and take corrective measures if necessary.

Check proper installation of fibre-optic cables (bending radius according to installation instructions).

2 Installation Checklist

SINUMERIK 805	
Cycles used	
T	M
☐	☐

Serial No.	____________
Software version	____________

Installation sequence

Note Section 1 of this Installation Guide!

Copy the installation checklist.

Cross yes/no as appropriate after completing each section.

Enter all the requested values as stated.

Print out the NC machine data, PLC machine data and setting data after installation.

	Initial installation	**Re-installation**
Name		
Date		
Office		
	Manufacturer:	**End-user:**
Address		

Explanations on the following points are given in the individual Sections of this Guide.

1. Are the preconditions fulfilled for installation according to Section 1? yes ☐ no ☐

2. Visual check: Mains connection, EMERGENCY STOP, earthing, position encoders, cable laying, shielding, distributed machine peripherals, hand-held units, operator keyboard, overall condition OK? yes ☐ no ☐

3. Voltage test performed according to Section 4? yes ☐ no ☐

4. Standard installation concluded and customer-specific data input? yes ☐ no ☐

5. PLC program entered and tested (safety functions) ? yes ☐ no ☐

6. Axis position control loops started up and the following checked: Axis speeds/tacho-generator compensation/multgain factors/ closed-loop gain (K_V factor)/acceleration/exact positioning/position control loop monitors/analog spindle speed/traversing ranges ? yes ☐ no ☐

7. Have all JOG mode functions been tested? yes ☐ no ☐

   Has the functional test been carried out with the test program (of the customer) ? yes ☐ no ☐

8. Have the following data been saved:

   - NC and PLC machine data? yes ☐ no ☐
   - PLC message and alarm texts? yes ☐ no ☐
   - Zero offsets? yes ☐ no ☐
   - Setting data? yes ☐ no ☐
   - R parameters? yes ☐ no ☐
   - Tool offsets? yes ☐ no ☐

9. Have these data been deposited at the machine ? yes ☐ no ☐

10. Has the PLC program been loaded in the EPROM submodule and is the module inserted? yes ☐ no ☐

11. Has the installation checklist been completed (NC MD, PLC MD, Setting data, Options), inserted in the log book and deposited at the control? yes ☐ no ☐

12. Have the following functions been explained to the customer:

    Drift compensation, reference point setting, backlash compensation? yes ☐ no ☐

13. Has the customer signed the installation report? yes ☐ no ☐

Signatures

Initial installation **Re-installation**

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Options list

Yes	No	Order code	Options	Retrofit order No.
		B07 B36 B61	SINEC LA2 interface Operator control and monitoring via external PC 3-D interpolation	6FC4 600-0AB07 6FC4 600-0AB36 6FC4 600-0AB61
		 C46 C47 C48 C62	User memory expansion from 16KB to 64 KB from 16 KB to 96 KB (as from SW 3.1) from 16 KB to 128 KB (as from SW 4.1) Second RS232C (V.24) interface	 6FC4 600-0AC46 6FC4 600-0AC47 6FC4 600-0AC48 6FC4 600-0AC62
		E31 E33 E36 E42 E86 E87	Thread cutting and rotational feedrate 3 analog setpoint outputs (as from SW 4.2) Tapping with dynamic following error compensation (as from SW 3.1) Oriented spindle stop (M19) Output of cam signals Speed overlay with handwheel pulses (as from SW 2.2)	6FC4 600-0AE31 6FC4 600-0AE33 6FC4 600-0AE36 6FC4 600-0AE42 6FC4 600-0AE86 6FC4 600-0AE87
		F05 F20	Analog spindle speed Internal clock (as from SW 4.1)	6FC4 600-0AF05 6FC4 600-0AF20
		H56	Leadscrew error compensation (SSFK)	6FC4 600-0AH56
		J33 J41 - J43 J44 J45 J47 J70	Screen texts in Czech (as from SW 4.2) Screen texts in English Screen texts in German Screen texts in French Screen texts in Italian Screen texts in Spanish Screen texts in Russian (Cyrillic characters) (as from SW 4.1) Expansion submodule for operator keyboard (S01) 16 inputs/16 outputs for keys or LEDs	 see Sections 3.1.8 and 3.1.9 6FC4 600-0AJ70

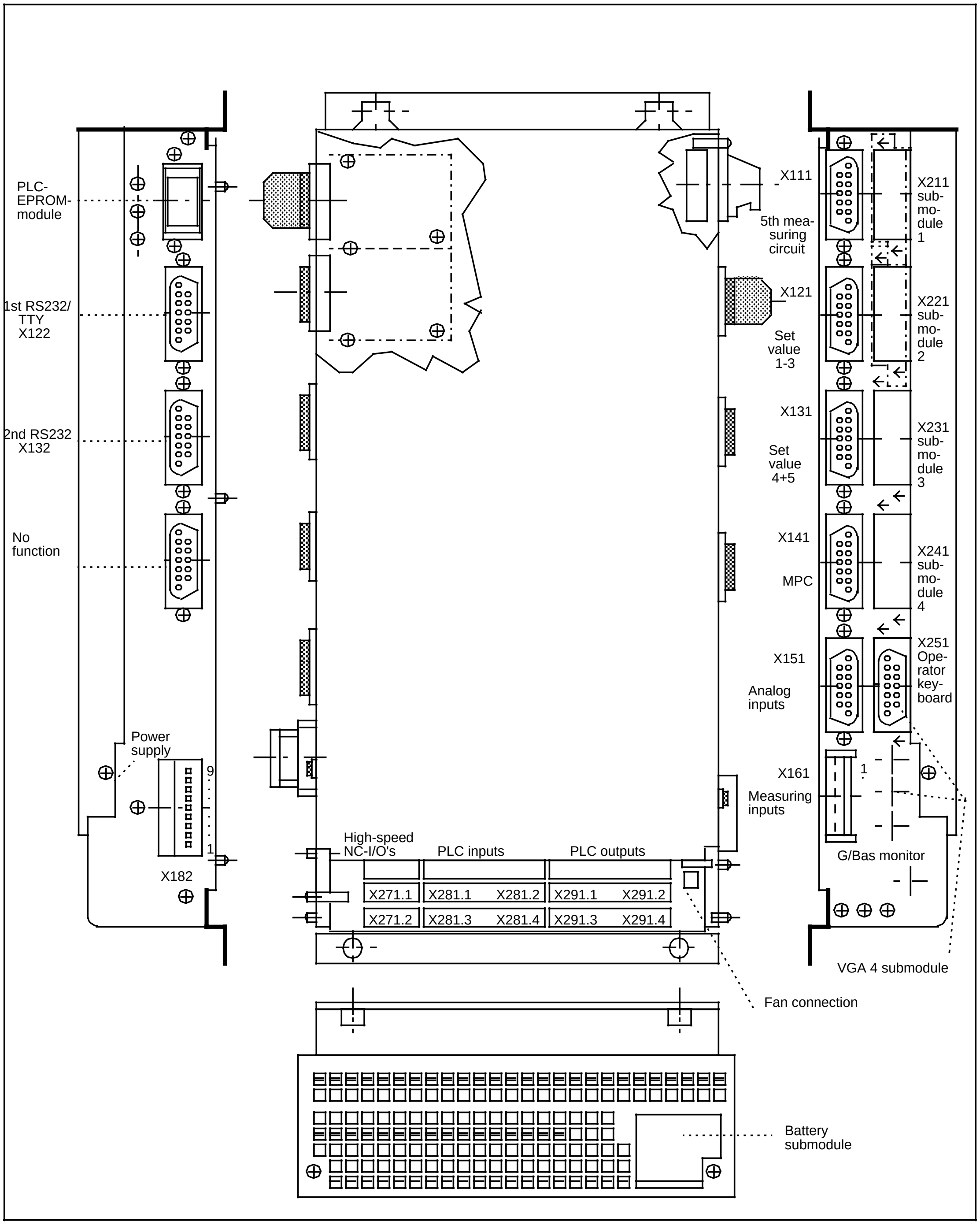
Yes	No	Order code	Options	Retrofit order No.
		K01 K02 K03 K04 K05 K11 K12 K13 K14 K21 K22 K23 K24	Act. val. submod. 1 without EXE Act. val. submod. 2 without EXE Act. val. submod. 3 without EXE Act. val. submod. 4 without EXE Act. val. submod. 5 without EXE (for 2nd handwheel only, as from SW 4.1) Act. val. submod. 1 with 5-fold EXE Act. val. submod. 2 with 5-fold EXE Act. val. submod. 3 with 5-fold EXE Act. val. submod. 4 with 5-fold EXE Act. val. submod. 1 with 10-fold EXE Act. val. submod. 2 with 10-fold EXE Act. val. submod. 3 with 10-fold EXE Act. val. submod. 4 with 10-fold EXE	6FC4 600-0AK01 6FC4 600-0AK01 6FC4 600-0AK01 6FC4 600-0AK01 6FC4 600-0AK01 6FC4 600-0AK11 6FC4 600-0AK11 6FC4 600-0AK11 6FC4 600-0AK11 6FC4 600-0AK21 6FC4 600-0AK21 6FC4 600-0AK21 6FC4 600-0AK21
		M10 M13 M25 M26 M27 M30 M33 M34 - - - - - - 	Ext. handwheel connection to 5th actual value input (job mode encoder) Connection of 2nd external handwheel (as from SW 4.1) 8 analog inputs High-speed NC inputs/outputs High-speed M functions (as from SW 4.1) DMP carrier module (DMP-TB), required for each DMP submodule (M33 or M34) DMP module with 16 INP/16 OUT DMP module with 32 INP DMP-IP65 terminal block (as from SW 4.2) DMP-IP65 module (as from SW 4.2) DMP compact terminal block (as from SW 4.2) DMP compact module 8 outputs (as from SW 4.2) DMP compact module 16 outputs (as from SW 4.2) DMP compact module 16 inputs (as from SW 4.2) DMP connector	6FC4 600-0AM10 6FC4 600-0AM13 6FC4 600-0AM25 6FC4 600-0AM26 6FC4 600-0AM27 6FC4 590-0AM30 6FC4 590-0AM33 66FC4 590-0AM34 6FC5 111-0CA72-0AA0 6FC5 111-0CA22-0AA0 6FC5 111-0CA73-1AA0 6FC5 111-0CA03-0AA0 6FC5 111-0CA02-0AA0 6FC5 111-0CA01-0AA0 6FC4 590-0AM38
		N46	PLC user memory expansion to 32 KB and data memory to 8 KB (as from SW 4.1)	6FC4 600-0AN46
		R04 R42 R50	Monitor, b/w, 24 V DC 9.7" LCD slimline monitor Monitor, color, 230 V AC (as from SW 4.1)	6FC4 600-0AR04 6FC4 600-0AR42 6FC4 600-0AR50

Ja	No	Order	Options	Retrofit order no.
		S01	Operator keyboard without expansion module (max. 2 expansion modules per J70 possible)	6FC4 600-1AS01
		- - - - - - - -	Hand-held unit (BHG) BHG without housing as machine control panel Distribution box for BHG SINUMERIK slimline operator panel (as from SW 4.2) 19” modular enclosure system, 10” monochrome display Machine control panel for slimline Operator panel (as from SW 4.2), T version As above, M version Cable set for machine control panel to slimline operator panel (as from SW 4.2)	6FC5103-0AD20-0AA0 6FC5103-0AD21-0AA0 6FC5147-0AA05-0AA0 6FC5103-0AB02-0AA0 6FC5103-0AD01-0AA0 6FC5103-0AD03-0AA0 6FC5147-0AA04-0AA0

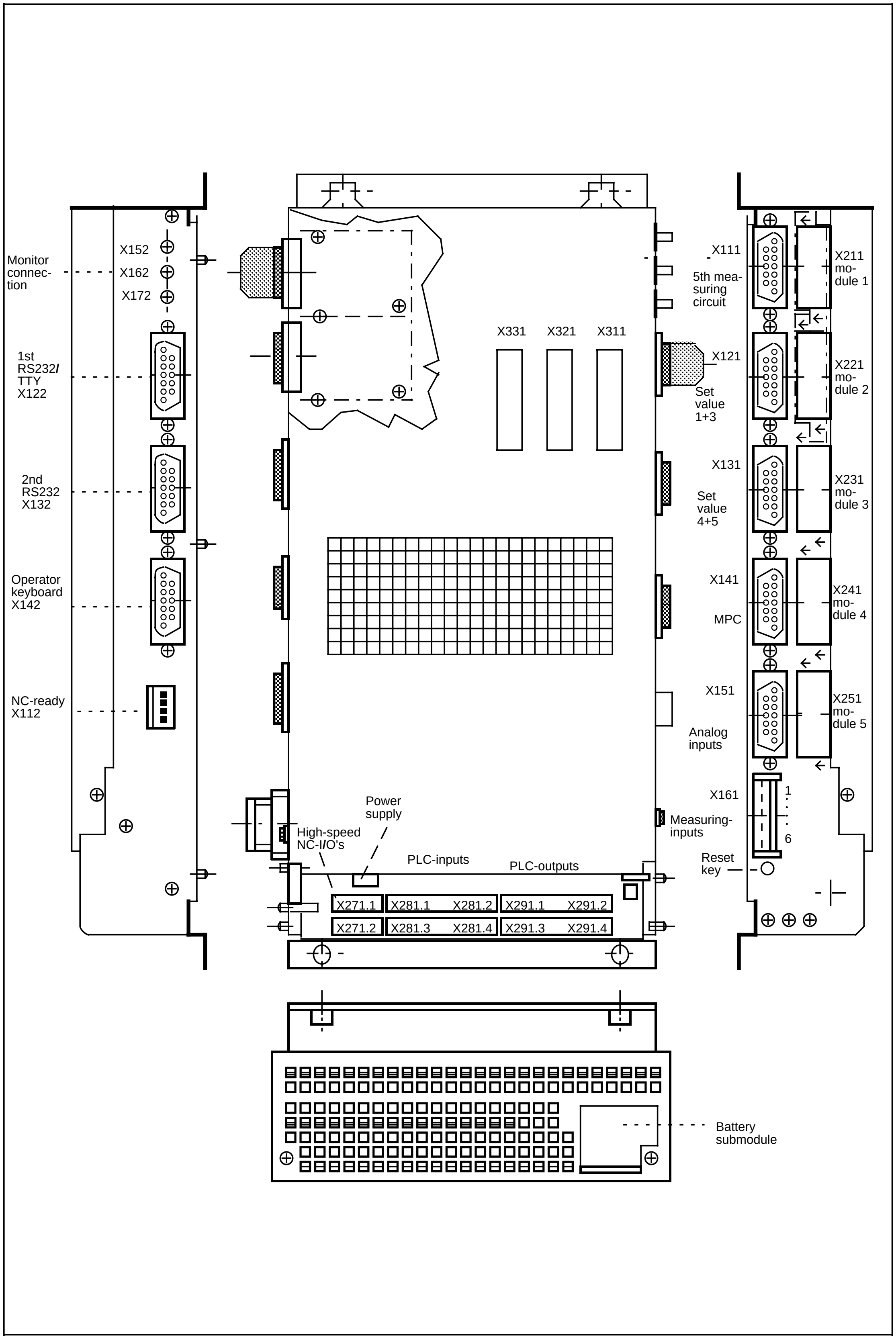
3 Overview of Devices with Standard Jumperings

3.1 Overview of central controller

Version 1 (up to Software Version 2.2)

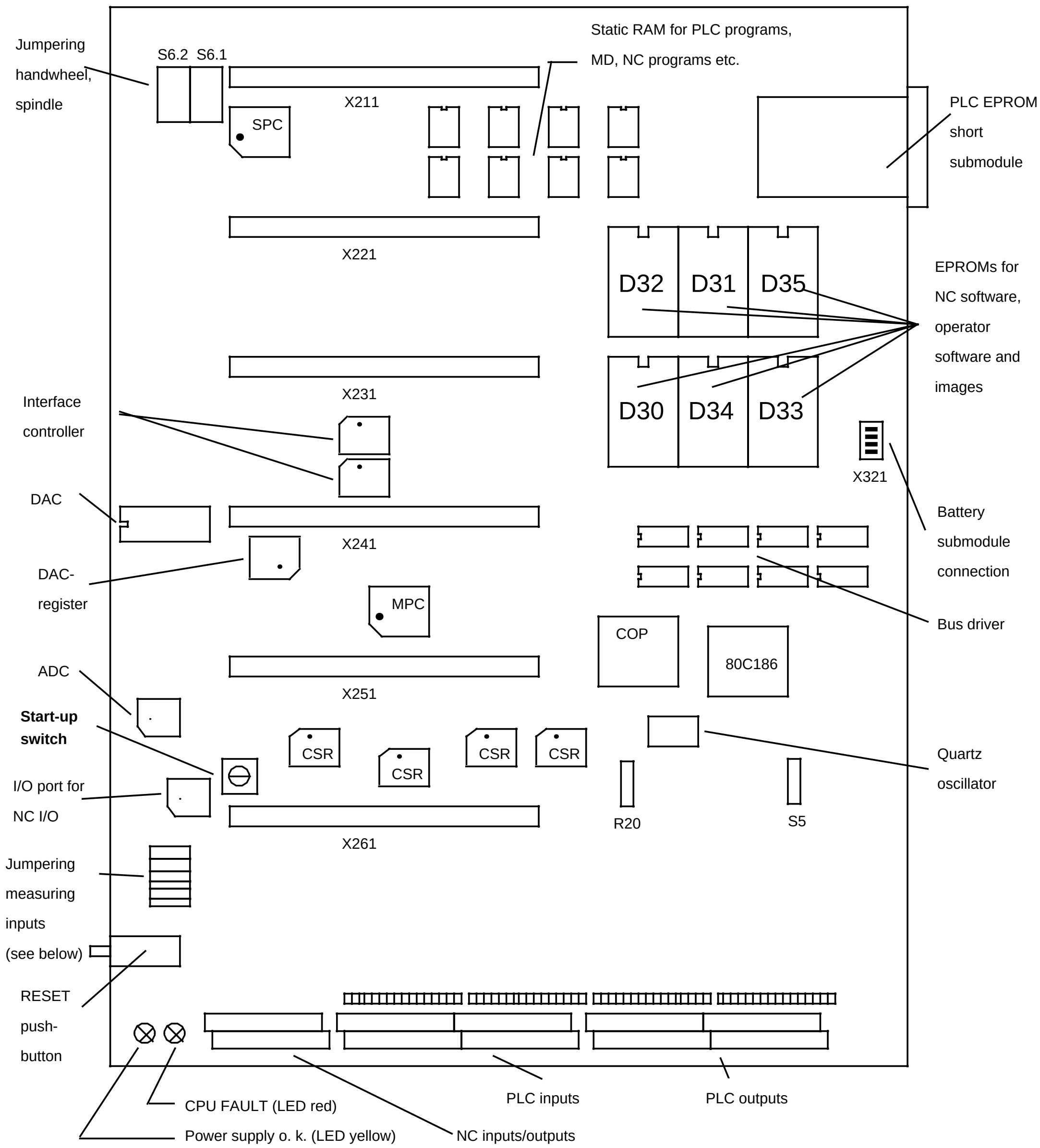


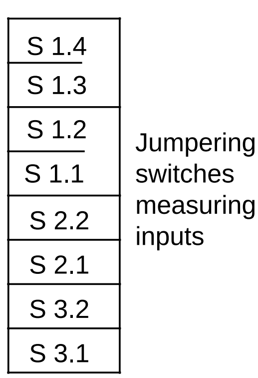
Version 2 (software version 3.1 onwards)



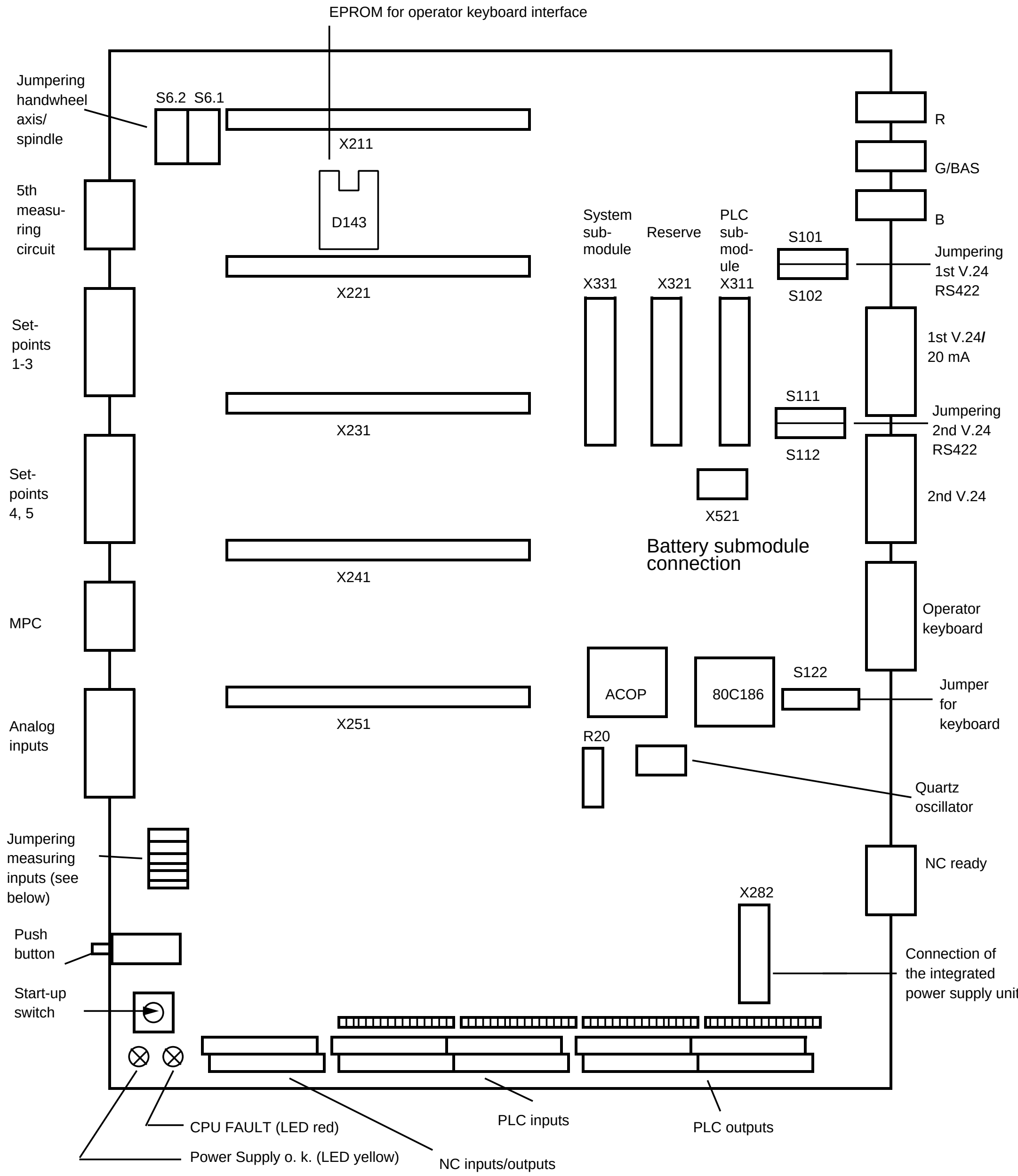
3.1.1 Overview of central processing unit

Central processing unit version 1 (up to Software Version 2.2)





Central processing unit version 2 (Software Version 3.1 onwards)

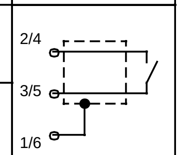
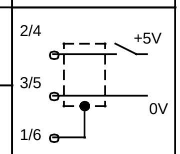
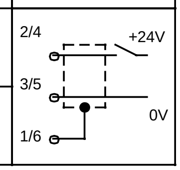


S 1.4	Jumpering switches measuring inputs
S 1.3	
S 1.2	
S 1.1	
S 2.2	
S 2.1	
S 3.2	
S 3.1	

3.1.2 Jumperings

3.1.2.1 Jumperings on the central board

Measuring inputs:

DIP-FIX-switch (on central processing unit)			Sensor 1				Sensor 2				Control switch connection
			S1.1	S1.2	S2.1	S2.2	S1.3	S1.4	S3.1	S3.2	
Component	Edge	Level	Active level		Signal level (5V/24V)		Active level		Signal level (5V/24V)		
open Collector Contact assembly		open (+5V)	*		*	*	*		*	*	
		closed (0V)		*	*	*		*	*	*	
TTL (5V)		+5V	*		*	*	*		*	*	
		0V		*	*	*		*	*	*	
24V		+24V	*				*				
		0V		*				*			

* ≙ Dip-Fix switch closed

Jumpering of the 5th measuring circuit (on central processing unit)

The 5th measuring circuit can process signals from a handwheel or an axis/spindle encoder. Jumpering is according to the following table with S6.1 and S6.2:

Component	S6.1	S6.2	Signal
Encoder or handwheel with tracks A, $\bar{A}$, B, $\bar{B}$.			Differential signal
Handwheel with tracks A, B.	*	*	TTL level

* ≙ DIP-FIX switch closed

Start-up switch
Position 0 ≙ normal
Position 2 ≙ start-up initialization mode

Jumpering of 1st V.24 (RS232 C), 2nd V.24 (RS232 C) interface (Version 2 only) and keyboard interface

1st V.24 (RS232 C) (X122)			2nd V.24 (RS232 C) (X 132)		Keyboard X 142
Operation	S101	S102	S111	S112	S122
RS232 (Standard setting)					
RS422 (in connection with RS 422 adaptor see Section 3.1.7.4)	*	*	*	*	*

*≙ *DIP-FIX switch closed*

Jumpering switch R20

Standard jumpering: open

Jumpering switch S5 (Version 1 only)

Standard jumpering: closed

3.1.3 Possible measuring circuit configurations

Function	1st sub-module location X211	2nd sub-module location X221	3rd sub-module location X231	4th sub-module location X241	5th sub-module location X251	5th actual value input (on central processing unit) X111
Axis	X 1)	X 1)	X 1)	X 1)		X
Spindle	X 1)	X 1)	X 1)	X 1)		X
Handwheel				X 2)	X 2)	X
Setpoint output (Servo command) sub-module (as from SW 4.2)				X	X	
SINEC L2 submodule (as from SW 4.1)					X	

Notes:

- max. 4 axes and 1 spindle
- max. 2 handwheels
- max. 1 SINEC L2 submodule
- max. 1 setpoint output (servo command) submodule

1) in conjunction with actual value submodule without/with EXE
2) in conjunction with handwheel submodule as 2nd handwheel (as from SW 4.1)

Assignment actual value submodule/set value output:

The 1st set value on X 121 is assigned to the 1st actual value submodule X 211.
The 2nd set value on X 121 is assigned to the 2nd actual value submodule X 221.
The 3rd set value on X 121 is assigned to the 3rd actual value submodule X 231.
The 4th set value on X 131 is assigned to the 4th actual value submodule X 241.
The 5th set value on X 131 is assigned to the 5th actual value (central processing unit).

3.1.4 Central controller power supply

Version 1 (up to Software Version 2.2)

The central controller is fed from an external power supply unit (6FC4700-0BA01) which is supplied with the control. The power supply unit is connected via a shielded cable to X 182.

X 182		
9	unassigned	
8	Power o.k. (actuated with +5V by the power supply unit)	
7	-15 V	
6	0 V	
5	+5 V	
4	0 V	
3	+15 V	
2	0 V	Power supply for fan (fan is connected to X 192) This power is not supplied by the power supply unit of the supplementary unit.
1	+24 V	

Terminal configuration block (9 screw terminals)

Version 2 (Software Version 3.1 onwards)

The SINUMERIK 805 central controller receives its power supply from the installed power supply unit (6EV3034-0AC) via connector X 282.

Ribbon cable

20-pin

1	+15V	0V	2
3	0V	0V	4
5	0V	+5V	6
7	+5V	+5V	8
9	+5V	+5V	10
11	+5V	+5V	12
13	0V	+5V	14
15	0V	0V	16
17	-15V	0V	18
19	Power OK	-	20

X 282

The installed power supply unit must be connected to a 24 V supply via terminal block X101.

X 101

Terminal block, 4-way

4	3	2	1
Shield	0V	24V	Shield

3.1.5 Pilot LEDs

The LEDs are located at the bottom left of the central processing unit.

LED yellow: Power supply (comes on when the installed power supply unit supplies power to the control)

LED red: CPU fault, internal monitoring (watchdog) has responded

Note:

Also see Section 4.2.1 (CPU monitor).

3.1.6 Battery buffering of the RAM memory

When the control is switched off, the RAM memory must be buffered by a battery voltage.
This retains the following data:

- PLC user program
- User texts (PLC alarm texts and PLC message texts)
- Machine data (NC MD and PLC MD)
- Part programs
- Tool offsets
- R parameter
- Zero offsets
- Setting data
- Clock (from software version 4.1)

RAM memory buffering is performed by a battery submodule.

Battery submodule (Version 1; up to Software Version 2.2)

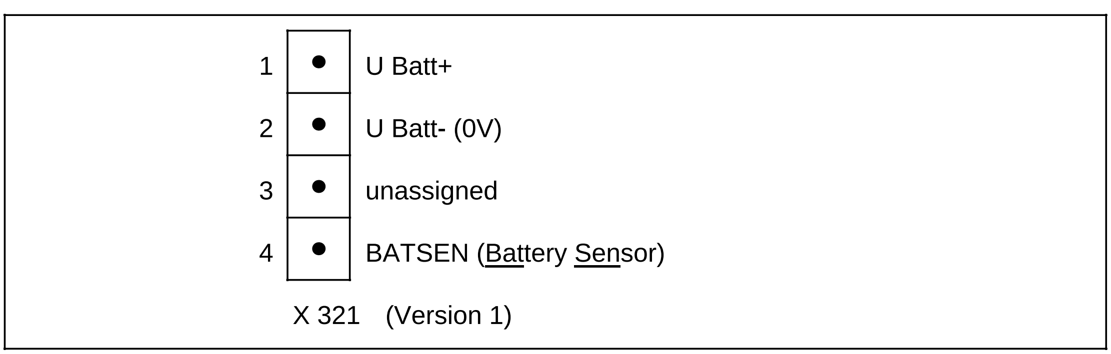
The battery submodule is located in the central processor at the top right. It contains a lithium battery. The battery voltage is cyclically monitored with the control switched on. If the voltage falls below 2.7V, NC alarm 1 (battery fault) is displayed on the screen.

Battery type: 3.4 V/5A, TL 2200 IEC-R-14

Backup time: approx. 1 year

Note:

Change the battery only with the control switched on.
The battery submodule is connected to the central processing unit by means of connector X 321.



Terminal configuration: male (Version 1) miniature connector

Battery submodule (Version 2; Software Version 3.1 onwards)

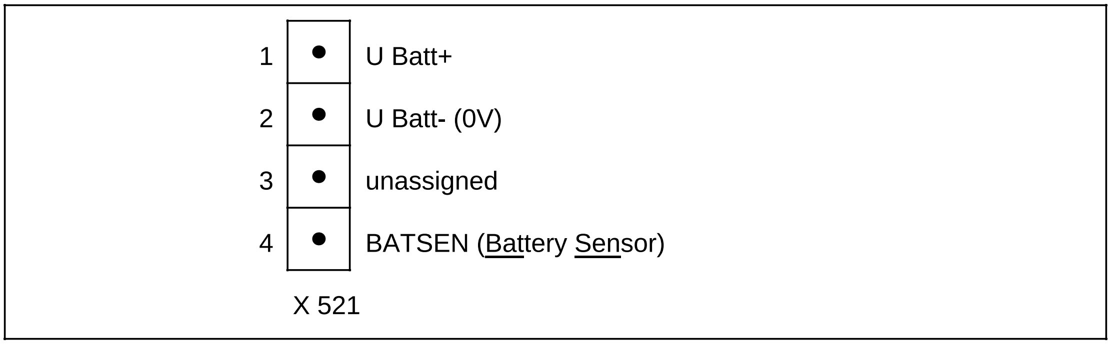
The battery submodule 6FX 1410-0CX46) is located in the central processor at the top right. The battery voltage is cyclically monitored with the control switched on. If the voltage falls below 2.9V, NC alarm 1 (battery fault) is displayed on the screen.

Battery type: 3×1.5V round cell, (LR6, usual commercial)

Backup time: approx. 1 year

Note:

Change the battery only with the control switched on.
The battery submodule is connected to the central processing unit by means of connector X 521.



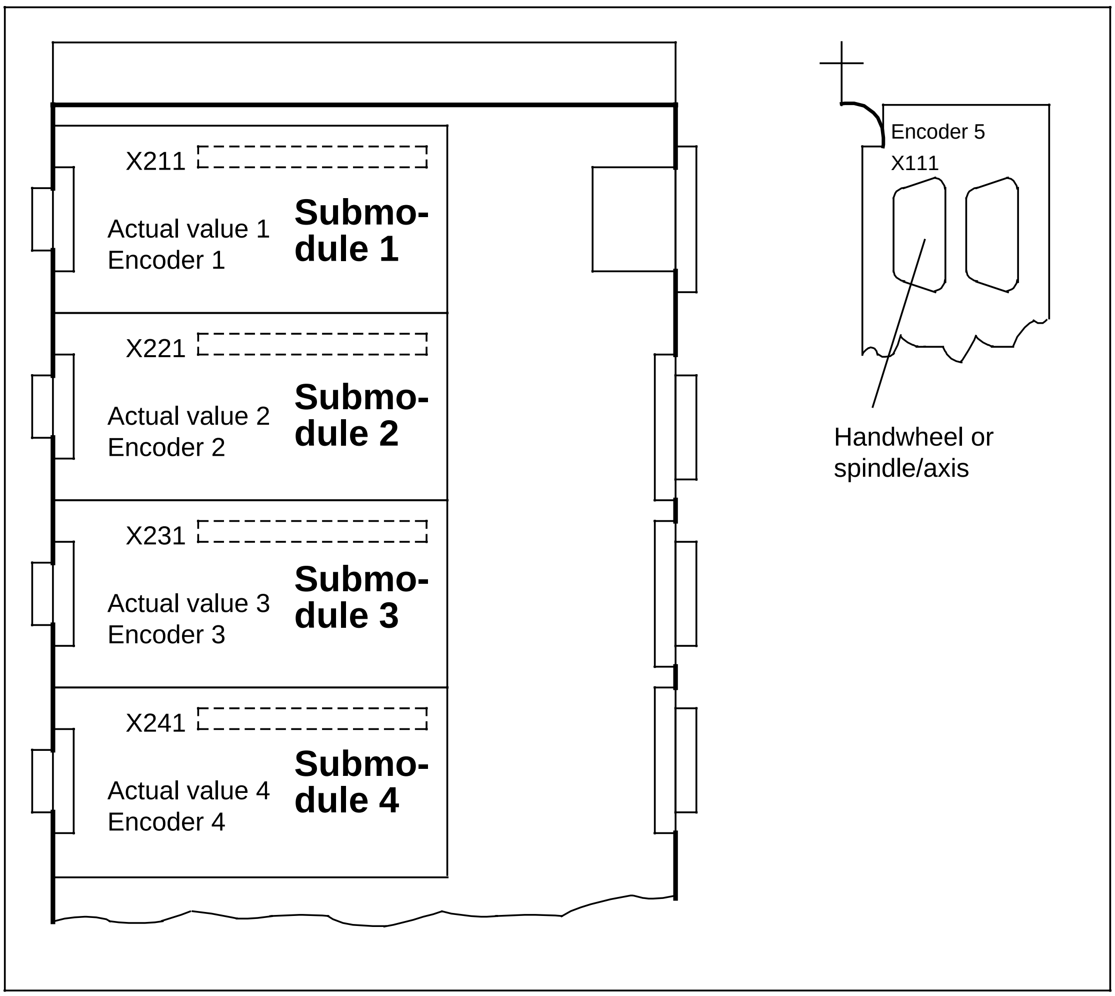
Terminal configuration: male (Version 2) miniature connector

3.1.7 Control interfaces

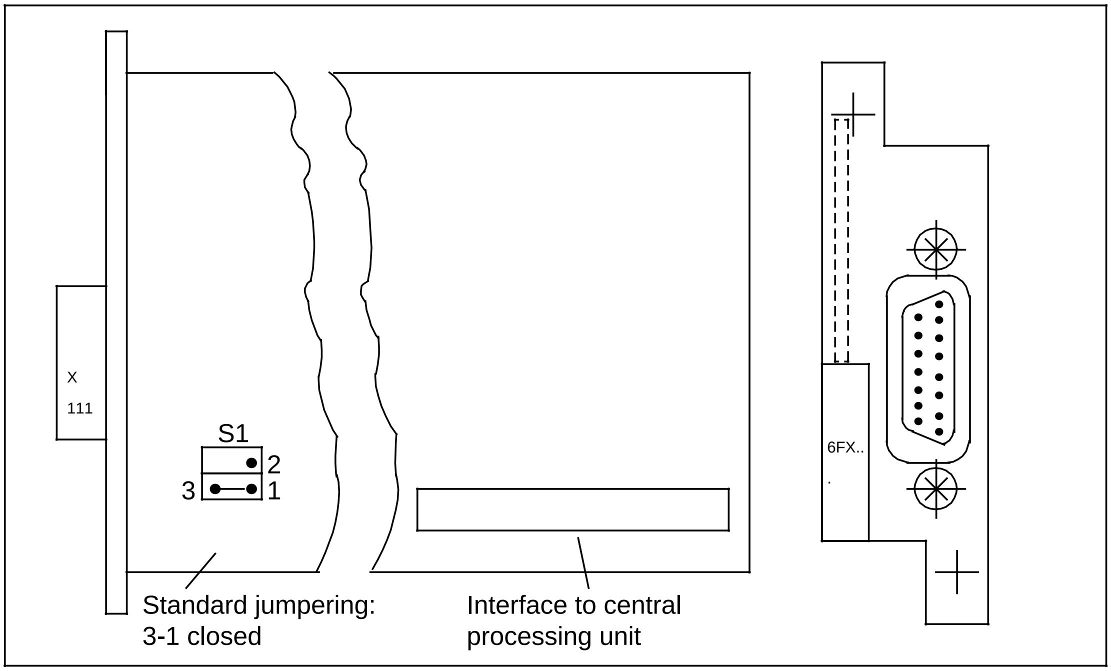
3.1.7.1 Measuring circuit actual value input

The actual values are supplied to the control by means of 15-way connectors. (i.e. the actual-value input has no EXE).
An actual value input for encoders with square-wave input signals is located on the central processing unit. Its designation is encoder 5 or actual-value input 5. The following types of actual value submodule can be inserted in the 4 submodule slots of the central proccessor:

- Submodule 6FX 1145-3BA: for encoders with square-wave output signals (max. encoder scanning frequency: 1 MHz)
- Submodule 6FX 1145-4BA: for encoders with sine-wave output signals (5-fold EXE: max. scanning frequency: 25 kHz)
- Submodule 6FX 1145-5BA: for encoders with sine-wave output signals (10-fold EXE: max. encoder scanning frequency: 12 kHz)

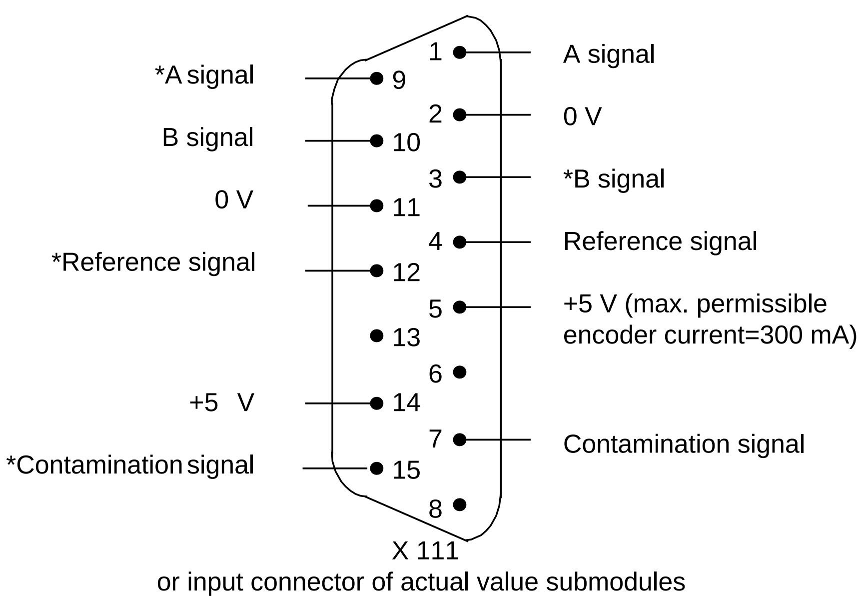


Actual value submodule slots



Typical actual value submodule jumpering

Connection: Subminiature male connector, 15-way



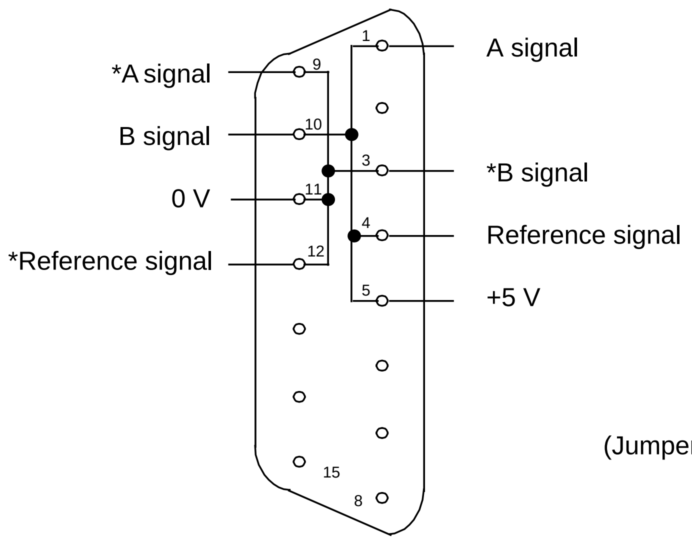
Actual value terminal assignment

Short-circuit connector for actual value input

Owing to their different pin assignments, the short circuit connectors for measuring systems of SINUMERIK System 3 and 8 **cannot** be used for System 800.

The connector is used to test installation and measuring circuits without connected measuring systems or if no axis is installed in cases where it would not be purposeful to change the NC MD 560* bit 0 (no measuring circuit monitoring).

Connection: female subminiature connector, 15-way

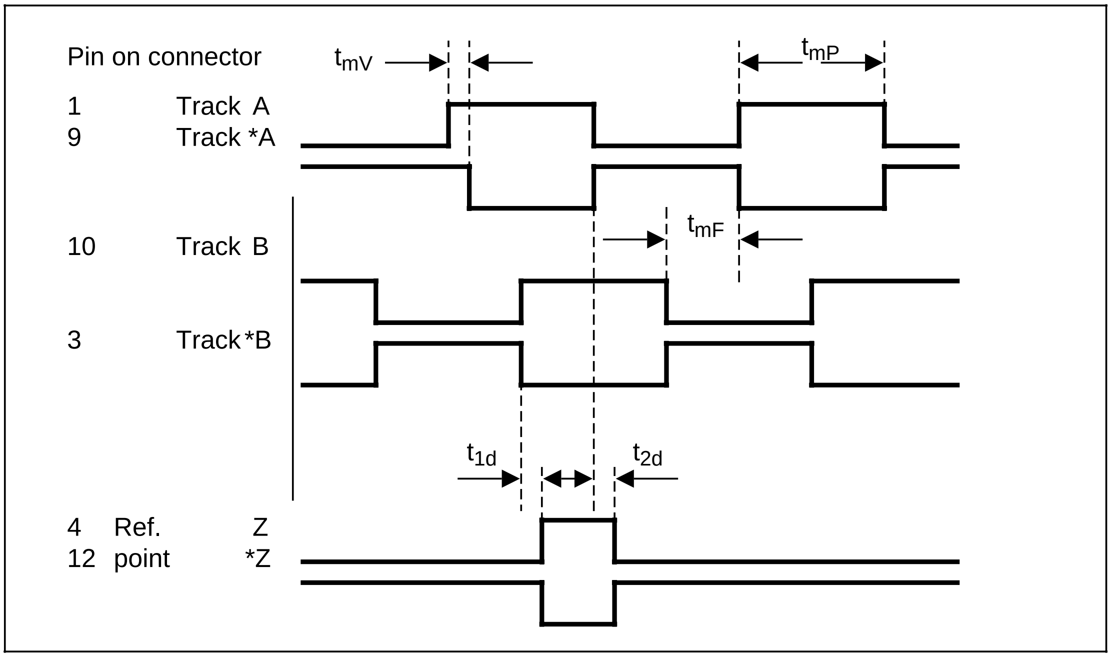


(Jumpers: 1 - 4 - 5 - 10
3 - 9 - 11 - 12)

Connector made by customer

Differential input

Input signals and characteristic values for digital measuring systems with differential input.



Some principle characteristic values:

- Encoder power supply — 5 V + 5 %
- Current per encoder system — 300 mA
- Ohmic input resistance — 470
- Differential input voltage e.g. between A and *A — 1 V
- Maximum differential input voltage — 10 V
- Maximum input frequency with 90° phase shift between A and B track pulses — 1 MHz (without EXE); 25 kHz (5-fold EXE); 12 kHz (10-fold EXE)
- Minimum pulse width t_{mP} — 1 µs
- Minimum spacing between two consecutive edges t_{mF} — 500 ns
- t_{1d} and t_{2d} — 200 ns
- Maximum time delay between two consecutive edges of a track t_{mV} — 50 ns
- Maximum input frequency when used as hand wheel input (5th measuring circuit) — 5 kHz (SW 4.1); 200 kHz (>SW 4.1)

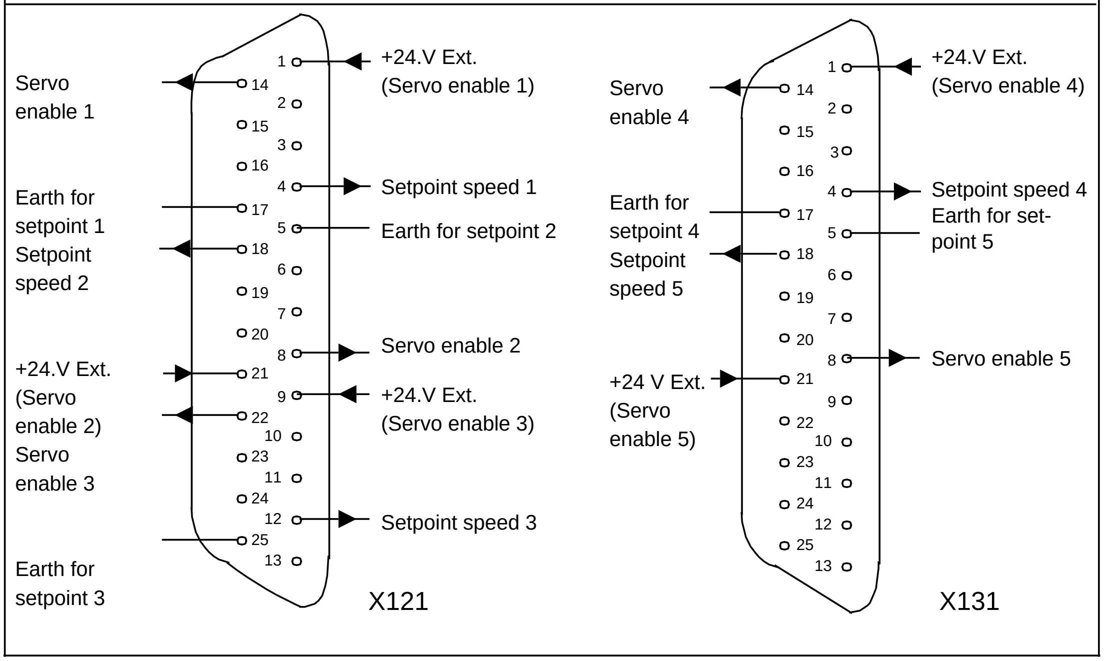
3.1.7.2 Measuring circuit set value output

The setpoint speeds and axis-specific servo enables (floating switching contact Version 2 onwards) are output by the control by means of two 25-way connectors on the central processor.

Connector assignment

X121	Setpoint connector	setpoints 1, 2 and 3
X131	Setpoint connector	setpoints 4 and 5

Connection: male subminiature connector, 25-way



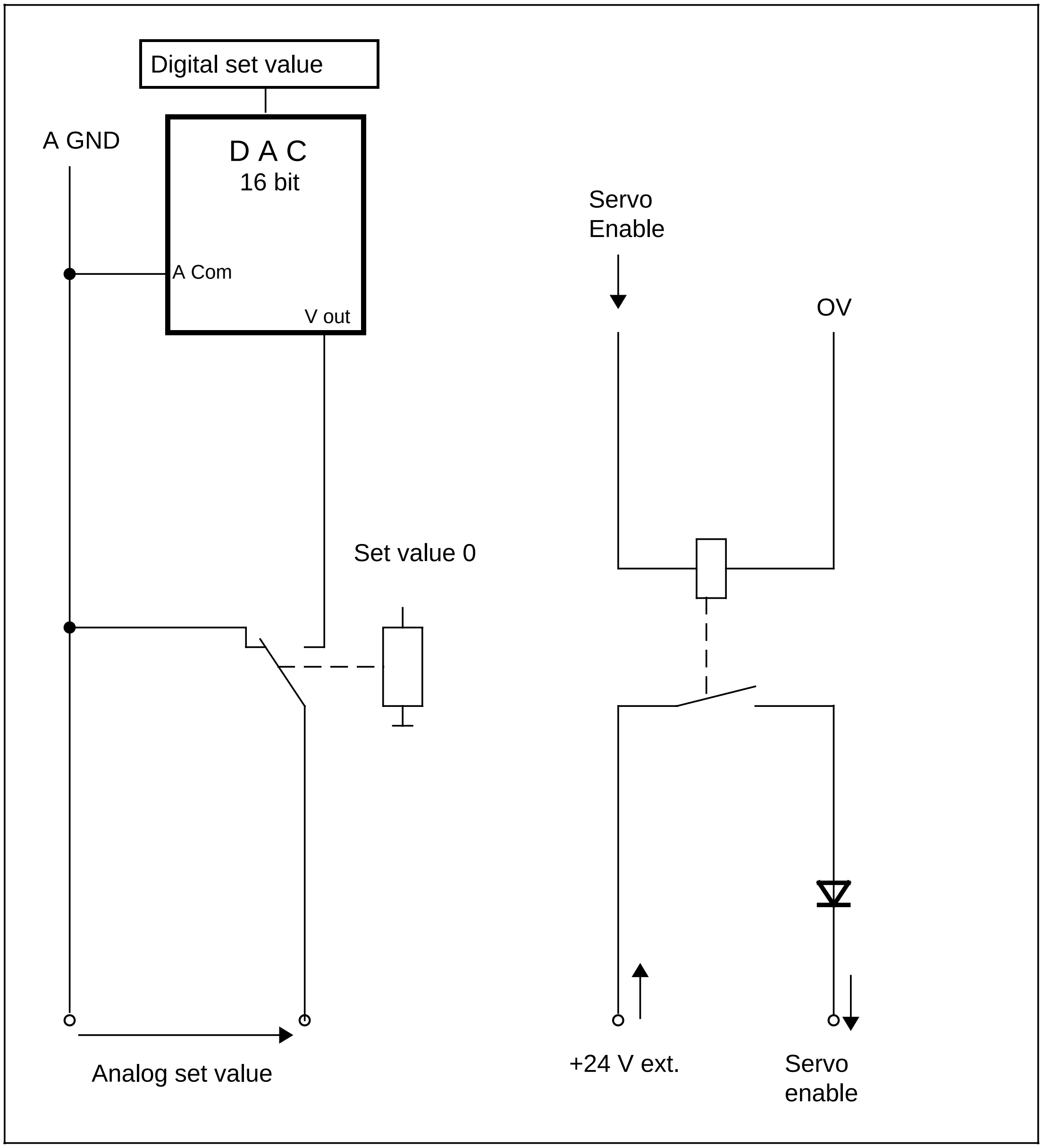
Setpoint terminal assignment

Characteristic values:

•	Setpoint:	max. analog voltage	±10 V	
		max. current	2 mA	
•	Servo enable:	Supply voltage	20 to 30 V	(floating)
		max. current	100 mA	(short-circuit-proof)

Caution!

The "servo enable x" signal from the NC (e.g.: X121 pin 14) must be used properly at the drive actuator.



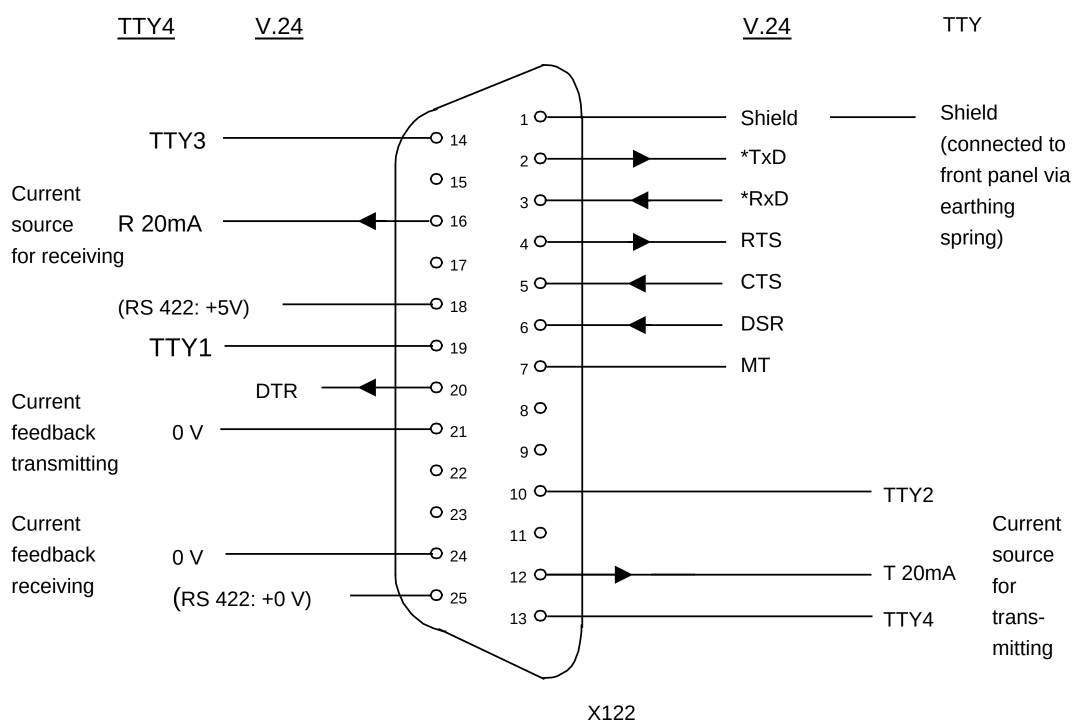
Equivalent circuit diagram (example for a set value)

The set value output is suitable for both differential inputs and non-floating inputs. If the drive actuator does not have a differential input, output A GND must be connected as 0 V.

3.1.7.3 1st user interface (V.24 (RS232 C)/TTY)

Usable for: V.24 (RS232/RS422) / TTY (20 mA)

Connection: female subminiature connector, 25-way



Pin assignments 1st interface

Characteristic values:

- V.24 Level±12 V
  Signals *RxD and *TxD are low-active
- 20 mA: Active or passive (determined by pin assignment);
  only full duplex operation possible.

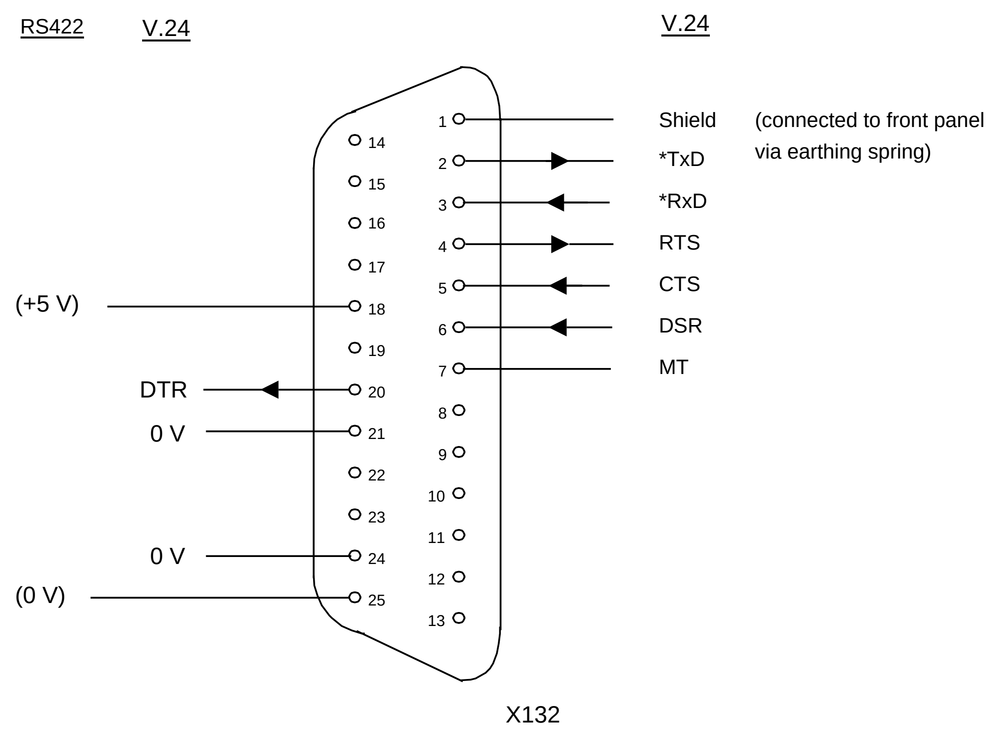
Note:

- When used as an RS 422 interface, an RS 422 adaptor (order no. 6FX 1137-2BA00) is placed directly onto the connector X132.
- Jumpering for interface: see Section 3.1.2.1 (only necessary for Version 2).

3.1.7.4 2nd user interface (RS232 C/V.24)

Usable for: V.24 (RS232) / RS422 (with RS422 adapter)

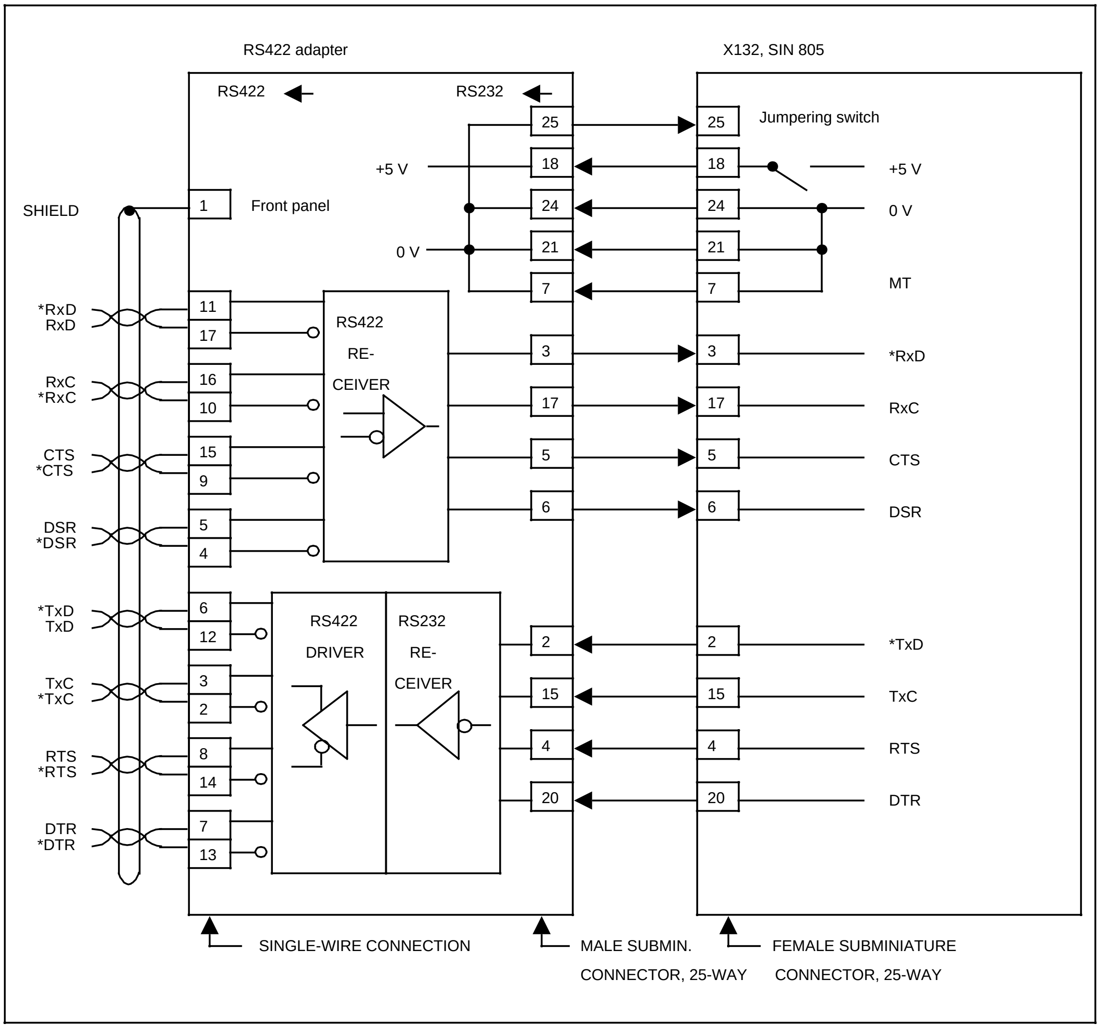
Connection: female subminiature connector, 25-way



Pin assignments 2nd interface

Note:

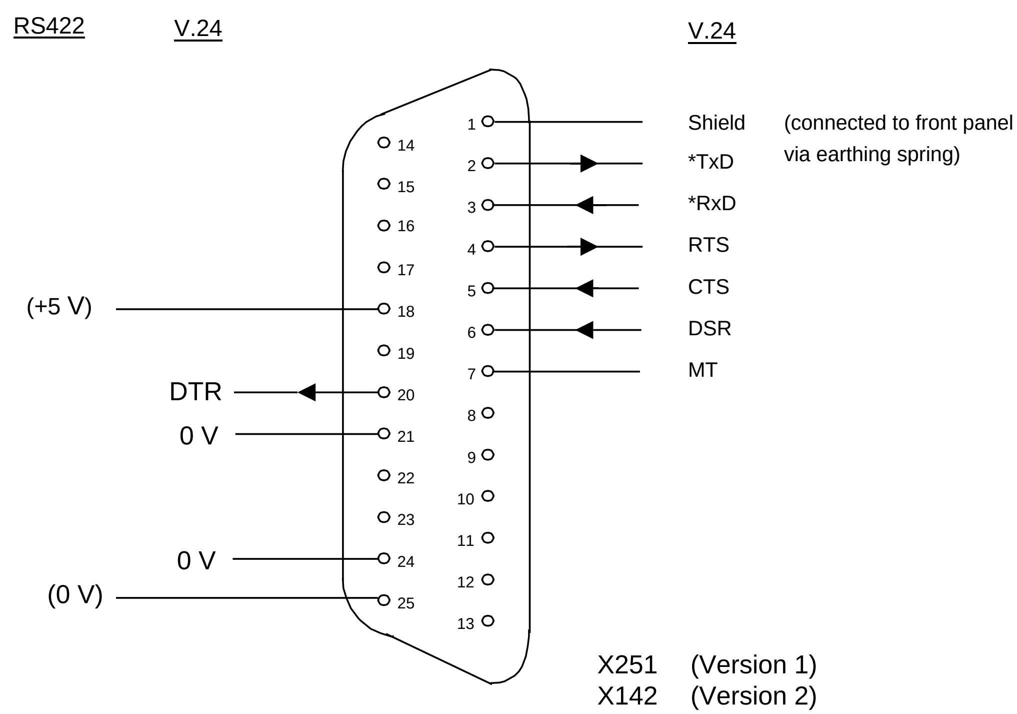
- Refer to the "UNIVERSAL INTERFACE" Planning Guide for a detailed description of the serial interfaces.
- Interface 2 is operational only if the "2nd V.24 interface" Option is available.
- For use as an RS422 interface, connect an RS422 adapter (Order No. 6FX1137-2BA00) directly to connector X132 (see block diagram RS422).
- Jumpering for interface: see Section 3.1.2.1 (only necessary for Version 2).



Block diagram RS422

3.1.7.5 Keyboard interface

Connection: female subminiature connector, 25-way



Pin assignments keyboard interface

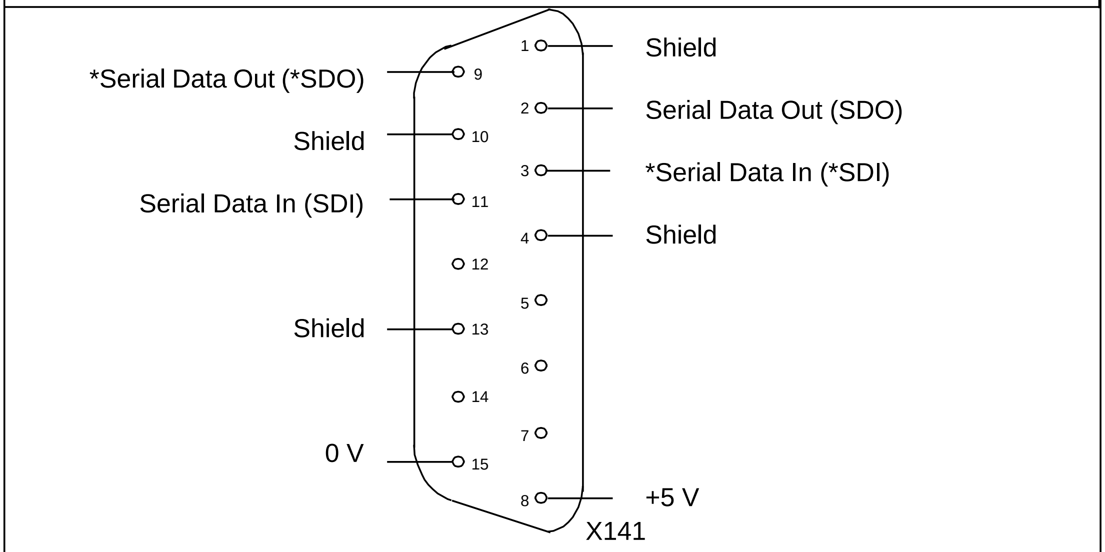
Note:

- On hardware version 1, the keyboard interface is situated on the VGA submodule, and on hardware version 2 it is situated on the central processing unit.
- For use as an RS422 interface an RS422 adapter (order No. 6FX1 137-2BA00) is directly plugged into connector X132 (see block diagram RS422).
- Jumpering for the interface: see Section 3.1.2.1 (only required for hardware version 2).

3.1.7.6 MPC interface

This interface is for data transmission between the control (MPC master) and distributed I/O devices (MPC slaves).

Connection: female subminiature connector, 15-way



Pin assignments MPC interface

3.1.7.7 Monitor interface

Characteristic values:

- VGA controller
- Resolution of 640 x 480 pixels with 16 colours
- Suitable for the connection of RGB analog colour monitors (with composite synch on green) or monochrome monitors with composite video (BAS) signal on green.

Connector designations:	X 152	R (RED)
	X 162	G (GREEN)/composite video signal
	X 172	B (BLUE)
Connector version:		1 BNC, female

Note:

- No jumpering is possible for the monitor interface.

- In the case of hardware version 1, the monitor interface is implemented together with the keyboard interface as a VGA submodule. The VGA submodule is situated on the submodule level underneath the slots for measuring circuit submodules.

- In the case of hardware version 2, the monitor interface is implemented on the central processing unit.

3.1.7.8 Sensor inputs 1 and 2

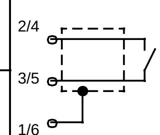
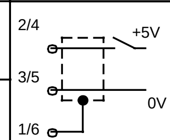
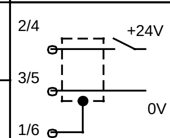
Connection: terminal block (6 screw terminals) X161			
Measuring pulse	Shield	1	
	(NC input 0)	2	Sensor 1
	0 V	3	
Measuring pulse	(NC input 1)	4	Sensor 2
	0 V	5	
	Shield	6	

Terminal configuration

Note:

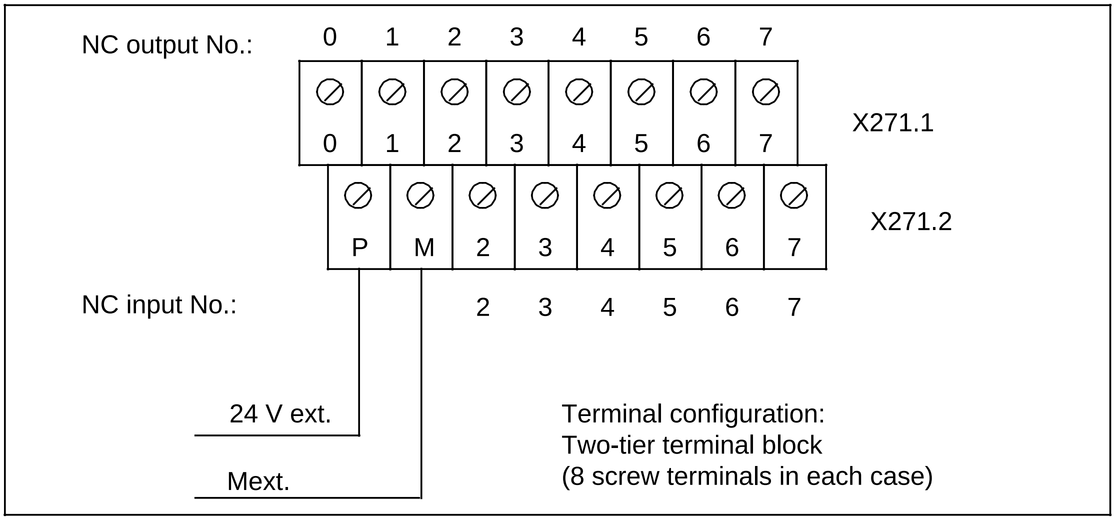
The sensor inputs can be scanned with the function @720 (see NC Programming Guide).

To match the control to the relevant sensors, the level (24 V/5 V) and active edge can be jumpered as follows with DIP-FIX switches on the central processing unit:

DIP-FIX-switch (on central processing unit)			Sensor 1				Sensor 2				Control switch connection
			S1.1	S1.2	S2.1	S2.2	S1.3	S1.4	S3.1	S3.2	
Component	Edge	Level	Active level		Signal level (5V/24V)		Active level		Signal level (5V/24V)		
open Collector Contact assembly		open (+5V)	*		*	*	*		*	*	
		closed (0V)		*	*	*		*	*	*	
TTL (5V)		+5V	*		*	*	*		*	*	
		0V		*	*	*		*	*	*	
24V		+24V	*				*				
		0V		*				*			

* Dip-Fix closed

3.1.7.9 High-speed NC inputs/outputs



Characteristic values:

NC outputs 0-7: 24 V, max. 400 mA, short-circuit proof
NC inputs 2-7: Active level +24 V

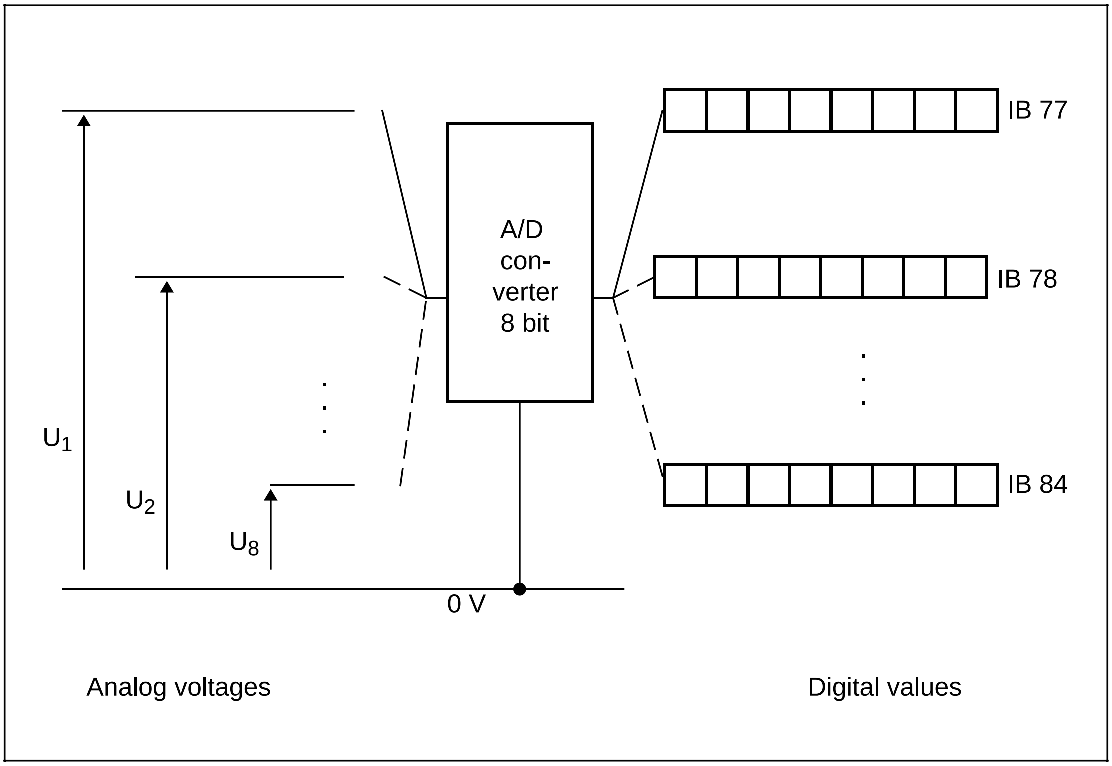
Note:

- The "high-speed NC input/output" function is an Option.
- NC inputs 0 and 1 are used as sensor inputs and are not an option.
- Image of the inputs: flag byte 22
- Image of the outputs: flag byte 20

3.1.7.10 Analog inputs

The max. 8 analog voltages that can be connected are digitalized by an 8-bit A/D converter in multiplex mode and the results are stored in IB 77 to IB 84.

Precondition: The "Analog inputs" Option must be available.



Block diagram analog inputs

Characteristic values:

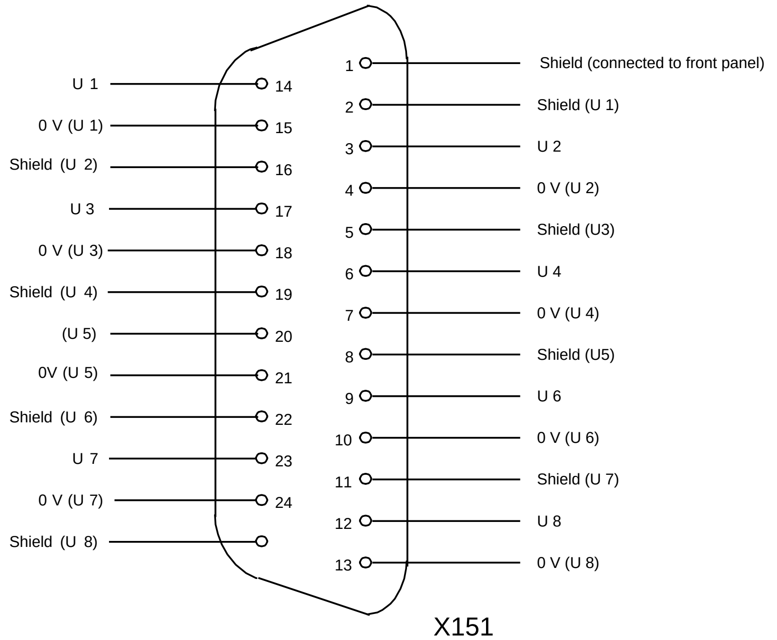
Voltage: 0...+10 V
Resolution: 8 bit (2^8=256 digits)

The inputs have reverse voltage protection.

Maximum limit voltage: +10.5 V
Minimum limit voltage: – 0.5 V

The manufacturer must ensure that the maximum and minimum voltage limits at the analog inputs are maintained.

Connection: female subminiature connector, 25-way



Terminal assignment analog inputs

Example:

With the aid of a temperature sensor and an analog input, it is possible the implement temperature monitoring of the control and of external devices.

3.1.7.11 Central I/O devices

The central controller provides the PLC user with 32 binary inputs and 32 binary outputs.

Binary inputs and outputs

These inputs and outputs are permanently assigned in the relevant process image:

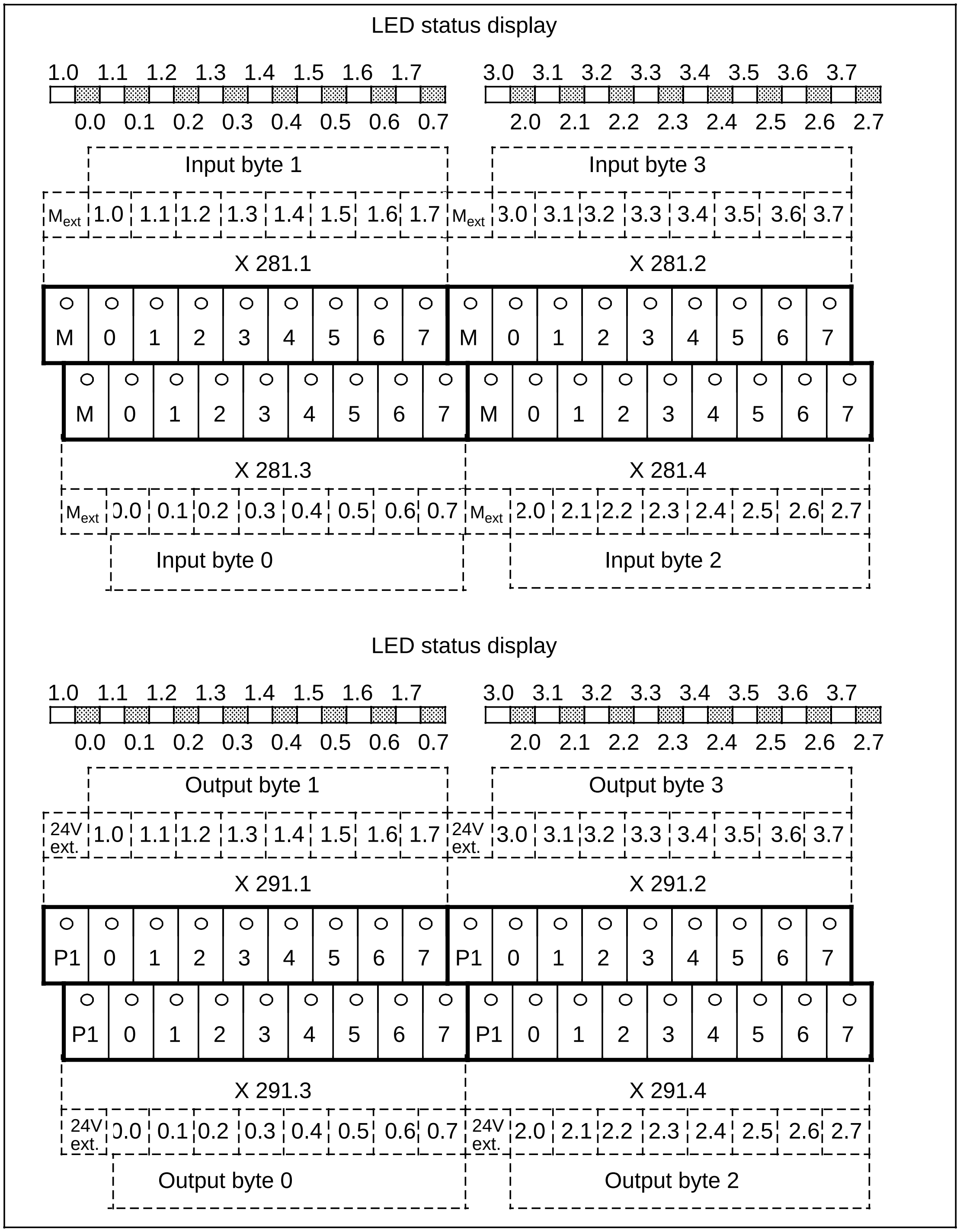


Illustration of input and output bytes

Characteristic values:

Inputs:	24 V, LED status display
Outputs:	24 V, max. 400 mA, short-circuit proof, LED status display, simultaneity factor 50%, non-floating
Terminal configuration:	2-tier terminal block (each with 2 x 9 screw terminals)

Note:

The following terminals are internally jumpered:
M from IB0 and IB1
M from IB2 and IB3
P1 from QB0 and QB1
P1 from QB2 and QB3

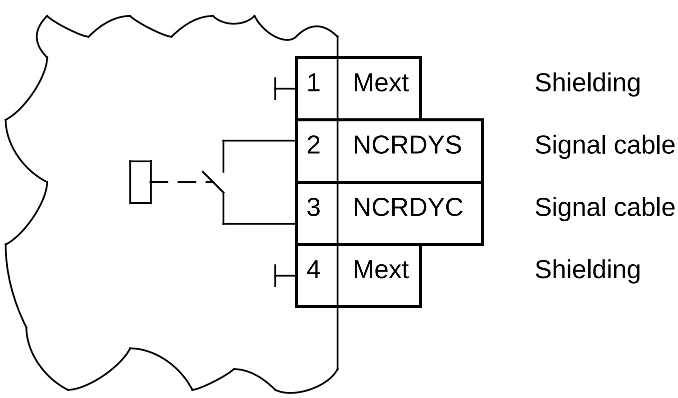
3.1.7.12 NC Ready signal (Version 2 only)

An ”NC ready” signal is provided to determine from outside whether the NC is ready for operation. It is implemented as a floating relay at connector X112.

1 signal: The relay contact is closed after switching on when all voltages are built up and the control is operating cyclically.

0 signal: The relay contact is open when
a) the undervoltage monitoring responds
b) the overvoltage monitoring responds
c) the computer monitoring responds
d) the PLC goes to STOP

Connector design:	terminal block with 4 screw terminals.
Connector no.	X112



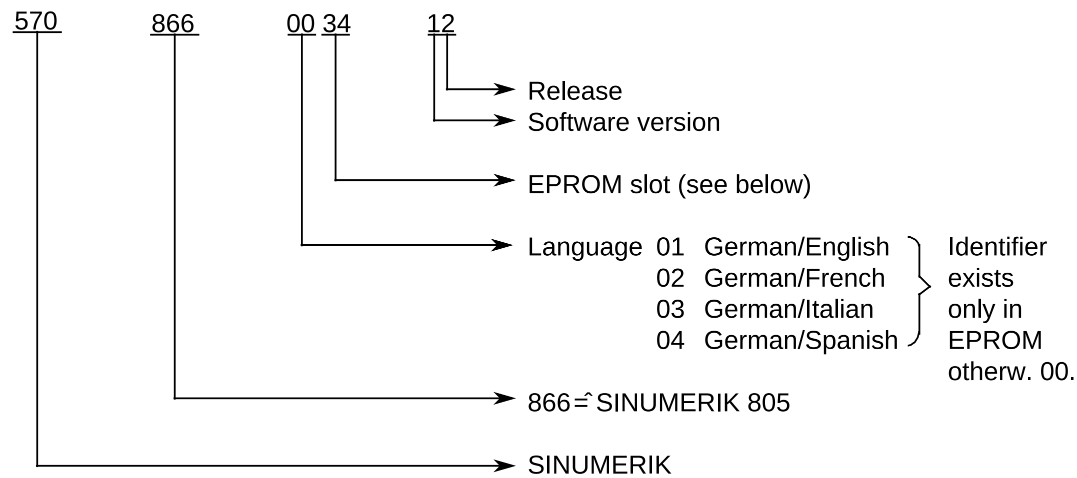
Characteristic values:
- Maximum current load on the contact (normally open)
  - 1A (ohmic load)
  - 0.5 A (inductive load)
- Maximum voltage load: 48 V

3.1.8 CPU and memory (Version 1 only, up to Software Version 2.2)

CPU: 16-bit microprocessor 80186 (clock frequency 16 MHz).
COP: Coprocessor for processing the bit instructions of the PLC user program.

System memory: 640 KB EPROM
comprising 5*27210 (megabit EPROMs)

Software identification



EPROM slots

D32 System	D31 System	D35 Language
D30 System	D34 reserved	D33 System

Note:

- The installed software version is displayed in the system screen.
- SINUMERIK 805 software consists of system software (4 EPROMs) and language software (1 EPROM).
- Order No. for the system software (SW 2.2) is: 6FX 1866-0BX03-2C.

Built-in languages	Order no. for language software (SW 2.2)
German/English	6FX 1866-0BX13-2C

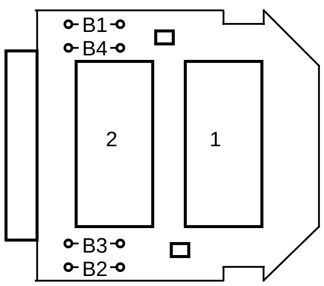
Main and data memory: 256 Kbyte RAM, buffered

Comprising 8×62256 static RAMs used for:

- Part program memory
- User data memory
- NC PLC interface
- PLC user program
- Machine data memory
- Tool offset memory

PLC EPROM submodule

The PLC EPROM submodule contains two EPROMS (27 256, 2 x 32 Kbytes).
Order No.: 6FX 1130 5BB00



Jumpers: B1, B2 closed

During installation, the PLC program must be copied from the EPROM submodule onto the RAM. This is necessary as the control only processes the PLC program which is to be found on the RAM.

Note:

The PG 685 (with submodule adaptor), the PG 730 and the PG 750 can be used for reading and writing on the PLC EPROM submodule.

Program number of the submodule: 162

3.1.9 CPU and memory submodule (Version 2 only, Software Version 3.1 onwards)

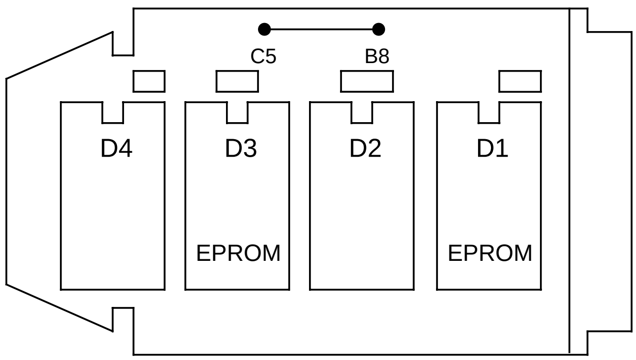
CPU: 16-bit microprocessor 80 186 (clock frequency 16 MHz)

ACOP: Coprocessor for processing the bit, byte and word instructions of the PLC user program.

PLC EPROM submodule

The PLC EPROM submodule contains two EPROMs (27 256, 2 x 32 Kbytes).

Order No.: 6FX 1126-OBN00
Slot No.: X311; submodule no. 1



Jumpers: C5 - B8

During installation, the PLC program must be copied from the EPROM submodule onto the RAM. This is necessary as the control only processes the PLC program which is to be found on the RAM.

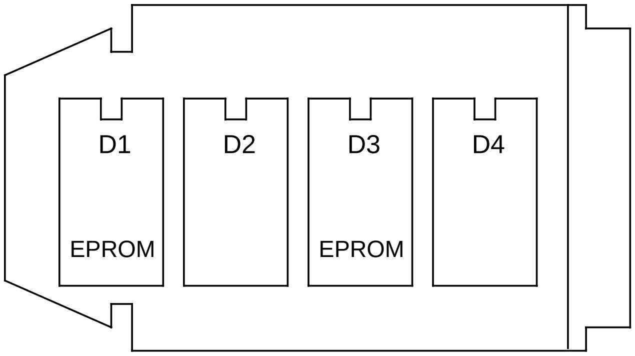
Note:

The PG 685 (with submodule adaptor), the PG 730 and the PG 750 can be used for reading and writing on the PLC EPROM submodule.

Program number of the submodule: 162

EPROM submodule (standby)

Order no.: 6FX 1122-6CB00
Slot no.: X321; submodule no. 2



The submodule contains 2 x 27C020 EPROMs (150 ns)

Jumpers: none

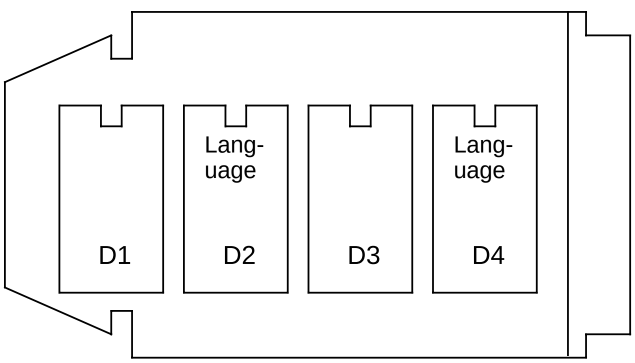
Note:

This submodule is not supplied with the basic configuration.

System EPROM submodule

This submodule contains all the system software including the two languages.

Order no.: 6FX 1122-6CA00 (submodule with empty EPROMs)
Slot no.: X331; submodule no. 3



The submodule contains 4 x 27C020 EPROMs (150 ns).

Jumpers: none

System EPROM submodule order numbers:

Built-in languages	Retrofit order no. of system EPROM submodule
German/English	6FX1866-0BX03-4C (SW 4.2)
German/French	6FX1866-0BX23-4C (SW 4.2)
German/Italian	6FX1866-0BX33-4C (SW 4.2)
German/Spanish	6FX1866-0BX43-4C (SW 4.2)
German/Czech	6FX1866-0BX53-4C (SW 4.2)
German/Russian	6FX1866-0BX63-4C (SW 4.2)

Main memory and data memory

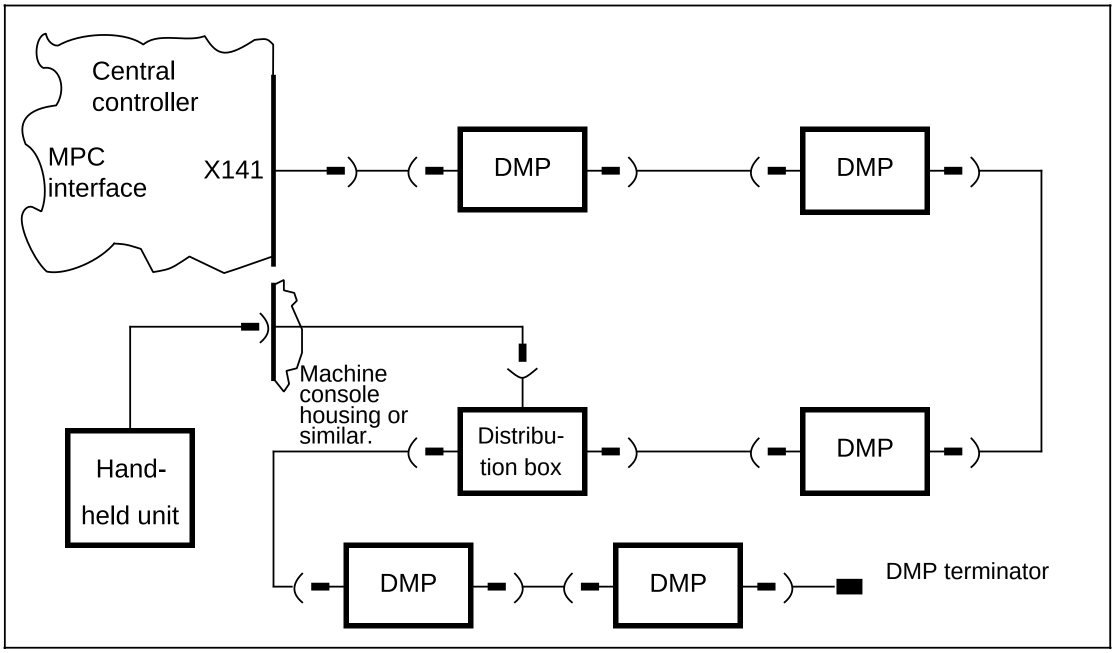
320 Kbytes, consisting of 10×62 256 RAMs

The following data types are situated in this memory area which is buffered by a battery submodule:

- NC, PLC machine data
- Part programs
- PLC user programs
- Zero offsets
- Setting data
- Interface parameters
- Tool offsets
- R parameters
- Clock

3.2 Distributed I/O devices

3.2.1 Maximum configurations



Up to five DMP stations and one hand-held unit can be connected to the MPC interface of the SINUMERIK 805.

The sequence of DMP stations (distributed machine peripherals) and the distribution box for the hand-held unit is freely selectable.

A station number (≙ user address) must be assigned to each DMP station using a rotary switch. The following station numbers are available: 2, 3, 4, 5, 6

The PLC-MDs 10-19 that refer to the station numbers are those in which the DMP stations are assigned to their specific 1st input byte and 1st output byte.

The hand-held unit has a permanent station number and therefore only needs to be activated by PLC MD 2002 bit 6.

Note:

A maximum of 320 inputs and 320 outputs can be assigned to the DMP stations.

WARNING

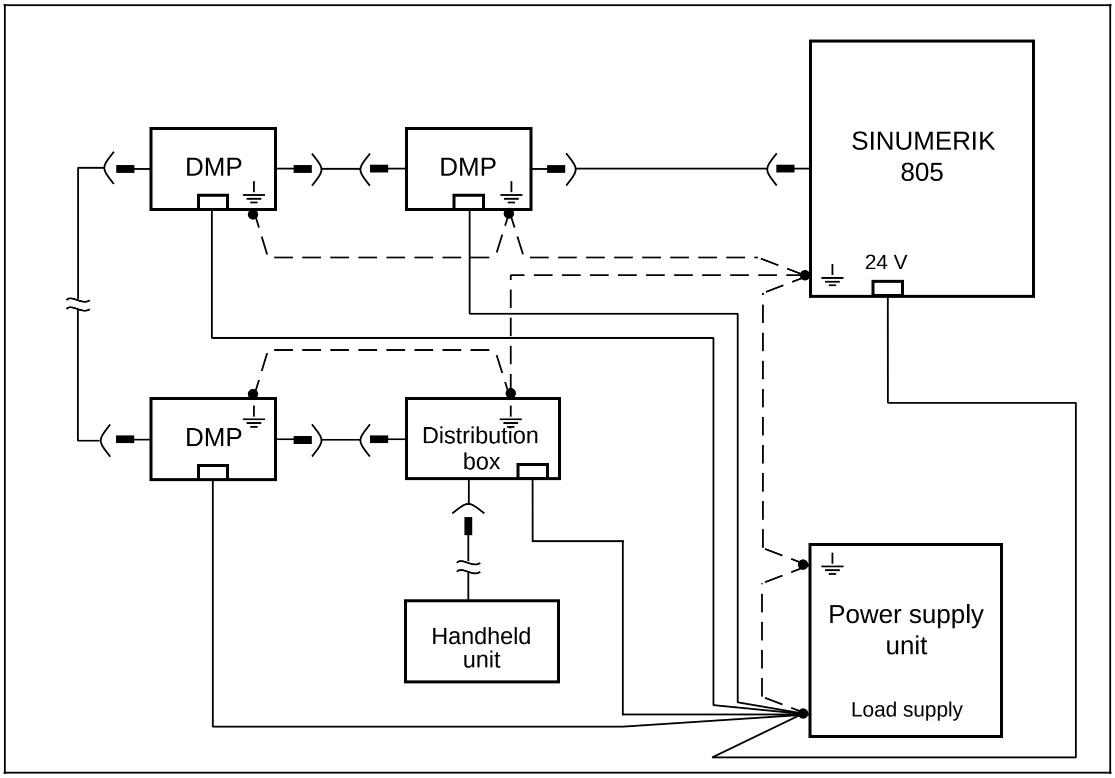
When using the I/O devices, the regulations regarding earthing and equipotential bonding must be followed.

3.2.2 Earthing concept for distributed I/O devices

When setting up an MPC line consisting of DMP stations and the distribution box/hand-held unit, the following rules regarding the equipotential bonding conductors and the 0V cables must be observed:

- A cable with a cross-section of at least 2.5 mm^2, or better 4 mm^2, should be used for the load supply 0V cable. The load supply cables should be connected in star from the power supply unit. Jumpers between the stations should be avoided.
- The equipotential bonding conductors should also be connected in star from the central earthing point of the control. The equipotential bonding conductor can be laid parallel to the signal line (DMP cable) if the stations are situated close together (less than 2 m apart).

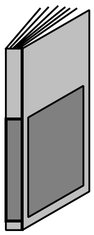
  Both of the equipotential bonding conductors (cable from one station, cable to the next submodule) must be connected on one side of the carrier module at one of the two earthing plates. The equipotential bonding conductor must have a minimum cross-section of 6 mm^2.
- The power supply units used for the load must also be provided with an equipotential bonding conductor which must be connected to the power supply unit 0V output.



4 Voltage and Functional Tests

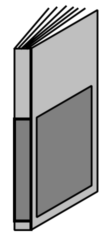
4.1 Voltage test

4.1.1 Power supply



For the voltages required by the individual control components, please refer to the documentation

SINUMERIK 805 Interface Description Part 2, Connection Conditions



4.1.2 Starting sequence of the control

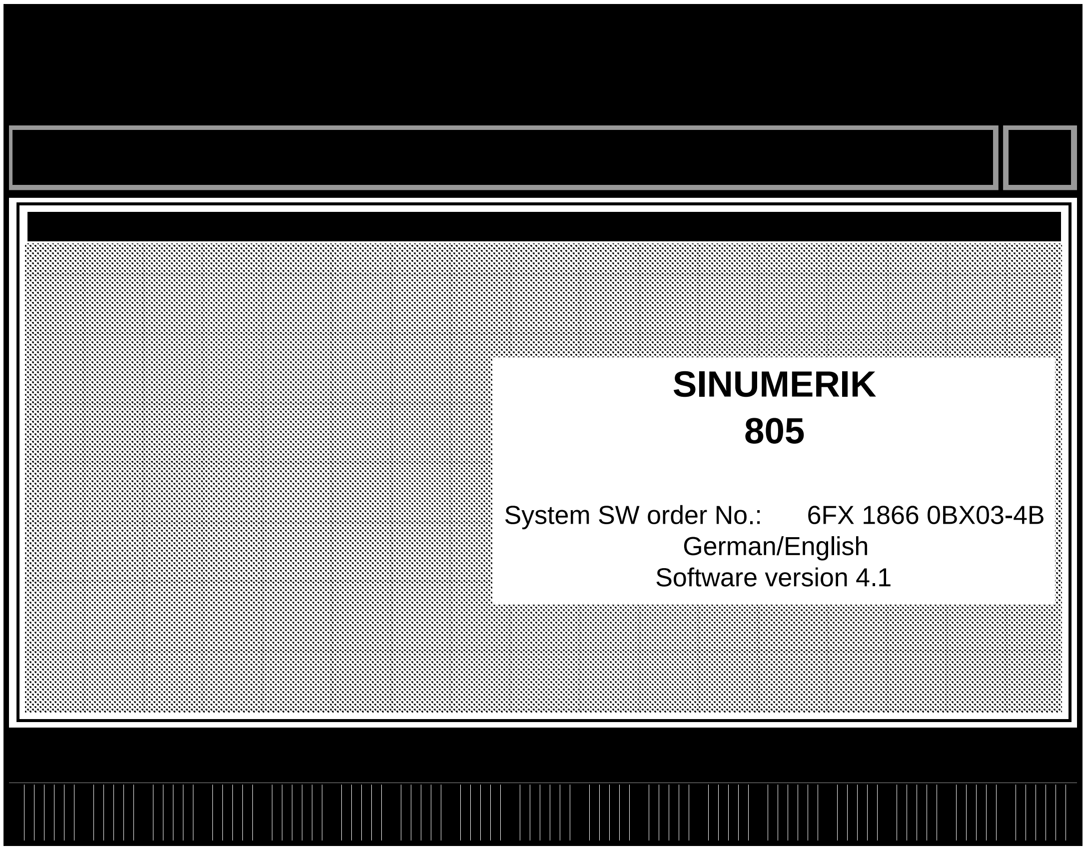
The following components must be supplied with power before the central processing unit:

1) Operator panel
2) Monitor
3) DMP stations
4) Distribution box

If this condition is not complied with, the central controller cannot identify those components and powers up with an error message.

4.1.3 Start-up screen

After switching on the control, a start-up screen appears for approximately 5 seconds and after that the basic display for the JOG operating mode.



6FX 1866 0BX03-4B:	Order No. of the built-in system software
Language German/English:	Plaintext note for the built-in languages
Software version 4.1:	Plaintext note for the built-in software version

4.2 Functional test central controller

4.2.1 CPU monitor

The yellow and red LEDs on the central controller provide information on the status of the control.

The yellow LED comes on when the control is switched on if all the DC voltages required for the central processing unit are available (voltages do not have to be in the set range).

The red LED comes on while the control is running up (Power On routines). The LED remains on after switching on the control or comes on during operation if one of the following conditions applies:

- Hardware fault on the central processing unit
- EPROM fault
- Incorrect jumpering
- CPU is in a loop
- CPU was in a loop for a lengthy time, causing the monitor to respond
- The INITIALIZATION dialog is selected (see Section 5.1)
- PLC STOP

4.2.2 EPROM CHECK

On the SINUMERIK 805, the EPROM checksums are tested cyclically.

NC alarm 7 (EPROM CHECK error) is displayed on the screen if a discrepancy is found when testing the checksum.

4.3 Functional test central controller/monitor/operator keyboard

The function of these 3 components depends on the following preconditions:

- Power supplies o.k.
  Central controller : +5 V/ ±15 V from power supply unit control
  +24V for the internal power supply unit supply
  Monitor : +24 V from power supply unit load current or 230 V AC
  (19”slimline operator panel)
  Measure voltage (note correct polarity)
  Operator keyboard : +24 V from power supply unit load current or 230 V AC
  (19” slimline operator panel)
  Measure voltage (note correct polarity)
- Cables connected
  Interface cable from central controller to keyboard
  Coaxial cable from central controller to monitor
- CPU running (red LED not on)
  (also see Section 4.2.1)

In the event of a fault, the following items must be checked in addition to the preconditions stated above:

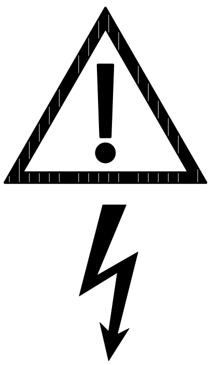
- Operator keyboard and monitor miniature fuses
- Interface signal SCREEN DARK (Q 79.6)
- Interface signal DISABLE KEYBOARD (Q 79.7)

4.4 Monitor adjustment

Screen brightness adjustment:

The brightness can be adjusted according to the ambient light conditions with a potentiometer. The potentiometer is located at the rear of the monitor and is accessible from the outside.

The hold control, image height, contrast etc. are normally correctly set at the factory.



DANGER

High voltage of approx. 16 kV in VDU, at high-voltage transformer, anode lead and anode terminal at the picture tube. The potentiometer settings on the monitor board can be modified only by trained personnel equipped with the proper tools
(epoxy resin screwdrivers).

The guidelines of the relevant precision engineering and electrical engineering associations must be complied with.

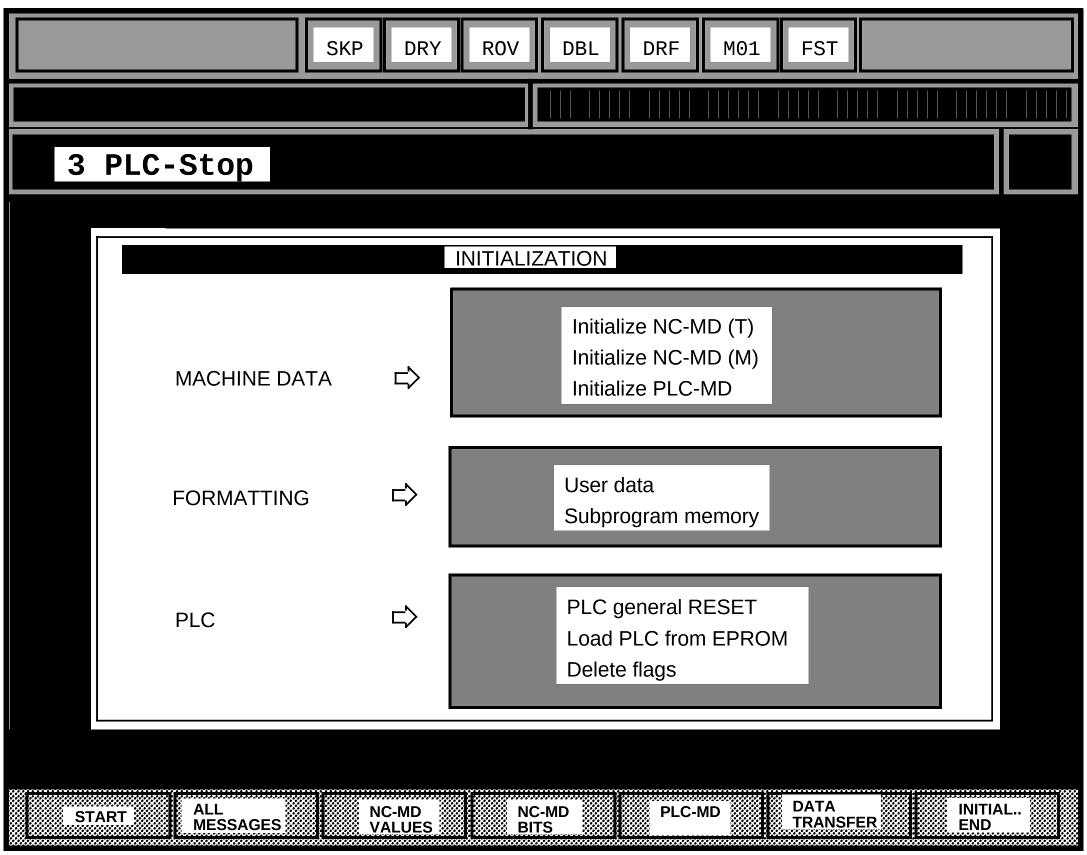
5 Standard Installation

5.1 Standard installation of NC and PLC

The contents of this Section presuppose the following:

- The system has been checked according to Section 1 (preconditions and visual inspection)
- The power supply to all components has been checked according to Section 4 (voltage and functional tests)
- The devices have been jumpered according to Section 3 (overview of devices with standard jumperings)
- The feed and main spindle drives are disabled until the axis and spindles have been started up (EMERGENCY STOP)
- The PLC user program (STEP 5) is executable and stored in the EPROM submodule. The submodule must be inserted.

The INITIALIZATION dialog of SINUMERIK 805 can be selected as follows:



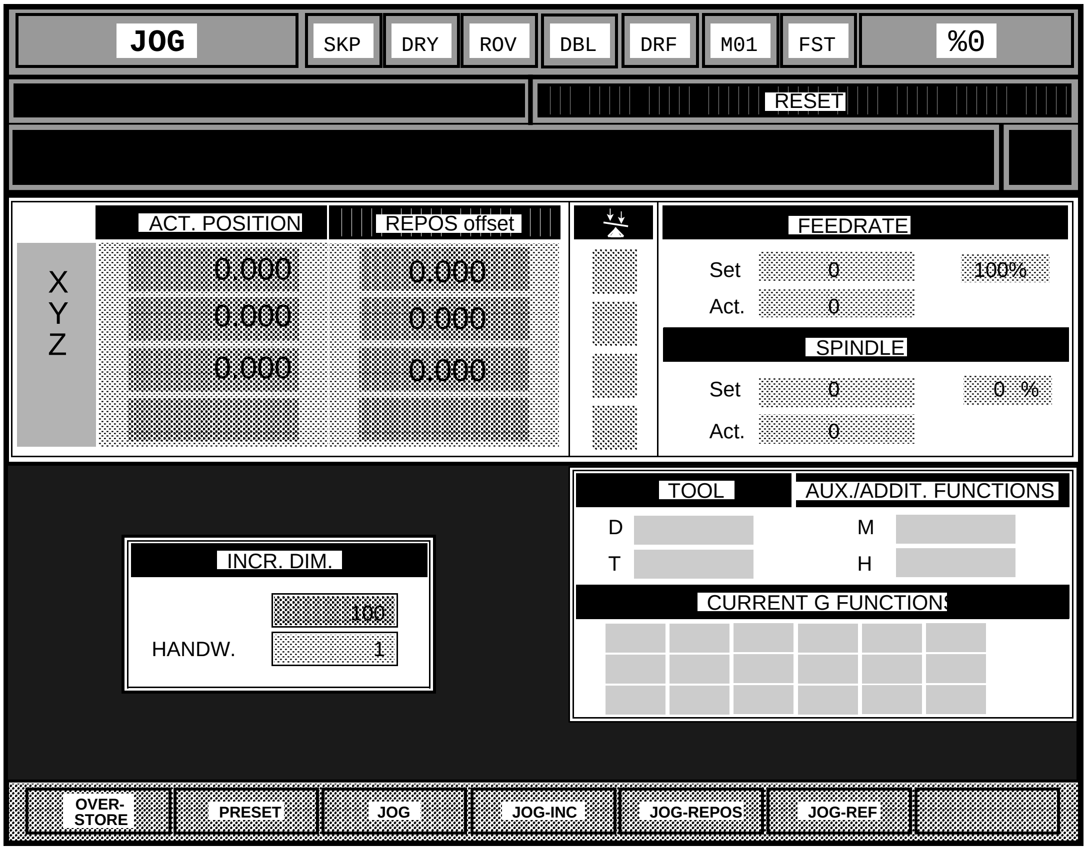
- On first start-up, by switching on the control using position 2 of the installation and start-up switch.
- When in operation, by pressing the following keys:
  - Operating area key
  - DIAGNOSTICS softkey
  - Menu expansion key
  - INITIALIZATION softkey

The various functions must be selected with the cursor keys; the selected item is highlighted.

Press the START softkey to execute the selected function. This is indicated by a checkmark which appears in front of the function.

Now execute the following functions consecutively:

- Initialize NC MD (NC MD area is cleared and defaulted with standard machine data), (T $\hat{=}$ turning machine data and M $\hat{=}$ milling machine data)
  When initializing to the T or the M version, the programming initial settings are also changed (see Programming Guide)
- Initialize PLC MD (PLC MD area is cleared and defaulted with standard machine data)
- Format user data (setting data, tool offsets, zero offsets, R parameters, program control parameters cleared and setting data preset)
- Format part program memory (the part program memory is cleared and a directory set up for the maximum number of part programs (NC MD 8))
- Clear PLC (the memory area for the PLC user program is cleared)
- Load PLC from EPROM (the PLC user program (STEP 5) is copied from the EPROM to the RAM MEMORY. Execute only if the EPROM submodule is inserted.)
- Clear flags (all PLC flags are reset to 0).
- Switch off the control (or switch off the control power supply unit)
- Turn the installation switch back to position 0
- Switch on the control

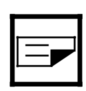


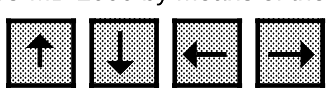
Axis/spindle assignments

The control is now in a permanently defined state. A few modifications still have to be made, however, to ensure that it operates correctly together with the machine.

To do so, select the NC MD area as follows:

1) Press the operator area key
2) "DATA" softkey
3) "NC MD VALUES" softkey

Now select NC MD 2000 by means of the page key  and

cursor keys 

Enter the wiring of the axes to the actual value submodules in machine data 2000 to 2003 (see description in Section 8 NC MD 200*)

NC MD	2000	=	1st axis
	2001	=	2nd axis
	2002	=	3rd axis
	2003	=	4th axis

State in machine data 4000 to which actual value submodule a spindle is wired (see description in Section 8 NC MD 4000).
Section 3.1.3 contains an assignment schedule.

Axis names

The desired axis names must be entered in the machine data 5680 to 5683 (see description in Section 8 NC MD 568*).
The NC programs refer to these axis names.

NC MD	5680	=	1st axis
	5681	=	2nd axis
	5682	=	3rd axis
	5683	=	4th axis

5.2 Axis installation

General:

Before commencing the NC axis installation routine, the axis should already have been operated trouble-free with the battery box acting as a setpoint generator. This means that the following work must have been completed:

- Controller module matched to motor (maximum current characteristic set according to speed)
- Tacho adjustment: the maximum speed must be reached at 95 % of the maximum set voltage
- The speed and current controllers must have been optimized (no overshooting or creepage)
- Remove setpoint connector from the NC
- The standard MD must be loaded
- Leave the actuator switched off

Caution:

The servo enable signal supplied from the NC to the drive actuator in the setpoint connector for each axis must be used at the drive actuator.

5.2.1 Control direction of feed axis - checking and adjusting

The position and speed control directions must be checked **before** closing the position control loop as an incorrectly set control direction results in uncontrolled axis movements at maximum speed.

The following must thus be determined before starting work:

- Traverse direction of the feed axes (stated by the customer or according to ISO)
- Polarity of controller setpoint speed voltage for positive axis movement

Example:

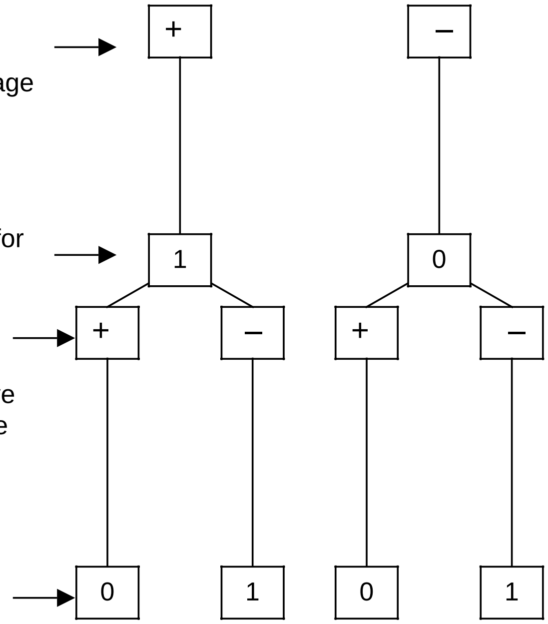
What is the polarity of the speed setpoint voltage at the battery box when the axis moves in the positive direction?

Set the machine data bits to change the sign for the speed setpoint (MD 564* bit 1).

Test the position control direction:

Move the feed axis mechanically in the positive direction. Note the direction of the actual value change on the display.

Sign change for part actual value (MD 564* bit 2).



5.2.2 Position control resolution, input resolution

The input resolution (NC MD bits 5002.4 to 5002.6) and position control resolution (NC MD 5002.0 to 5002.2) must be input (see NC MD 5002 for permissible bit combinations) before closing the position control circuits (insert setpoint connector).

The following relationship exists between the axis-specific maximum speed (NC MD 280*) and the position control resolution:

Max. axis speed	Position control resolution
3.4 m/min	$0.5 \cdot 10^{-4}$ mm
34 m/min	$0.5 \cdot 10^{-3}$ mm
340 m/min	$0.5 \cdot 10^{-2}$ mm

Axes not involved in 2D/3D interpolation can also be assigned as follows:

Max. axis speed	Position control resolution
6.0 m/min	$0.5 \cdot 10^{-4}$ mm
60 m/min	$0.5 \cdot 10^{-3}$ mm
600 m/min	$0.5 \cdot 10^{-2}$ mm

As the position control resolution is valid for all axes, it must be set according to the axis with the highest maximum speed.

5.2.3 Maximum axis speed

The axis-specific maximum speeds must be entered in the NC machine data 2800 to 2803. The axis-specific maximum speeds are determined by the manufacturer according to requirements and the mechanical design (see NC MD 280*).

5.2.4 Definition of maximum setpoint

The axis-specific maximum speeds desired by the customer (NC MD 280*) are assigned a setpoint speed (NC MD 268*).

Note in this connection that an additional control reserve of approx. 5 % is required.

The output limits are set by the DAC of the setpoint (10 V) or by the drive controller.

The setpoint is specified by means of NC MD 268*. The NC thus restricts the output voltage. In operating conditions, the restriction determined by NC MD 268* must not be reached.

The maximum permissible setpoint is 10 V.
Conversion to input data: 10 V 8192 units.

The maximum setpoint must be input according to the maximum permissible input voltage of the drive controller.

- Maximum permissible input voltage of the drive controller   10 V:
  Input in NC MD 268*: 8192 units= 10 V
  Owing to the control margin of 5 % the maximum axis speed is already reached at 9.5 V.

- The drive controller operates with a maximum setpoint speed voltage < 10 V, e.g. 5V:

  Input in NC MD 268*: $\frac{8192}{10\ \text{V}} \cdot 5\ \text{V} = 4096$

  - Max. actuator input voltage: 5 V
  - Input in NC MD 268*: 4096
  - Tacho compensation: The maximum speed should be reached at 4.5 V

The setpoint should generally be set as high as possible because the control behaviour is better with higher setpoint voltages.

5.2.5 Variable incremental weighting

- Input the values for NC MD 364* (pulse number for variable incremental weighting) and NC MD 368* (traverse path for variable incremental weighting) according to the description in the Section "NC machine data".

- Subsequent value verification:
  Traverse, for example, 1000 increments in the JOG-INC-VAR mode; calculate the path depending on the set input resolution (1 increment = 1 unit (IS)) and check with a dial gauge.

5.2.6 Closing the position control loop

With the control switched off, insert the setpoint connector and cancel any other interlocks for this axis (fuses, servo disable). Interlock the other axes, switch on the control and actuator.

WARNING

No person must be within the traverse ranges of the axes when the position-control loop is closed. In the event of uncontrolled movement of the feed axes, press EMERGENCY STOP immediately to rule out any danger to man and machine.

Cause of uncontrolled movement	Symptom
Incorrect polarity of position or speed control loop (incorrect NC machine data bits)	Axis traverses at maximum speed
Position control loop not closed	Axis traverses with constant low speed, measuring device does not follow the axis movement (e.g. loose coupling) Bonding to frame, open or short-circuit causes the measuring circuit monitor to respond
No setpoint at speed controller	Axis traverses with constant low speed (drift)
Control loop fault • Tacho feedback interrupted • Tacho feedback with incorrect polarity • Incorrect optimization • K_V factor too great	Axis vibration and pronounced oscillation

5.2.7 Axis traverse in JOG mode

The setpoint cable must be inserted. The control direction and pulse weighting must be correct. Traverse the axis at low speed with the direction keys.

- If the "Feed hold" message appears, check the interface signals.
  The following interface signals are required:
  - Feed enables (axis-specific and general)
  - No axis disable
  - No follow-up operation
  - Controller enable
  - Feedrate override not at 0

- Continuous+/- sign in the motion ( ) field perform drift compensation (see NC MD 272*)
- If alarms appear see alarm list

5.2.8 Multgain NC MD 260*

A multiplication factor (multgain NC MD 260*) has to be input to calculate the setpoint speed. This permits axes with different maximum speeds to be traversed making full utilization of the specified setpoint.

Axes traversed with continuous path control must have the same position control loop gain factor. For this reason, the multiplication factor (multgain) must be calculated for each axis according to the following formula:

$$\text{Multgain} = \frac{3 \cdot 10^7}{V_{max}\ [1000\ \text{units(MS)/min}]} \cdot \frac{U_{max}\ [V]}{10\ [V]}$$

Example:

max. axis speed V_{max}=20m/min => position control resolution $0.5 \cdot 10^{-3}$ mm
=> 1 unit (MS)=$2 \cdot 0.5 \cdot 10^{-3}$ mm=$1 \cdot 10^{-3}$ mm => V_{max}=20000 (1000units(MS)/min]
=> setpoint voltage at V_{max}=**9.5 V**

$$\text{Multgain} = \frac{3 \cdot 10^7}{20000\ [1000\ \text{units(MS)/min}]} \cdot \frac{9.5\ [V]}{10\ V} = \mathbf{1425} \left[\frac{\text{min}}{1000\ \text{units(MS)}}\right]$$

Note:

In conjunction with an inch input system (IS) the maximum speed (MD 280*) has to be converted into mm/min and entered as V_{max} in the formula.

In conjunction with a metric input system (IS), the maximum speed (MD 280*) must be converted into inch/min and entered as V_{max} in the formula.

Additional multgain calculation examples:

1) Input system resolution (IS)=$1 \cdot 10^{-3}$ mm 1 unit (IS)=$1 \cdot 10^{-3}$ mm
Measuring system resolution (MS)=$0.5 \cdot 10^{-3}$ mm 1 unit (MS)=$2 \cdot 0.5 \cdot 10^{-3}$ mm= $1 \cdot 10^{-3}$ mm
Max. speed=10 $^{m}/_{min}$ MD 280*=10000 [1000 units $^{IS}/_{min}$]
Tachogenerator compensation to 9V

Conversion from V_{max} to Measuring system resolution:
V_{max}=10m/min=10000 [1000 units $^{MS}/_{min}$]

$$\text{Multgain} = \frac{3 \cdot 10^7}{10000\ [1000\ \text{units}\ ^{MS}/_{min}]} \cdot \frac{9\ [V]}{10\ [V]} = \mathbf{2700}$$

2) Input system resolution (IS) = $1{\cdot}10^{-3}$ mm   1 unit (IS) = $1{\cdot}10^{-3}$ mm
Measuring system resolution (MS) = $0.5{\cdot}10^{-4}$ mm   1 unit (MS) = $2{\cdot}0.5{\cdot}10^{-4}$ mm = $1{\cdot}10^{-4}$ mm
Max. speed = 4 $^{m}/_{min}$ MD 280* = 4000 [1000 units $^{IS}/_{min}$]
Tachogenerator compensation to 9V

Conversion from V_{max} to measuring system resolution:
V_{max} = 4 $^{m}/_{min}$ = 40000 [1000 units $^{MS}/_{min}$]

$$\text{Multgain} = \frac{3 \cdot 10^7}{40000\ [1000\ \text{units}\ ^{MS}/_{min}]} \cdot \frac{9\ [V]}{10\ [V]} = \mathbf{675}$$

3) Input system resolution (IS) = $1{\cdot}10^{-4}$ inch   1 unit (IS) = $1{\cdot}10^{-4}$ inch
Measuring system resolution (MS) = $0.5{\cdot}10^{-3}$ mm   1 unit (MS) = $2{\cdot}0.5{\cdot}10^{-3}$ mm = $1{\cdot}10^{-3}$ mm
Max. speed = 400 $^{inch}/_{min}$ MD 280* = 4000 [1000 units $^{MS}/_{min}$]
Tachogenerator compensation to 9V

Conversion from V_{max} to measuring system resolution:

$$V_{max} = 400\ \frac{\text{inch}}{\text{min}} = 400\ \frac{\text{inch}}{\text{min}} \cdot \frac{25.4\ \text{mm}}{\text{inch}} = 10160\ \frac{\text{mm}}{\text{min}} = 10160\ [1000\ \text{units}\ ^{Ms}/_{min}]$$

$$\text{Multgain} = \frac{3 \cdot 10^7}{10160\ [1000\ \text{units}\ ^{MS}/_{min}]} \cdot \frac{9\ [V]}{10\ [V]} = \mathbf{2657}$$

4) Input system resolution (IS) = $1{\cdot}10^{-3}$ mm   1 unit (IS) = $1{\cdot}10^{-3}$ mm
Measuring system resolution (MS) = $0.5{\cdot}10^{-4}$ inch   1 unit (MS) = $2{\cdot}0.5{\cdot}10^{-4}$ inch
Max. speed = 20 $^{m}/_{min}$ MD 280* = 20000 [1000 $^{unit\ IS}/_{min}$]
Tachogenerator compensation to 9V

Conversion from V_{max} to measuring system resolution:

$$V_{max} = 20\ ^{m}/_{min} = 20000\ \frac{\text{mm}}{\text{min}} \cdot \frac{\text{inch}}{25.4\ \text{mm}} = 787.4\ \frac{\text{inch}}{\text{min}} = 787.4\ [1000\ \text{units}\ ^{Ms}/_{min}]$$

$$\text{Multgain} = \frac{3 \cdot 10^7}{787.4\ [1000\ \text{units}\ ^{MS}/_{min}]} \cdot \frac{9\ [V]}{10\ [V]} = \mathbf{34290}$$

5.2.9 Servo gain factor K_V

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 deceleration capability).
- 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 does not reach its current limit.

Enter the servo gain according to the following conversion formula in NC MD 252*:
For the servo gain (K_V) factor the following applies:

$$K_V=1= \frac{1m/min}{1mm} = \frac{\text{velocity}}{\text{following error}}$$

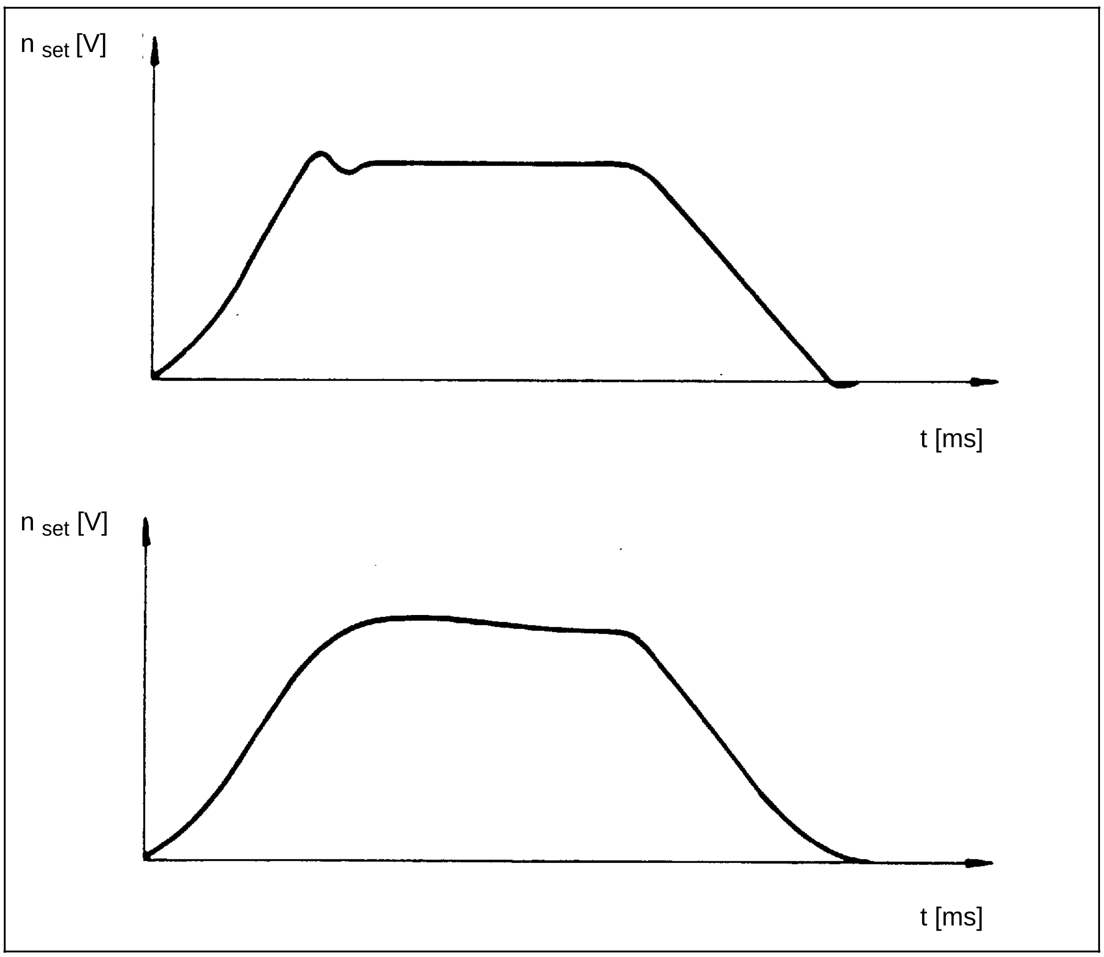
$$= \frac{1000\ mm/min}{1mm} =1000 \frac{1}{60\ s} =16.66 \frac{1}{s}$$

$$K_V\ (0.01\ s)=1666 \left[\frac{1}{0.01\ s}\right]$$

The number 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 Oszillomink ink jet plotter or storage oscilloscope. Traverse at various feedrates.



Especially deceleration can be observed with high voltage gain on the oscilloscope or Oszillomink.

Overshooting may also have one of the following causes:

- Acceleration too great (current limit 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 in the multgain or on the speed actual value potentiometer.

5.2.10 Acceleration

The axes are accelerated and decelerated with the input acceleration values (NC MD 276*)

$$b \cdot 10^{-2}\ [m/s^2]$$

This permits precise and fast running up to speed and positioning, also protecting the machine.

Consult the customer to determine the maximum acceleration to which the machine is suited. Enter this value (provided that the drive is not overloaded) in NC MD 276*.

These values normally lie between 0.3 m/s^2 and 2 m/s^2

WARNING

Too high acceleration values can overload the mechanical parts of the machine and cause damage.

Checking and determining the acceleration values

Setting: NC MD 276*

Criterion: Accelerating and positioning at rapid traverse (acceleration stop limit) without overshooting
At maximum load conditions (heavy workpieces on table)

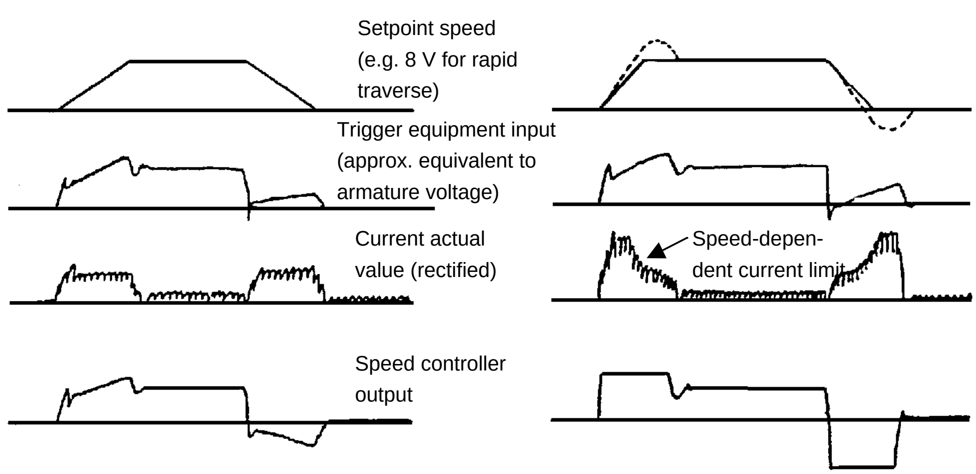
Measuring device: Pen recorder or storage oscilloscope

Measuring point: Setpoint speed and possibly current actual value and speed controller output

After adjusting the acceleration, execute travel at rapid traverse and record the current actual values and possibly the n-controller output. Refer to the result to determine whether the current limit was reached or not. The drive can reach the current limit for a brief period. This must occur only in the rapid traverse range, however. The drive must return to speed control for a while, otherwise the axes will overshoot the position.

Example:

6-pulse circulating-current-free feed drive with current limiting regulation



Example 1:

Well-chosen acceleration

Example 2:

Acceleration too great, current limit is reached.

---- The increased following error results in overshooting the setpoint in the positive and negative directions with the position control loop.

Relationship between acceleration and current actual value

Minor load fluctuations (due to sluggishness or lubricant) must not lead immediately to the current limit being reached. For this reason the entered acceleration value should be at least 10 % lower.

To protect the mechanical components, the acceleration can be further reduced at the customer's request.

The axes can be given different acceleration values.

5.2.11 Approach to reference point

Corresponding NC MD

- MD 240* (reference point value)
- MD 244* (reference point shift)
- MD 284* (reference point cutoff speed)
- MD 296* (reference point approach speed)
- MD 5008 Bit 5 (setup in JOG mode)
- MD 560* Bit 6 (reference point approach with automatic direction detection)
- MD 564* Bit 0 (reference point approach direction)

In indirect relationship:

- MD 5004 Bit 3 (NC START without reference point)
- MD 560* Bit 4 (no start disable from reference point)

Automatic direction detection with reference point approach

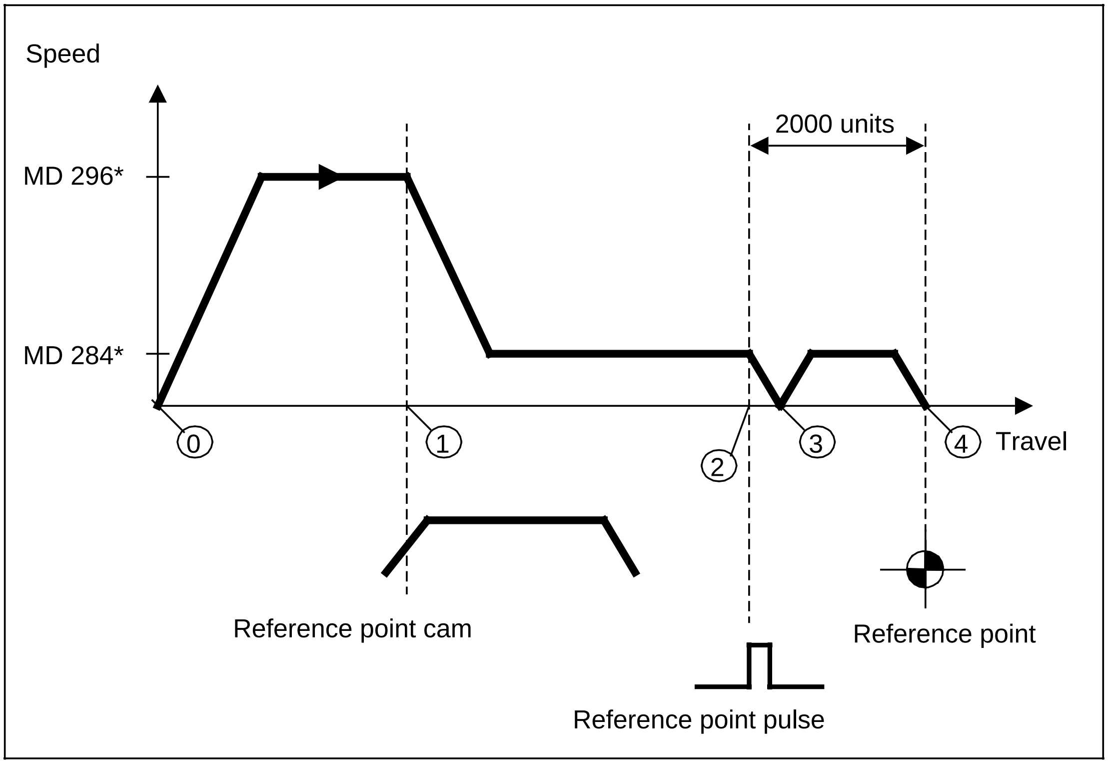
The control offers two different methods of approaching the reference point. Select the desired method by means of NC MD 560* bit 6 (reference point approach with automatic direction detection).

5.2.11.1 Reference point approach without automatic direction detection

Preconditions:

- NC MD bit 560*.6="0"
- General feed enable present
- Axis-specific feed enable present
- Reference point between reference point cam and limit switch

Example 1: Axis in front of the reference point cam



0 Depending on NC MD bit 564*.0 (reference point in negative direction), the reference point approach in the relevant direction is initiated with the positive or negative key at the speed stated in NC MD 296* (reference point approach speed).

1 When the reference point cam is reached, the axis speed is reduced to the value in MD 284* (reference point cutoff speed) via the "DECELERATION" interface signal.

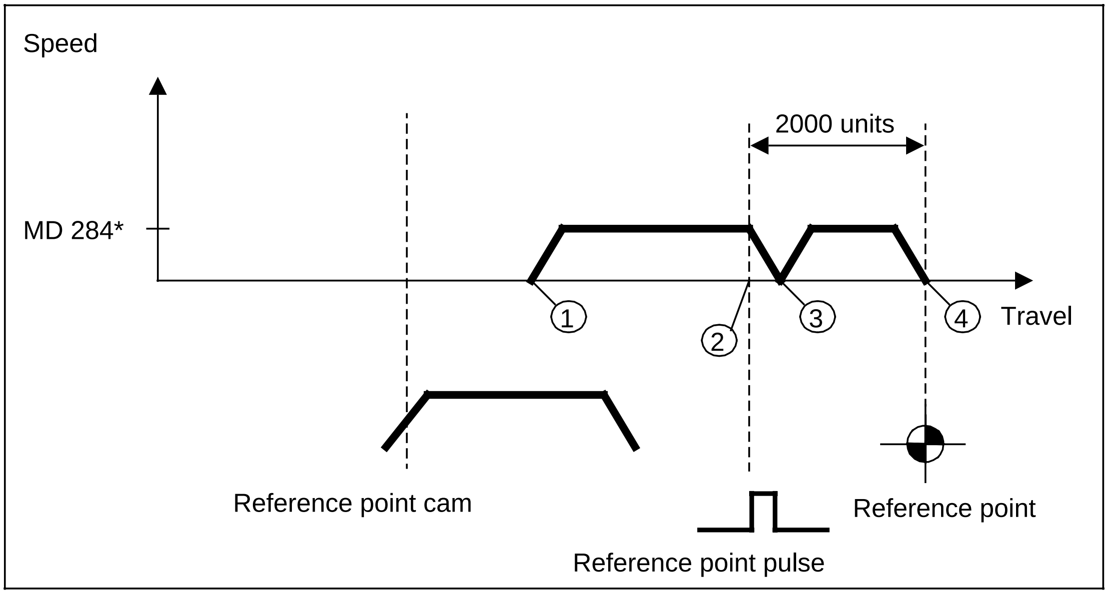
2 After passing the reference point cam, the next reference point pulse is scanned and the axis braked.

3 To exclude the machine backlash with reference point approach, a fixed path of 2000 units is traversed from the reference point pulse to the reference point.
Because point is located at different positions depending on the speed, the path still to be traversed ( ) must be determined before the actual reference point is approached. To achieve this, the axis brakes to a standstill and traverses the remaining path as far as .

4 Reference point reached.

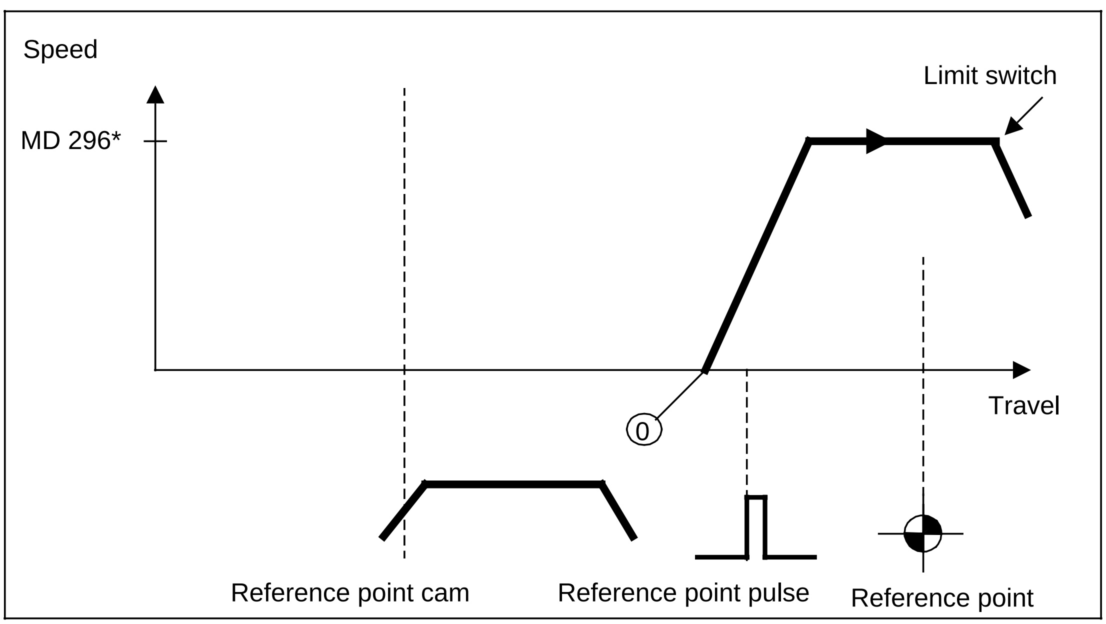
Example 2: Axis located on the reference point cam
Reference point approach speed

The axis does not accelerate to the reference point approach speed (NC MD 294*), but immediately adopts the reference point cutoff speed (NC MD 284*).



Example 3: Axis positioned after the reference point cam

Since the "DECELERATION" zero signal has the same status after the reference point as it does in front of it, the control assumes that the axis is in front of the reference point cam and accelerates to the reference point approach speed (MD 296*); i.e. the axis runs up against the limit switch (EMERGENCY STOP) in the case illustrated in example 3 because the software limit switches are not effective before or during the reference point approach.



Complex traverse interlocks had to be integrated in the PLC to avoid the occurrence described in example 3. For this reason, it was decided to offer a facility to rule out the situation in example 3 during reference point approach without additional support from the PLC. This function is referred to as reference point approach with automatic direction detection.

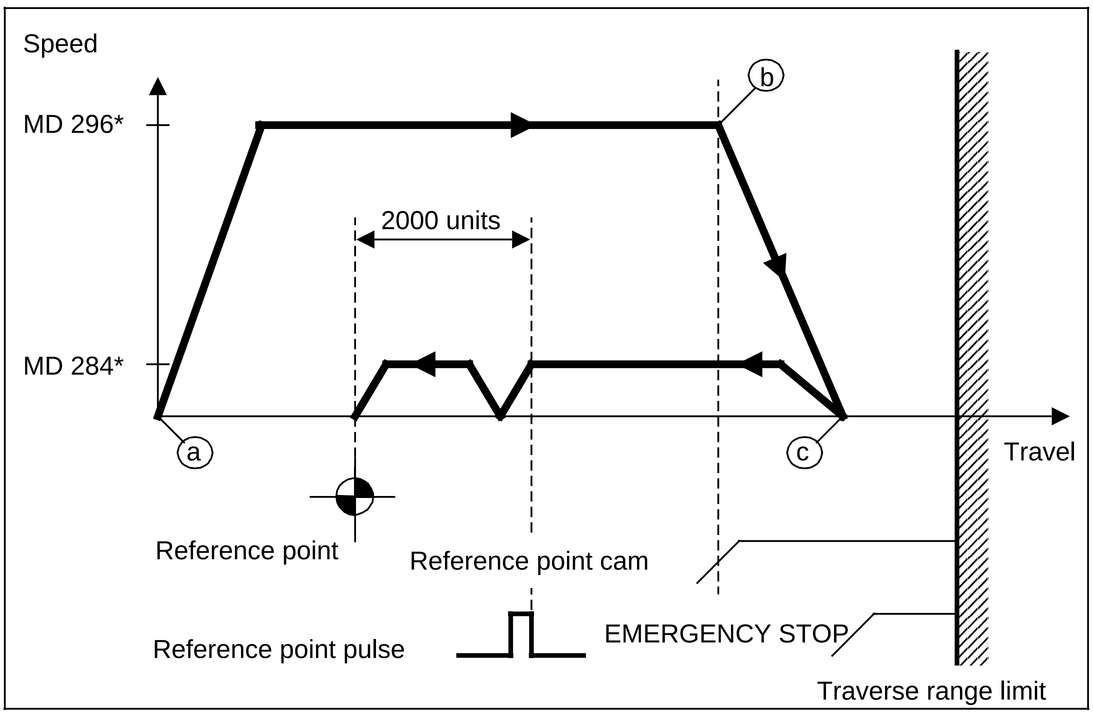
5.2.11.2 Reference point approach with automatic direction detection

Preconditions:

- NC MD 560* . 6 ="1"
- Feed enables (general and axis-specific) present
- Reference point cam reaches as far as the traverse range limit
- Reference point in front of the reference point cam

Example 3, depicting reference point approach without automatic direction detection, is excluded by the automatic direction detection facility.

Example 1: Axis in front of the reference point cam

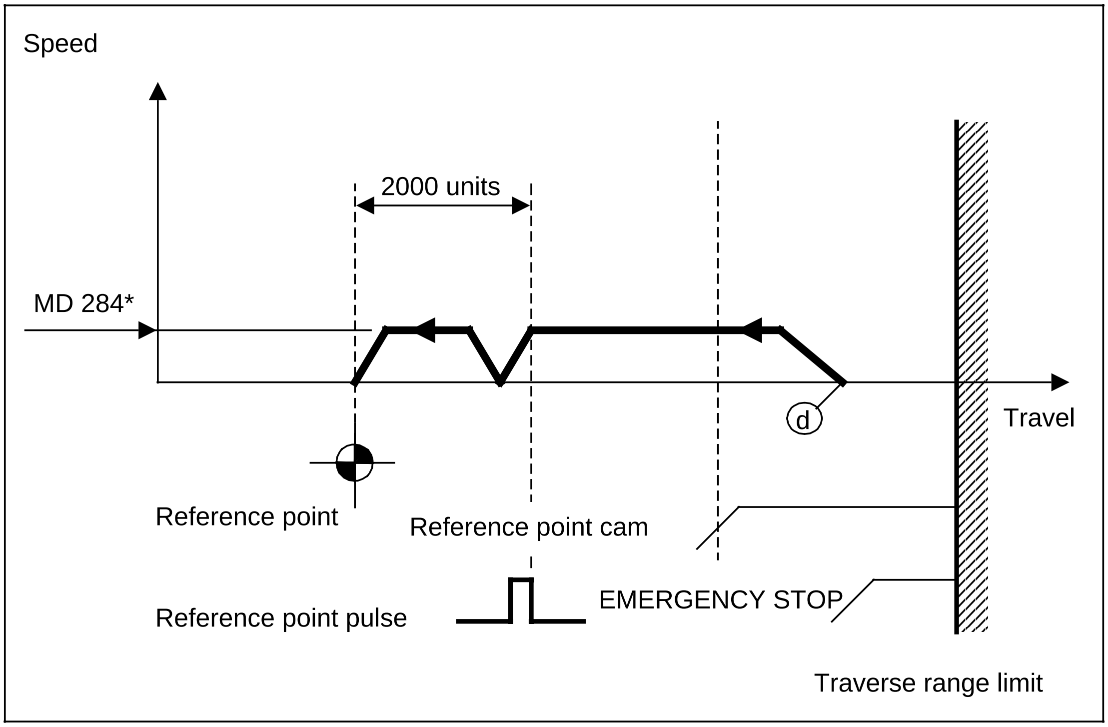


(a) Depending on NC MD bit 564*.0 (reference point in negative direction), the reference point approach in the relevant direction is initiated with the positive or negative key at the speed stated in NC MD 296* (reference point approach speed).

(b) When the reference point cam is reached, the axis is braked to a standstill with the "DECELERATION" interface signal.

(c) The departure from the reference point cam in the opposite direction is executed at the speed stated in NC MD 284* (reference point cutoff speed) and the next reference point pulse is interpreted (for an exact description of the remaining procedure see Section 5.2.10.1).

Example 2: Axis located on the reference point cam



(d) When the reference point approach is initiated by pressing the appropriate direction key, the NC derives from the "DECELERATION" interface signal that the axis is already located on the reference point cam. The axis then departs from the reference point cam in the opposite direction at the speed stated in NC MD 284* (reference point cutoff speed) and interprets the next reference point pulse (for an exact description of the remaining procedure see Section 5.2.10.1).

5.2.12 NC MD 204* and NC MD 208* (exact stop limit coarse and fine)

The approached position is checked. If the following error (distance to go) is greater than the value stated in NC MD 204* or NC MD 208*, a "+" or "-" is displayed in the AXIS MOVEMENT ( ) field.

Exception:

The exact stop limit is not monitored in the case of clamped axes.

Setting:

The approach accuracy depends on the quality of the position and speed control loops.

Determine the normal deviation by observing the following error at a standstill.

According to the customer's wishes and the achieved approach accuracy, the entered value should be between 10 μm and 50 μm, but at least twice as great as the maximum deviation of the following error at a standstill.

5.2.13 NC MD 212* (clamping tolerance)

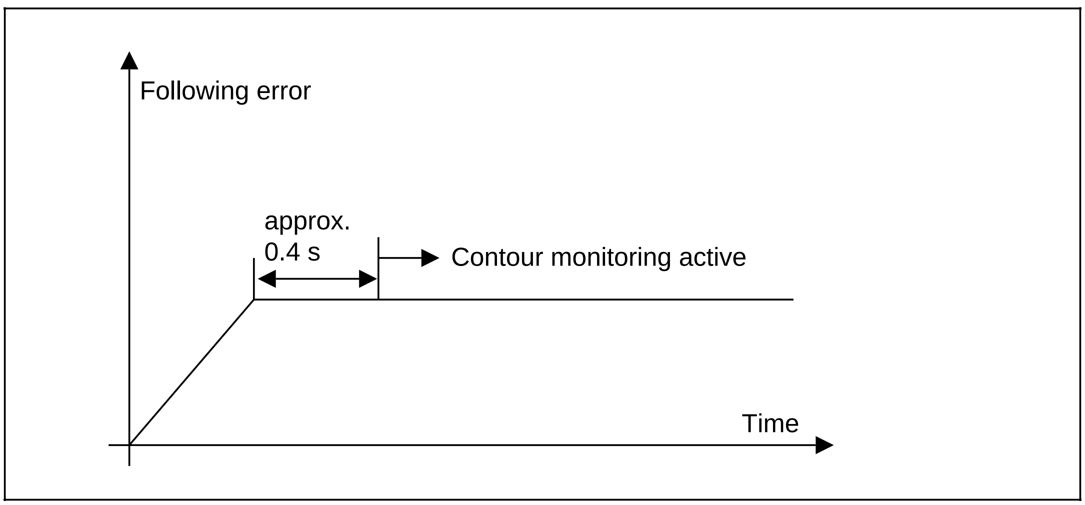
The machine manufacturer must attempt to keep the position deviation very small, i.e. to remain below the exact stop limit NC MD 204* or NC MD 208* if possible. The value input for the clamping tolerance (NC MD 212*) must be approx. twice as high as the value in NC MD 204* or NC MD 208*. If one of the axes is forced out of position at a standstill (after expiry of the time in NC MD 156*) (clamp active and removal of servo enable), Alarm 112* (standstill monitor) appears.

5.2.14 Contour monitoring

Contour monitoring operates according to the following principle:

At the end of an acceleration or deceleration period, the following error of an axis in position control remains constant. Drive load changes (e.g interrupted cut or heavy stock removal work) are taken into account by the speed controller (PI behaviour). The following error at constant speed does not change until the drive overload (e.g. tool failure) overburdens the speed controller. This change is used as the trigger criterion for contour monitoring.

To prevent minor speed fluctuations erroneously triggering the monitor function, a tolerance band is permitted for maximum contour deviation. In addition, a delay time must expire with each speed change before the monitor can be activated.



Activation of contour monitoring at constant setpoint speed

Accurate contouring is possible only if all axes that interpolate together are set to the same servo gain (also applies to rotary axes).

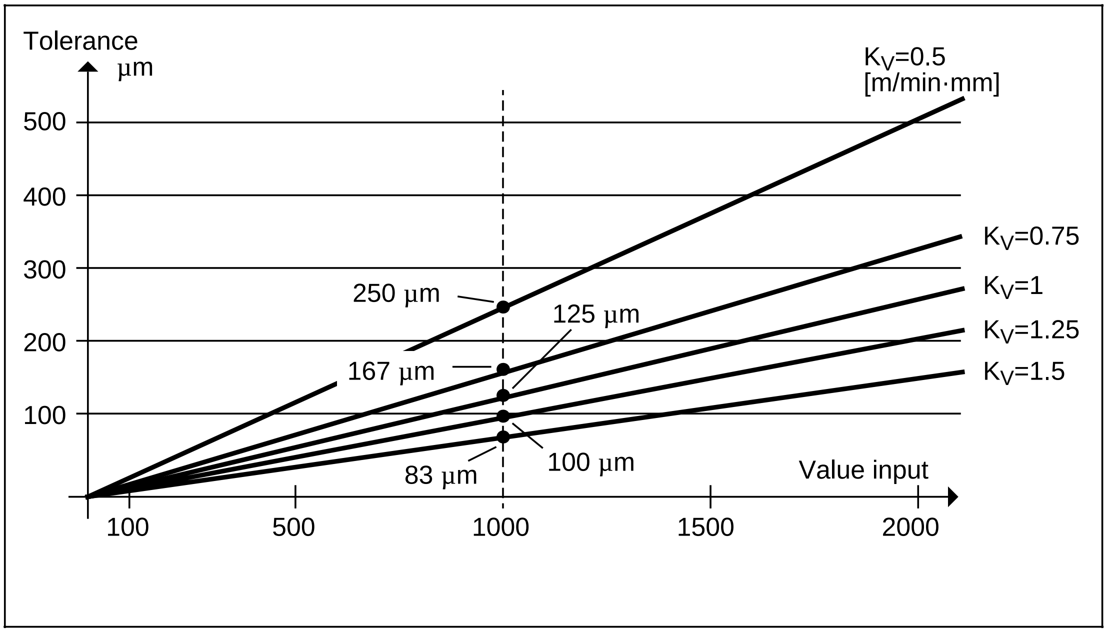
The K_V factor should be as high as possible.

Besides the values NC MD 252* (K_V) and NC MD 260* (multgain) set as machine data in the NC, the servo gain is also determined by the tacho compensation in the speed controller, the variable increment weighting, gear ratios etc.

The NC MD 332* and 336* are used to influence contour monitoring.

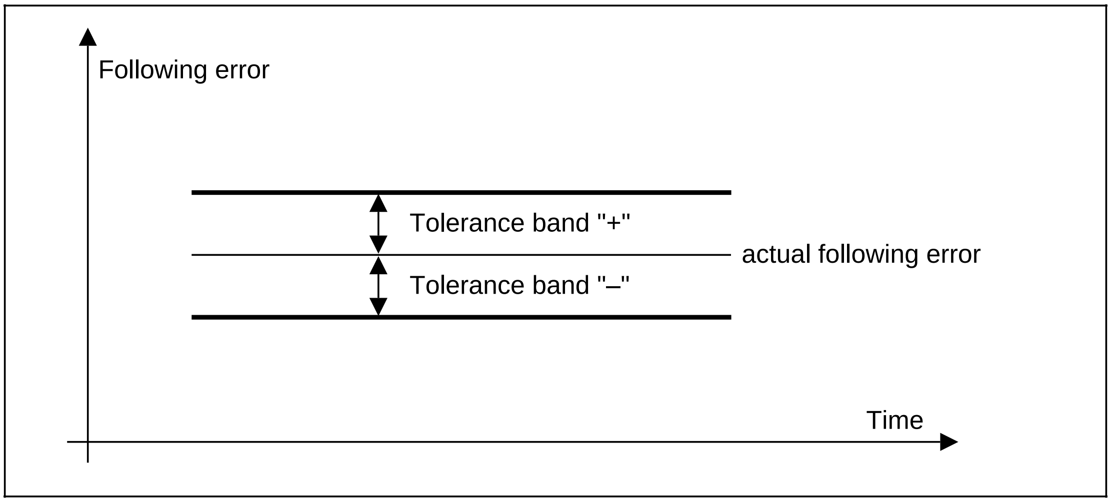
The speed at which contour monitoring is to become active is entered in units/min (ms) in NC MD 336*. If the value input is 0, contour monitoring is also active with the axis at a standstill. In this condition, the standstill monitoring also watches for excessive axis movements.

The tolerance band for permissible contour monitoring is entered in NC MD 323*. The value input for the desired tolerance band can be determined from the following set of curves (with position control resolution 0.5 µm):



Determining the value input for the tolerance band

The selected tolerance band is set as follows:



Tolerance band for contour monitoring at constant setspoint speed

The actual contour deviations can be displayed in the diagnosis menu with the softkeys "Diagnosis"/"Service" in the data range for the individual axes.

Contour monitoring becomes ineffective if the set position value changes. This means that no monitoring would be active in the case of circular interpolation. To provide machine protection in this case as well, the signs for following error, set position value and actual position value are continuously compared. The contour alarm switchoff (Alarm 116*) is triggered in the event of discrepancies.

When the monitor triggers, Alarms 116* are output and the drives braked by specifying setpoint "0" at the current limit. In addition, the speed controller enables are removed and switched to follow-up operation. The alarms can be cancelled only by means of "RESET" (M2/M30).

Alarms 116* are triggered as soon as the set tolerance band is overstepped or if the axis does not reach the new speed within the time determined by the K_V factor when the drives accelerate or brake.

The occurrence of Alarms 116* indicates that the speed control loop is poorly optimized, the K_V factor has been selected too high for this machine or that a tolerance band is too small.

5.3 Spindle installation

5.3.1 Preconditions

- The spindle start-up with set value from the battery box and external enables has been concluded
- The set value cable (set value + servo enable) and the actual value cable are connected
- The standard machine data have been loaded
- The Option F05 (S analog) is available
- The minimum and maximum speeds as well as the acceleration time constants for each gear are known

The following NC MD and PLC NC signals must be noted in conjunction with spindle installation:

NC MD

131 146	Spindle offsets	
4000 4010	Spindle assignment Spindle drift	
4030 : 4100	Max. speed for	Gear 1 : Gear 8
4110 : 4180	Min. speed for	Gear 1 : Gear 8
4190 : 4260	Acceleration time constants	Gear 1 : Gear 8
4440 4450 4460 4470 4480 4510 5200 Bit 0 5200 Bit 1 5200 Bit 2 5210 Bit 1 5210 Bit 7	Spindle speed tolerance Max. spindle speed tolerance Shutdown speed tolerance Delay time for servo enable Lowest motor setpoint speed Max. spindle speed Actual value *2 Sign change actual value Pulse encoder available Sign change set value Spindle available	

PLC NC signals

Q 100.7 Spindle enable
Q 100.6 Spindle controller enable
Q 100.5 Preset set value ZERO
Q 100.4 Spindle speed compensation effective
Q 101.3 Automatic gear selection

The following NC machine data must be set first:

MD 4000	value***	spindle assignment
MD 5210	bit 7	spindle available

5.3.2 Speed inputs for gears

NC MD 4030 to 4100	enter max. speed
NC MD 4110 to 4180	enter max. speed

These data must be available to the manufacturer.

5.3.3 Acceleration time constants

NC MD 4190-4260

This data must be available to the manufacturer and be optimized before installation (also see Description of Operation "M19").

5.3.4 Spindle setting data

The maximum spindle speed must be entered in setting data 4030, spindle speed limitation.

5.3.5 Testing spindle in mode MDA

Enter MD3/MD4 with an S value:

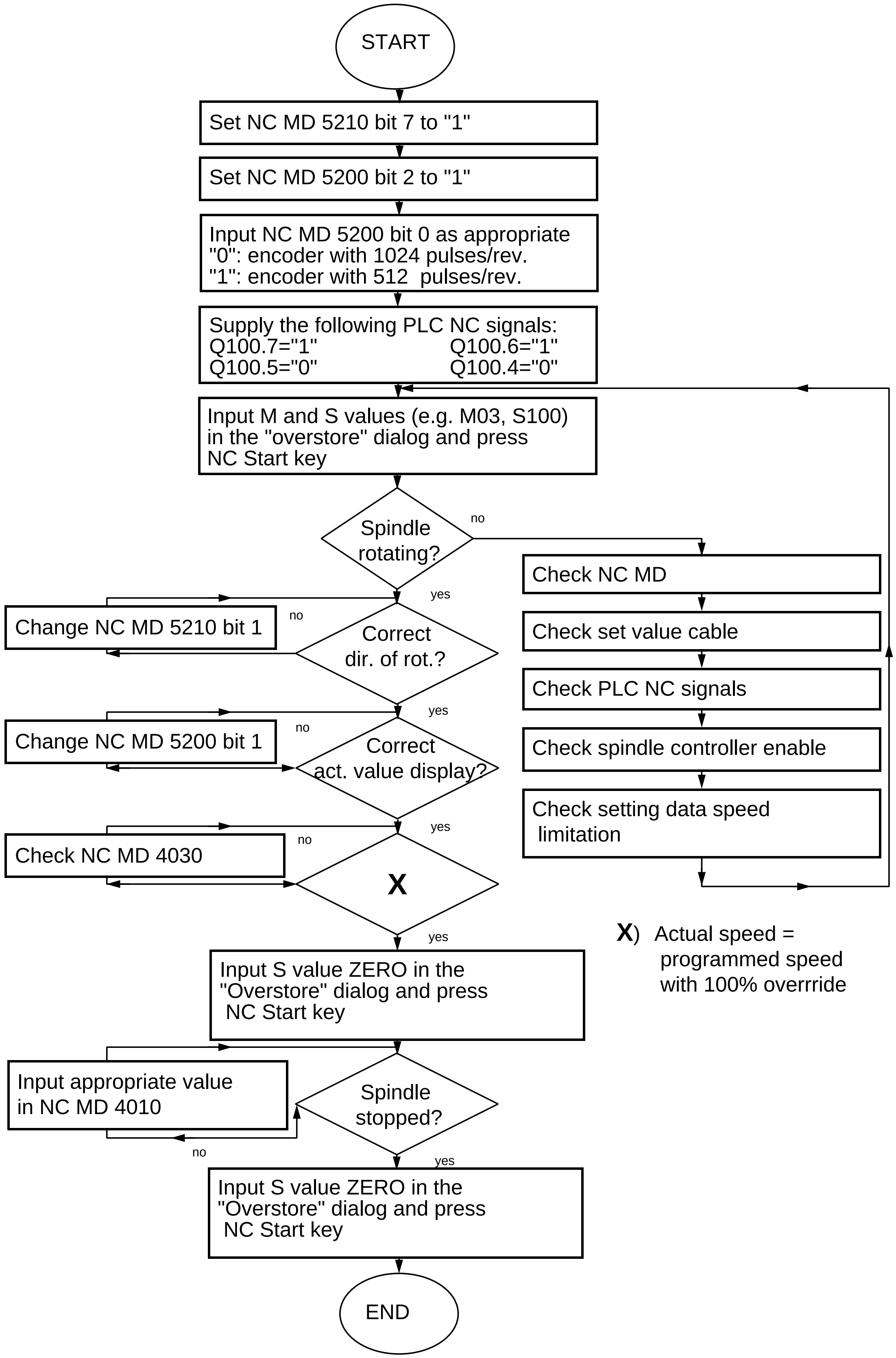
- Incorrect direction of rotation — Change NC MD 5210 bit 1
- No rotation — Check interface signals

The following interface signals are required:

Q 100.7	Spindle enable
Q 100.6	Spindle controller enable
Q 100.5	No preset set value ZERO
Q 101.3	Automatic gear selection (always "1" with S analog)
Q 100.4	Spindle speed compensation effective

Preset S value 0:

- Spindle drifts — Perform drift compensation (NC MD 4010)


START
Set NC MD 5210 bit 7 to "1"
Set NC MD 5200 bit 2 to "1"
Input NC MD 5200 bit 0 as appropriate
"0": encoder with 1024 pulses/rev.
"1": encoder with 512 pulses/rev.
Supply the following PLC NC signals:
Q100.7="1" Q100.6="1"
Q100.5="0" Q100.4="0"
Input M and S values (e.g. M03, S100)
in the "overstore" dialog and press
NC Start key
Spindle rotating?
no
Check NC MD
Check set value cable
Check PLC NC signals
Check spindle controller enable
Check setting data speed limitation
yes
Correct dir. of rot.?
no
Change NC MD 5210 bit 1
yes
Correct act. value display?
no
Change NC MD 5200 bit 1
yes
X
no
Check NC MD 4030
yes
X) Actual speed = programmed speed with 100% overrride
Input S value ZERO in the "Overstore" dialog and press NC Start key
Spindle stopped?
no
Input appropriate value in NC MD 4010
yes
Input S value ZERO in the "Overstore" dialog and press NC Start key
END

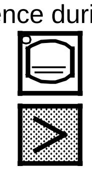
5.4 Standard installation of NC and PLC on standard machines

The contents of this Section presuppose the following:

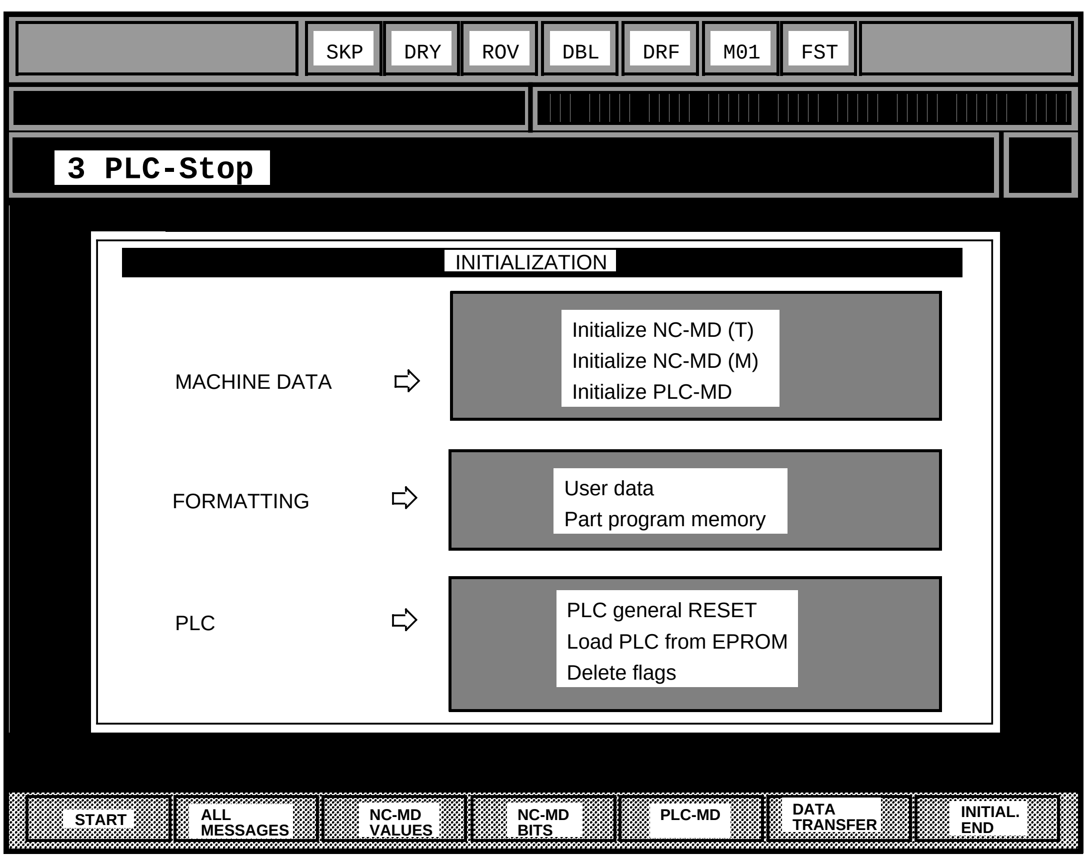
- The system has been checked according to Section 1 (Preconditions and Visual Inspection)
- The power supply to all components has been checked according to Section 4 (Voltage and Functional Tests)
- The devices have been jumpered according to Section 3 (Overview of Devices with Standard Jumpering)
- The feed and main spindle drives are disabled until the axes and spindles have been started up (EMERGENCY STOP)
- The PLC EPROM submodule contains the PLC program and is inserted
- The standard machine data (machine data etc.) are available on diskette or punched tape

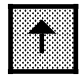
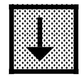
The INITIALIZATION dialog can be selected as follows with the SINUMERIK 805:

- When starting up for the first time, by switching on the control with the installation switch at position 2 (see Section 3.1.1 for location)
- By means of the following key sequence during operation:
  - Operator area key
  - "DIAGNOSIS" softkey
  - Menu expansion key
  - "INITIALIZATION" softkey



The following display appears:



The various functions must be selected with the cursor keys  and  .
The selected item is highlighted.

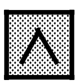
Press the START softkey to execute the selected function. Execution is indicated by a checkmark that appears in front of the function.

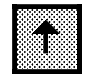
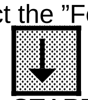
Now execute the following functions consecutively:

- Initialize NC MD (NC MD area is cleared and preset with standard machine data), T ≙ turning machine data, M ≙ milling machine data
- Initialize PLC MD (PLC MD area is cleared and preset with standard machine data)
- Format user data (delete setting data, tool offsets, zero offsets, R parameters, program parameters and preset setting data)
- Format part program memory (the part program memory is cleared and a directory set up for the maximum number of part programs (NC MD 8))
- PLC general reset (the memory area for the PLC user program is cleared)
- Load PLC from EPROM (the PLC user program (STEP 5) is copied from the EPROM to the RAM memory. Execute only if the EPROM submodule is inserted).
- Clear flags (all PLC flags are reset to 0).
- Connect external device (PG 685, tape reader etc.) at interface 1
- Press DATA TRANSFER softkey
- Press PARAMETER softkey

  The following parameters must be set by pressing the appropriate softkeys:

Device type:	RTS-LINE
Baud rate:	9600
Stop bits:	2
Parity:	none

- Press the return key 
- Press READ-IN START softkey
- Initiate value output at the external device of NC machine data (see Section 10.6)
- Press STOP softkey after the end of the value output

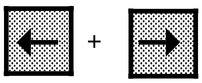
- Press RECALL key 
- Select the ”Format part memory part program”function with the cursor keys  and 
- Press START softkey
- Press DATA TRANSFER softkey
- Press READ-IN START softkey
- Start value output of PLC machine data at the external device
- Press STOP softkey at the end of the value output
- This read-in procedure must be followed for each type of data to be read in, such as:
  - Main programs
  - Subroutines
  - R parameters
  - Zero offsets
  - Tool offsets
  - Setting data
- Press SET-UP END
- Switch off control (or switch off the control's power supply unit)
- Turn installation switch back to position 0
- Switch on the control

5.5 Changing the colour setting

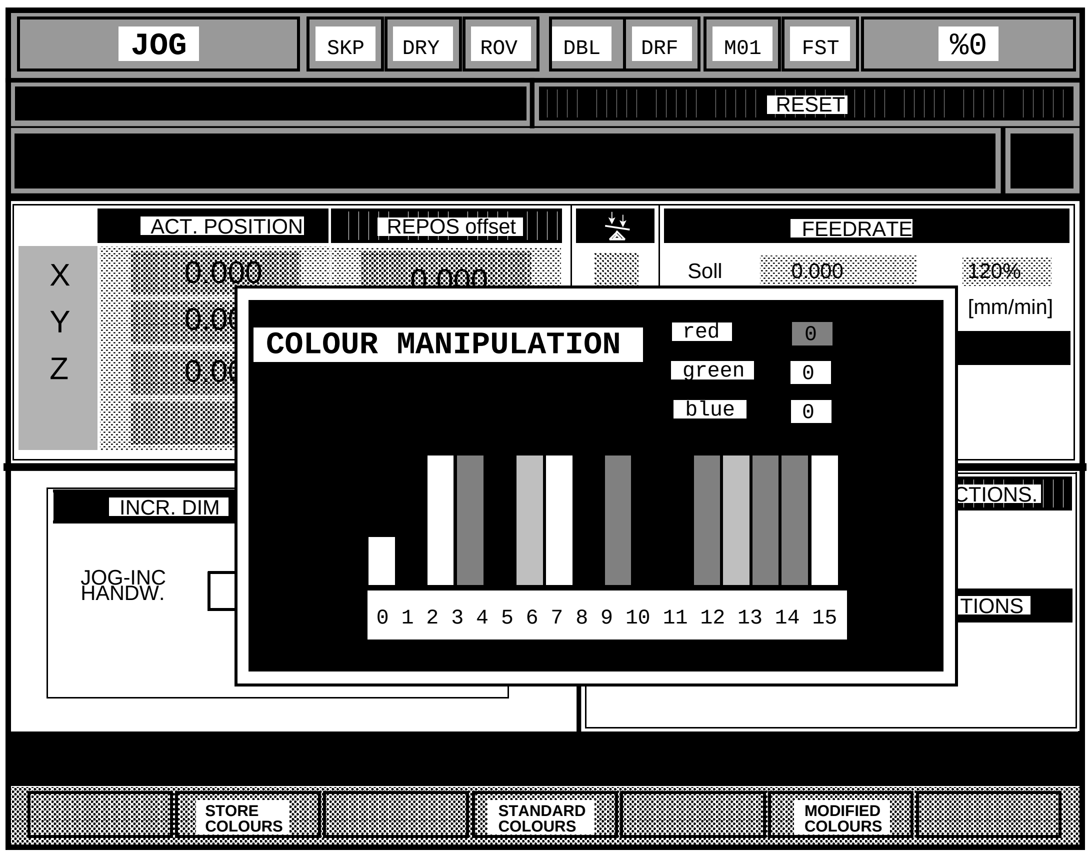
As from software version 4.1 it is possible to assign new values to the 16 colours used in the operator interface. The changes of the colour values can be stored and are thus taken as the valid colour values at the next POWER ON.

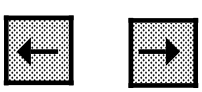
The changed colour values are stored in the NC MD 400-447.
Prerequisite: NC-MD 5149.7 = 1 (colour selection for the operator interface)

Operator sequence

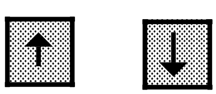


If you press the cursor left and cursor right keys at the same time you open the following window:





If you press the cursor left key or the cursor right key you can select the colours to be changed.



If you press the cursor up key or cursor down key you can select the red, green or blue component of the colour to be changed.

\+ −

Using the addition or subtraction key you can increment or decrement the selected colour component (red, green or blue). Alternatively, you can enter the value of the colour component directly after having opened the input field.

Meaning of the softkeys

STORE COLOURS

When you press this softkey the changed colours of all 16 colours are transferred into NC MD 400-447.
If you do not press this softkey after making changes, the colour value changes are only valid until the next POWER-ON.

STANDARD COLOURS

When you press this softkey the current colour values are replaced by the standard values for all 16 colours.

MODIFIED COLOURS

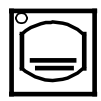
When you press this softkey the current colour values are replaced by the colour values last stored.

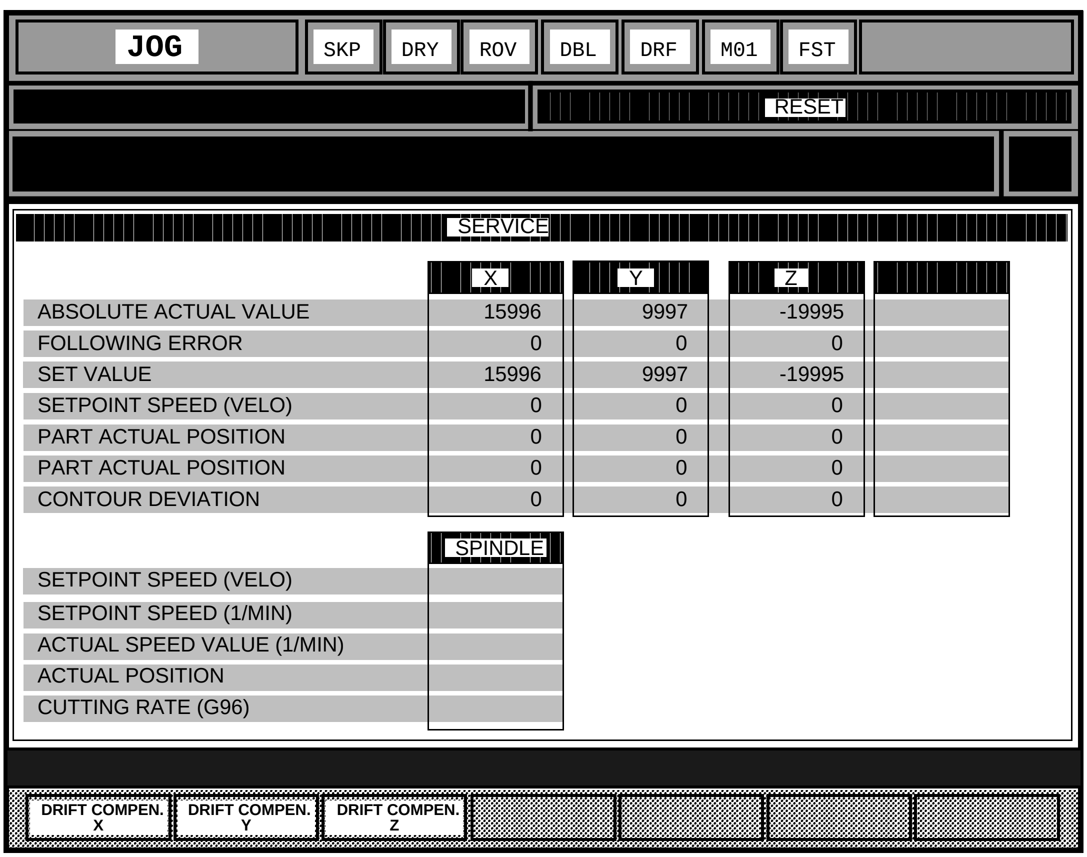
6 Service Displays

For fault diagnosis as well as axis and spindle drive optimization purposes, the data transferred from the SINUMERIK 805 to the axes and spindles and the data transferred from the measuring system to the SINUMERIK 805 (e.g. setpoint speed, absolute actual value, ...) must be displayed.

6.1 Selection of service displays for axes and spindle

The service displays are selected with the following operating sequence:

1. Data area key:  this branches from any machine area menu to the basic menu of the data area.
2. Softkey DIAGNOSIS
3. Softkey SERVICE



6.2 Service data for axes

The following data are displayed with the SINUMERIK 805:

- Absolute actual value — Actual position of the axis. The position is displayed in the machine-related system (ZO and TO ignored) in units of position control resolution.

  Example:

  A display of 200 000 with a position control resolution of 0.5×10^{-3} mm indicates that the axis is positioned at 100 mm (referred to machine zero).

- Following error — Difference between the set and absolute actual values. The following error is displayed in units of position control resolution.

  Example:

  A display of 2000 with a position control resolution of $0.5 \cdot 10^{-3}$ mm indicates a following error of 1mm.

- Set value — The target position specified by means of programming. In the target position (at rest), the set value is the same as the absolute actual value (any remaining discrepancy can be eliminated by means of drift compensation). The set value is displayed in units of position control resolution.

  Example:

  A display of 202000 with a position control resolution of $0.5 \cdot 10^{-3}$ mm indicates a set value of 101 mm (referred to machine zero).

- Setpoint speed — The set speed determined by the control and supplied to the drive actuator as an analog voltage value.
  Unit: 1.22 mV ($\hat{=}$ 1 VELO)
  8192 Velo $\hat{=}$ 10 V

  Example:

  A display of 5638 is equivalent to a setpoint speed of 6.87836 V

- Part actual pos. — Pulses from the measuring system x 4 per sampling interval (5 ms). Multiplication by 4 is required so that the part actual position (sampling time 5 ms) can be compared with the part set position (sampling time 20 ms).
  Unit: position control resolution (standard: 0.5 µm)

  Example:

  A display of 24 is equivalent to a path of 12 µm per 20 ms with a position control resolution of 0.5 µm.

- Part set pos. — Pulses per interval (20 ms) output by the interpolator to the position controller.
  Unit: position control resolution (standard: 0.5 µm)

  Example:

  A display of 18 is equivalent to a path of 9 µm per 20 ms with a position control resolution of 0.5 µm.

- Contour deviation — Actual contour deviation (variations in following error caused by compensating processes at the speed controller due to load changes)
  Unit: position control resolution (standard: 0.5 µm)

  Example:

  A display of 2 is equivalent to contour deviation of 1 µm with a position control resolution of 0.5 µm.

6.3 Service data for spindle

The following data are displayed with the SINUMERIK 805:

- Setpoint speed (VELO) — Setpoint value output by the control to the spindle controller in VELOs (1 VELO=1.22 mV)
- Setpoint speed (rpm) — Set value output by the control to the spindle. The setpoint speed is displayed in revolutions per minute.
- Actual speed value (rpm) — Actual spindle speed. The actual speed value is displayed in revolutions per minute.
- Actual position (degrees) — Display of spindle position in DEGREES. The position is displayed in the range from 0.1 to 359.9 degrees.
- Cutting rate mm/min — Current cutting rate of tool tip in mm/min with G96 selected.

7 Data

7.1 General

The following data areas can be selected by means of the DATA softkey in the basic menu of the SINUMERIK 805 data area:

- R parameters
- Setting data (SD)
- NC machine data values (NC MD values)
- NC machine data bits (NC MD bits)
- PLC machine data (PLC MD)

Only in the NC MD and PLC MD data areas is an input dependent on a password.

7.2 R parameters

R parameter No.	**Permanently assigned**	**Function**
R0 . . R49	As long as standard cycles are being processed	Standard cycle transfer parameters
R50 . . R99	As long as standard cycles are being processed	Local R parameters Cycle calculation is performed with these R parameters
R100 . . R109	yes	Reserved for Siemens cycles
R110 . . R199	yes	Reserved for measuring cycles If no measuring cycles are used, this area is at the free disposal of the user
R200 . . R499	yes	These R parameters are used internally (in conjunction with CL800)
R500 . . R699		Reserved for Siemens Nürnberg
R700 . . R999		Free for user

7.3 Setting data (SD)

7.3.1 Working area limitations

SD No.	Designation	Standard value	Maximum input value	Ref. syst.	Input unit
300*	Min. working area limitation	0	±99999999	IS	units
304*	Max. working area limitation	0	±99999999	IS	units

The working area limitations can be used in addition to the software limit switches separately to restrict the traversing ranges of the maximum of 4 axes.

The sign " * " is the token character for the axis number:

0 ≙ 1st axis
1 ≙ 2nd axis
2 ≙ 3rd axis
3 ≙ 4th axis
3002 = min. working area limit of the 3rd axis.

The values can be modified by means of a direct input in the relevant field or by programming G25... (minimum working area limitation) or G26... (maximum working area limitation).

The working area limitations are effective only in the JOG and AUT operating modes as follows:

AUT: always effective
JOG: effective if NC MD bit 5003.6 (working area limitation with JOG) is set to 1.

7.3.2 Spindle data

SD No.	Designation	Standard value	Maximum input value	Ref. syst.	Input unit
1	Smoothing constant, thread cutting	0	5		
. . .					
4010	Programmed spindle speed limitation	0	12000		rev/min 0.1 rev/min, if NC MD 5800.3=1
4020	Oriented spindle stop (M19)	0	359.5		0.5 degree
4030	Speed limitation	0	12000		rev/min

Speed limitation

The spindle speed is restricted to the value entered in this field (also note NC MD 4510 (max. spindle speed)).

Programmed speed limitation (G92)

The programmed speed limitation (92) is effective only with activated constant cutting rate (G96).
In addition to the speed limitations stated above, a lower maximum spindle speed, with a restricting effect, can be specified in the part program with the programmed speed limitation (G92 S...).

Oriented spindle stop (M19)

This field is effective only if the "Oriented spindle stop (M19)" Option is available.
When "M19" is identified in the part program, the spindle positions to the angle contained in this field.
If "M19 S120" has been programmed, the value "120" is entered in the field and the spindle positions to this new value.

Smoothing constant, thread cutting

In cases where the feedrate varies with the spindle speed (e.g. with thread cutting), the NC calculates the spindle speed change in the IPO cycle and influences the feedrate by means of an appropriate set value output.
Value inputs greater than 1 mean that fluctuations in the spindle speed are averaged over the stated cycle time before they are used to influence the feedrate.

Input value	0	1	2	3	4	5
IPO cycle time x	1	1	3	7	15	31
Set value output for feed drive	Jump		Ramp			

7.3.3 Dry run feedrate

If the (DRY) function is selected by means of the "PROGRAM CONTROL" softkey, the value stored in this field (unit mm/min) is effective in the part program instead of the programmed feedrate.

Note:

- This value must be input before NC Start in order to be effective.
- Also note NC MD 280* (max. speed)

SD No.	Designation	Standard value	Maximum input value	Ref. syst.	Input unit
0	Dry run feedrate	0	24000	IS	1000 units/min

7.3.4 Incremental dimensions

The following setting data cannot be entered by the operator in the "Setting data" menu, but have to be entered in the relevant input fields in the JOG, JOG-INC and JOG-REPOS modes.

SD No.	Designation	Standard value	Maximum input value	Ref. syst.	Input unit
2	Incremental dimension INC-VAR	1	10000	IS	units
3	Incremental dimension handwheel	1	100	IS	units

Incremental dimension INC-VAR: The relevant axis is traversed by this amount when the axis direction key (+ or -) is pressed.

Incremental dimension handwheel: The selected axis is traversed by the entered amount per handwheel pulse.

Caution:

The handwheel functions in the JOG, JOG-INC and JOG-REPOS modes.

7.3.5 Setting data bits

The setting data bits appear in this tabular form only with reading out/reading in via the V.24 (RS 232 C) interface. In the case of manual inputs in the control, however, the plain text input is converted to this tabular form.

SD No.	Bit No.							
	7	6	5	4	3	2	1	0
5000						1) Cycles V.4 Turning cycles L93-L99	1) Cycles V.4 Drilling cycles L900-L930	1) Cycles V.4 Drilling cycles L81-L89
5001								Display actual value system for workpiece
5002								

1) In SINUMERIK 805 these SD-bits are always preset to 1.
Setting data bits can be changed through code @ 411 (see NC Programming Guide).

The following setting data bits can be input in the DATA TRANSFER menu in plain text by operating the PARAMETER SOFTKEY

SD Nro	Bit No. 7	6	5	4	3	2	1	0
5010			Device identifier for read in, 1st interface					
5011		Transmission format for read in, 1st interface						
	Number of stop bits		odd parity	with parity		Baud rate		
5012			Device identifier for read out, 1st interface					
5013		Transmission format for read out, 1st interface						
	Number of stop bits		odd parity	with parity		Baud rate		
5014		X_{on} Start character 1st interface (value e.g. 11_H)						
5015		X_{off} Start character 1st interface (value e.g. 13_H)						
5016			Special bits 1st interface					
	Start without X_{on}	Progr.start with LF	Block end with CR LF	Output in EIA code	Stop with end of transmiss. character	Readiness analysis	No leader and trailer with read out	Read-in program from System 3/8
5017			Special bits 1st interface				No REORG via interface	Time watchdog off
5018		Device identifier for read in, 2nd interface						
5019		Transmission format for read in, 2nd interface						
	Number of stop bits		odd parity	with parity		Baud rate		
5020		Device identifier for read out, 2nd interface						
5021		Transmission format for read out, 2nd interface						
	Number of stop bits		odd parity	with parity		Baud rate		
5022		X_{on} Start character 1st interface (value e.g. 11_H)						
5023		X_{off} Start character 1st interface (value e.g. 13_H)						
5024			Special bits 2nd interface					
	Start without X_{on}	Progr.start with LF	Block end with CR LF	Output in EIA code	Stop with end of transm. character	Readiness analysis	No leader and trailer with read out	Read-in program from System 3/8
5025							No REORG via interface	Time watchdog off
5026			EIA code for "@" (value e.g. 6 D_H)					
5027			EIA code for ":"					
5028		End of transmission character (value e.g. 03 H)						
5029			E/A code for ":"					

Explanation of setting data bits

SD 5000 Bits 0 to 2: If the user wishes to use the cycles from standard UMS 03 (standard cycles), he must set the relevant bit. (Reason: extended parameterization of standard cycles from UMS 03).

SD 5001 Bit 0: The actual value display of the axes refers to workpiece zero and not to machine zero (or reference point).

SD 5010, 5012:
SD 5018, 5020

Determines the transmission mode of the connected device.

0000 0000	For line-controlled devices (universal devices, also valid for PG 675 etc., operating in the CPIM mode)
0000 0001	X_{on}/ X_{off} character-controlled devices (software handshake)
0000 0010	SINUMERIK readers T10 and T20
0000 0100	Programmers (PG 675 etc.) operating in ON-LINE mode with the PLC.

SD 5011, 5013
SD 5013, 5021

Bits 0-3: The baud rate of the connected devices is entered here (baud rate= number of bits transmitted per second)

0000 = 110 baud
0001 = 150 baud
0010 = 300 baud
0011 = 600 baud
0100 = 1200 baud
0101 = 2400 baud
0110 = 4800 baud
0111 = 9600 baud

Bit 4: Determines whether an additionally generated 9th bit is transmitted as a parity bit

Bit 5: Parity type 0=even
1=odd
The last bit (8th data bit or 9th bit) is always transmitted as a parity bit.

Bits 6,7: Determines how many stop bits the connected device operates with
00= 1 stop bit
01= 1 stop bit
10= 1 stop bits
11= 2 stop bits

SD 5014, 5022: The value of the X_{on} character (=DC 1 with software handshake) with which the connected device operates is entered here (usual value for X_{on}=11_H=0001 0001).

SD 5015, 5023: The value of the X_{off} character (=DC 3 with software handshake) with which the connected device operates is entered here (usual value for
X_{off} =13_H=0001 0011
=93_H=1001 0011 with EIA code)

5016, 5024 Bit 0: Read in subroutines of Systems 3 and 8

0= Read in main programs and subroutines to System 800 format
1= Read in main programs and subroutines to System 3/8 format

When reading in subroutines to System 3/8 format, the identifier 00 of the subroutine number is eliminated

Bit 1: Output without leader and trailer

0= Data output with leader and trailer (as tape)
1= Data output without leader and trailer (in memory)

Bit 2: Analyse DSR readiness

0= "DSR" line (pin 6) is not evaluated
1= "DSR" line (pin 6) is evaluated

Bit 3: Stop with "End of transmission" character

0= Read-in stop with M02/M30
1= Read-in stop with "End of transmission" character

Connects several programs to be read in as a block (e.g. the main programs, subroutines, tool data, data blocks belonging to one workpiece).

Bit 4: Output in EIA code

0= Output in ISO code
1= Output in EIA code

Bit 5: Block end CR LF

0= Conclusion of block with output with LF CR CR
1= Conclusion of block with output with CR LF

Bit 6: Program start with LF

1= Read in start with LF

Allows a part program to be read in. The next LF to be read is interpreted as program beginning and this program is stored as % 0 in the part program memory.

Bit 7: Output without 1st X_{on} character

0= Output start following request via X_{on} character
1= Output start without request

With interfacing of character-controlled devices, data output begins with Data Start without waiting for the X_{on} character of the external device. Subsequent starting and stopping is via the X_{on} / X_{off} characters.

5017, 5025 Bit 0: Switches off the time watchdog for the transmission of data to the 2 interfaces.

Bit 0=0: Time watchdog active. If no character is emitted for 60 s during transmission, the NC interrupts the transmission circuit and triggers Alarm 22.

Bit 0=1: Time watchdog switched off.

Bit 1: Permits suppression of automatic reorganisation of the part program memory after Clear Program via the V.24 (RS 232 C) interface.

0= Reorganisation
1= No reorganisation

5026: The "@" character is not available in the EIA code. The code of the character used to replace "@" with the output via V.24 (RS 232 C) has to be entered here (usual code: 0110 1011 = "m").

5027: No ":" character is available in the EIA code. The code of the character used to replace ":" with the output via V.24 RS 232 C) has to be entered here (e.g. 0110 1100 = "n").

5028: The code of the character identified as the "End of transmission" character by the connected devices is entered here (also see SD 5016/ 5024 bit 3) (usual value: 0000 0011 = control "C").

5029: No "=" character is available in the EIA code. The code of the character that replaces "=" with the output via V.24 (RS 232 C) has to be entered here.

Further explanations are given in the "SINUMERIK System 800" Universal Interface publication.

7.4 NC machine data values (NC MD values)

The data area for NC MD values is described in detail in Section 8.7 of this Guide.

7.5 NC machine data bits (NC MD bits)

The data area for NC MD bits is described in detail in Section 8.8 of this Guide.

7.6 PLC machine data (PLC MD)

The data area for PLC MD is described in detail in Section 9 of this Guide.

8 NC Machine Data

8.1 General

The machine data (MD) are used to match the NC control to the machine tool. They must be carefully determined and optimized during the machine installation routine. The NC MD are divided into NC MD values and NC MD bits and are stored in the buffered RAM memory of the central controller. The NC MD must be saved after starting up the machine tool (also see Section 2 (Installation Checklist)).

8.2 Overview of NC MD

MD No.:	Area	
0 . . 327	General NC MD values	NC MD values
2000 . . 3683	Axis-specific NC MD values	
4000 . . 4520	Spindle-specific	
5000 . . 5016 5148 5150	General	NC MD bits
5200 5210	Spindle-specific	
5400 . . 5580	Program-specific	
5600 . . 5763	Axis-specific	
6000 . . 6249	Bits for leadscrew error compensation	

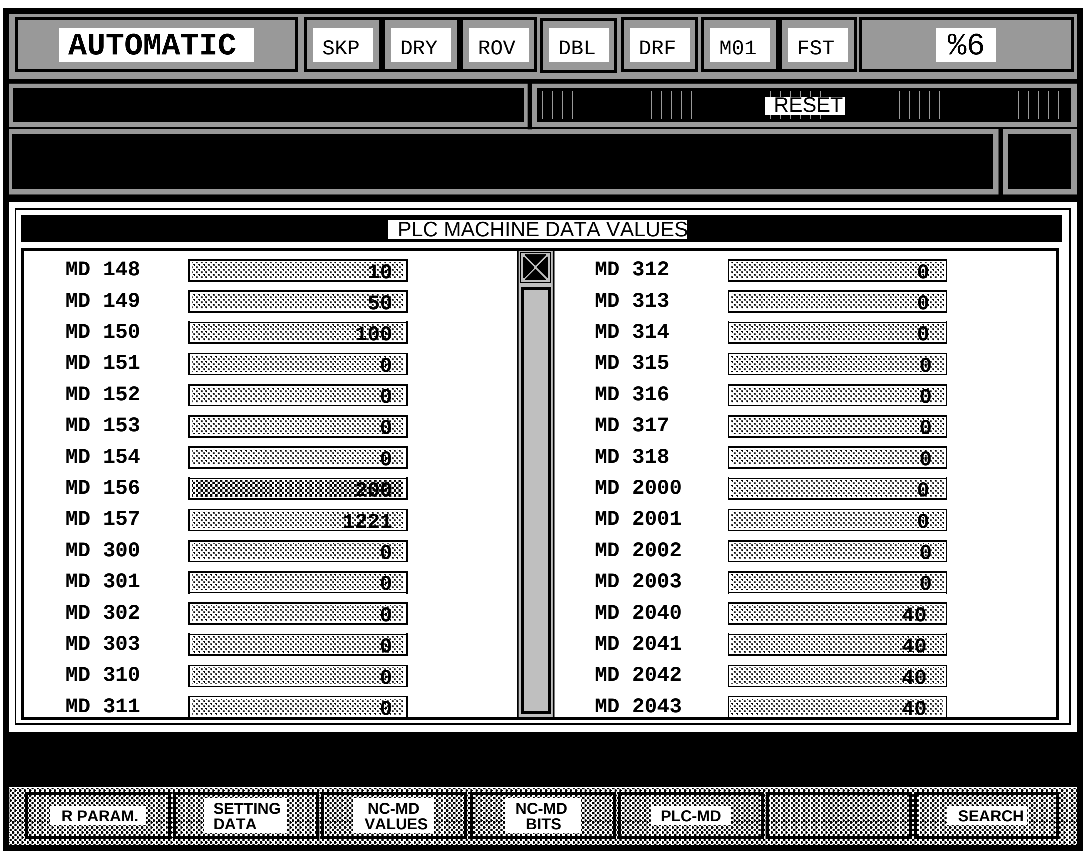
8.3 Display and input of NC MD

Selecting a NC MD:

1. Data area key: Press this key to branch from any machine area menu to the basic menu of the data area.
2. Softkey Data
3. Softkey NC MD VALUES or NC MD BITS

Display: Select the desired page with the key or .

Input:
- Select the NC MD to be modified by means of the page and cursor keys or the SEARCH softkey.
- Press key and input the password (conclude the input with key).
- Press key
- Input the value or bit pattern and conclude with key .



Notes:

- Return to preceding menu with the key .
- Return to the main menu of the set mode in the machine area with the key
- Editing in the input field can be performed with the keys and (delete field and delete character).
- Press key to obtain the original value in the input field before conclusion with .

8.4 Activation of individual machine data

By turning the control on and off (Power On) all MD changes become active except for MD 8, different option bits.

8.5 Input units

Reference system MS (Measure System)

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

Example:

1 unit of position control resolution = 1/2 µm (NC MD 5002 = xxxxx010)	1 unit (MS) = 1 µm

Reference system IS (Input System)

1 unit (IS) = 1 unit of input resolution

Example:

1 unit of input resolution = 1 µm (NC MD 5002 = x010xxxx)	1 unit (IS) = 1 µm

8.6 Explanatory notes on NC MD

NC MD values

Axis-specific values

To ensure that the NC system software can be used universally and to equip the system for future developments, software provisions have been made for 40 axes. On the SINUMERIK 805, however, only the first 4 axes are provided as hardware and can be activated.

The meaning of the MDs thus changes in jumps of 40 in each case, e.g.:

MD	2040	Course exact stop limit for the	1st axis
	2041	"	2nd axis
	2042	"	3rd axis
	2043	"	4th axis
	2080	Fine exact stop limit for the etc.	1st axis

For clarity, the last position of the MD No. is represented by the symbol * (e.g. 204* = coarse exact stop limit). With the display and input of MD, the symbol * must be replaced by the actual digit according to the following schedule.

*	0	1st axis
	1	2nd axis
	2	3rd axis
	3	4th axis

8.7 Description of NC MD values

8.7.1 General values

NC MD	Significance		
0	**Pre-limit switch**		
Sign	Input limits	Standard value	Units
+	0 to 99 999 999	20 000	units (MS)

Pre-limit switch ahead of software limit switch (software limit switch 1 or 2). The distance by which braking is to be prematurely initiated must be entered if the momentary speed is greater than the speed stored in MD No. 1. This ensures that the position of the software limit switch is only insubstantially overrun with circular interpolation.

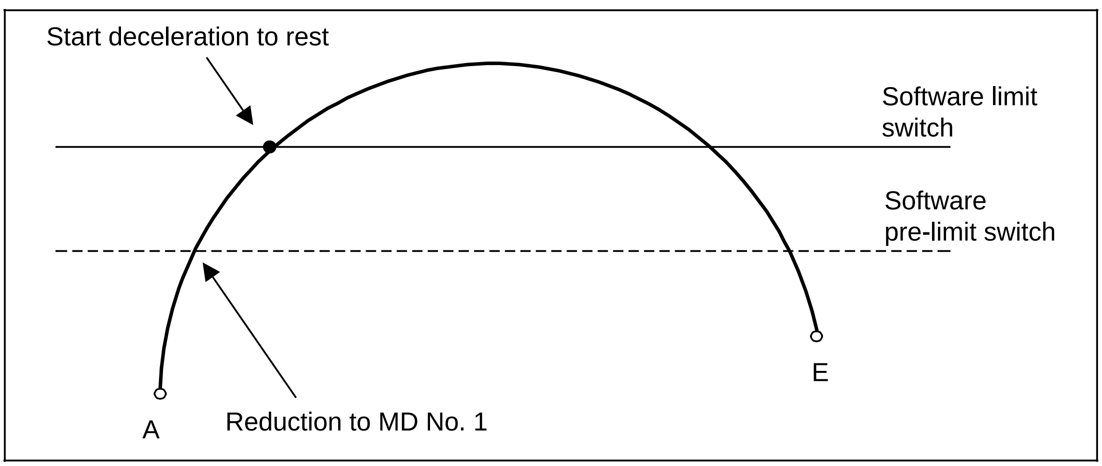
Overrunning the prelimit switch activates Alarm 2034 (reduction at software pre-limit switch) unless the movement is in rapid traverse.

Recommended value:
Slightly greater than the rapid traverse braking distance to NC MD No. 1.

Travel movements with end positions behind the software limit switch are not even executed.

Linear interpolation: If the end position is behind the software limit switch, the block is not processed and Alarm 2065 (programmed position behind software limit switch) is activated.

Circular interpolation:
a) If the end position is behind the software limit switch, the block is not processed and Alarm 2065 is activated.
b) If the end position is not behind the software limit switch but the movement leads to a point behind the switch, see the following diagram.



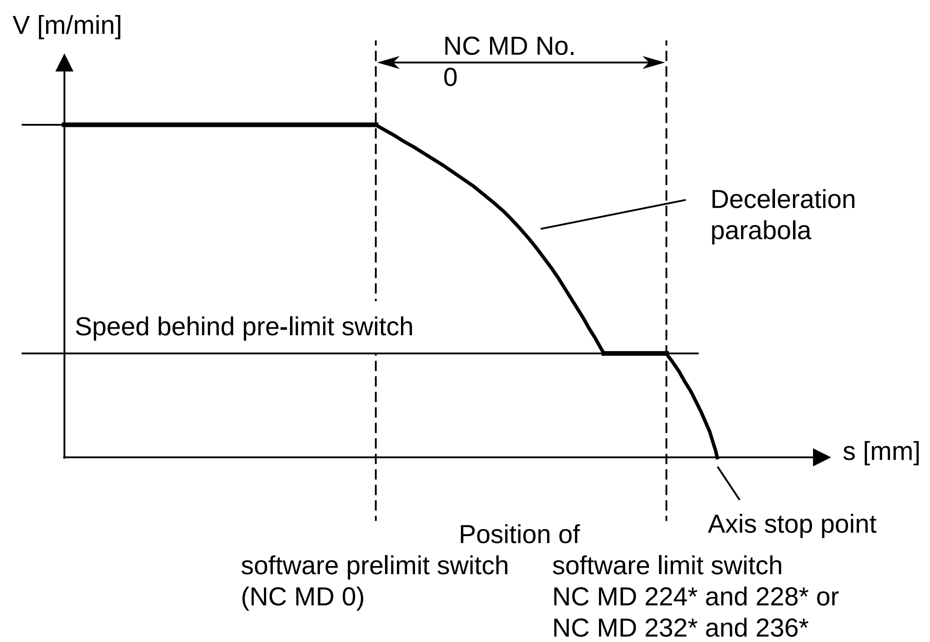
Schematic of speed regulation at pre-limit switch

The area between the software pre-limit switch and software limit switch is fully utilisable without contour errors if the tool path feedrate is slower than the speed in MD1 (speed behind pre-limit switch).

MD No.	Significance		
im **1**	**Speed behind pre-limit switch**		
Sign	Input limits	Standard value	Units
+	0 to 15 000	500	1000 units min (IS)

Note:

NC MD No. 1 has no effect if zero is entered in NC MD No. 0.

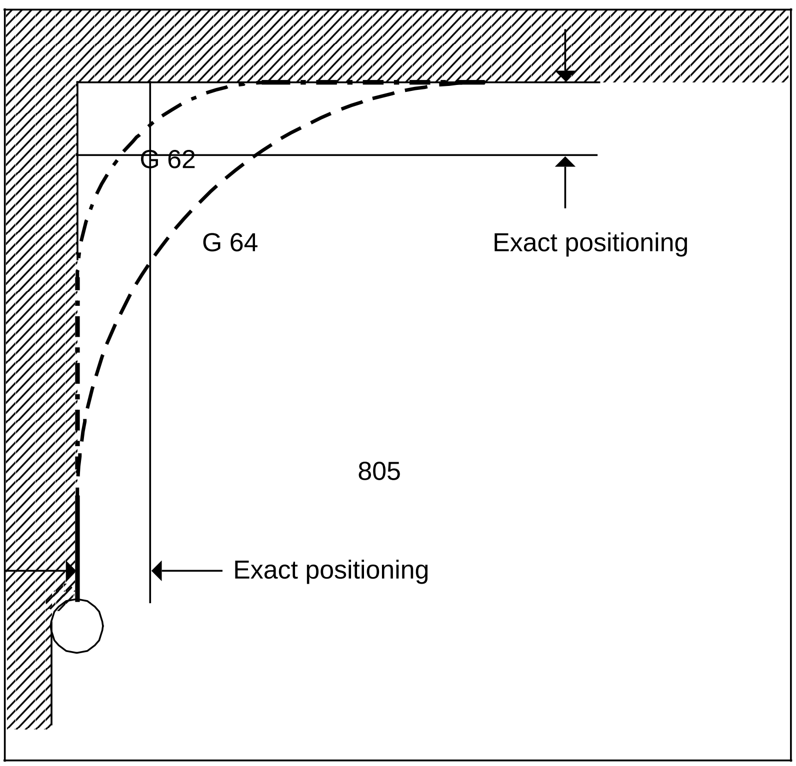


Schematic of speed behind limit switch

MD No.	Significance		
3	**Corner deceleration rate**		
Sign	Input limits	Standard value	Units
+	0 to 15 000	500	1000 units/min (MS)

In continuous-path control (G64), block transitions are covered without feedrate reduction, i.e. the tool path feedrate is maintained and the exact stop tolerance ranges are not scanned.

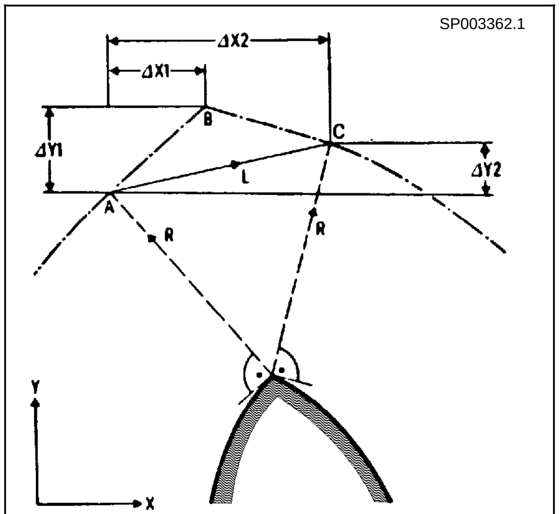
As a result of function G62 (continuous-path operation with feedrate reduction), the tool path feedrate at the block transition is reduced to the rate entered in NC MD 3 provided that the selected feedrate was greater.
The rounding radius is thus reduced at discontinuous block transitions.



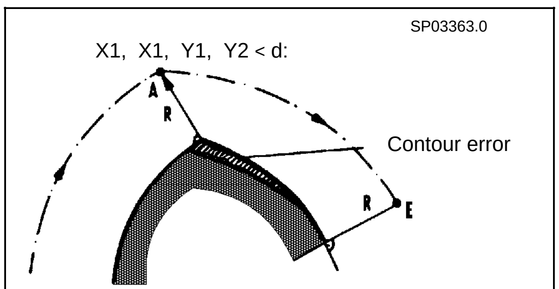
Schematic of exact positioning with corner deceleration rate

MD No.	Significance		
6	**Threshold for CRC insertion blocks**		
Sign	Input limits	Standard value	Units
+	0 to 2 000	0	units (IS)

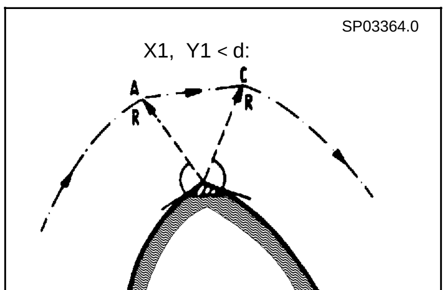
One or more intermediate blocks for linear compensating movement (s) are inserted for transitions from a circular contour to a straight contour or to another circular contour (see Programming Guide). With these compensating movements, the programmed feedrate is maintained along the cutter centre path; during machining, however, the rate of feed is maintained with respect to the workpiece contour. This results in feedrate differences. In order to prevent drops in speed if the travel is inadequate, the compensating movements for CRC insertion blocks are shortened or omitted as follows:



Complete compensating movement



No compensating movement. The required correction is not made until the end (E) of the block.



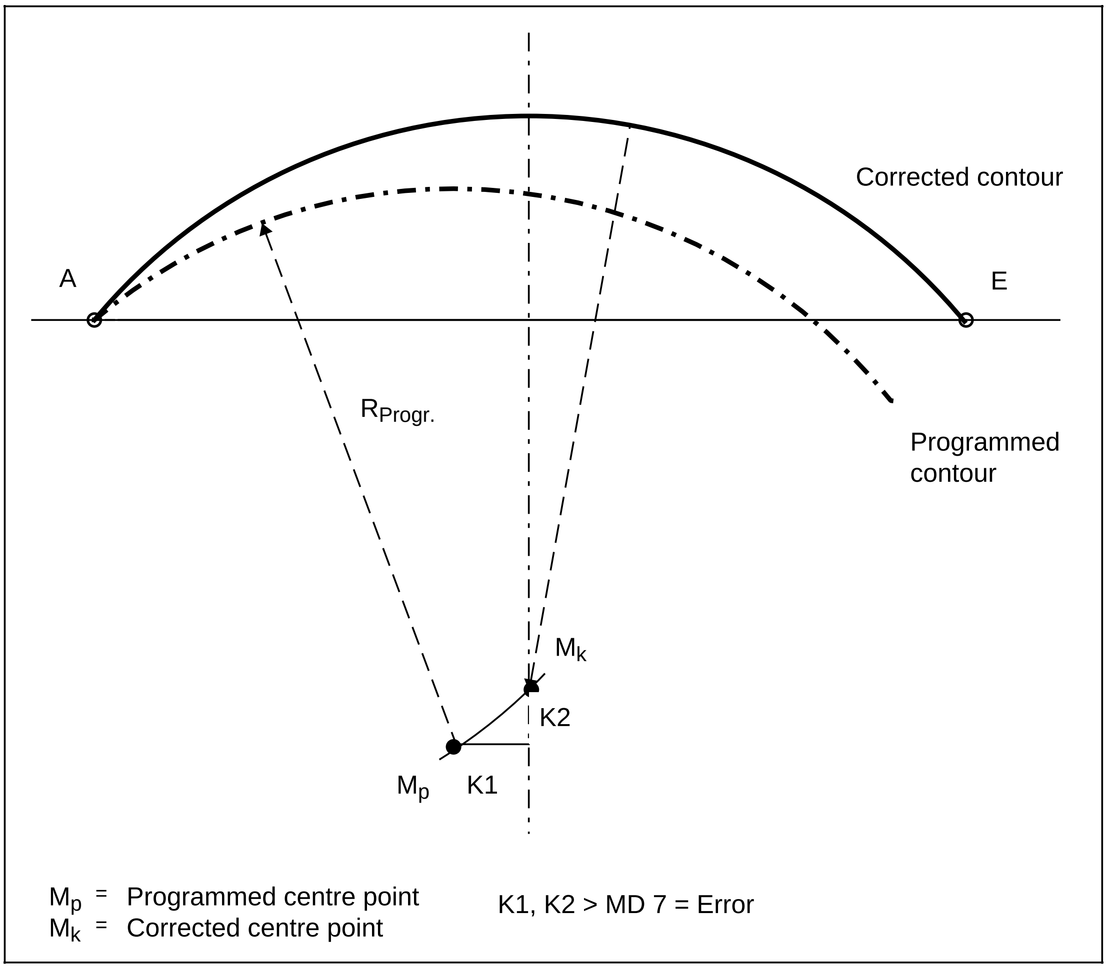
Shortened compensating movement A - C

x1	Length of 1st compensating movement in X direction
y1	Length of 1st compensating movement in Y direction
x2	Total length of both compensating movements in X direction
y2	Total length of both compensating movements in Y direction
d	MD 6 (threshold for CRC insertion blocks)
A	End point of 1st block with cutter radius compensation selected
R	Cutter radius

MD No.	Significance		
7	**Circle end position monitoring**		
Sign	Input limits	Standard value	Units
+	0 to 32 000	5	units (IS)

Before a circular block is processed, the NC checks the "correctness" of the programmed values by determining the difference in radii for the starting and end positions. If the difference exceeds the upper limit specified above, the block is not cleared for processing and Alarm 2048 (circle end point error) is displayed.

If the difference is less than but not equal to 0, the centre point parameters are corrected since it is assumed that the end position has been correctly programmed. The circle is then traversed on the basis of the new centre point.



Schematic of circle end position monitor

MD No.	Significance		
8	**Maximum number of machining programs**		
Sign	Input limits	Standard value	Units
+	0 to 200	50	–

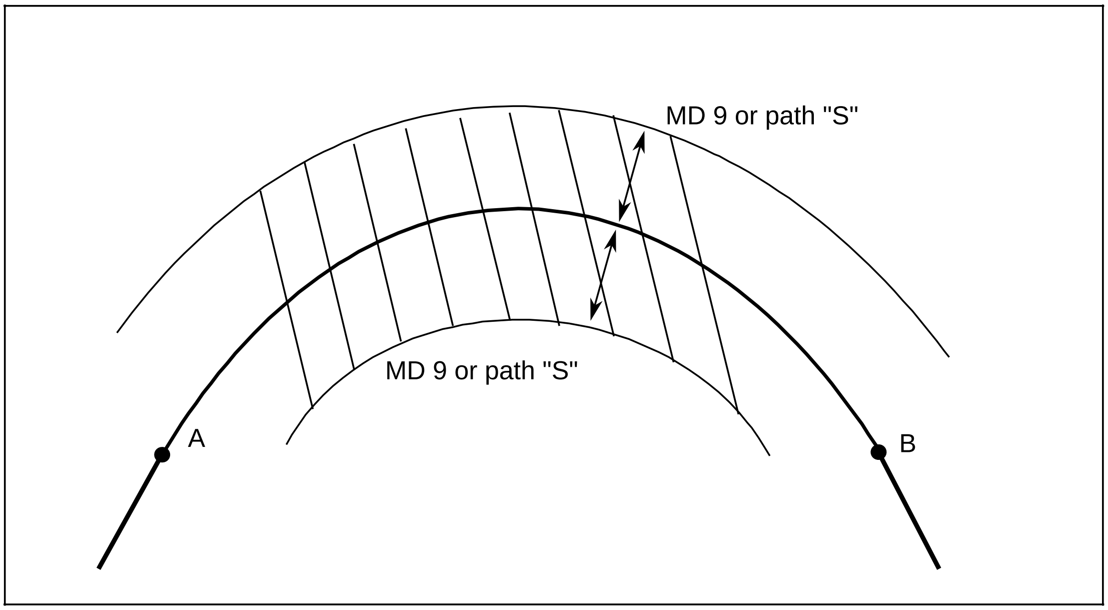
The SINUMERIK reserves a small memory area (10 bytes) for each machining program for program organisation purposes. As 10000 main programs and subroutines can be processed but considerably fewer programs are normally held permanently in the memory (max. 200), a considerable area of memory would have to remain unused. To prevent this, the memory can be matched to the anticipated number of part programs.

Caution:

Any modification of this value is not valid until the FORMAT PART PROGRAM MEMORY functions have been executed in the initialization dialog.

MD No.	Significance		
NC **9**	**Error window for repositioning to circular contour**		
Sign	Input limits	Standard value	Units
+	0 to 32 000	200	units (IS)

If a traversing movement is aborted in the automatic mode in a circular block (NC STOP) and the axis is moved away from the interruption position in the JOG mode, for instance, the distance between the axes and the interruption position is checked during NC Start. As regards the maximum permissible distance to the circular contour, 2 paths are taken into account by the control. The limit is set to the smaller value in each case: either MD 9 or path "S" derived from the formula. If the distance to the circular contour exceeds the smaller of the 2 paths, the program is not started and Alarm 3018 (interval to contour too great) is activated.



The actual axis position must be in the shaded area with NC START.

$$\text{Formula } S = \frac{\text{MD } 276^* \cdot \text{IPO}^2}{200} \quad \text{(units)}$$

Example: Calculation of path with repositioning

NC MD 276*: 200
NC MD 9: 200
IPO cycle: 20 ms (up to SW 4.1); 16 ms (as from SW 4.2)

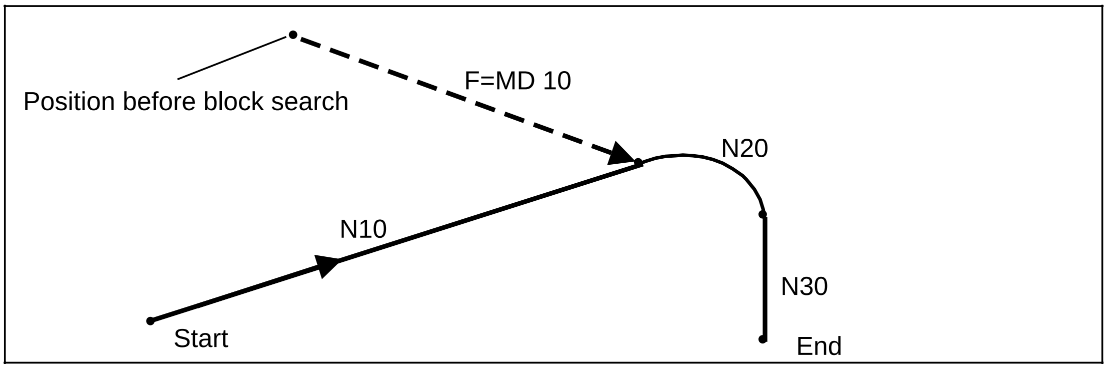
$$S = \frac{200 \cdot 20^2}{200} = 400 \text{ (units)}$$

Formula S= 400 Not effective owing to limitation to **shorter** path in NC MD 9.

MD No.	Significance		
10	**Feedrate after block search**		
Sign	Input limits	Standard value	Units
+	0 to 15 000	1 000	1000 units/min (IS)

If the machine program is initiated not at the start but at an existing block, by means of block search, the programmed feedrate may not be suitable for the travel (e.g. F value very small).

The block end point is therefore approached at the speed specified via MD 10. After the point is reached, travel is continued at the speed specified for the block search.



Feedrate for return to contour after block search.

Caution:

MD 10 has no effect in the event of block search for a block with G00 (rapid traverse movement). G00 rapid traverse moves immediately to the end point of the block.

MD No.	Significance		
11	**Password**		
Sign	Input limits	Standard value	Grading
+	0 to 9 999	0	1

A four-character password (0 to 9999) can be entered in NC MD 11. It is used as a reference with all password enquiries under the following conditions:

- With NC MD 11 = 0, the password enquiry remains "1111" as before.
- Leading zeros must be entered when stating the password.
- Read-out is possible via the V.24 (RS 232 C) interface (also in normal mode).

MD No.	Significance		
14, 15 16, 17	**Protected R parameters (cycle machine data and setting data)**		
Sign	Input limits	Standard value	Units
+	0 to 10 000	10 000	–

Appropriate definitions in MD 14 to MD 17 make it possible to protect R parameter ranges from input via the keyboard. In this way, cycle machine data and setting data (cycle MD/SD) can be implemented.
The range is specified via general NC data.

- Cycle MD: MD14 from R parameter number
  MD15 up to R parameter number
  Input disabled by means of password

- Cycle SD: MD16 from R parameter number
  MD17 up to R parameter number
  Input disabled by means of key-operated switch (activated by NC MD 5005, bit 3)

If the ranges overlap, the corresponding data are defined as cycle SD.

MD No.	Significance		
30	**Subroutine number for PLC alarm texts and user cycle alarm texts**		
Sign	Input limits	Standard value	Units
+	1 to 999	0	–

This determines the subroutine number under which the PLC user alarms (6000-6063) and messages (7000-7063), as well as user cycle alarms (5000-5099) are stored in the part program memory.

This subroutine is entered in the control like any other subroutine.

Example:

NC MD 18 = 340

The PLC user alarms and messages are input as subroutine 340 as follows.

```
% SPF 340
N6000 (... max. 50 characters ...) LF
:
:
N6063 ( .....) LF
N7000 ( .....) LF
:
:
N7063 ( .....) LF
M17 LF
```

Only the alarms/messages that are actually required need to be input.

MD No.	Significance		
31	**Subroutine number for standard cycle alarms**		
Sign	Input limits	Standard value	Units
+	1 to 999	998	–

The subprogram containing cycle alarms of the Siemens Standard Cycles is delivered when Siemens Standard Cycles are ordered. This subprogram has to be loaded into the control with the program number given in NC MD 31.

MD No.	Significance		
32	**Positions 2 to 32 of the feedrate override**		
Sign	Input limits	Standard value	Units
+	1 to 999	997	–

Available from Software Version 2.2 onwards

The number of the subroutine in which the operator guidance texts for the Siemens standard cycles and for the user cycles are stored is entered in this machine data. This subroutine is keyed into the control in the same way as any other subroutine.

A declaration block must be produced for each cycle which is to be given operator guidance.

All these declaration blocks together form the contents of the subroutine.

Example:

	% SPF 997	
Declaration block for L932	**//** L932 (title, max. 49 characters) LF	Details of subroutine and comment
	(R10**/-**20 200**/**Text, max. 30 characters) LF	With details of limit values
	(R11 Text, max. 30 characters) LF	No limit values
	(R12**/***12 13 1 ...**/**Text max. 30 characters) LF	Only listed values can be entered
	LF	Text block end for L932
	:	
Declaration block für L950	**//** L950 (....) LF	
	(R10 Text, max 30 characters) LF	
	:	
	(R23 Text, max. 30 characters) LF	
	LF	
	M 17 LF	

Notes:

- Operator guidance must be activated by NC-MD 5150.2.
- For a detailed description on operator guidance refer to the documentation "NC Programming Instructions".

MD No.	Meaning		
33	**Subroutine number for user screen**		
Sign	Input limits	Standard value	Units
+	1 to 999	0	–

Available from SW version 4.2

The number of the subroutine in which the user screen is declared is entered in this machine data.

Note:

For a detailed description on creating the user screen refer to the documentation "NC Programming Instructions".

MD No.	Significance		
100-130	**Positions 2 to 32 of the feedrate override**		
Sign	Input limits	Standard value	Units
+	0 to 150	–	%

A feedrate override switch with up to 32 positions can be used. The % values can be assigned as required, with the exception of 0 % which is permanently assigned to the far left switch position (position 1). If 0 % is assigned to another switch position, the "FST" (feed stop) display is not activated as it is in position 1.
Assignments in excess of 150 % are possible, but this value is set as the limit inside the NC.

The following default values are entered with automatic MD setting: 1, 2, 4, 8, 10, 20, 30, 40, 50, 60, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120; the remaining MD (MD 122 to MD 130) are set to 0.

MD No.	Significance		
131-146	**Positions 1 to 16 of spindle override switch**		
Sign	Input limits	Standard value	Units
+	50 to 130	0	units (IS)

Assignment to max. 16 spindle override switch positions as required.
The following default values are entered with automatic MD setting:

50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 120.

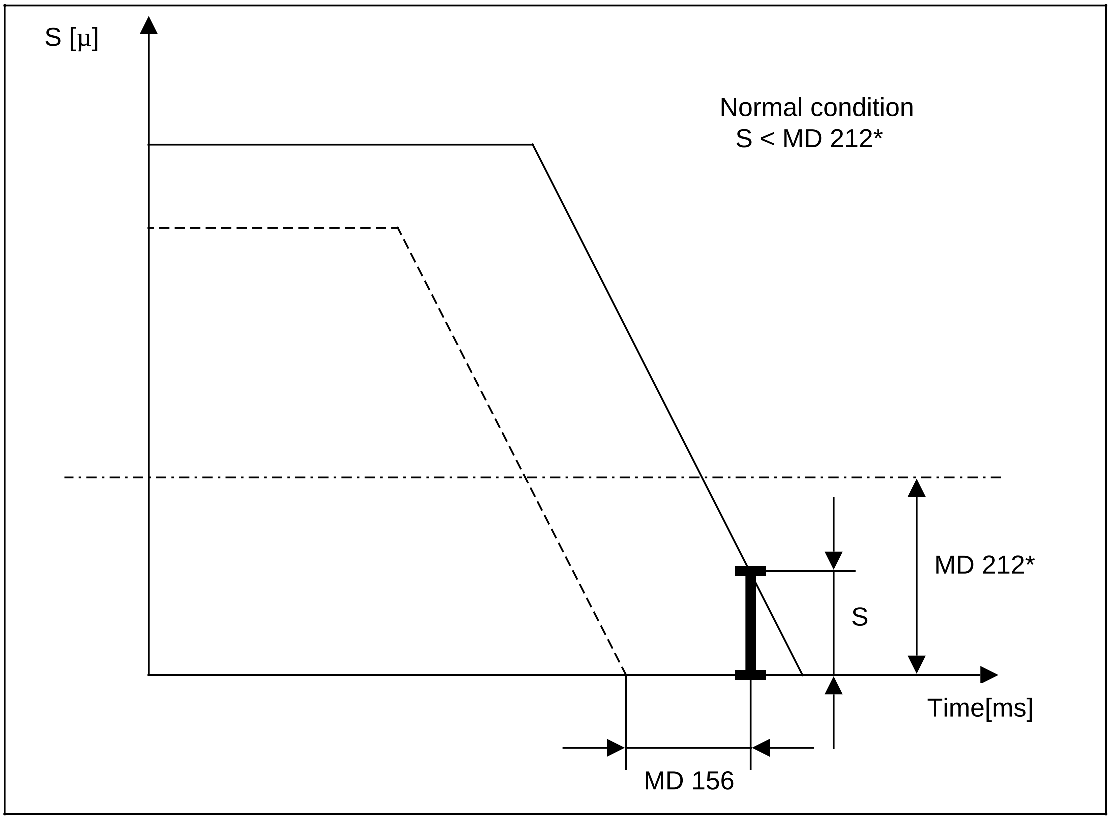
MD No.	Significance		
147-154	**Positions 1 to 8 of rapid traverse override switch**		
Sign	Input limits	Standard value	Units
+	0 to 100	–	%

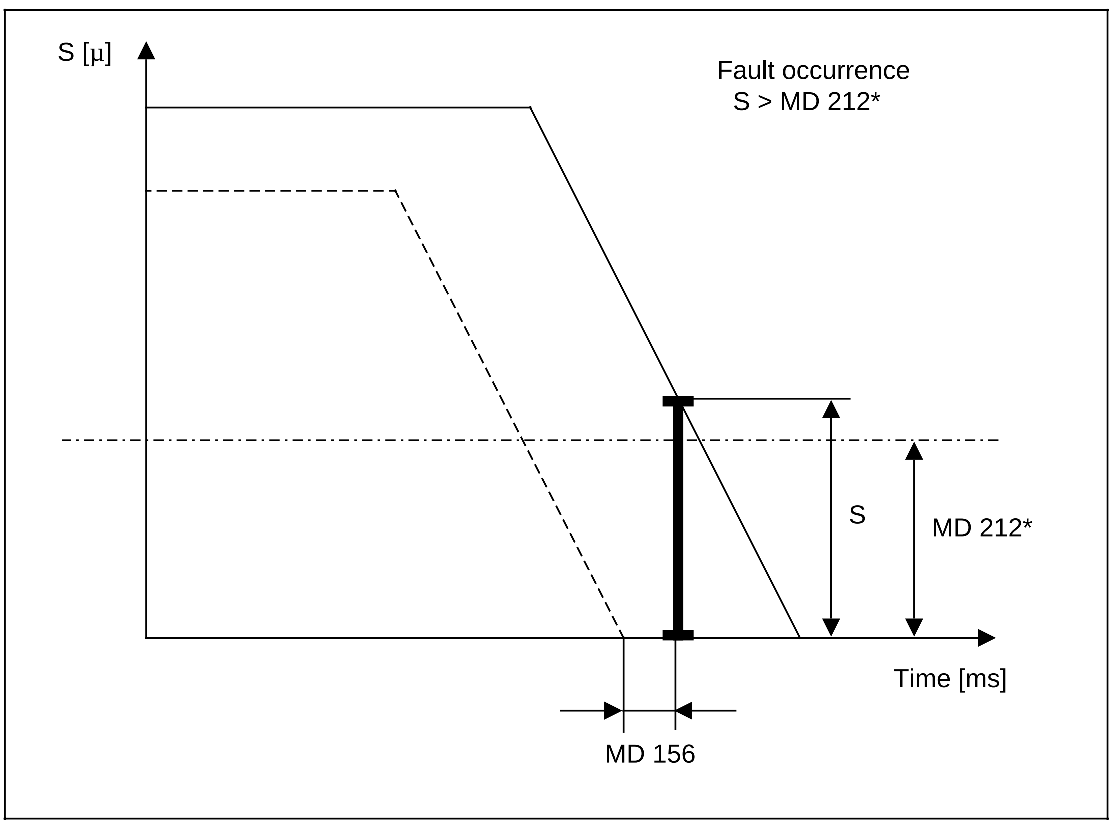
Assignments to the 8 rapid traverse override switch positions can be varied.
The default values are : 1, 10, 50, 100, 0, 0, 0, 0

MD No.	Significance		
156	**Servo enable cutoff delay**		
Sign	Input limits	Standard value	Units
+	0 to 1000	200	ms

The effect of the delay is as follows:

- Once the interpolator has reached the programmed position, the clamping tolerance (MD 212*) is activated after this delay has elapsed. At this instant, the following error must therefore be smaller than the clamping tolerance. The selected delay must be such that the maximum following error (rapid traverse) can be suppressed. In the event of a fault, the servo enable relays drop out and Alarm 112* (zero-speed control) is activated.


S [μ]
Normal condition
S < MD 212*
MD 212*
S
Time[ms]
MD 156


S [μ]
Fault occurrence
S > MD 212*
S
MD 212*
Time [ms]
MD 156

- Delay for drop-out of the servo enable relay after faults which result in immediate shut down of the axes (e.g. contour monitoring, zero-speed control).

- Delay for drop-out of the servo enable relay if the "servo enable" signal is cancelled by the interface unit.

MD No.	Significance		
157	**Control type for standard cycles, software version**		
Sign	Input limits	Standard value	Units
+	(see below)	(see below)	–

The SIEMENS standard cycles evaluate the identifier with the software version. This permits branching within the cycles with reference to the control and software version. The following table is valid for SINUMERIK 805:

SIEMENS standard cycles	Identifier	Softw. version
Turning cycles	0 6	X X
Milling cycles	0 7	X X

Example:
Turning (turning cycles)
NC software version 3.1

NC MD 157 = 0631

The identifier for turning and for milling is set according to the NC MD initialization for turning or milling machines. (See Section 5.1)

MD No.	Significance		
161 - 163	**Drift compensation for analog outputs 1 - 3**		
Sign	Input limits	Standard value	Units
+	+255 to –255	0	VELO

Available as from SW version 4.2.

With these machine data, the component drift of the 3 analog outputs of the setpoint output module can be compensated. A change in the machine data is immediately effective.

The drift compensation which can be set here is supplied to the analog output only if this is set.

Notes:

- The "3 analog setpoint outputs" function is described in Section 11.12 in more detail.
- These machine data are not related to the setpoint outputs of the measuring circuits.

MD No.	Significance		
310	**1st R parameter of cam parameter block**		
Sign	Input limits	Standard value	Units
+	0 to 992	0	–

The entered value represents the number of the 1st R parameter of the cam parameter block. The cam parameter block comprises 8 R parameters (see Section 11.2, Description of Functions, "Output of cam signals").

Notes:
- The cam parameter block should not be located in the area of the internal and cycle R parameters (0 to 699). The R parameters 700 to 999 are at the free disposal of the user. The cam parameter block should also be located in this range.
- The "Output of cam signals" function is an Option.

MD No.	Significance		
311-318	**Assignment NC control signals cam pairs 1-4**		
Sign	Input limits	Standard value	Units
+	10-17 and 20-27	0	–

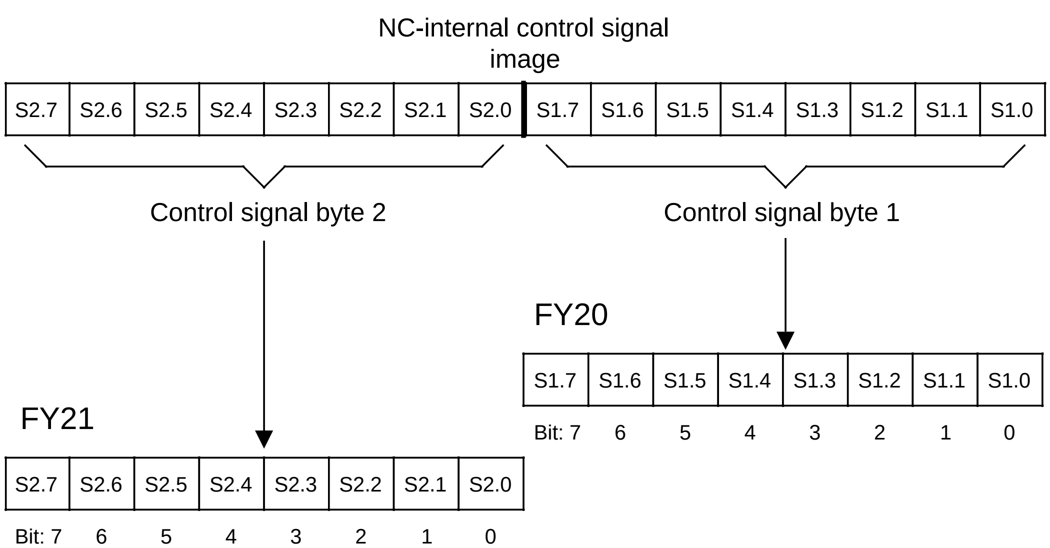
The OUTPUT OF CAM SIGNALS function (see Section 11.2) generates NC control signals depending on the cam positions.

These NC MD assign the control signals from control signal bytes 1 and 2 (S1.0 - S1.7 and S2.0 - S2.7) to the cam pairs 1-4 (negative cams 1-4 and positive cams 1-4) as follows:

311	NC control signal for neg. cam	Cam pair 1
312	---'--- for pos. cam	
313	NC control signal for neg. cam	Cam pair 2
314	---'--- for pos. cam	
315	NC control signal for neg. cam	Cam pair 3
316	---'--- for pos. cam	
317	NC control signal for neg. cam	Cam pair 4
318	---'--- for pos. cam	

The control signal bytes 1 and 2 (S1.0 - S1.7 and S2.0 - S.2.7) are transferred to the PLC flag bytes FY 20 and FY 21 in the interpolator cycle (IPO cycle).

Input assignment	→	Control signal bit	→	Flag bit
10	→	1.0	→	20.0
11	→	1.1	→	20.1
12	→	1.2	→	20.2
13	→	1.3	→	20.3
14	→	1.4	→	20.4
15	→	1.5	→	20.5
16	→	1.6	→	20.6
17	→	1.7	→	20.7
20	→	2.0	→	21.0
21	→	2.1	→	21.1
22	→	2.2	→	21.2
23	→	2.3	→	21.3
24	→	2.4	→	21.4
25	→	2.5	→	21.5
26	→	2.6	→	21.6
27	→	2.7	→	21.7



Notes:

- The "Output of cam signals" function is an Option
- In addition, the control signal byte 1 (S1.0 to S1.7) can be output via the NC outputs Q0 to Q7 with the RAPID NC INPUTS AND OUTPUTS Option.
- Values outside the input limits are ignored (the value 0 is entered in such cases).
- The same bit must not be used in several functions at the same time (connection of standard motors, cam signals, rapid M functions).

MD No.	Significance		
322-327	**Number of preceding function assigned to rapid NC input**		
Sign	Input limits	Standard value	Units
+	0 - 4	0	–

Inputs 0 and 1 of the total of 8 rapid NC inputs are reserved for probes. Inputs 2 to 7 (X 271.2) can be assigned functions by means of machine data values 322 to 327. In this context, machine data 322 refers to input 2 and machine data 323 to input 3 etc.

The function is assigned by entering its number in the relevant machine data.

The following functions are available:

1 ≙ NC STOP (0/1 edge active)
2 ≙ NC START (0/1 edge active)
3 ≙ Read-in enable (1 signal active)
4 ≙ Feed enable (1 signal active)

The rapid NC input is combined internally with the PLC NC interface signal using the ”OR” function.

If an NC input whose machine data contains the function number 0 is accessed, the NC ignores the signal but does not issue an error message.

The image of the rapid NC inputs can be read by the PLC in flag byte 232.

Updating of the NC inputs in IPO pulse.

Precondition: The "Rapid NC inputs/outputs" Option must be available.

Note:
The rapid NC inputs can be disabled individually by means of the interface signals A80.2 to A80.7.

MD No.	Significance		
330-345	**Assignment of NC control signals standard motor control signals**		
Sign	Input limits	Standard value	Units
+	10-17 and 20-27	0	–

provided as from software version 4.1

The function CONNECTION OF STANDARD MOTORS (see Section 11.8) generates NC control signals when processing standard motor axis instructions.

Four signals are output for every standard motor.

With these NC MD the control signals from control signal bytes 1 and 2 (S1.0-S1.7 and S2.0-S2.7) are assigned to the control signals of the standard motors as follows.

330	NC control signal for	RAPID SPEED	Standard motor 1
331	NC control signal for	CREEP SPEED	
332	NC control signal for	CW	
333	NC control signal for	CCW	
334	NC control signal for	RAPID SPEED	Standard motor 2
335	NC control signal for	CREEP SPEED	
336	NC control signal for	CW	
337	NC control signal for	CCW	
338	NC control signal for	RAPID SPEED	Standard motor 3
339	NC control signal for	CREEP SPEED	
340	NC control signal for	CW	
341	NC control signal for	CCW	
342	NC control signal for	RAPID SPEED	Standard motor 4
343	NC control signal for	CREEP SPEED	
344	NC control signal for	CW	
345	NC control signal for	CCW	

The control signal bytes 1 and 2 (S1.0 - S1.7 and S2.0 - S2.7) are transferred to the PLC flag bytes FY 20 and FY 21 in the interpolator cycle (IPO cycle).

Input assignment →	Control signal bit →	Flag bit
10 →	1.0 →	20.0
11 →	1.1 →	20.1
12 →	1.2 →	20.2
13 →	1.3 →	20.3
14 →	1.4 →	20.4
15 →	1.5 →	20.5
16 →	1.6 →	20.6
17 →	1.7 →	20.7
20 →	2.0 →	21.0
21 →	2.1 →	21.1
22 →	2.2 →	21.2
23 →	2.3 →	21.3
24 →	2.4 →	21.4
25 →	2.5 →	21.5
26 →	2.6 →	21.6
27 →	2.7 →	21.7

Note:

- In addition, the control signal byte 1 (S1.0 to S1.7) can be output via the NC outputs Q0 to Q7 with the RAPID NC INPUTS AND OUTPUTS option.
- Values outside the input limits are ignored (the value 0 is entered in such cases).
- Changes to the machine data do not take effect until after POWER-ON.
- The same bit must not be used in several functions at the same time (connection of standard motors, cam signals, rapid M functions).

MD No.	Description		
350-381	**Assignment of M function NC control signals**		
Sign	Input limits	Standard value	Units
+/-	0-99	-1	---

provided as from software version 4.1

With this machine data the set/reset M functions for the NC control signals are assigned.

An M function can also be defined for several set/reset functions at the same time.

This function called RAPID M FUNCTION is explained in Section 11.9

MD No.	Meaning	Control signal	Flag bit	Rapid NC output
350	M function to set	1.0	20.0	Q0
351	M function to reset			
352	M function to set	1.1	20.1	Q1
353	M function to reset			
354	M function to set	1.2	20.2	Q2
355	M function to reset			
356	M function to set	1.3	20.3	Q3
357	M function to reset			
358	M function to set	1.4	20.4	Q4
359	M function to reset			
360	M function to set	1.5	20.5	Q5
361	M function to reset			
362	M function to set	1.6	20.6	Q6
363	M function to reset			
364	M function to set	1.7	20.7	Q7
365	M function to reset			

MD No.	Meaning	Control signal	Flag bit	Rapid NC output
366	M function to set	2.0	21.0	
367	M function to reset			
368	M function to set	2.1	21.1	
369	M function to reset			
370	M function to set	2.2	21.2	
371	M function to reset			
372	M function to set	2.3	21.3	
373	M function to reset			
374	M function to set	2.4	21.4	
375	M function to reset			
376	M function to set	2.5	21.5	
377	M function to reset			
378	M function to set	2.6	21.6	
379	M function to reset			
380	M function to set	2.7	21.7	
381	M function to reset			

Note:

- The rapid NC outputs Q0 to Q7 are only set/reset by the rapid M functions if the RAPID NC INPUTS AND OUTPUTS option is available.
- Changes to the machine data do not take effect until after POWER-ON.
- The same bit must not be used in several functions at the same time (connection of standard motors, cam signals, rapid M functions).

MD No.	Description		
400-447	**Colour components**		
Sign	Input limits	Standard value	Units
+	63	see below	---

provided as from software version 4.1

With the SINUMERIK 805 you have the option of changing the 16 grey scales or colours which your monitor is capable of displaying. A change can be made via the operator interface (see Section 5.5) or by changing the machine data directly.

The colour components (red, green, blue) of each colour are entered in the NC MD when they are stored as follows:

NC MD	Description	Standard value
400	Red component, 1st colour	0
401	Green component, 1st colour	0
402	Blue component, 1st colour	0
403	Red component, 2nd colour	7
404	Green component, 2nd colour	7
405	Blue component, 2nd colour	7
406	Red component, 3rd colour	13
407	Green component, 3rd colour	13
408	Blue component, 3rd colour	13
409	Red component, 4th colour	16
410	Green component, 4th colour	16
411	Blue component, 4th colour	16
412	Red component, 5th colour	19
413	Green component, 5th colour	19
414	Blue component, 5th colour	19
415	Red component, 6th colour	23
416	Green component, 6th colour	23
417	Blue component, 6th colour	23
418	Red component, 7th colour	27
419	Green component, 7th colour	27
420	Blue component, 7th colour	27
421	Red component, 8th colour	31
422	Green component, 8th colour	31
423	Blue component, 8th colour	31
424	Red component, 9th colour	35
425	Green component, 9th colour	35
426	Blue component, 9th colour	35
427	Red component, 10th colour	39
428	Green component, 10th colour	39
429	Blue component, 10th colour	39
430	Red component, 11st colour	43
431	Green component, 11st colour	43
432	Blue component, 11st colour	43
433	Red component, 12nd colour	47
434	Green component, 12nd colour	47
435	Blue component, 12nd colour	47
436	Red component, 13th colour	52
437	Green component, 13th colour	52
438	Blue component, 13th colour	52
439	Red component, 14th colour	56
440	Green component, 14th colour	56
441	Blue component, 14th colour	56
442	Red component, 15th colour	60
443	Green component, 15th colour	60
444	Blue component, 15th colour	60
445	Red component, 16th colour	63
446	Green component, 16th colour	63
447	Blue component, 16th colour	63

MD No.	Significance		
200*	**Axis assignment**		
Sign	Input limits	Standard value	Units
+	100-500		---

The submodules are designated according to the installed location of the actual-value submodules at slots 1 to 4 (also see Sections 3.1.3 and 3.1.7.1) (e.g. submodule at slot 2 submodule 2, actual value 2, encoder 2). As from software version 4.1, the 5th actual value input (on the main printed-circuit board) can be used as an axis actual value input. This NC MD specifies setpoint output and the actual value input to which the existing axes are assigned (also see NC MD 564* bit 7 (axis available)).

Standard assignments:

Milling machine:

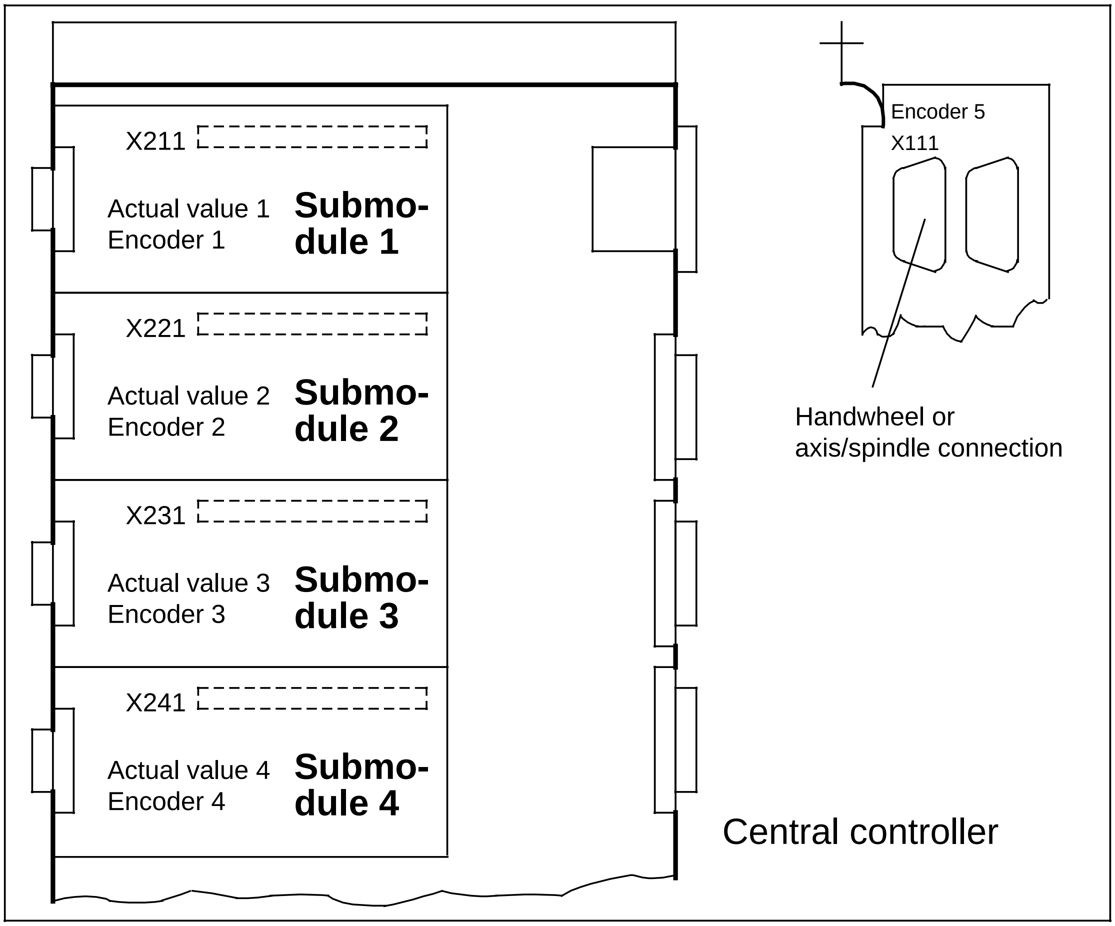
Axis 1 (X axis) to submodule 1 NC MD 2000 = 100
Axis 2 (Y axis) to submodule 2 NC MD 2001 = 200
Axis 3 (Z axis) to submodule 3 NC MD 2002 = 300

Turning machine:

Axis 1 (X axis) to submodule 1 NC MD 2000 = 100
Axis 2 (Z axis) to submodule 2 NC MD 2001 = 200

The axis assignments must be defined continuously beginning with NC MD 2000.

Correct:	***2000=100***	***Incorrect:***	***2000=0***
	2001=300		***2001=300***
	2002=200		***2002=100***
	2003=0		***2003=200***



Poss. values	Meaning
0	Axis not available at machine (permissible only with NC MD 564* bit 7 = '0'
100	Axis connected to actual value submodule 1 (encoder 1)
200	Axis connected to actual value submodule 2 (encoder 2)
300	Axis connected to actual value submodule 3 (encoder 3)
400	Axis connected to actual value submodule 4 (encoder 4)
500	Axis connected to actual value submodule 5 (encoder 5)

Note:

The axis set values are output according to the content of this NC MD, e.g.:
NC MD 2000 = 100   Set value output via set value 1
NC MD 2001 = 300   Set value output via set value 3, etc.

Set values 1, 2 and 3 are output by the NC via connector X121, set value 4, 5 is output by the NC via connector X131.

MD No.	Significance		
204*	**Coarse exact stop limit**		
Sign	Input limits	Standard value	Units
+	0 to 16 000	40	units (MS)

A larger value can be entered in the coarse exact stop limit than in the fine exact stop limit. Consequently, the block change to the next machining block is initiated accordingly earlier.

If this function is not desired, it can be disabled by inputting equal exact positioning values in both machine data.

The coarse exact stop limit is effective with:

- G00
- Block before G04
- Block before G58/G59/G92/G25/G26
- Block before which only auxiliary functions are programmed
- Single block without G60/G09
- JOG
- JOG-INC
- Program end

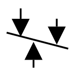
Note:

The exact stop limits are not approached in continuous path control G64. No sequential error results from a large number of consecutive positioning operations since the position control is not "shut down" by the exact stop limit, but block 2 is processed ahead of the end position of block 1.

The actual traversing path is now:
Remainder of block 1 and block 2 etc. 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 made so that the following error = 0 and the axis remains precisely in position.

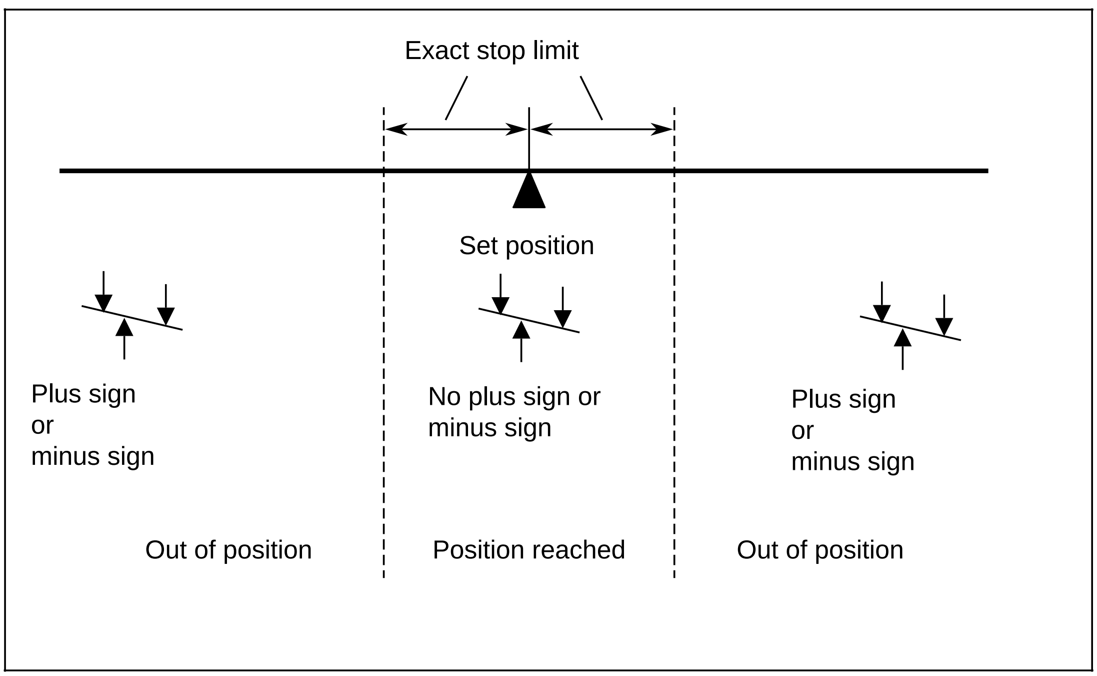
MD No.	Significance		
208*	**Fine exact stop limit**		
Sign	Input limits	Standard value	Units
+	0 to 16 000	10	units (MS)

A traversing movement is considered to have been completed when the axis has reached the set position ± the entered exact stop limit.

If the actual position is not within this range, a negative or positive sign remains on the monitor in the  field. The block is treated as not completed. The next block is not read in.

Corrected action:

e.g. drift compensation

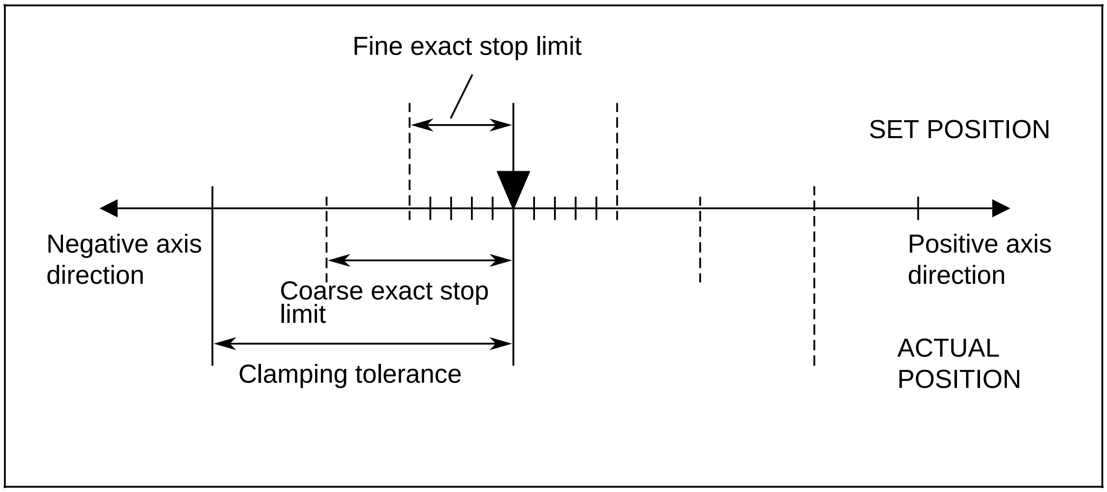


Schematic of fine regulation of exact stop limit

The fine exact stop limit is effective with:

- G09/G60
- Block ahead of G33

MD No.	Significance		
212*	**Clamping tolerance**		
Sign	Input limits	Standard value	Units
+	0 to 16 000	100	units (MS)



Representation of clamping tolerance

The NC monitors the position at rest (holding position). Alarm 112* appears if the clamping tolerance is exceeded at rest.

The following conditions may occur:

a) If the servo enable signal for an axis is cancelled by the interface control, this means that the axis can no longer be held in position by the NC. The interface control must hold the axis in position itself by means of clamping (activation of holding brake).

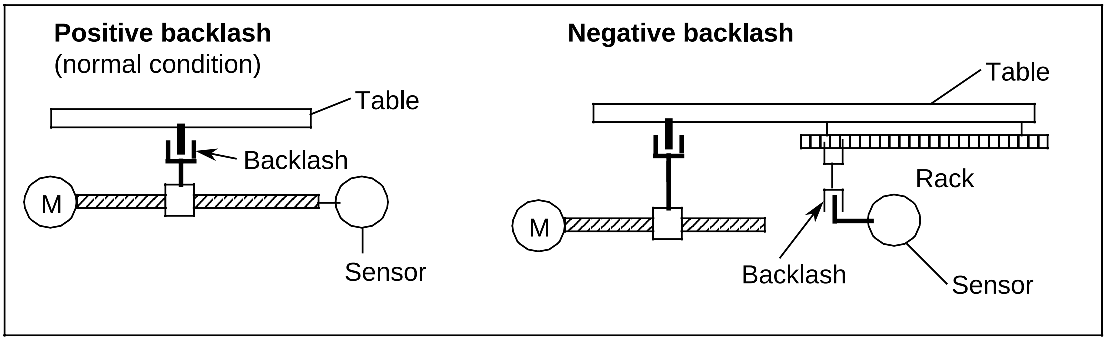
In such cases, the clamped axis can be forced out of position as a result of mechanical forces.

b) The axis can be forced out of position as a result of high mechanical forces or drive faults.

The input clamping tolerance must be **greater** than the fine and coarse **exact stop limits.**

MD No.	Significance		
220*	**Backlash compensation**		
Sign	Input limits	Standard value	Units
±	0 to 255	0	units (MS)

In the case of axes with indirect measuring systems, mechanical backlash results in corruption of the traversing path. On reversal of the direction of movement, the traverse path is either shortened or extended by the amount of backlash, depending on the design.



Representation of backlash determination

Actual sensor value ahead of actual value (table):

Table travels too short

Actual value (table) ahead of actual sensor value:

Table travels too far

The input correction value (amount of backlash) is positive for positive backlash and negative for negative backlash.

MD No.	Significance		
224*	**Software limit switch 1 (positive direction)**		
Sign	Input limits	Standard value	Units
±	0 to 99 999 999	99 999 999	units (MS)

The customary range limit switch must be replaced by the software limit switch on the SINUMERIK 805. The absolute position of the positive range limit for each axis is input in relation to the reference point.
Deceleration to zero speed is performed at a distance ahead of the software limit switch which ensures that the switch is precisely reached but not overrun (e.g. in JOG mode).

Alarm message: 148* (positive software limit switch)

Note:

In the case of interpolating axes, all the axes are shut down if the range limit of one axis has been reached. However, stopping without contour violation is ensured only with MD No. 5003 bit 7 ("no deceleration at limit switch") not set, that is with deceleration according to the acceleration ramp.

MD No.	Significance		
228*	**Software limit switch 1 (negative direction)**		
Sign	Input limits	Standard value	Units
±	0 to 99 999 999	– 99 999 999	units (MS)

Same significance as MD 224* but for traversing limit in negative direction.

Alarm message: 152* (negative software limit switch)

Note:

The software limit switches do not become active until the reference point of the axis concerned has been approached.

Note for MD 224* and MD 228* :

Input signals for hardware limit switches are not provided. These could operate only by means of:
- Feed hold (unfavourable owing to ramp - slow)
- Servo disable (most suitable because fast with jump function)
- Emergency stop (fast with jump function but additional effects, therefore unfavourable)

MD No.	Significance		
232*	**Software limit switch 2 (positive direction)**		
Sign	Input limits	Standard value	Units
+	0 to 99 999 999	99 999 999	units (MS)

A 2nd limit switch position can be specified in the positive direction. Which of the two software limit switches (1 or 2) is then active is selected by the PLC by means of the interface signal (e.g. Q 108 bit 1 for the 1st axis).

Q 108.1	Bit 1="0"	Bit 1="1"
	Software limit switch 1 (+) effective (1st axis)	Software limit switch 2 (+) effective (1st axis)

Typical application:

Reduction of permissible traversing range with tailstock in position.

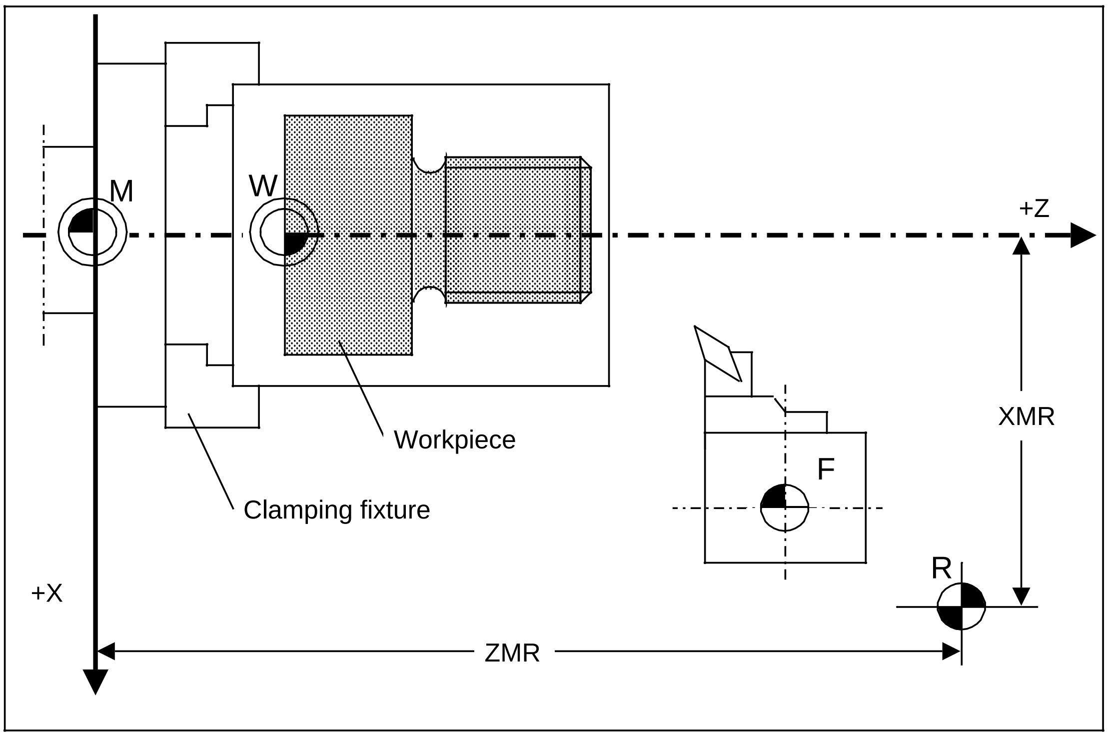
MD No.	Significance		
236*	**Software limit switch 2 (negative direction)**		
Sign	Input limits	Standard value	Units
±	0 to 99 999 999	– 99 999 999	units (MS)

Same significance as MD 232* but in the negative direction.
Selection by means of QB 108.1 (for 1st axis).

QB 108.0	Bit 0="0"	Bit 0="1"
	Software limit switch 1 (-) effective (1st axis)	Software limit switch 2 (-) effective (1st axis)

MD No.	Significance		
240*	**Reference point value**		
Sign	Input limits	Standard value	Units
±	0 to 99 999 999	0	units (MS)

The difference between absolute machine zero and the fixed reference point is input for the relevant axis. These values are set as actual values with reference point approach.



Reference point value setting

M . . .	Machine zero
W . . .	Workpiece zero
R . . .	Machine reference point
F . . .	Machine slide reference point
XMR . . .	Reference point coordinate in X direction
ZMR . . .	Reference point coordinate in Z direction

MD No.	Significance		
244*	**Reference point shift**		
Sign	Input limits	Standard value	Units
±	0 to 9999	0	units (MS)

The measuring system reference points can be shifted by means of the reference point shift. This allows the reference point to be shifted electrically by up to ± 9999 units instead of mechanically shifting or rotating the measuring system (and thus the "*Deceleration" cam as well).

Shifting in excess of the distance traversed between 2 zero marks is not advisable since this can be achieved by correct adjustment of the operating cam.

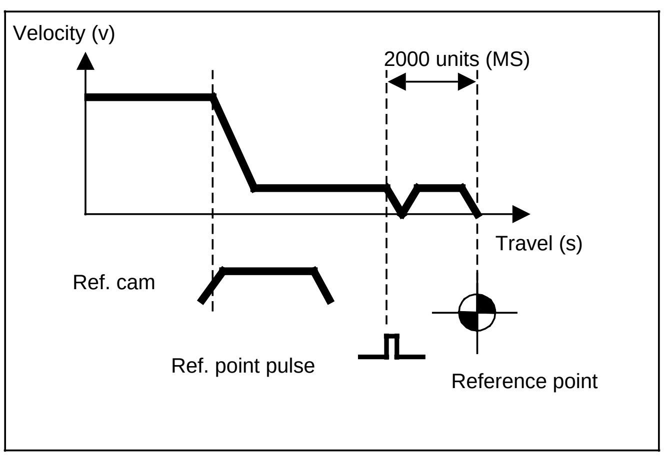
The reference point shift path is traversed at creep speed (MD 284*) which must already be reached at the operating cam.

Without reference point shift, the reference point is located 2000 units (MS) behind the first zero point after the operating cam has become free again.

With positive input, the axis travels in the positive direction beyond the normal reference point by the amount specified by the input value (2000 units (MS) after the zero mark).

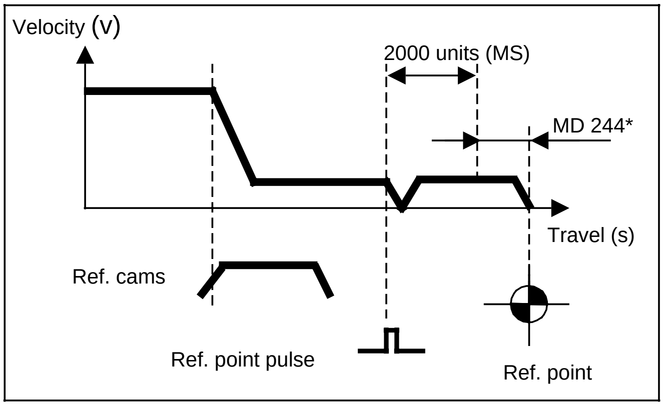
With negative input, the axis travels to the value resulting from the difference between 2000 units (MS) + the input value after overrunning the zero mark. Given a reference point shift of more than approx. 2000 units (MS), the axis reverses the direction of travel (backlash).

a) MD 244*=0

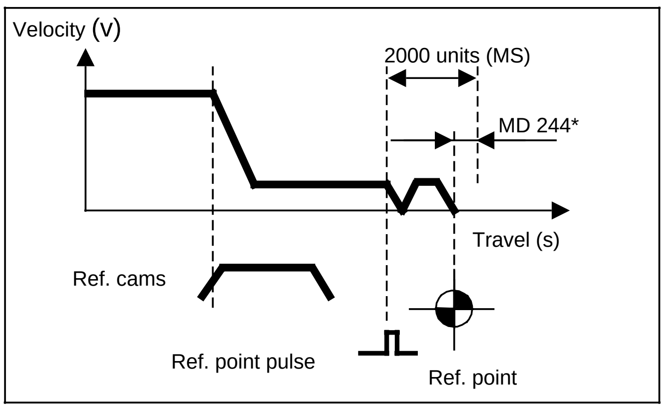


Representation of reference point shift

b) MD 244* greater than 0 (e.g. 1000 units (MS))



c) MD 244* less than 0 (e.g.- 700 units (MS))



Representation of reference point shift

MD No.	Significance		
im **248***	**Tool reference value**		
Sign	Input limits	Standard value	Units
±	0 to 99 999 999	0	units (IS)

Tool reference value for position of measuring device.

For machines with tool measuring attachments, the reference point of the measuring device relative to machine zero must be known for automatic determination of the tool geometry data.

Typical application:

Once the tool has been moved into the measuring device, it can be gauged by MD reading with @.

MD No.	Significance		
252*	**K_V factor**		
Sign	Input limits	Standard value	Units
+	0 to 10 000	1666	0.01 s^{-1}

When inputting the K_V factor, note that the gain factor of the overall position control loop also depends on other control system parameters. Strictly speaking, therefore, a distinction must be made between a "desired K_V factor" (MD above) and an "actual K_V factor" (obtained at the machine). Only if all the control loop parameters are correctly adjusted in relation to each other, are these K_V factors equal.
These parameters are as follows:

- Multgain (MD 260*)
- Tacho-generator compensation at speed controller
- Tacho-generator at drive

Note:

Axes operating together in continuous-path control **must** exhibit precisely the same gain in the position control loop (i.e. the same following error at the same speed = 45° slope).
Any deviations will result in contour errors.
Only axes that **never** contribute to continuous path control can be defined with different values.

Example of K_V factor setting:

Input resolution:	$1 \cdot 10^{-3}$ mm	MD 5002
Position control resolution:	$0.5 \cdot 10^{-3}$mm	MD 5002
K_V factor (1):	1666	MD 252*
Multgain:	2700	MD 260*
Max. speed (10m/min):	10 000 $^{mm}/_{min}$	MD 280*

The drive must be adjusted to 9V, equivalent to 10 $^{m}/_{min}$, by means of the battery box. The axis for adjustment is traversed in the JOG mode at a speed of 1 $^{m}/_{min}$. The following error must be observed on the service display.

$$K_V = \frac{\text{Speed}}{\text{Following error}} \left[\frac{\text{m/min}}{\text{mm}}\right]$$

$$\text{Following error} = \frac{\text{Speed}}{K_V}$$

$$\text{Following error} = \frac{1\text{m/min}}{1 \; \frac{\text{m/min}}{\text{mm}}}$$

1 mm on the service display corresponds to 2000 units of position control resolution. The setpoint speed should be approx. 737 VELO, equivalent to 0.9 V (10 % of max. speed). In the event of greater deviations from the theoretically determined following error, the tacho-generator compensation potentiometer at the drive unit must be adjusted. Precision setting of the following error is performed with Multgain because of the better adjustment scope.

The axis is then traversed at maximum speed to check the settings. The set drive voltage must be approx. 9 V.

The actual K_V value is 1 if the following error is 1 mm at an axis speed of 1 m/min.

MD No.	Significance		
256*	**Difference time constant**		
Sign	Input limits	Standard value	Units
+	0 to 9999	0	0.1 ms

provided as from software version 3.1

This machine data is only required for option E36 ”Tapping with dynamic following error compensation”.

For a more detailed explanation of this machine data see Section 11.7.

MD No.	Significance		
260*	**Multgain**		
Sign	Input limits	Standard value	Units
+	0 to 64 000	2 400	min/1000 units (MS)

The multgain factor serves to match the control system to the K_V factor specified by means of MD 252*. The multgain is a purely a multiplication factor for the entered K_V factor and should be used for **digital tacho-generator matching** on account of the very fine adjustment scope.

After correct input or matching of the multgain, a K_V factor corresponding exactly to the input value must be obtained for the relevant axis.

Note:

Matching the actual K_V factor by means of the K_V factor MD (NC MD No. 252*) is not recommended since different input values would then be obtained for the individual axes, although all axes would have the same gain in the position control loop.

The Multgain is calculated by the formula: $\dfrac{3 \cdot 10^7}{V_{max}} \cdot \dfrac{U_{max}}{10}$

V_{max}: max. velocity [1000 units (MS)/min]
U_{max}: max. voltage at V_{max} [volts]

Determination of the multgain as shown in the table:

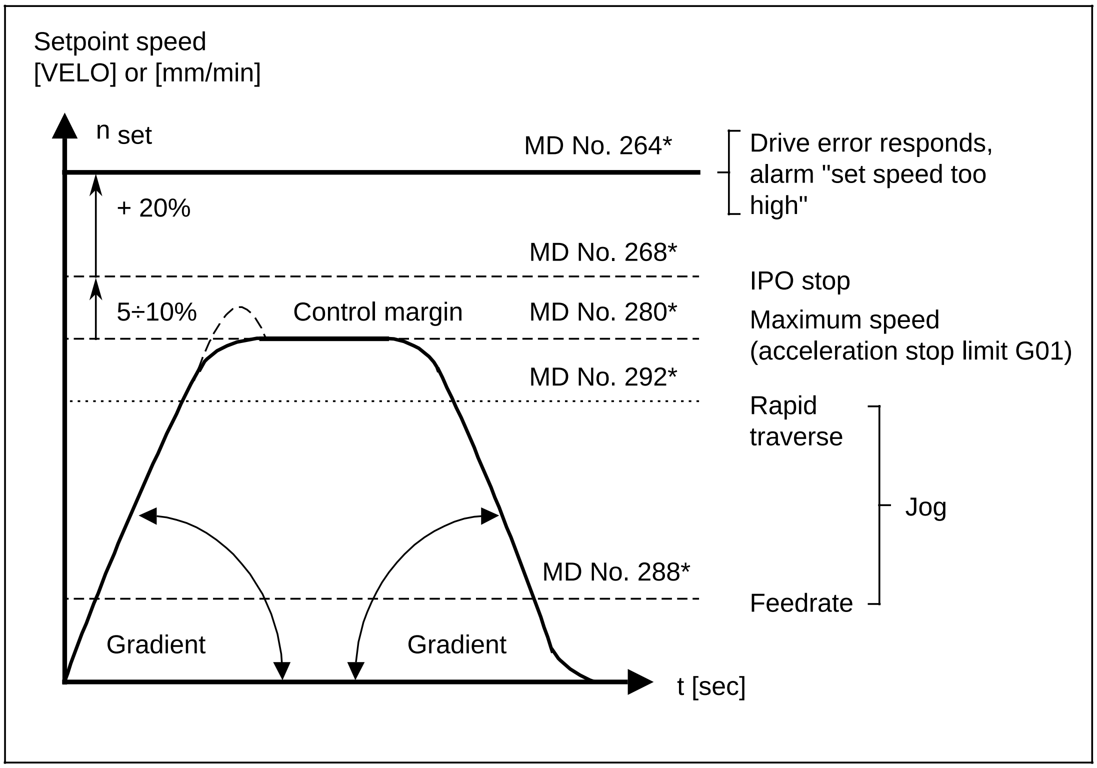
Max. velocity [1000 units (MS)/ min]	Setpoint speed			
	4 V	8 V	9 V	9.5 V
24000	500	1000	1125	1188
22000	545	1090	1227	1296
20000	600	1200	1350	1425
18000	666	1332	1500	1883
16000	750	1500	1687	1781
15000	800	1600	1800	1900
14000	857	1714	1928	2036
12000	1000	2000	2250	2375
10000	1200	2400	2700	2850
8000	1500	3000	3375	3663
6000	2000	4000	4500	4750
5000	2400	4800	5400	5700
4000	3000	6000	6750	7125
3000	4000	8000	9000	9500
2000	6000	12000	13500	14250
1000	12000	24000	27000	28500
750	16000	32000	36000	38000
500	24000	48000	–	57000
375	32000	–	–	–

The max. value in the multgain is 64 000.

MD No.	Significance		
264*	**Drive error threshold**		
Sign	Input limits	Standard value	Units
+	0 to 15 000	9 600	VELO

This monitor triggers Alarm 156* (set speed too high) if the specified setpiont speed is too high. The input value must be greater than the largest value entered in NC-MD 268* (maximum setpoint speed (IPO stop)).

Guide value: approx. 20% greater than MD No. 268*



Representation of drive error threshold

MD No.	Significance		
268*	**Max. setpoint speed (IPO-STOP)**		
Sign	Input limits	Standard value	Units
+	0 to 8192	8192	VELO

This input specifies the maximum voltage value to be output as the setpoint speed. The value depends on any existing setpoint limits in the driving unit (usually 10 V with speed controllers). Interpolation stop and Alarm 104* are activated when the limit is exceeded.

The standard machine data of 8192 corresponds to a voltage of 10 V.

Caution:

It must be possible to reach the maximum speed (rapid traverse) reliably, i.e. tacho-generator compensation must be performed in such a way that reading and adjustment inaccuracies arising from speed fluctuations during operation do not result in the IPO stop limit being reached (e.g . maximum speed = 9 to 9.5 V).

VELO: Smallest unit of the digital-analog converter

The following applies with a 14 bit converter: 1 VELO = $\frac{10\ \text{V}}{8192}$ = 1.22 mV

MD No.	Significance		
272*	**Drift compensation**		
Sign	Input limits	Standard value	Units
±	0 to 500	0	VELO

The temperature drift of analog electronic components (primarily in the motor driving unit) causes the axes to wander from their set position. The counter-set value (following error) that occurs corresponds to the currently effective temperature drift.

Software drift compensation is performed as follows:

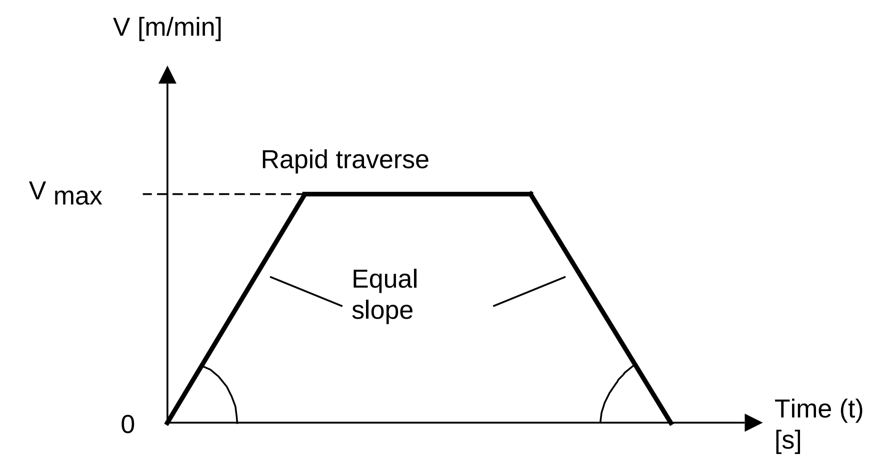
1. Press the control range key
2. Select DIAGNOSIS softkey
3. Select SERVICE softkey
4. Select DRIFT COMPENSATION... softkey for the desired axis

The new compensation value is indicated in the machine data.
With compensation values greater than approx. 500 VELO, the positional deviation can no longer be referred to as drift; this is a fault and Alarm 160* is triggered.

Note:

The drift compensation value can also be entered manually in the machine data.

MD No.	Significance		
276*	**Acceleration**		
Sign	Input limits	Standard value	Units
+	0 to 2 000	50	10000 units/s^2 (IS)



Acceleration/deceleration

The axes need not be set to equal acceleration values. The control assumes the lowest acceleration value of the interpolating axes involved.
The values also apply to deceleration (braking).

Example (metric machine):

Values of 50 ... 150 (0.5 ... 1.5 m/sec^2) are customary.

MD No.	Significance		
280*	**Maximum speed**		
Sign	Input limits	Standard value	Units
+	0 to 60 000	10 000	1000 units/ min (IS)

The input value indicates the limit speed up to which the axis may accelerate (rapid traverse limit).
Traversing is performed at this speed with programmed rapid traverse G00.

The following relationship exists between the axis-specific maximum speed and position control resolution.

Position control res.	max. axis speed
$0.5 \cdot 10^{-4}$ mm	3.4 $^{m}/_{min}$
$0.5 \cdot 10^{-3}$ mm	34 $^{m}/_{min}$
$0.5 \cdot 10^{-2}$ mm	340 $^{m}/_{min}$

The following assignment can be made for axes not involved in 2D or 3D interpolation.

Position control res.	max. axis speed
$0.5 \cdot 10^{-4}$ mm	6.5 $^{m}/_{min}$
$0.5 \cdot 10^{-3}$ mm	60 $^{m}/_{min}$
$0.5 \cdot 10^{-2}$ mm	600 $^{m}/_{min}$

MD No.	Significance		
284*	**Reference point creep speed**		
Sign	Input limits	Standard value	Units
+	0 to 15 000	300	1000 units/ min (IS)

The creep speed becomes effective during reference point approach as soon as the reducing cam is reached, i.e. the *deceleration signal is active.
Only the first position (0 %) of the feedrate override switch is taken into account.

Guide value:
A reasonable upper limit is 1 m/min, but values between 200 and 500 mm/min are better, depending on the K_V factor.

MD No.	Significance		
288*	**Jog feedrate**		
Sign	Input limits	Standard value	Units
+	0 to 15 000	2 000	1000 units/min (IS)

The input value applies to travel in the JOG mode with 100 % feedrate override.

MD No.	Significance		
292*	**Jog rapid traverse**		
Sign	Input limits	Standard value	Units
+	0 to 60 000	10 000	1000 units/min (IS)

The input value applies to travel in the JOG mode with the rapid traverse override key actuated and the rapid traverse override switch in the 100 % position. This value is not used for programmed rapid traverse G00. Programmed rapid traverse G00 is specified by the maximum speed MD No. 280*.

Guide value:

Slightly less than rapid traverse G00, to allow for the operator's reaction time.

MD No.	Significance		
296*	**Reference point approach speed**		
Sign	Input limits	Standard value	Units
+	0 to 15 000	10 000	1000 units/min (IS)

If the direction key leading to the reference point (selected with NC MD 564* bit 0) is pressed in the JOG-REF mode, the axis accelerates to the reference point approach speed.

Exception:

The axis is already at the deceleration cam and automatic reference point approach is selected (see Section 5.2.10).

MD No.	Significance		
300*	**Incremental speed**		
Sign	Input limits	Standard value	Units
+	0 to 15 000	500	1000 units/min (IS)

The input speed is active only with travel in the JOG-INC mode.

MD No.	Significance		
304*	**Interpolation parameter**		
Sign	Input limits	Standard value	Units
+	0 to 3	–	–

In the case of circular movements (G2(G3) and thread cutting (G33), 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 values:

	M version		T version	
Axis 1	X axis	MD 3040 = 1 (I)	X axis	MD 3040 = 1 (I)
Axis 2	Y axis	MD 3041 = 2 (J)	Z axis	MD 3041 = 3 (K)
Axis 3	Z axis	MD 3042 = 3 (K)	–	MD 3042 = 0
Axis 4	–	MD 3043 = 0	–	MD 3043 = 0

With special machines, however, the 4th axis may have to assume the function of the X axis and must therefore operate with interpolation parameter I for circular movements.

In this case: MD 3040 = 0
MD 3043 = 1

MD No.	Significance		
316*	**Pointer compensation +**		
Sign	Input limits	Standard value	Units
+	0 to 249	0	MD offset

The NC activates leadscrew error compensation after reaching the reference point. The NC must therefore be informed by means of MD 316* which of the 1000 possible compensation points represents the reference point for the axis in question (see Section 11, description of operation, leadscrew error compensation).

MD No.	Significance		
320*	**Pointer compensation -**		
Sign	Input limits	Standard value	Units
+	0 to 249	0	MD offset

If leadscrew error compensation is **direction-dependent**, the compensation curves are separate for positive and negative traversing movements. Consequently, 2 compensation indicators (MD 316* for "+" and MD 320* for "-") are also required. The value refers to the compensation point corresponding to the reference point (also see Section 11, Description of Functions, leadscrew error compensation).

MD No.	Significance		
324*	**Distance between two leadscrew error compensation points**		
Sign	Input limits	Standard value	Units
+	0 to 32 000	0	units (MS)

The distance between 2 grid elements of leadscrew error compensation depends on the following:

- Permissible tolerance band
- Maximum gradient of the sum check error characteristic of the spindle/measuring system
- Maximum number of compensation points

(also see Section 11, Description of Functions, leadscrew error compensation)

MD No.	Significance		
328*	**Leadscrew error compensation value**		
Sign	Input limits	Standard value	Units
+	0 to 100	0	units (MS)

The compensation value depends on the permissible tolerance band for the axis position. Input the value for the tolerance band or a slightly smaller value to make use of the full bandwidth for each compensation (also see Section 11, Description of Functions, leadscrew error compensation).

MD No.	Significance		
332*	**Contour monitoring tolerance band**		
Sign	Input limits	Standard value	Units
+	0 to 16 000	1 000	–

On completion of an acceleration or deceleration operation (i.e. in the steady state), the following error is proportional to speed. No fluctuations in the following error must therefore develop during travel at constant speed as this would result in contour deviations.

However, minor fluctuations in the following error that trigger control processes are allowed.

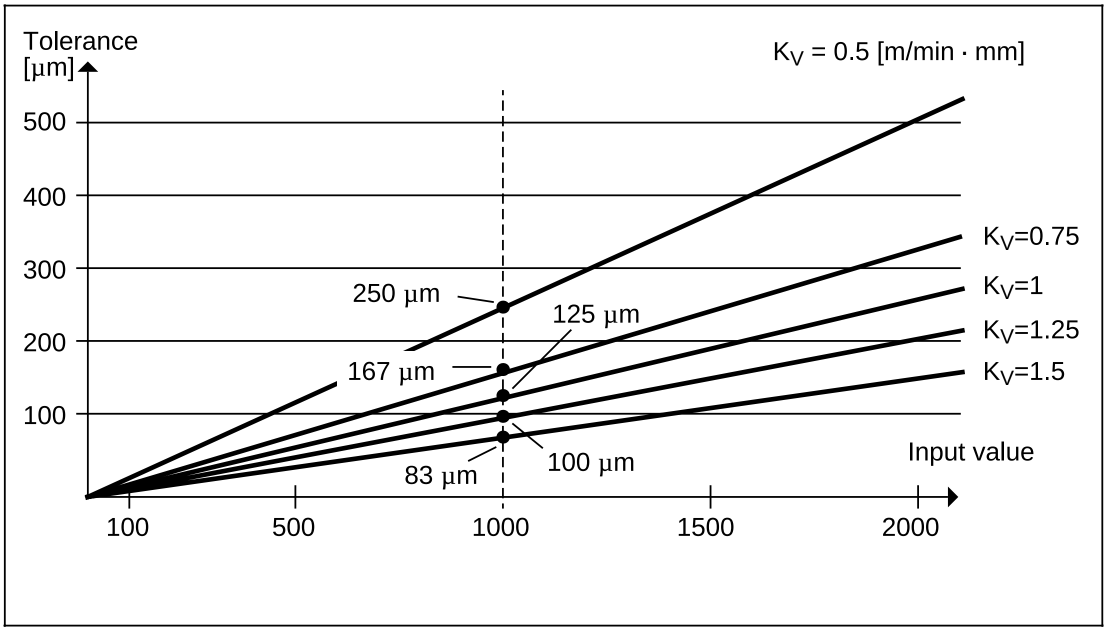
The input of a tolerance band is intended to prevent erroneous tripping of the contour monitoring system owing to slight speed fluctuations derived from operational control processes.

The standard value of 1000 corresponds to a tolerance band of 125 µm at K_V=1.

Equation for determining tolerance band:

$$\text{Tolerance} \quad (\mu m) \quad = \frac{\text{MD 332* x 125}}{K_V \text{ factor x 1000}}$$

$$\text{Example: Tolerance} = \frac{1000 \text{ x } 125}{1 \text{ x } 1000} = 125\ \mu m$$



Tolerance determination from the individual tolerance band curves

MD No.	Significance		
336*	**Contour threshold speed**		
Sign	Input limits	Standard value	Units
+	0 to 24 000	0	1000 units/min (MS)

The speed above which contour monitoring is to be active is input. Even when 0 is entered, no contour monitor is active with the axis at rest. In this case the zero-speed monitor checks for illegal axis movements (Alarm 112*).

MD No.	Significance		
340*	**Tool change position**		
Sign	Input limits	Standard value	Units
±	0 to 99 999 999	0	units (IS)

In the tool change cycle, the maximum retract position at which collision-free tool changing is possible is calculated by the NC from the tool and workpiece data. This MD makes it possible to specify a maximum retract position, e.g. to protect machine parts located behind.
(also see MD 248* tool reference value.)

MD No.	Significance		
344*	**Modulo value for continuous rotary axis with leadcrew error comp.**		
Sign	Input limits	Standard value	Units
+	0 to 92 160 000	360 000	units (MS)

This machine data is valid only in conjunction with leadscrew error compensation. The error curve for each rotary axis must be repeated cyclically. The error cycle is stored axially in this machine data.
Illegal values are not monitored and can result in uncontrolled system execution.

MD No.	Significance		
352*	**Second K_v factor for thread cutting (G33, G34, G35)**		
Sign	Input limits	Standard value	Units
+	0 to 10 000	0	0.01 s^{-1}

For thread cutting G33, G34, G35 a second K_v factor can be input in MD 352*. If this factor is for G33 = 0, the K_v factor is taken from MD 252*. If G33 is selected the K_v factor from MD 352* becomes active.
Both K_v factors (MD 252* and MD 352*) are **not** additive!

Weighting: 1666 corresponds fo K_v 1.

MD No.	Significance		
360*	**Symmetrizing time constant (Tsym)**		
Sign	Input limits	Standard value	Units
+	0 to 9999	0	0.1 ms

provided as from software version 3.1

This machine data is only required for option E36 ”Tapping with dynamic following error compensation.”

For a more detailed explanation of this machine data see Section 11.7.

MD No.	Significance		
364*	**Pulse number for variable increment weighting**		
Sign	Input limits	Standard value	Units
	1 to 65 000	1	$^1/_4$ encoder pulse

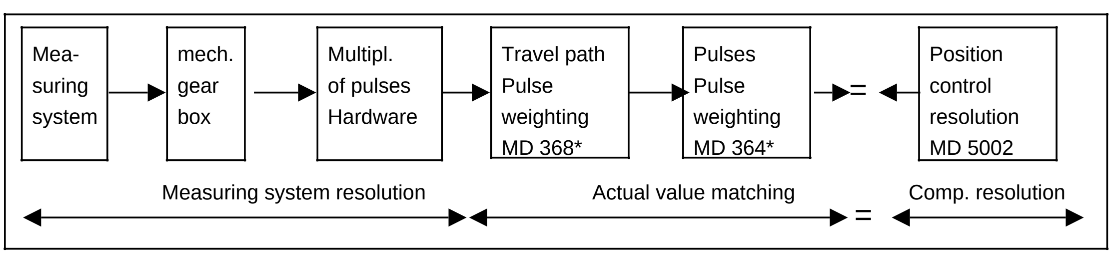
MD No.	Significance		
368*	**Travel for variable increment weighting**		
Sign	Input limits	Standard value	Units
	1 to 65 000	1	0.5* units (MS)

Variable pulse weighting (MD 364*, MD 368*)

In order to generate a correctly closed position control loop, the pulses from the digital measuring system and the position control accuracy of the control must be matched to each other.

To determine the machine data 364* and 368*, the pulse number of the encoder and the associated traverse path on the machine must be known.

The value of the traverse path must be entered in MD 368* (in units of position control resolution). The pulse number of the encoder for this traverse path times all subsequent multiplications (EXE, measuring mechanism, hardware multiplication on measuring circuit module) must be entered in MD 364* provided that the machine data values do not exceed 65000. In this case, both values must be divided by a common multiple.



Block diagram of position control parameters

Determination of possible position control parameters (MD 364* and MD 368*):

1. Determination of measuring system resolution "m"

- The ROD encoder is mounted directly on the ball screw

$$\text{MD 368*} = \frac{l}{b} \qquad \text{MD 364*} = p \cdot 4$$

- The ROD encoder is mounted on the motor with a gearbox between the motor and ball screw

$$\text{MD 368*} = \frac{l \cdot r}{b} \qquad \text{MD 364*} = p \cdot 4$$

- A linear scale with EXE is used

$$\text{MD 368*} = \frac{g}{b} \qquad \text{MD 364*} = f \cdot 4$$

- A rotary axis is used

$$\text{MD 368*} = \frac{l}{b} \qquad \text{MD 364*} = p \cdot f \cdot 4$$

Symbol	Machine data	Significance
b	5002, bits 2, 1, 0	Position control resolution of control
l		Ball screw pitch
p		Number of pulses of ROD encoder per revolution
r		Mechanical gearbox between motor and ROD encoder (if fitted)
g		Period spacing on linear scale
f		EXE multiplier
MD 364*	364*	Pulses for variable pulse weighting
MD 368*	368*	Traverse path for variable pulse weighting

2. Examples illustrating determination of MD 364* and MD 368*:

- The ROD encoder is mounted directly on the ball screw
  l=10 mm
  p=2500 pulses per revolution
  $b=1/2 * 10^{-3}$ mm

$$\text{MD 368*} = \frac{l}{b} = \frac{10\ \text{mm}}{1/2 \cdot 10^{-3}\ \text{mm}} = \underline{20000} \qquad \text{MD 364*} = p \cdot 4 = 2500 \cdot 4 = \underline{10000}$$

- The ROD encoder is mounted on the motor with a gearbox between the motor and the ball screw

  l=0.2 inch
  p=1000 pulses per revolution
  r=1:2 (2 revolutions of motor = 1 revolution of ball screw)
  $b=1/2 \cdot 10^{-4}$ inch

$$\text{MD 368*} = \frac{l \cdot r}{b} = \frac{0.2\ \text{inch} \cdot 1/2}{1/2 \cdot 10^{-4}\ \text{inch}} = \underline{2000} \qquad \text{MD 364*} = p \cdot 4 = 1000 \cdot 4 = \underline{4000}$$

- Same values as in example 2.2 except $b=1/2 * 10^{-3}$ mm

$$\text{MD 368*} = \frac{l \cdot r}{b} = \frac{0.2\ \text{inch} \cdot 25.4\ \text{mm/inch} \cdot 1/2}{1/2 \cdot 10^{-3}\ \text{mm}} = \underline{5080} \qquad \text{MD 364*} = p \cdot 4 = 1000 \cdot 4 = \underline{4000}$$

- A linear scale with EXE is used

  g=0.02 mm
  f=10
  $b=1/2 \cdot 10^{-3}$ mm

$$\text{MD 368*} = \frac{g}{b} = \frac{0.02\ \text{mm}}{1/2 \cdot 10^{-3}\ \text{mm}} = \underline{40} \qquad \text{MD 364*} = f \cdot 4 = 10 \cdot 4 = \underline{40}$$

- A rotary axis is used

  p=18000 pulses per revolution
  f=5
  $b=1/2 \cdot 10^{-3}$degrees

$$\text{MD 368*} = \frac{l}{b} = \frac{360\ \text{degrees}}{1/2 \cdot 10^{-3}\text{degrees}}\ \underline{720000\ !!} \qquad \text{MD 364*} = p \cdot f \cdot 4$$

$$\text{MD 364*} = 18000 \cdot 5 \cdot 4 = \underline{360000\ !!}$$

Since the values exceed 65000, both of them must be divided by a common factor (e.g. = 100)

MD 368*= <u>7200</u>   MD 364*= <u>3600</u>

Determination of variable pulse weighting by measurement

Precondition: MD 364* = 1
MD 368* = 1

The axis is traversed by a certain value (e.g. 10 mm) in the JOG INC or MDA mode.
The actual traversed path is recorded with a dial gauge (e.g. 8.32 mm).

MD 364* = set traverse path 10000 µm = 10000
MD 368* = actual traversed path 8320 µm = 8320

MD No.	Significance		
380*	**Standard motor exact stop limit coarse**		
Sign	Input limits	Standard value	Units
+	0 to 99 999 999	100 000	units (MS)

For explanation see NC MD 384*

MD No.	Significance		
384*	**Standard motor exact stop limit fine**		
Sign	Input limits	Standard value	Units
+	0 to 99 999 999	10 000	units (MS)

provided as from software version 4.1

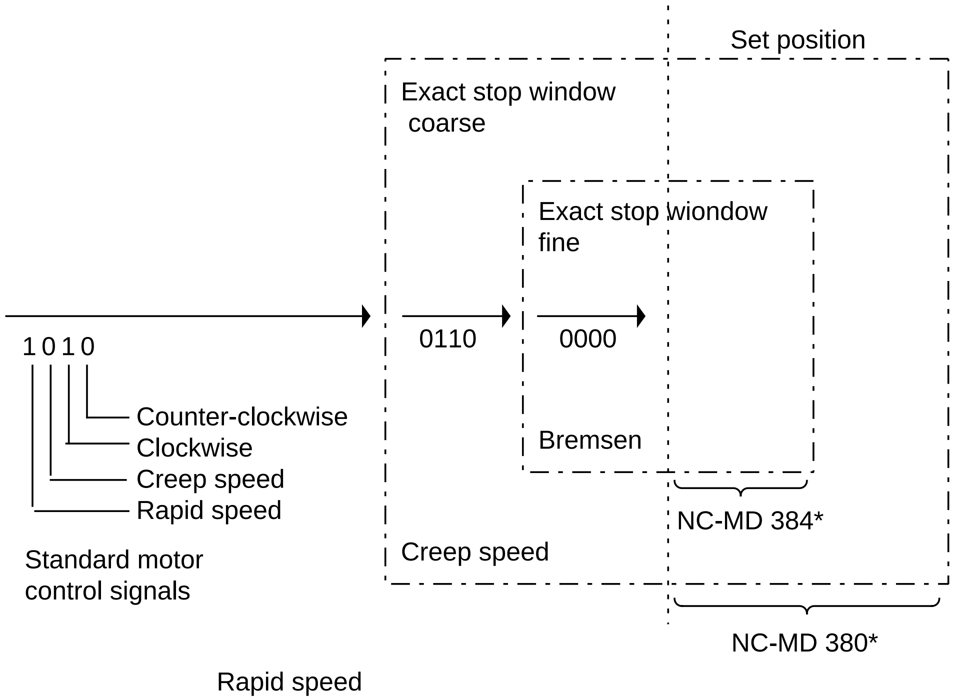
Separate NC MD for the exact stop limits were defined for the function CONNECTION OF STANDARD MOTORS.

Velocity control of the standard motors is performed using the exact stop limits for the standard motors (see also Section 11.8).

a) Standard motor axis within "standard motor exact stop limit fine":
The motor stops (possibly with mechanical brake)

b) Standard motor axis within "standard motor exact stop limit coarse":
The motor is moving at creep speed

c) Standard motor axis outside "standard motor exact stop limit coarse":
The motor is moving at rapid speed



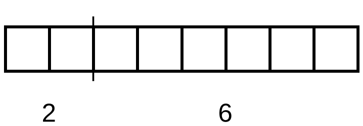
MD No.	Significance		
388*	**Axis specific weighting factor**		
Sign	Input limits	Standard value	Units
+	0 to 99 999 999	0	----

provided as from software version 3.1

With the axis specific weighting factor it is possible to program a specific axis value but to traverse a prepared axis value

Conversion formula:
prepared axis value = programmed axis value·weighting factor

Eight-digit input of the MD:



2 Integer places
6 Fractional places

For every input except zero the first two places are interpreted as integer places and the remaining six as fractional places

e.g. input 12345678 gives a weighting factor of 12.345678

If the setpoint exceeds the internal format because of the weighting factor or too high a speed, the Alarm 2031 ”Weighting factor too large” is set and NC start and machining are disabled.

Standard value: 0 (Weighting factor 1)

MD No.	Significance		
4000	**Spindle assignment**		
Sign	Input limits	Standard value	Units
+	500	0	----

The submodules are designated according to the installed location of the actual value modules at slots 1 to 4 (e.g.: submodule at slot 2 submodule 2, actual value 2, encoder 2, setpoint 2).

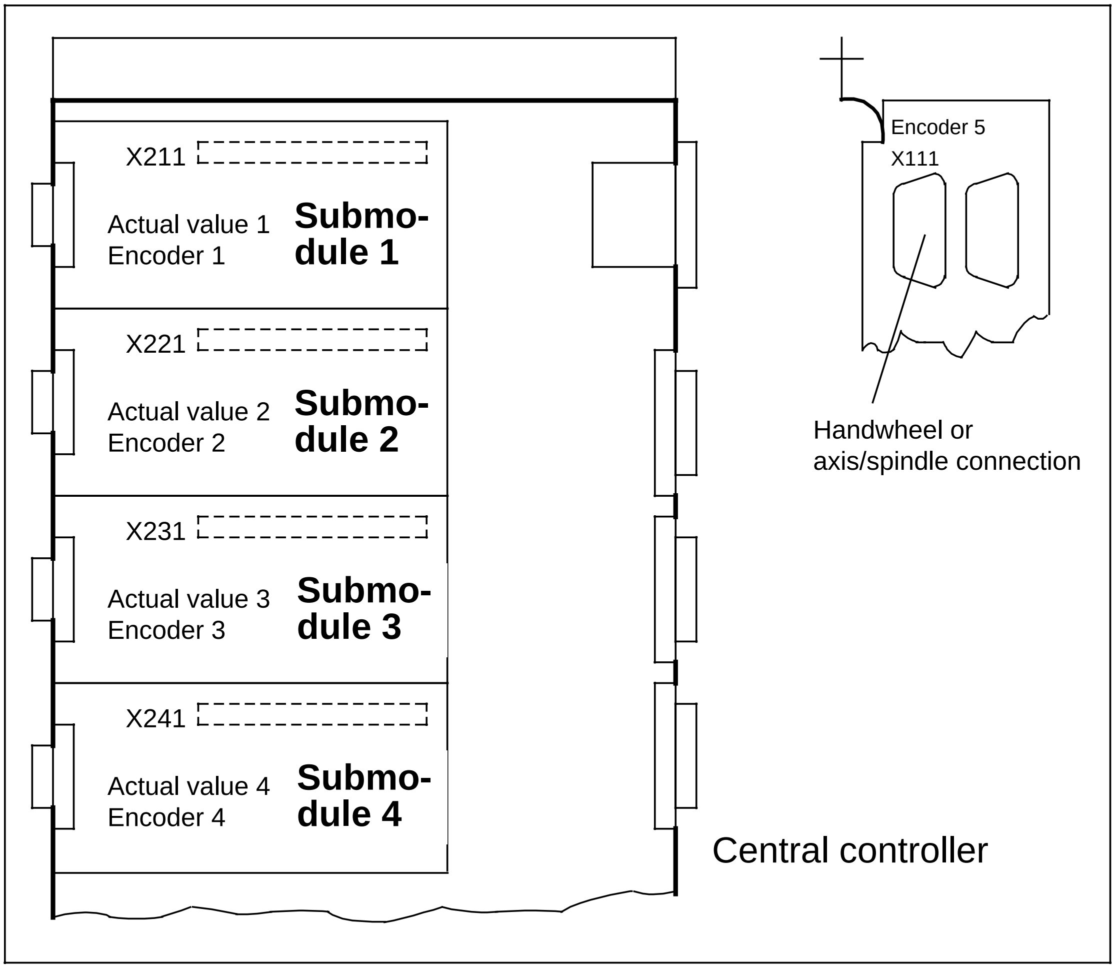
This NC-MD determines the actual value input or setpoint output to which the spindle is assigned (also see NC MD 5210 bit 7 (spindle available)).

The spindle can be connected to measuring circuits 4 to 5 (also see Section 3.1.3).

Standard assignment Milling machine: NC MD 4000 = 0
Turning machine: NC MD 4000 = 500

The following applies up to SW version 4.1:

A hardware actual value input must always exist for a defined spindle even if no encoder is connected to it (e.g. spindle without encoder).



Permissible values	Significance
0	Spindle not available at machine (permissible only with NC-MD 5210 bit 7 = '0')
100,200,300, 400,500	The spindle obtains its set value from setpoint output 1, 2, 3, 4 or 5. Encoder 1, 2, 3, 4, or 5 is used as the actual value input.

Note:

The spindle set value is output according to the content of this MD, e.g.:

NC-MD 4000 = 300 set value output via set value 3
NC-MD 4000 = 500 set value output via set value 5

MD No.	Significance		
4010	**Spindle drift compensation**		
Sign	Input limits	Standard value	Units
±	0 to 500	0	VELO

The input value must be modified in the appropriate direction until the spindle exhibits equal actual speeds in both directions of rotation.

The adjustment must be made at low speeds (e.g. 100 $^{rev}/_{min}$). The spindle speed can be monitored in the basic display of the AUTOMATIC, JOG or MDA modes (for spindles with encoder), for example, or measured with a rev counter.

MD No.	Significance		
4020	**Zero mark offset for spindle**		
Sign	Input limits	Standard value	Units
±	0 to 4095	0	ca. 1/11 degrees (1024 pulse generator)
±	0 to 2047	0	ca. 2/11 degrees (512 pulse generator)

A zero mark offset for the spindle can be set in this machine data.

When synchronizing the spindle (Power ON or PLC signal Q 103.3 ”Resynchronize spindle”) the spindle position value is not deleted and but changes to the value of machine data 4020. After overwriting MD 4020 in the running program by @ 400, the zero mark offset becomes effective at once.

Example of application: G33 or M19

For the

- 1024 pulse generator one increment corresponds to:

$$\frac{360 \text{ degrees}}{4096 \text{ pulses}} = 0.08789... \text{ degrees} \qquad \text{ca. } 1/11 \text{ degrees}$$

- and for the 512 pulse generator

$$\frac{360 \text{ degrees}}{2048 \text{ pulses}} = 0.017578... \text{ degrees} \qquad \text{ca. } 2/11 \text{ degrees}$$

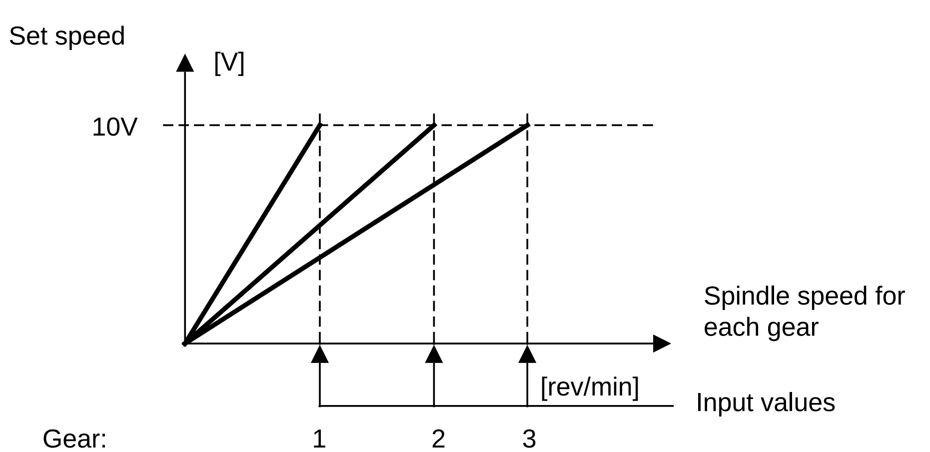
MD No.	Significance		
4030-4100	**Maximum speed for 8 gears**		
Sign	Input limits	Standard value	Units
+	0 to 16 000	see table	rev/min

Assignment:

Gear	1	2	3	4	5	6	7	8
MD No.	4030	4040	4050	4060	4070	4080	4090	4100
Standard value	500	1000	2000	4000	4000	4000	4000	4000

The machine data specify the maximum spindle speed reached in the individual gears with a set value input of 10 V.

The value 0 is entered for unavailable gears.



Determination of standard values for max. speeds

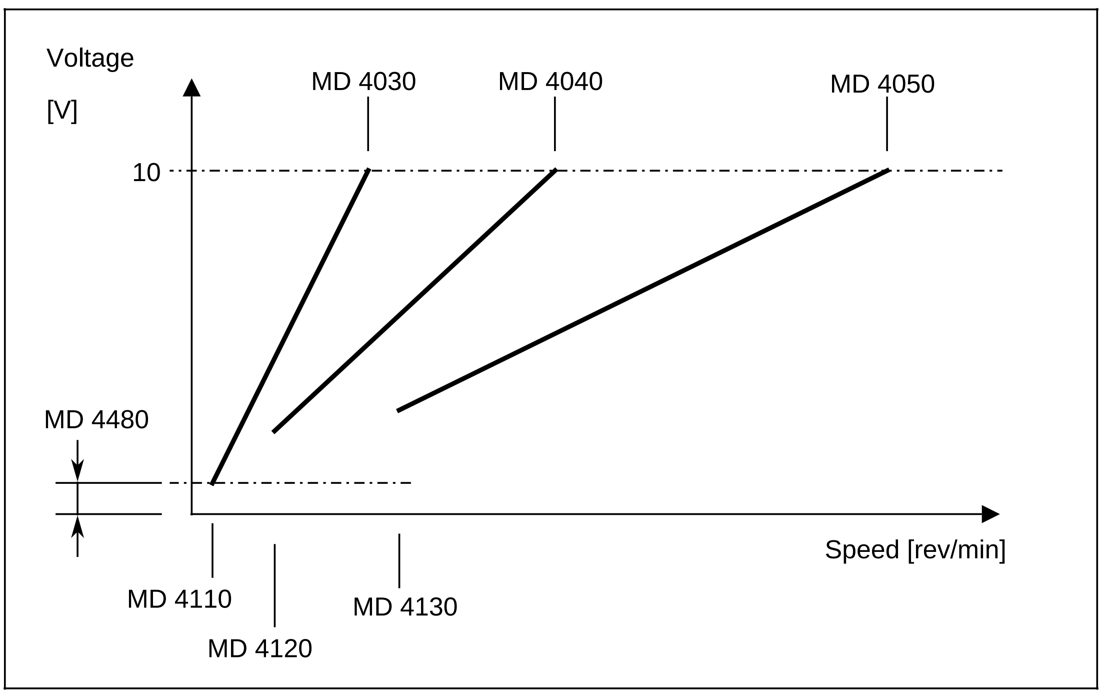
Note:
The max. programmable spindle speed is 12 000.

MD No.	Significance		
4110-4180	**Minimum speed for 8 gears**		
Sign	Input limits	Standard value	Units
+	0 to 16 000	see table	rev/min

Assignment:

Gear	1	2	3	4	5	6	7	8
MD No.	4110	4120	4130	4140	4150	4160	4170	4180
Stand. value	50	500	1000	2000	2000	2000	2000	2000

The inputs specifying the minimum and maximum speeds in the individual gears mean that their speed range is now defined. On the basis of the programmed spindle speed, the NC can now transmit the required gear and a request signal for a gear change to the PLC. Selection in the case of overlapping speed ranges is based on the lowest operating frequency (selection via interface signal AUTOMATIC GEAR SELECTION, Q 101.3).



Determination of minimum speeds

If 3rd gear is engaged, the new S value must be smaller than MD 4130 to ensure that the NC activates a gear change.

MD No.	Significance		
4190-4260	**Acceleration time constant for 8 gears**		
Sign	Input limits	Standard value	Units
+	0 to 16 000	2 000	4 ms

Assignment:

Gear	1	2	3	4	5	6	7	8
MD No.	4190	4200	4210	4220	4230	4240	4250	4260

The control specifies the set value for acceleration in ramp form as a function of this machine data. The machine data acts as a variable ramp-function generator.
The setting is determined by measuring each time interval from zero speed to maximum speed.
This time is entered in the machine data. The standard value of 2000 corresponds to a time of 8 seconds.

MD No.	Significance		
4270-4340	**Cutoff speed with M19 for 8 gears**		
Sign	Input limits	Standard value	Units
+	0 to 2 000	100	rev/min

This machine data indicates the spindle speed to which reduction takes place with oriented spindle stop (M19) and at which travel continues until positioning is performed via the position control characteristic set by means of the gain factor.

Assignment:

Gear	1	2	3	4	5	6	7	8
MD No.	4270	4280	4290	4300	4310	4320	4330	4340

(also see Section 11.4.3)

MD No.	Significance		
4350-4420	**Gain with M19 for 8 gears**		
Sign	Input limits	Standard value	Units
+	0 to 10 000	200	$\frac{\text{rev/min}}{\text{360 degrees}}$

Assignment:

Gear	1	2	3	4	5	6	7	8
MD No.	4350	4360	4370	4380	4390	4400	4410	4420

The spindle position control is activated in the event of oriented spindle stop (M19). The gain is defined by means of the positioning gradient to the cutoff position. The gradient is defined as the spindle speed (in rev/min) with positional deviation of 360°.

MD No.	Significance		
4430	**Positional tolerance for M19**		
Sign	Input limits	Standard value	Units
+	0 to 4096	11	approx. 1/11 degree

With oriented spindle stop (M19), the SPINDLE POSITION REACHED message is output to the PLC via the interface signal input 114.4 as soon as the positional deviation lies within this tolerance.

However, the spindle position control tries further to reduce the positional deviation.

The positional tolerance is stated in pulse generator increments. 1 increment is equivalent to 360/4096 degrees. Given a pulse generator with 1024 pulses per revolution, hardware four-fold multiplication yields 4096 pulses per revolution. Only pulse generators with 1024 pulses (512 pulses) may be used.

The standard value of 11 is approximately equivalent to 1°.

The spindle position control remains active until (depending on NC MD 5210.4)

- Interface signal SPINDLE ENABLE is removed
- Interface signal ACKNOWLEDGE M19 (Q 103.2) is set
- M3 or M4 is programmed in the NC part program.

Corresponding MD: MD 5200 bit 5
MD 5200 bit 6
MD 5210 bit 4

MD No.	Significance		
4440	**Spindle speed tolerance**		
Sign	Input limits	Standard value	Units
+	0 to 100	10	%

On systems with analog spindle speed and spindle encoder, the difference between the actual and set speed is determined.

The actual speed is measured by means of ROD encoders. Deviations outside the tolerance range for the programmed spindle speed are signalled to the PLC by cancelling the interface signal SPINDLE IN SET RANGE (I 114.5).
The rev/min tolerance is derived from the input tolerance in % relative to the programmed set speed concerned.

(Set speed tolerance) - actual speed - (set speed + tolerance)

The monitor is disabled at 100 %.

Example:

- S value: 1000 rev/min
- Tolerance in MD: 3 %
  This yields a permissible actual speed range of 970 to 1030 rev/min

MD No.	Significance		
4450	**Maximum spindle speed tolerance**		
Sign	Input limits	Standard value	Units
+	0 to 100	100	%

On systems with analog spindle speed and spindle encoder, a deviation beyond the maximum speed + tolerance limit activates the "speed limit exceeded" signal (I 114.0 in PLC) and Alarm 2152 (spindle speed too high). The lowest of the following maximum spindle speed limits becomes effective in each case:

- Max. gear speed (MD 4030 - 4100)
- Max. spindle speed (MD 4510)
- With G96: value in setting data (G92 S ...)
- Spindle speed limit (setting data)

The monitor is disabled at 100 %.

MD No.	Significance		
4460	**Zero-speed tolerance**		
Sign	Input limits	Standard value	Units
+	0 to 10000	10	0.01 %

Unit: 0.01 % of max. gear speed

On systems with analog spindle speed and spindle encoder, the actual speed is measured. Spindle speed understepping is reported to the PLC via the interface signal SPINDLE STATIONARY (I 114.3).

MD No.	Significance		
4470	**Servo enable cancelling delay**		
Sign	Input limits	Standard value	Units
+	16 to 16000	1 000	ms

When spindle set value 0 is output, the servo enable for the spindle is cancelled after this delay, to prevent drifting.

The delay is active for:

- Cancelling the servo enable for the spindle.

MD No.	Significance		
4480	**Minimum motor set speed**		
Sign	Input limits	Standard value	Units
+	0 to 8192	50	VELO

This machine data specifies the minimum motor speed which must not be understepped, for instance, at constant cutting speed and as the turning diameter increases; in other words, the cutting speed is no longer constant, but increases with the turning diameter from this point onwards. The MD should be set to ensure smooth running of the motor at all times.

Example:

MD 4480 =50
50 x 1.22 mV =61 mV

MD No.	Significance		
4490	**Basic speed**		
Sign	Input limits	Standard value	Units
+	0 to 9999	50	rev/min

If the BASIC SPEED signal (Q 103.5) is activated by the PLC, a spindle set value corresponding to this spindle speed is output taking the gear just selected into account. The spindle override is effective. (Also see Interface Description Part 1 Signals.)

MD No.	Significance		
4500	**Set oscillation speed**		
Sign	Input limits	Standard value	Units
+	0 to 8192	50	VELO

The (low) spindle **motor speed** entered here takes effect when the OSCILLATION SPEED signal (Q 103.6) is activated by the PLC.
(Also see Interface Description Part 1 Signals.)
The standard value of 50 is equivalent to a set value of 61 mV.

Note:

The selection of an oscillation speed does not yet result in oscillation. This must be generated by the PLC by means of the SET DIRECTION OF ROTATION CLOCKWISE/ COUNTER-CLOCKWISE signal (Q 103.7).

MD No.	Significance		
4510	**Maximum spindle speed**		
Sign	Input limits	Standard value	Units
+	0 to 16000	4 000	rev/min

If this maximum spindle speed is exceeded by more than the set tolerance specified in NC MD 4450 (maximum spindle speed tolerance), the SPEED LIMIT EXCEEDED signal (I 114.0) is output to the PLC. Alarm 2152 (spindle speed too high) is also output.

Note:

The maximum programmable spindle speed is 12 000.

MD No.	Significance		
4520	**Spindle position with external M19**		
Sign	Input limits	Standard value	Units
+	0 to 3599	0	0.1 degrees

If M19 is initiated from the PLC with the POSITION SPINDLE PLC signal (Q 103.4), the NC positions the spindle at the angle entered in MD 4520 (see Interface Description Part 1 Signals).

8.8 Description of NC MD bits

Note:

The significance of the individual MD bits always refers to the **set** bit. If a bit is not set, the statement (name) must be negated.

NC MD	Bit no. 7	6	5	4	3	2	1	0
5000					Name of RADIUS and CHAMFER			

Name (address) of radius and chamfer for:

- Polar coordinate programming
- Diameter ratio for cylinder milling
- Radii and chamfers for insertion with blueprint programming
- Circle programming with specified radius

Coding of addresses (axis names)

Bit No.	7 … 4	3 … 0
	always 0000	Address name

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

e.g. 0000 0010 = Z
0001 1001 = Q

NC-MD	Bit no.							
	7	6	5	4	3	2	1	0
5001					Name of ANGLE			

Name (address) of the angle

- Polar coordinate programming
- Blueprint programming

Coding of addresses:

Bit No.	7 … 4	3 … 0
	always 0000	Address name

X	=	0000
Y	=	0001
Z	=	0010
A	=	0011
B	=	0100
C	=	0101
U	=	0110
V	=	0111
W	=	1000
Q	=	1001
E	=	1010

e.g. 0000 0010 = Z
0000 1001 = Q

MD no.	Bit no. 7	6	5	4	3	2	1	0
5002		Input resolution		Reset position G70		Position control resolution		

The input resolution (IS) determines the increment weight for displays and dimension inputs. The reset position G70 (inch) or G71 (mm) is defined at the same time.

The position control resolution (MS) determines the assignment of one increment of the part actual value to a certain traverse path.

Standard value: 00100010

Linear axes

Input resolution

Bit 6	Bit 5	Bit 4	Significance
0	0	0	10^{-2} mm
0	0	1	10^{-3} inch
0	1	0	10^{-3} mm
0	1	1	10^{-4} inch
1	0	0	10^{-4} mm
1	0	1	10^{-5} inch

Position control resolution

Bit 2	Bit 1	Bit 0	Significance
0	0	0	0.5 * 10^{-2} mm
0	0	1	0.5 * 10^{-3} inch
0	1	0	0.5 * 10^{-3} mm
0	1	1	0.5 * 10^{-4} inch
1	0	0	0.5 * 10^{-4} mm
1	0	1	0.5 * 10^{-5} inch

Rotary axes

Input resolution	always 10^{-3}	degrees
Pos. control resol.	always 0.5 * 10^{3}	degrees (720 000 pulses per revolution)

Possible combinations of input and position control resolutions

Input resolution / Position control resol.	Input resolution					
	10^{-2} mm	10^{-3} mm	10^{-4} mm	10^{-3} inch	10^{-4} inch	10^{-5} inch
$0.5*10^{-2}$ mm	***	***		***	***	
$0.5*10^{-3}$ mm	***	***	***		***	***
$0.5*10^{-4}$ mm		***	***			***
$0.5*10^{-3}$ inch	***			***	***	
$0.5*10^{-4}$ inch	***	***		***	***	***
$0.5*10^{-5}$ inch		***	***		***	***

All combinations marked "*** " are permissible and can be input.

In the event of impermissible combinations being selected, a conversion factor of 1/1 is assumed and NC Alarm 4 (incorrect unit system) is output on the screen.

Note:

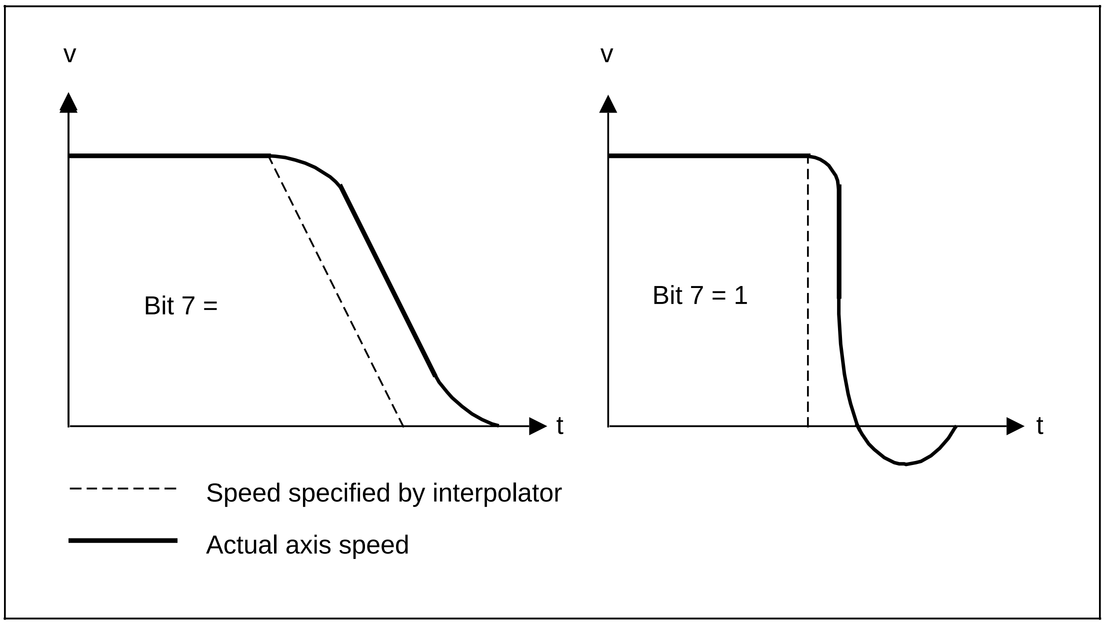
The position control resolution should always be 1/2 input resolution.
This is the only way to ensure that the programmed position is exactly reached.

NC MD	Bit no.							
	7	6	5	4	3	2	1	0
5003	No deceleration at limit switch	JOG working area limitation active	Interpolat. parameters I, J, K dependent G90 / 91	Polar coordinate angle dependent G90/91	Do not clear PRESET OFFSET with Power On	Aux. function output before travel		

Bit 7 No deceleration on reaching the software limit switch.
With the bit set, braking is not performed according to the acceleration/deceleration characteristic; only the following error is suppressed, whereby the limit switch is not overrun by any great extent.

Note:

In the case of interpolating axes, all axes are shut down if the range limit of an axis has been reached. However, stopping without contour violation is ensured only if NC MD No. 5003 bit 7 (no deceleration at limit switch) is not set, i.e. during braking via the acceleration ramp.



Deceleration curves with interpolation

Bit 6 In addition to the software limit switches, the working area can also be limited in the JOG mode, thus better safeguarding the machine against unintentional travel. However, since working area limitation is also a software limitation, proper operation can be ensured only after reference point approach.

Bit 5 When this bit is set, the interpolation parameters I, J, K are programmed depending on G90/G91.
If bit 5 = 0, the interpolation parameters are output in increments (incremental dimension).

Bit 4 With this bit set, the polar coordintate angle is programmed depending on G90/G91. If bit 4 = 0, the angle is output as an absolute value.

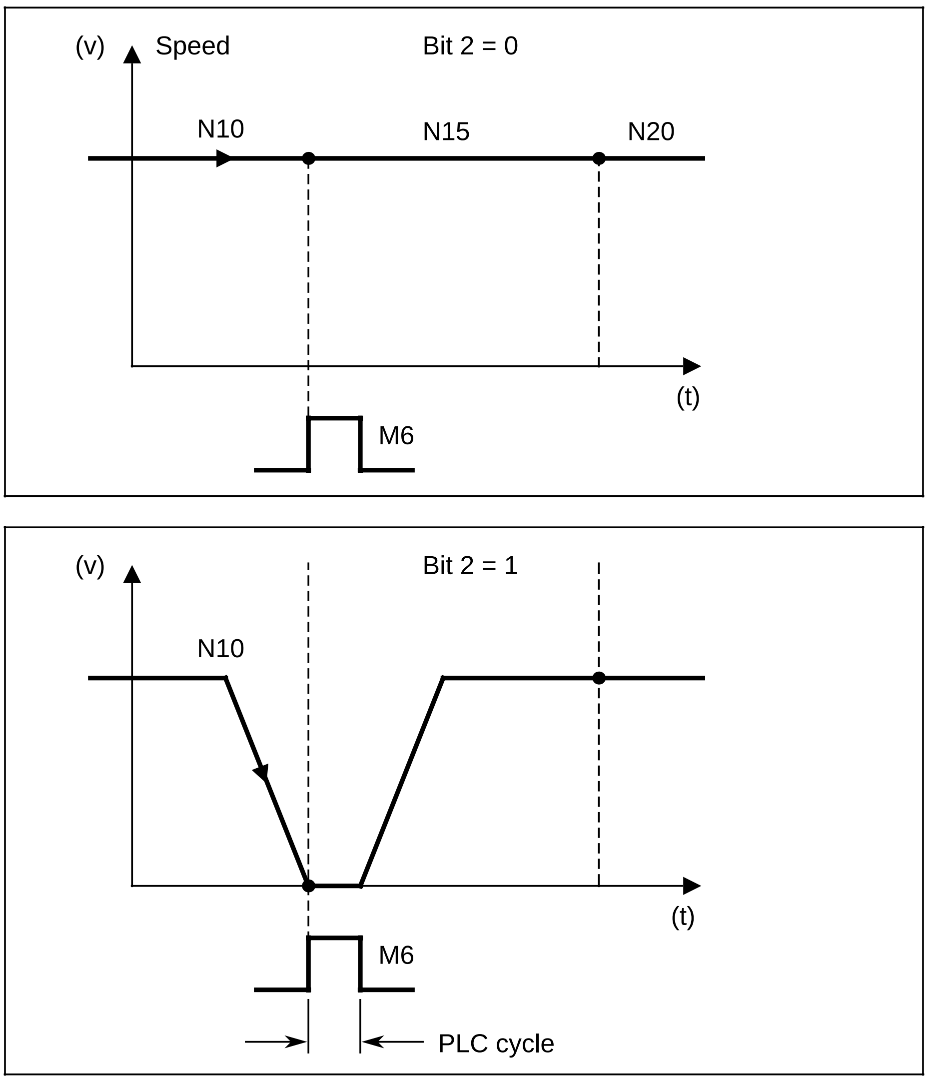
Bit 3 The old PRESET OFFSET is automatically transferred to the actual value display again after switching on.

Bit 2 Bit 2=0 Auxiliary function output during axis movement
Bit 2=1 Auxiliary function output before travel

If an auxiliary function (M, S, T, H) is also programmed in a traversing block, the following 2 conditions can occur with the help of bit 2:

Example:

```
N 10
N 15 M6 X100 LF
N 20
```



Auxiliary function output during and before travel

NC MD	Bit no.							
	7	6	5	4	3	2	1	0
5004				Indepen-dent rapid traverse override	NC Start without reference point	Hand-wheel function enabled		

Bit 4 Bit 4 = 1 Rapid traverse override switch in use. The switch code (normally a 3 bit code) has to be transmitted to the interface (QB 82 bits 0 to 2) by the PLC user program (also see Interface Description Part 1 Signals).

Note:

- The override switch is effective only with programmed rapid traverse (G00)
- Also note NC MD 147 to 154
- The RAPID TRAVERSE OVERRIDE EFFECTIVE interface signal (QB 85 bit 5) must be "1".

Bit 4 = 0 No rapid traverse override switch in use.

Bit 3 Bit 3 = 1 The NC START interface signal (QB 87 bit 0) initiates program start even if the reference points have not been approached.
To ensure correct workpiece machining, synchronization of the feed axis with machine zero must be performed by another means, e.g. by the scratch method and PRESET (set actual value).

Note:

Software limit switches 1 and 2 are not effective until after the axes have performed reference point approach.

Bit 3 = 0 No program start is possible before axis referencing. If the NC Start button is pressed before referencing the axes, NC Alarm No. 2039 (reference point not reached) is displayed.

Bit 2 Bit 2 = 1 If the handwheel installed via the hand-held unit or an external handwheel connected to the 5th actual value input (option M10 required) is to be used, this bit must be set to ”1” (handwheel function enabled).

Bit 2 = 0 Handwheel function disabled, jog increment window is not displayed.

NC MD	Bit no. 7	6	5	4	3	2	1	0
					Keyswitch effective with:			
5005				ZO additive	ZO protected R parameters	TO wear	TO geometry basis	reserved

Bit 4,3, 2,1 By setting the appropriate bits, modification of the following data can be disabled by means of the keyswitch (Q 78.6):

Bit 4 : Zero offsets (G54 to G57) additive (ZO fine)
Bit 3: Zero offsets (G54 to G57)
Protected R parameter ranges (cycle SD), also see MD 16, 17
Bit 2: TO wear (P5 to P7)
Bit 1: TO geometry (P2 to P4, P8-P9)

NC MD	Bit no. 7	6	5	4	3	2	1	0
		Keyswitch effective with:						
5006		Progr. No. input	Initialization MDs	TEACH-IN selection	PP manual input	DRY	DRF	Overstore

Bit 6-0 By setting the appropriate MD bits, input for the following operator actions can be locked by means of the keyswitch:

Bit 6 : Program No. input (main programs and subroutines)
Bit 5 : Selection of initialization mode, modification of machine data, L2 data
Bit 4 : TEACH IN selection via keyboard
Bit 3 : Input of part programs via operator panel (not MDA input)
Bit 2 : Selection of dry run feedrate (DRY)
Bit 1 : Traversing via handwheel in automatic mode (DRF).
Bit 0 : Overstoring of H, S, T, M functions in overstore mode

NC MD	Bit no.							
	7	6	5	4	3	2	1	0
5007	TO in diameter	Tool wear value not included	Mixed program-ming of G90/91 in block		Basic tool dimension active	No output of M17	G53 as for @ 706	Length compen-sation also with non-pro-grammed axes

Bit 7 Bit 7 = 0 The cutter (tool parameter P1 = 20) is defined as length (P2) and radius (P4)
Bit 7 = 1 The cutter is defined as length and diameter.
The tool nose radius on turning tools is always in the radius.

Bit 6 This allows all tool wear data to be declared invalid (P5-P7).

Bit 5 Mixed programming of G90 and G91 in one block.

Bit 3 On the SINUMERIK 805, the tool offset can be expanded by 2 additional parameters (P8, P9).

Bit 2 Bit 2= 0 Subroutine end (M17) is issued to the PLC as an M function.
Bit 2= 1 Subroutine end is active only internally in the NC.

Bit 1 Bit 1= 0 With G53 all zero offsets (G54 to G59 + ext. ZO) are cancelled.
Bit 1= 1 With G53 all zero offsets (G54 to G59 + ext. ZO), DRF and PRESET are cancelled. Tool offset (TO) is not cancelled.

Bit 0 Apply length compensation even if axes are not programmed (T version only):
If the change in tool length compensation (e.g. cancelled by means of D0) yields a traversing path in an axis which is not programmed in this block, traversing is performed nevertheless. If the bit is not set, traversing is performed only when the axis has been programmed.

Example of programming for SINUMERIK 805:

```
:
N5 G17 G0 X0 Z0 LF
N10 G01 F200 D3 Z10 LF        D3 ....   type 9 (turning tool) length 20
N20 X30 LF
:
```

With the bit set, the length compensation (the X axis for turning) is already moved to position X20 in block N10.
If the bit is not set, the X axis is not moved to position X50 (X30 + length compensation) until block N20.

NC MD	Bit no. 7	6	5	4	3	2	1	0
5008		REPOS in JOG mode	Setting up in JOG mode	TO Type 0= Type 20				

Bit 6 Bit 6 = 0 In the REPOS mode, return to contour is initiated by briefly pressing the corresponding direction key.

Bit 6 = 1 Return to contour is performed only while the corresponding direction key remains pressed.

Bit 5 As for bit 6, but for setting-up modes (JOF-REF, JOG-INC)

Bit 4 Bit 4 = 1 TO Type 0 acts like Type 20
If TO Type 0 is selected, it acts like Type 20. No alarm is triggered. The TO Type 0 display is contained in the tool offset memory. Radius and length compensation are assigned as with Type 20.

Bit 4 = 0 If no type is entered for TO, Alarm 2060 (program error, TO No.) is triggered when called in the NC program.

NC MD	Bit no. 7	6	5	4	3	2	1	0
	Functions for transverse axis							
5011	@ read/ load in diameter	Actual value display in diameter	Diameter program- ming with G91	Diameter progr. G90 TO in diam.	Tool length Type 1-9 in diam.	INC, handwh. DRF in diameter	Zero offset in diameter	

Bit 7 @ read/write transverse axis value in radius or diameter depending on MB bits (MD 5011, bits 1-6).

Bit 6 Actual value display of transverse axis in diameter

Bit 5 Diameter programming with G91 for transverse axes.

Bit 4 Diameter programming with G90 for transverse axes.
Lathe tools (tool types 1-9): input of wear in diameter for transverse axis.

Bit 3 Lathe tools (tool types 1-9). Input of geometry (basic tool dimensions as well) in diameter for transverse axis.

Bit 2 INC (incremental dimension), handwheel increments, DRF offset.
Input and display in diameter for transverse axis.

Bit 1 Programmable (G58- G59) and settable (G54 - G57) zero offsets; display and programming in diameter.
External zero offset, PRESET offset, distance to go, JOG offset (REPOS): display in diameter.

Treatment of transverse axis values in @ instructions

Since an accuracy of only 1 unit of input resolution can be achieved when reading and writing values via the @ instruction, but radius values in diameter I/O have 1/2 unit of input resolution, reading and writing of diameter values must also be possible. A new machine data bit is introduced for this purpose. If this bit is set to 1, the machine data bits stated in MD 5011 for transverse axes are also scanned in the @ instructions.

MD 5011, bit 7=0 @ read/write transverse axis values in radius

MD 5011, bit 7=1 @ read/write tranverse axis values in radius or diameter depending on MD bits

The following table applies:

@ command	Data for transverse axis	Machine data 5011
320/420/423	Tool offset TO Types 1-9 Tool length (P2) Tool wear (P5)	 Bit 3 Bit 4
330/430	Settable ZO (G54 . . G57, coarse/fine)	Bit 1
431	Settable ZO additive (G54 . . G57)	Bit 1
331/432	Programmable ZO (G58/G59)	Bit 1
333/434	DRF - offset	Bit 2
334/435	PRESET - offset	Bit 1
360	Workpiece-related actual value	Bit 6
361	Actual control value	Bit 6
440	Programmable axis position	Bit 4

Instruction @336 always yields a radius value.

NC MD	Bit no.							
	7	6	5	4	3	2	1	0
5012					Control interface with DB37	Disable MD over-writing with @ command		

Bit 2 When bit 2 is set, machine data cannot be overwritten with the aid of @ instructions.

Bit 3 This bit has to be set in order to activate the V.24 (RS 232 C) interfaces with the aid of DB 27 (PLC controlled input/output via the V.24 (RS 232 C) interface).

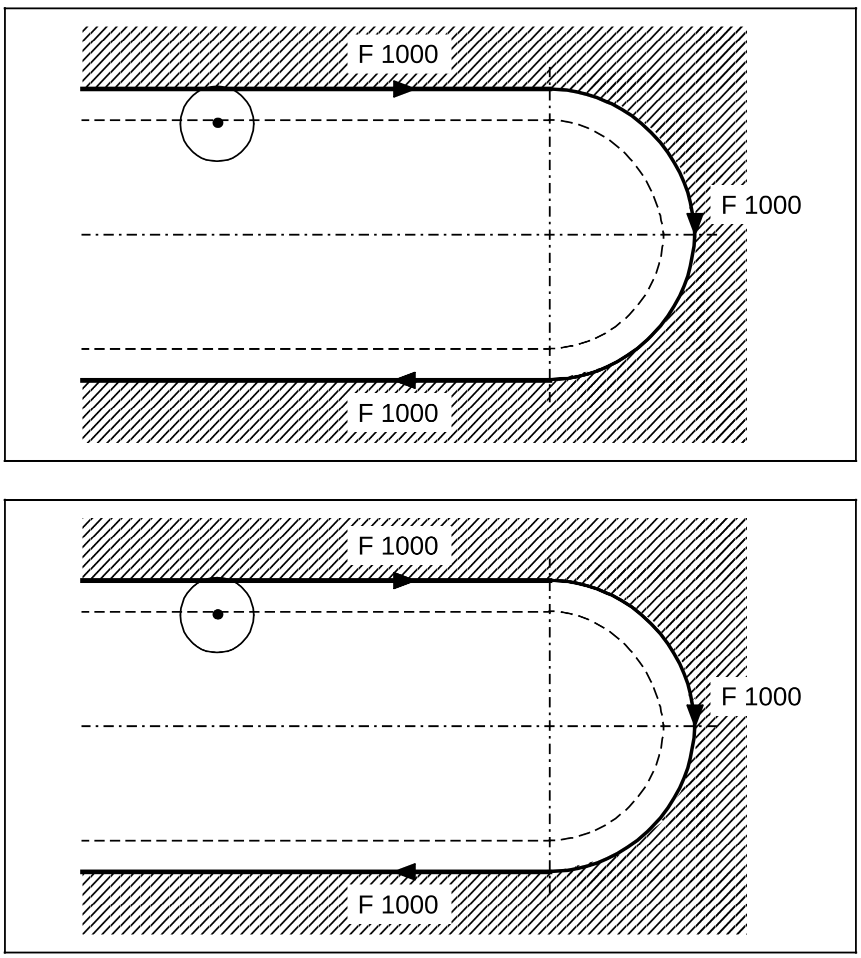
NC MD	Bit no.							
	7	6	5	4	3	2	1	0
5013	Circle radius programming	Polar coordinates		Feedrate not contour-related			Tapping without encoder	G63 without feedrate reduction

Bit 7 With this bit set, a circle can be programmed by specifying the radius and/or angle.

Bit 6 With this bit set, a traverse path can be programmed with polar coordinates.

Bit 4 The programmed feedrate refers to the cutter centre path (tool nose radius centre path).

Example:



Bit 4=0

Constant feedrate at contour

Bit 4=1

Constant cutter feedrate

Cutter feedrate with bit 4

Bit 1 When tapping with the standard cycle L84 (G84), it can be specified whether an encoder (ROD encoder) is available at the spindle.

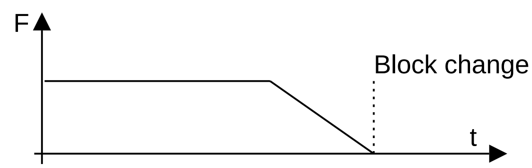
Bit 1= 0: The spindle has an encoder (512 or 1024 pulses). With thread tapping cycle L84, G33 lead I, J, K in mm/rev is thus used.

Bit 1 = 1: The spindle does not have an encoder.
With thread tapping cycle L84, G63 (F in mm/min) is thus used. The programmer must specify the feedrate and spindle speed in such a way as to ensure the correct thread pitch. Minor errors are eliminated by the compensating chuck.

Bit 0 Bit 0 = 0 G63 with feedrate reduction: the control behaves as with G09/ G60.The feedrate is reduced towards block end with reference to the acceleration characteristic.

- Exact stop G09/ G60
- Programmable feedrate limitation

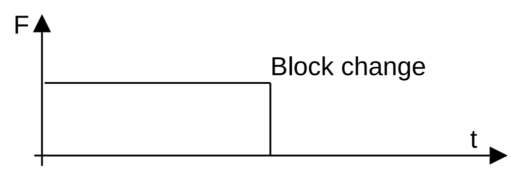
Path speed



Bit 0 = 1 G63 without feedrate reduction: the feedrate is not reduced towards block end.

- Block end reduction is not possible

Path speed



NC MD	Bit no. 7	6	5	4	3	2	1	0
5014	TNRC/ CRC	Blueprint program- ming	Cycles (ref. pt. condition - ing)					

Bit 7 TNRC/CRC: Activation of tool nose or cutter radius compensation (G41/G42)

Bit 6 This bit must be set to 1 if blueprint programming is being used.

Bit 5 Cycles: **The bit must always be set to "1".**

NC MD	Bit no. 7	6	5	4	3	2	1	0
5015							External data input FB 61/62	

Bit 1 This bit must be set in order to transfer data from the PLC to the NC or vice versa with the aid of function blocks FB 61 and FB 62.

NC MD	Bit no. 7	6	5	4	3	2	1	0
5148	INC weighting from the PLC				Prog. analog output in [V]	Own RESET for analog outputs	Basic setting ZO via PLC	

Bit 7 With this bit set, a fixed increment assignment can be made according to the mode code (QB82 bits 0-3) instead of variable increment input by means of the user interface.

Example:

Use of the System 800 mode selector switch

Bit 1 With this bit set, one of the settable zero offsets (G53 to G57) can be selected setting from the PLC as the basic setting (also see Description of Operation Section 11.1).

Bit 3 The 3 analog outputs of the setpoint output module can be programmed either in [V] or in [mV] by means of the auxiliary function H11=**/** H12=**/** H13=.

Bit 3=0: The programmed values have the unit [mV] (-10000 bis +10000).

Bit 3=1: The programmed values have the unit [V] (-10.000 bis +10.000).

Available as from SW 4.2
see also Description of Functions, Section 11.12

Bit 2 With this bit the RESET behaviour of the 3 analog outputs of the setpoint output module can be defined.

Bit 2=0: M02**/**M03 and RESET delete the setpoints programmed with H11=**/** H12=**/** H13=

Bit 2=1: The setpoints programmed with H11=**/** H12=**/** H13= can be deleted by the PLC by means of Q104.6 when the control is in the RESET state.

Available as from SW 4.2
see also Description of Functions, Section 11.12

Bit 1 When this bit is set one of the settable zero offsets (G53-G57) can be selected as basic setting from the PLC (see also Description of Functions, Section 11.1).

NC MD	Bit no.							
	7	6	5	4	3	2	1	0
5149	Colour	Incr. mode data menu						Second language

Bit 7 If a colour monitor is used the colour display of the operator interface must be selected with this bit.
Bit 7 = 0 Operator interface in grey scales
Bit 7 = 1 Operator interface in colour
provided as from software version 4.1

Bit 6 With this bit you can select whether to have the appropriate basic menu or the data area menu list selected displayed when a data area is selected.
Bit 6 = 0 Basic menu (standard)
Bit 6 = 1 Data area menu last selected
provided as from software version 4.1

Bit 0 The second language can be selected with this bit (active after POWER ON).

Example:
Standard software German/English
Bit 0 = 0 German selected
Bit 0 = 1 Foreign language selected (English)
Other languages Option

NC MD	Bit no. 7	6	5	4	3	2	1	0
5150				Velocity overlay offset: 10		Operator guidance	Simulate key/menu code	Track key/menu code

Bit 4 With option E87 ”Velocity overlay by handwheel pulses” the velocity offset achieved can be reduced by setting this bit to $^1/_{10}$ of the previous value.
from software version 2.2
machine data modification is active immediately.

Bit 2 Activation of ”Operator guidance” function (parameter support of subroutines)
provided as from Software Version 2.2
see also NC MD 32 and Programming documentation, Section 12
machine data modification active immediately

Bit 1 Activation of "Simulate key/menu code" function (simulate key operation)
see Interface Description Part 1 Signals Section 3.3.6

Bit 0 Activation of "Track key/menu code" function
see Interface Description Part 1 Signals Section 3.3.6

NC MD	Bit no. 7	6	5	4	3	2	1	0
5151	Connect-ing standard motors				No rapid M function transfer to PLC	Reset M functions at last par-tial set-point value	Reset M functions at exact stop	

Bit 7 Activation of "Connecting standard motors" function
Available as from SW version 4.2
Machine data modification effective after POWER ON
See also Description of Functions, Section 11.8

Bit 3 With this bit, transfer of the rapid M functions to the PLC can be disabled. The NC then no longer needs to wait for the acknowledgement signal "M functions received" from the PLC and can process the block faster.
provided as from software version 4.1
machine data modification is active after POWER-ON
see also Section 11.9, Description of Functions

Bit 2 With this bit, resetting of the rapid M function signals at the time of outputting the last partial setpoint from the IPO (last chord) can be selected; i.e. when the axis has reached its programmed position as far as computation is concerned.
provided as from software version 4.1
machine data modification is active after POWER-ON
see also Section 11.9, Description of Functions

Bit 1 With this bit, resetting of the rapid M function signals on reaching the exact stop coarse can be selected.
provided as from software version 4.1
machine data modification is active after POWER-ON
see also Section 11.9, Description of Functions

NC MD	Bit no.							
	7	6	5	4	3	2	1	0
5152					Reset test 4th axis	Reset test 3rd axis	Reset test 2nd axis	Reset test 1st axis

Bits 0 to 3 These bits define which axes are to be tested to determine the conditions for resetting the rapid M functions (see also NC MD 5151 bit 1 or 2).
provided as from software version 4.1
machine data modification is active after POWER-ON
see also Section 11.9, Description of Functions

NC MD	Bit no.							
	7	6	5	4	3	2	1	0
5200	Spindle override effective with thread cutting	No M19 abort with RESET	M19 with axis movement		Speed in 0.1 rev/min	Pulse generator available	Actual value sign change	Actual value ×2

Bit 7 **Caution:** When the bit is set, a change in the following error (due to modified spindle speed) produces a thread fault.

Bit 6 Bit 6=1 M19 is not interrupted with RESET or M02/M30 (program end)
Bit 6=0 M19 is interrupted immediately with RESET or M02/M30

Bit 5 Bit 5=1 Signifies no waiting for positioning of the main spindle; instead, the next program block (possibly with axis movement) is executed after output of M19 to the PLC (simultaneous positioning of axes and spindle).

Bit 3 The programmed S word is given the dimension (0.1 rev/min), i.e. the speed range is between 0.1 (rev/min) and 1200 (rev/min).

Bit 2 Must be set if a function is wanted that requires a spindle pulse generator.
- G33 (thread cutting)
- M19 (oriented spindle stop)
- G95 (feedrate per revolution)

The control requires a pulse encoder with 1024/ 512 pulses per revolution. The pulse encoder is assigned by means of NC MD 4000.

Bit 1 Resetting the bit produces a software change of sign in the spindle encoder pulses.

Bit 0 Bit 0=1 Doubles the pulses coming from the encoder. This is necessary if a pulse encoder with 512 pulses per revolution is used.

NC MD	Bit no.							
	7	6	5	4	3	2	1	0
5210	Spindle available	Inde-pendent spindle RESET	Spindle speed ac-ceptance after ac-know-ledgement	M19 acknow-ledgement by PLC or M03/M04			Set value sign change	

Bit 7 Spindle available
Up to 4 axes and one spindle can be connected. All spindle MD are first activated with this bit 7 (including spindle override).

Caution:
This bit is active only after Power On.

Bit 6 With this bit set, the Reset key on the machine control panel does not affect the spindle. In this case, the spindle's independent reset (Q101.5) takes effect when the control is in the Reset state.

Bit 5 Spindle speed acceptance only after acknowledgement by the PLC. With this bit set and AUTOMATIC GEAR SELECTION (Q101.3), the CHANGE GEAR (I115.7) signal must be reset by the PLC user program. Only then is the new setpoint speed output.

Bit 4 Bit 4=1 M19 acknowledgement by
1. ACKNOWLEDGE M19 (Q103.2) PLC signal.
2. M03/ M04 from NC program (if MD 5200 bit 5 = 1)

Bit 4=0 M19 is acknowledged by cancelling the spindle enable (Q 100.7).

Bit 1 Resetting the bit produces a change of the set value sign. With bit 1 = 0, a positive set speed is output to the main spindle with M03. The set value may also be reversed from the PLC with the INVERT SPINDLE SPEED (Q 101.4) interface signal.

NC MD	Bit no.							
	7	6	5	4	3	2	1	0
5400		Feedrate in $^{m}/_{min}$	0	0				Aux. functions to PLC

Bit 6 Bit 6=0 Reset (default setting)
Feedrate in [mm/min]

Bit 6=1 Feedrate in [m/min]

This machine data is effective in all metric input systems. The maximum actual speeds specified in the machine data remain unaffected by the machine data. The feedrate value display depends on the machine data. The feedrate value of F external and dry run feedrate is not converted to [m/min].

Note:
The feedrate values programmed in the NC program are now also dimensioned in $^{m}/_{min}$.

Bit 5, 4 These bits must always be set to 0.

Bit 0 Bit 0=0 disables output of auxiliary functions to the PLC.

NC MD	Bit no.							
	7	6	5	4	3	2	1	0
5460		Auxiliary functions not skipped during block search but output immediately H		T	S	M		No aux. function output with block search

Bit 6, 4,3,2 The auxiliary functions specified here are not skipped with block search, but output immediately (may result in several switching functions being triggered in rapid succession via the PLC).

Bit 0 If this bit is set, all auxiliary functions are skipped with block search.

Examples of possible bit patterns:

	Bit pattern for bits 6	5	4	3	2	0	Significance
Example a)	irrelevant					**1**	**No auxiliary function output**
Example b)	**0**	**0**	**0**	**0**	**0**	**0**	**All auxiliary funcitons are skipped and the last auxiliary function is output after NC Start**
Example c)	**1**	**0**	**1**	**1**	**1**	**0**	**All auxiliary functions are output during block search**
Example d)	**0**	**0**	**0**	**0**	**1**	**0**	**M functions are output during block search; H, T, S functions are skipped**
Example e)	**1**	**0**	**0**	**0**	**0**	**0**	**H functions are output during block search; T, S, M functions are skipped**

etc. etc.

NC MD	Bit no. 7	6	5	4	3	2	1	0
5480	Name of abscissa (horizontal axis) for G16 (same code as for axis definition)							
5500	Name of ordinate (perpendicular axis) for G16 (same code as for axis definition)							
5520	Name of applicate (vertical axis) for G16 (same code as for axis definition)							

These MD specify which axes define the space (planes) following NC Start. The basic setting can be altered in the program by means of G16.

The basic setting may have to be modified if, for instance, the cutter length is to be corrected in the Y or 4th axis. The G16 planes must also be redefined if the 4th axis is declared the main axis.

Coding of addresses (axis names)

Bit No. 7 ... 4	Bit No. 3 ... 0
always 0000	Address name
	X= 0000
	Y= 0001
	Z= 0010
	A= 0011
	B= 0100
	C= 0101
	U= 0110
	V= 0111
	W= 1000
	Q= 1001
	E=1010

e.g. 0000 0010 = Z
0000 1001 = Q

NC MD	Bit no. 7	6	5	4	3	2	1	0
5540	Number of axis with constant cutting speed							

Number of axis with constant cutting speed G96
Machine data 554* determines which axis is to be the reference axis for the constant cutting speed function G96 S... .

MD 554*	0000 0000	≙	Axis 1
	0000 0001	≙	Axis 2
	0000 0010	≙	Axis 3
	0000 0011	≙	Axis 4

NC MD	Bit no. 7	6	5	4	3	2	1	0
5580							No CRC alarm when D no. changed	Axis supple-ment after block search

Bit 0 Bit 0 = 0 Axes are not supplemented after block search and NC Start. Only the axes programmed in the target block are traversed.

Bit 0 = 1 Axes are supplemented after block search.

Programming example (current axis position: X33, Y93, Z-25):

```
:
:
N5  G0  X0  Y0  Z0
N10  X100  Y2100  Z100
N15  T1  D1
N20  M50  X200
N25  ...
:
:
```

In the event of advance to block N20, the other axes are moved to the position of block N10 after NC Start and M50 is output.

Position:	before block search:	X33	Y93	Z-25
	after block search:	X33	Y93	Z-25
Position:	after NC Start or processing N20:	X200	Y2100	Z100

Caution:

The traversing block after block search is executed with linear interpolation (possible risk of collision).

Bit 1 When TNRC/CRC are selected, alarm 3021, ”TRC/CRC contour error” may be given when the tool offset number is changed. Machining is then stopped. In such a situation, the alarm and machining stop can be prevented by setting this bit although the contour error has been recognized.

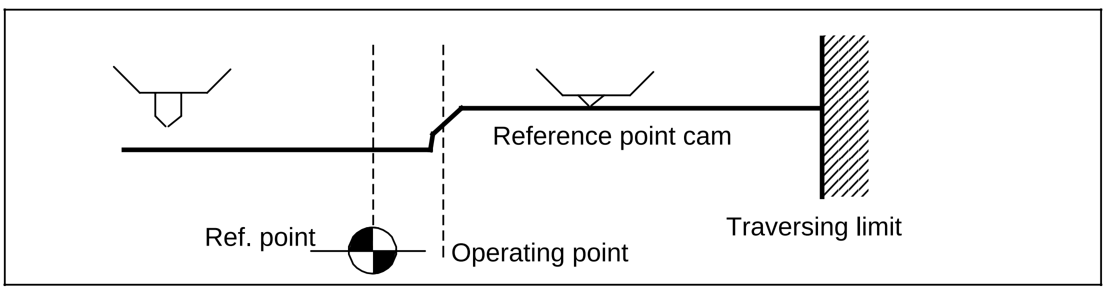
Bit 1 = 0: Alarm is generated, machining is stopped
Bit 1 = 1: Alarm and machining stop are suppressed.

NC MD	Bit no.							
	7	6	5	4	3	2	1	0
560*	Display actual value modulo 360°	Automatic reference point approach	Software limit switch and working area limitation	No start disable for reference point	Rounding for rotary axes active	Rounding to whole degrees instead of half degrees		No measuring circuit monitoring

Bit 7 For rotary axes only. The actual value display jumps from 359.999 to 0 degrees after 1 revolution of the rotary axis.

Bit 6 Bit 6=0 If the axis is between the reference point cam and EMERGENCY STOP after the NC has been switched on, the axis moves to EMERGENCY STOP during the approach to reference point since the NC cannot detect from the "*Deceleration" interface signal whether the axis is ahead of or behind the reference point cam.

Bit 6=1 The NC can detect precisely the direction of the reference point from the "*Deceleration" interface signal since the reference point cam extends as far as the traversing limit.



Position of the reference point cam

Bit 5 Bit 5=0 Causes the software limit switches (software limit switches 1 + 2) and working area limitations to be overrun without response.

Bit 4 Bit 4=1 A program can be started with NC START without reference point approach in this axis. Specific axes can therefore be excepted from reference point approach using this bit.

Bit 3 Effective only for rotary axes
Bit 3=1 Causes the rounding routine to be active. Rounding to half degrees is carried out as standard.

Bit 2 Effective only for rotary axes (prerequisite: bit 3=1)
In the JOG mode, rouning (positioning) to whole or half degrees is performed depending on bit 2 so that the rotary table can be correctly lowered into the rim gear. In the automatic mode, alarm 2064 (rounding for rotary axis incorrectly programmed) is activated with unrounded increments.

Bit 2=1 Rounding to whole degrees
Bit 2=0 Rounding to half degrees

Bit 0 Bit 0=1 Alarm 132* (control loop hardware) is disabled. The cable to the measuring system is no longer monitored for correct pulses and breaks.

NC MD	Bit-Nr.							
	7	6	5	4	3	2	1	0
564*	Axis exists		Rotary axis	Standard motor axis (as from SW 4)		Actual value sign change	Set value sign change	Ref. point approach in negative direction

Bit 7 The set bit causes the axis to appear on the screen and the position controller and measuring circuit monitor to be activated.

Note:

The position controller and measuring circuit monitor become active only after POWER ON although the axis address is displayed immediately on the screen.

The axes must be defined in ascending order (it is not possible to define a 2nd axis without having a 1st axis).

Bit 5 If an axis is declared a rotary axis, the following functions assume a different significance:

- Programming in degrees
- Resolution fixed to 0.001 degree

Combinations of possible rotary axis functions:

Rotary axis 564*.5	Modulo progr. 572*.2	Modulo act. val. 560*.7	
0	0	0	Linear axis
1	0	0	Resolution 10^{-3}, range overflow correction, absolute display, @ function modulo, absolute data channel transfer, programming as for linear axis
1	0	1	Resolution 10^{-3}, range overflow correction, modulo display, @ function modulo, modulo data channel transfer, programming as for linear axis
1	1	1	Resolution 10^{-3}, range overflow correction, modulo programming (display @ function data channel transfer) modulo
1	1	0	Use not allowed
0	0	1	Use not allowed since modulo conversion of actual values is performed with a resolution of 10^{-3}
0	1	1	
0	1	0	Use not allowed

Bit 4 If this bit is set, an axis is declared the standard motor axis (see also Section 11.8 CONNECTION OF STANDARD MOTORS).
For standard motor axes NC MD 204* and 208 are no longer valid as exact stop limits, but NC MD 380* (exact stop limit coarse) and NC MD 384* (exact stop limit fire).
provided as from software version 4.1
machine data modification is active after POWER-ON

Bit 2 The sign of the measuring system pulses can be interchanged by resetting the bit. This is necessary if the axis traverses uncontrollably at maximum speed or if Alarm 112* (zero-speed control) is set during installation with standard MD.

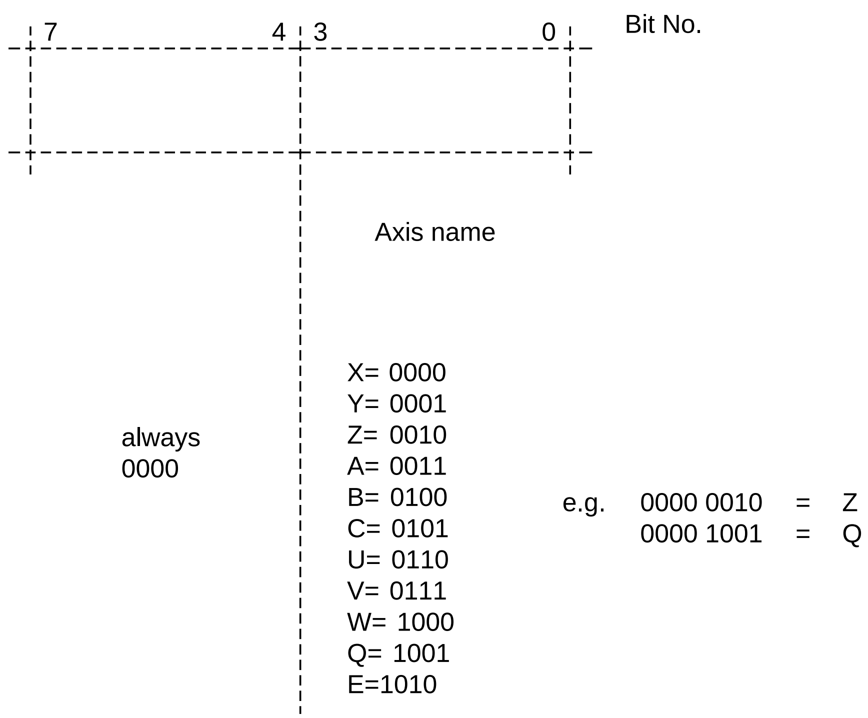
Bit 1 Resetting the bit produces a change in the polarity of the speed controller set voltage (necessary if the axis moves in the mechanically incorrect direction). Either bit 1 **or** bit 2 must be changed if the position control direction is inverted. Both bits must be changed if the position control direction is correct but the traversing direction is incorrect.

Note:

This bit is not active with a standard motor axis

Bit 0 Bit 0=0 Start of reference point approach with "+" key
Bit 0=1 Start with "-" key

NC MD	Bit no.							
	7	6	5	4	3	2	1	0
568*	Axis name							



NC MD	Bit no. 7	6	5	4	3	2	1	0
572*				Rotary axis full/half circle progr.	TO mirroring for transverse axis	Modulo 360° program. with rotary axes	Trans-verse axis	

Bit 4 Bit 4 = 0 All current offsets (e.g. zero mark offset, TO ...) are added to the programmed path in the block decoding after the Modulo calculation (G90, G68).
This means that axial traversing paths of more than 360° can result.

Bit 4 = 1 If this bit is set only paths less than or equal to 360° can arise.
See also Section 11.5, Rotary axis function

Bit 3 If the transverse axis is mirrored, this MD can be used to select whether the TO is also to be mirrored (also see Interface Description Part 1 Signals)

Bit 2 Bit 2=1 The guidelines for modulo programming of rotary axes apply (Section 11.5, Rotary axis function)

Bit 1 If an axis is defined as a transverse axis, special functions can be activated:

- MD 5011 bit 6 actual value display in diameter
- MD 5011 bit 4 diameter programming for G90
- MD 5011 bit 2 handwheel/DRF in diameter
- TO wear in diameter
- PRESET in diameter
- MD 572* bit 3

NC MD	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	+/–
–								
–								
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

Note:

MD Nos. 6000 to 6249 are used only with the ”Leadscrew Error Compensation Option”.

9 PLC Description

9.1 Technical data

- 128 bytes Inputs
  of which max. 44 bytes free for user
  (4 bytes central inputs, 40 bytes distributed inputs)

- 128 bytes Outputs
  of which max. 44 bytes free for user
  (4 bytes central outputs, 40 bytes distributed outputs)

- 256 bytes Flags
  of which 63 bytes free for user
  24 bytes reserved for standard FBs
  31 bytes transfer flags

- 32 timers 0...31
  Timers from 0.1 s ...9990 s
- 32 counters 0...31

all free for user

- STEP 5 programming language (see "PLC Programming, SINUMERIK 805" for instruction list)

- 8 Kbytes for program blocks (including pre-header)
  16 Kbytes (as from software version 4.1)
- 32 Kbytes (as from SW 4.1, as an option)

- 4 Kbytes for data blocks (including pre-header)
- 6 Kbytes (as from SW 4.1)
- 8 Kbytes (as from SW 4.1 as an option)

- PLC cycle time=12 x scanning time of position controller

- 5.0 ms Response time for PLC interrupt processing (OB2)
  (as from SW 4.2 4.0 ms)

9.2 PLC MD, PLC MD bits

9.2.1 Overview of PLC MD

PLC MD	Areas
0 . . . 19	System data
1000 . . . 1007	User MD words
2000 . . . 2003	System bits
3000 . . . 3003	User MD bits

All PLC MD become active only after a PLC cold restart (Power On).

9.2.2 PLC MD description

PLC MD 0	No. of interrupt-processing input byte

If interrupt-driven program processing has been activated (PLC MD bit 2002.0 = 0), the bits of the input byte entered in this MD are checked for edge changes according to the position control cycle (currently 5.0 ms). In the event of an edge change at one of these inputs, OB2 (Alarm OB) is called and processed.

Input range: IB 0 - IB 31
Default setting: IB 3

Note:

If interrupt-processing is not selected, this input byte behaves like normal I/Os. The alarm input byte can be located in the area of central and distributed I/Os.

PLC MD 1 — Max. permissible interpreter running time in percent (0B1 + 0B2)

The PLC program is stored in the control not in an assembler program but in MC5 code (machine code of STEP 5 programming language). The MC5 interpreter translates every STEP 5 command into assembler and processes the PLC program.
Because of the single processor system, only a certain amount of the CPU load is available to the MC5 interpreter for processing the cyclical and interrupt controlled PLC program. This maximum CPU load is stated in % with reference to 12 · position control cycle or 4 · position control cycle (depending on PLC MD bit 2003.6).

Example:

PLC MD bit 2003.6="0" (no segmenting)	PLC MD bit 2003.6="1" (segmenting S5 program)
Position controller scanning time =	4.0 ms (as from SW 4.2) 5.0 ms (as from SW 4.1)
12 · 4.0 ms=48 ms (cycle time)	4 · 4.0 ms=16 ms
assuming: PLC MD 1=15%	
0.15 · 48 ms=7.2 ms	0.15· 16 ms=2.4 ms

i.e.: the maximum permissible interpreter running time (OB1 + OB2) must not exceed 7.2 ms (2.4 ms) with a CPU load of 15 %.

If the MC5 interpreter exceeds this specified percentage CPU load, the reaction is according to PLC MD bit 2003.1:

PLC MD bit 2003.1="0"	PLC MD bit 2003.1="1"
PLC does **not** assume stop state	PLC assumes stop state
Display of Alarm 6159 (running time exceeded S5 program)	

Standard value: 15%
max. value: 20%
min. value: 5 %

PLC MD 3 — Max. permissible interpreter running time 0B2

This MD specifies the maximum permissible interpreter running time in µs that can be required for OB2 (Alarm OB) within 4 · scanning time of the position controller. The OB2 can be called and processed a maximum of 4 times within this period.

Example : assuming PLC MD 3 = 2000 µs

i.e.: to avoid the interpreter running time being exceeded in the worst possible case (4 alarms within 4 · scanning time of the position controller), OB2 must have a maximum interpreter running time of 2000 µs/4=500 µs.

If this maximum interpreter running time is exceeded, the reaction is according to PLC MD bit 2003.1:

PLC MD bit 2003.0="0"	PLC MD bit 2003.0="1"
PLC does **not** assume stop state	PLC assumes stop state
Display of Alarm 6160 (running time exceeded OB2)	

Standard value: 2000 µs
max. value: 2500 µs
min. value: 1000 µs

PLC MD 5 — Cycle time monitoring

The maximum time in ms which the PLC user program (OB1 + OB2) is allowed to require. If this time is exceeded, the PLC assumes the stop state and Alarm 6161 (cycle time exceeded) is displayed.

Standard value : 300 ms
max. value : 320 ms
min. value: 100 ms

The cycle time is understood as the period between two OB1 processing starts.

PLC MD 6	No. of the last enabled STEP 5 timer

The user has a maximum of 32 timers (0-31) at his disposal in the STEP 5 program. These timers must be systematically updated, i.e. processed, by the system program even if they are not programmed by the user. This causes an unnecessary strain on the CPU by the PLC system program. PLC MD 6 allows the user to determine the timers, from T0 to T31, that he enables for his STEP 5 program.

Example:

PLC MD 6 = 10
T 0 to T 10 = 11 timers are enabled

Standard value : 15
max. value : 31
min. value: 1

PLC MD 8	No. of the interface for DB37

This PLC MD assigns the PLC a serial interface. This interface can be controlled by means of DB 37 (see also NC MD 5012.3).

Only one interface can be active at any one time with the SINUMERIK 805.

PLC MD 10-19 — 1st byte of the DMP stations

Various types of DMP stations (distributed machine I/O devices) are currently available for expansion purposes:

The type of station and thus the number of required input and output bytes is determined with reference to a module code (fixed).

The maximum of 5 DMP stations (differentiated by means of the user addresses, settable on the DMP station) are addressed only if the number of the 1st input or output byte is entered as follows in the relevant PLC MD:

PLC MD		DMP stations with station address
10	1st input byte	02
11	1st output byte	02
12	1st input byte	03
13	1st output byte	03
14	1st input byte	04
15	1st output byte	04
16	1st input byte	05
17	1st output byte	05
18	1st input byte	06[1)]
19	1st output byte	06[1)]

Standard value: 0 ≙ DMP station not available
max. value: 73 for input bytes (for DMP stations with 32 inputs)
63 for output bytes (for DMP stations with 16 outputs)
min. value: 4

Note:

- The number of the 1st byte (and also the following used bytes) must be within the range of the distributed I/O devices (IB4 - IB76 or QB4 - QB46).
- Alarm 6140 (MD 10 - MD 19 DMP start address error) is displayed in the event of incorrect addressing.
- With input stations the PLC MD for the 1st output byte is without any significance.

1) *as from SW version 4.2*

Bits for PLC MD 1000-1007	User MD words

These MD words can be freely used by the user. With each COLD RESTART of the PLC, they are transferred to flag bytes 121 to 135 where they can be processed by the PLC program (e.g. to supply timers).

PLC MD	Flag word	
1000	FW 120	(FY 120 and FY 121)
1001	FW 122	(FY 122 and FY 123)
1002	FW 124	(FY 124 and FY 125)
1003	FW 126	(FY 126 and FY 127)
1004	FW 128	(FY 128 and FY 129)
1005	FW 130	(FY 130 and FY 131)
1006	FW 132	(FY 132 and FY 133)
1007	FW 134	(FY 134 and FY 135)

Note:

Depending on PLC MD 2000 (PLC user MD in BCD), the values are stored in the relevant flag words in PLC MD 1000-1007 as a fixed-point or BCD number.

Input range: 0-32767 with fixed-point number
0-9999 with BCD number

Bits for PLC MD 2000	PLC user MD in BCD

Bit:	7	6	5	4	3	2	1	0
	FW134 in BCD	FW132 in BCD	FW130 in BCD	FW128 in BCD	FW126 in BCD	FW124 in BCD	FW122 in BCD	FW120 in BCD

PLC user MD 1000-1007 can be stored as both fixed-point numbers (value range: 0-32767) and BCD numbers (value range: 0-9999) in the relevant flag words.

The distinction is based on the corresponding bit in PLC MD 2000: Bit="0" Fixed-point No.
Bit="1" BCD number

Example: PLC MD 1006=2048

MD 2000.6 =	"0":	FW 132	KH=0800 (Fixed-point number)
MD 2000.6 =	"1":	FW 132	KH=2048 (BCD number)

Bits for PLC MD 2001 — NC PLC data transfer in BCD code

Bit:	7	6	5	4	3	2	1	0
	H No. in BCD	T No. in BCD	S No. in BCD	M No. in BCD				

Bit 4 - 7: These 4 bits can be used to determine whether the numbers of the auxiliary functions (M, S, T and H function) are transferred from the NC to the PLC as fixed-point or BCD numbers.
(Value ranges: see Interface Description Part 1 Signals Section, "Auxiliary function output (NC PLC)").

Bit="0" Fixed-point number
Bit="1" BCD number

The numbers of the auxiliary functions are transferred to the following flag words:

M No.	(M word 1-3)	FW 55, FW 59, FW 63
S No.	(S word)	FW 67 and FW 69
T No.	(T word)	FW 73 and FW 75
S No.	(H word)	FW 79 and FW 81

Bit 3: When DB 37 (PLC controlled data transfer) is in use, this bit can be used to select whether the area limits are given in BCD code or as fixed-point numbers (provided as from software version 2.2).

Bit="0" Fixed-point number
Bit="1" BCD number

Bits for PLC MD 2002

Bit 0 No PLC interrupt processing (OB2)

Bit = 0 When a bit in the alarm input byte changes edge (specified by PLC MD 0), the system program calls OB2.
If OB2 is not available, Alarm 6105 (MC-5 block missing) is displayed.

Bit = 1 The system program ignores the alarm input byte.

Bit 2 Alarm 6163 not displayed

If the SINEC L2 LAN link is used and the data received from the L2 module were not transferred to the PLC by a RECEIVE job within 20 PLC cycles, Alarms 6163 ”Time monitoring” is generated.

This alarm does not cause a PLC stop.

Bit = 0: Alarm 6163 is displayed

Bit = 1: Alarm 6163 is not displayed

provided as from software version 4.1

Bit 3 Transfer from process image inputs (PII) to process image outputs (PIO)

Bit = 0 The following signals can be transferred from PII to PIO by the PLC user program.

Bit = 1 Before processing the cyclical PLC program, the system software transfers the following signals from PII to PIO. The signals in the PIO can then still be changed by the PLC user program.
The signals in the PIO are not transferred to the NC and thus do not become effective until the cyclic PLC program has been completed.

Signal name	PII	PIO	Signal name
NC Start	I 93 bit 0	Q 87 bit 0	NC Start
NC Stop	I 93 bit 1	Q 87 bit 1	NC Stop
Single block	I 93 bit 6	Q 83 bit 6	Single block
Reset	I 93 bit 7	Q 82 bit 6	Reset
Cancel alarm (acknowl. softkey)	I 103 bit 5	Q 82 bit 5	Cancel alarm
Modes	I 103 bit 0 to 3	Q 82 bit 0 to 3	Modes
DRF shift (DRF) selected	I 104 bit 1	Q 82 bit 7	DRF effective
Rapid traverse override (RVO) sel.	I 104 bit 2	Q 85 bit 5	Rapid trav. override eff.
Program stop (M01) selected	I 104 bit 3	Q 83 bit 3	M01 effective
Dry run feedrate (DRY) selected	I 104 bit 4	Q 83 bit 4	Dry run feedrate
Decoding single block (DBL) sel.	I 104 bit 5	Q 83 bit 5	DEC single block
Skip block (SKP) selected	I 104 bit 7	Q 83 bit 7	Skip block

When using the SINUMERIK 19" slimline operator panel the following must be observed:

Pressing the key switches to the AUTOMATIC mode. This occurs due to the fact that the slimline operator panel sends the same key code for the key as the standard keyboard does for the key "AUTOMATIC mode".

Hence, when pressing the key, the control enters the operating mode code for AUTOMATIC in IB 103. This is then automatically transferred to QB 82 (if the bit is set).

This can be prevented by writing the relevant mode code in QB82 (mode selection) in the user PLC program only if the mode keys are operated on the machine control panel (slimline operatror panel).

Bit 5	Rapid traverse/feedrate override for 3rd/4th axes in T version

This bit functions when the NC-MD are initialized as T machine data in the initialization mode.

Bit = 0 The 3rd and 4th axes always traverse at 100%. No rapid traverse/feedrate override possible.

Bit = 1 Rapid traverse/feedrate override also active for 3rd and 4th axes (auxiliary axes).

Bit 6 — Hand-held unit available

Bit = 0 No hand-held unit available.
Bit = 1 Hand-held unit available. The signals of the hand-held unit are transferred by means of the MPC interface and are represented in the corresponding area of inputs and outputs.

Bits for PLC MD 2003

Bit 0 — PLC STOP with runtime exceeded OB2

Bit = 0 If the interpreter runtime exceeds the value stated in PLC MD 3, only Alarm 6160 (runtime exceeded OB2) is output.

Bit = 1 Interpreter runtime > PLC MD 3
- PLC assumes the stop state
- Alarm 6160 is displayed

Bit 1 — PLC STOP with runtime exceeded OB1 + OB2

Bit = 0 Interpreter runtime > PLC MD 1
- Only Alarm 6159 (runtime exceeded STEP 5 program)
- PLC cycle time can exceed 60 ms

Bit = 1 Interpreter runtime > PLC MD 1
- PLC assumes the stop state
- Alarm 6159 is displayed

Bit 2 PLC STOP when distributed I/O faulty

This bit permits the user to choose whether the PLC assumes the stop state when one of the following distributed I/O device faults occurs. (Fault must occur while PLC is running).

- MPC user does not respond (Alarm 6138)
- MPC transmission error (Alarm 6139)
- Change in distributed I/O devices (Alarm 6147)

Bit = 0 Only the corresponding alarm is displayed with one of the faults stated above. The distributed I/O devices (DMP submodules+hand-held unit) are not processed completely. Only the centralized I/O devices and the keyboard expansion submodules still function.

Bit = 1 The PLC assumes the stop state and the relevant alarm is also displayed with one of the faults stated above.

Bits for PLC MD 2003

Bit 4 STEP 5 system command enable

The system commands (only in FBs) permit direct access to specific addresses in the control storage area. Owing to the difference in application over an S-5 control, the system commands have been disabled by bits.

Bit = 0 LIR; TIR; TNB; TNW disabled
Bit = 1 LIR; TIR; TNB; TNW enabled

Note:

The correct use of the system commands is described in the ”SINUMERIK 805, PLC Programming”.

Bits for PLC MD 2003

Bit 6 Segmentation of STEP 5 program processing

This PLC MD bit is designed to permit adaptation of the PLC user program to the requirements of the machine concerned.

Bit = 0 No segmentation
PLC cycle time = 12 · position controller scanning time;
as from SW 4.2 = 48 ms (up to SW 4.1 = 60 ms),
i.e. interrupt handlers and cyclic programs must not exceed the permissible interpreter runtime of 7.2 ms (with PLC MD 1 = 15 %) within 48 ms
(applies as from SW 4.2)

Bit = 1 Segmentation
The permissible interpreter runtime in PLC MD 1 always refers to a 16 ms interval (up to SW 4.1 20 ms) (4 x position controller scanning time) (i.e. one part of the PLC program is executed every 16 ms
(20 ms) until finished). The cycle time can exceed 48 ms (60 ms) in this context.

Example: Built-in SW version: 4.2

Calculation of the cycle time with a PLC interpreter runtime of 11 ms

PLC MD 1 = 15 %, PLC MD bit 2003.6=1
15 % of 16 ms = 2.4 ms (permissible interpreter runtime per 16 ms)

$$\frac{11.0 \text{ ms}}{2.4 \text{ ms}} = 4.58 \qquad 5 \text{ program parts}$$

Cycle time: 5 program parts x 16 ms = 80 ms

OB1 is called only every 48 ms 80 ms > 48 ms increment

Two 48 ms increments are required to execute the PLC program.

The cycle time is thus 2 x 48 ms = **96 ms**

Bits for PLC MD 2003

Bit 7 — Diagnosis function enable (stored in DB1)

This MD bit enables the diagnosis function for runtime measurements of the PLC program.

Bit = 0 Diagnosis function disabled
Bit = 1 Diagnosis function enabled

Notes:

- Set bit 7 to "1" only during installation and start-up. Reset the bit to "0" after installation and start-up.
- The diagnosis DB has its own initiation bit (D9.15); it is not enough to simply enable the diagnosis function.

Description of diagnosis DB

DW 0 :	Actual cycle time	[ms]
DW 1 :	Actual interpreter runtime OB1 + OB2	[µs]
DW 2 :	Actual cyclic interpreter runtime OB1	[µs]
DW 3 :	Actual interrupt-controlled interpreter runtime OB2	[µs]
DW 4 :	Number of interrupt processing routines per cycle	

Notes:

The measured values refer in each case to the cycle time in DW0 that has just occurred.

DR 8 : Bit 0 MPC does not respond (MPC user >>DL10)
Bit 1 Distributed I/O transfer disrupted
Bit 4 Faulty start addresses distributed peripherals
Bit 5 DMP group fault

DL10 : MPC user belonging to DR8 ($02_{hex} \hat{=}$ submodule No. 2)

DR15 bit 0..bit 4 Module code belonging to the DMP user
$1F_{Hex}$= DMP 16INP/ 16OUT or IP65-DMP
$1E_{Hex}$= DMP 32INP
$1C_{Hex}$= Hand-held unit
17_{Hex}= Machine control panel DMP module of the slimline operator panel
19_{Hex}=DMP compact with 4 input and 4 output modules
$1A_{Hex}$=DMP compact with other components

Bit 6 Bit for DMP 24 V supply not ok.
Bit 7 Bit for overtemperature in DMP submodule (low active)

DW 8
to DW 15: If the PLC does not assume the stop state with the fault messages in DW 8 to DW 15, group bit F8.0 is set in the basic signal flag area.
(The STEP5 user program then initiates the diagnosis DB, reads out the DW 8 - 15 and responds accordingly.)

Initiation options of the diagnosis function

- Periodic display by means of PG function
  STATUS VAR and corresponding initiation program in OB1

```
OB1
C DB 1          Call diagnosis DB
A F 0.7
= D 9.15        Initiation bit for diagnosis
L DW 0          Load cycle time (for example)
T FW 200        Transfer cycle time to FW 200
.
.
.
.
BE
```

DB 1 is called and updated in every cycle. This permits an accurate assessment of running time fluctuations (neither the cycle time nor interpreter run time are constant variables). In addition, this is the only way of showing the interrupt-controlled interpreter runtime (OB2) and the number of interrupt processing routines occurring per cycle (e.g. simulation of change in interrupt input byte).

- Periodic display of individual variables on the NC screen by means of STATUS FW and corresponding initiation program in OB1.

```
OB1
C DB 1        Call diagnosis DB
A F 0.7
= D 9.15      Initiation bit for diagnosis
L DW 0        Load cycle time (for example)
T FW 200      Transfer value of active cycle time to FW 200
.
.
.
.
BE
```

Note:

The active cycle time is stated in FW 200 in hexadecimal form (FW 200 KH = ...);
FW 200 can also be represented in decimal form (KF ...) with the programmer.

PLC MD 3000-3003	User MD bits

These 4 bytes can be freely used by the user. With each COLD RESTART of the PLC they are transferred to flag bytes 116 - 119, where they can be processed by the PLC program.

PLC MD		Flag byte
3000	→	FY 116
3001	→	FY 117
3002	→	FY 118
3003	→	FY 119

9.3 PLC installation and start-up

9.3.1 General

See Section 5.1 for the PLC installation sequence.

INITIALIZATION

In the INITIALIZATION mode, the PLC is in STOP as standard. The outputs can be accessed by means of the PG function CONTROL. The PLC OVERALL RESET function is possible only in STOP.
The PLC can be started by means of the programmer. The PLC is then ready to run, but subject to the following restriction:

- The NC/PLC is in an inactive state for the NC and PLC.

9.3.2 NC machine data for the PLC

The following NC MD and NC MD bits are of special importance for the PLC and must be modified from the standard value where necessary.

- NC-MD bit 5400.0 (Auxiliary function output to PLC)
- NC-MD bit 5460.0 (No auxiliary function output with block search)
- NC-MD bit 5460.2-5460.6 (Auxiliary functions that are not skipped with block search but output immediately)
- NC-MD bit 5004.4 (Independent rapid traverse override)

Selecting, setting and activating interface 1 (see Section 10.4.2)

The following parameters must be set for interface 1:

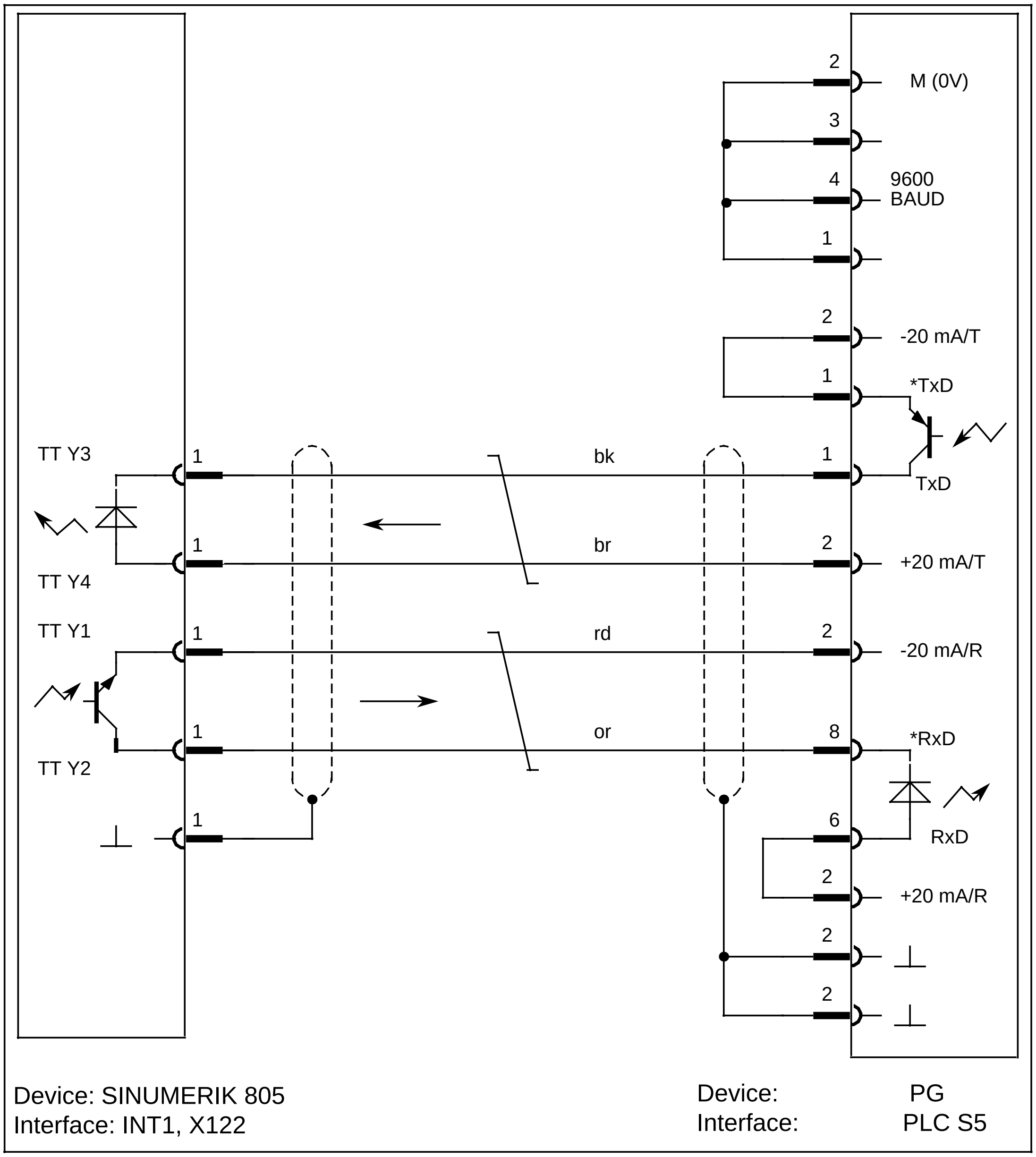
Device type	PLC-PROG
Baud rate	9600
Stop bits	2
Parity	none

9.3.3 Link PLC PG

Hardware preconditions:

For linking with the PLC, the PG 750/685/675/670/635/615 (interface: PLC S5) can be operated only at interface 1 (INT 1, X 122) of the SINUMERIK 805 in the TTY (20 mA) mode with the following cable:

Cable name: PG 750/730/685/675/670/635/615 PLC
Order No.: 6FC 9340-8G



Link image PLC PG

Note:
- An adapter must be used with PG 750/730
- Interface parameters in the NC: PLC-PROG, 9600, no parity, 2 stop bits
- Pressing the softkey READ-IN START, activates the interface for PLC operation.

9.3.4 PG commands

The following functions are available in the control:

- Functions operating only in PLC STOP:
  - I STACK output
  - B STACK output
  - Clear blocks (CLEAR PLC)
  - Initial clear (CLEAR PLC, block B)
  - Compress memory (COMP. PLC)
  - Cold restart of PLC (PLC START)
  - CONTROL (outputs e.g. QB0; only the outputs are controlled, not the process image)

- Functions also operating in cyclic operation:
  - Block input
  - Block output
  - STATUS VAR
  - STATUS block
  - CONTROL VAR
  - SYSPAR (see "PLC Programming Guide, SINUMERIK 805")
  - Information BUCH PLC, OB, PB, FB, SB, DB blocks
  - Output cross-reference list
  - SPAUS PLC (see "PLC Programming Guide, SINUMERIK 805")
  - STOP PLC

The following functions are not available

- Processing check
- PLC warm restart (general)

9.4 PLC operating system

Available functions in the PLC operating system:

- Processing of error messages (Nos.6000 - 6063)
- Processing of operational messages (Nos.7000 - 7063)
- M decoding in static and dynamic flags
- External data transfer PLC-NC with standard FBs
- Transfer of various signals from input image to output image (see PLC MD 2002.3) with PLC MD 2002 bit 3 set.
- PLC STATUS on NC screen
- Transfer between NC/PLC interface and PLC user interface
- Handwheel selection via softkeys
- After PLC OVERALL RESET, the following blocks are initialized and loaded by the operating system:

DB	1	FB	62
DB	36	FB	65
DB	37	FB	66
FB	11		
FB	60		
FB	61		

9.5 PLC status

9.5.1 General

A PLC Status function is incorporated in the PLC operating system as a service and test aid. In this mode, the inputs, outputs, flags, timers and counters operands can be displayed and modified as follows:

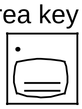
Operand	Example	Read	Write	Format	Value	Area
Inputs		yes	yes			0-127
	I0.0			B	0	
	IB 2			B	0101 1010	
				H	5A	
				D	90	
	IW 2			B	0101 1010 1100 0011	
				H	5AC3	
				D	23235	
Outputs		yes	yes			0-127
	Q 0.1			B	1	
	QB 20			B	1101 0110	
				H	D6	
				D	214	
	QW 20			B	1101 0110 1100 0011	
				H	D6C3	
				D	40379	
Flags		yes	yes			0-255
	F 0.7			B	0	
	FY 60			B	1011 0100	
				H	B8	
	FW 60			D	180	
				B	1011 0100 0100 0000	
				H	B880	
				D	47232	
Timers		yes	no			0-31
				B		
				H		
				D		

Formats: B= binary
H= hexadecimal
D= decimal

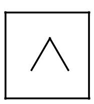
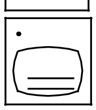
Operand	Example	Read	Write	Format	Value	Area
Counters		yes	no			0-31
				B H D		
Data block **Data word**		yes	yes			0-255 0-255
	DB 3 DW 9			H D B	A 10 0000 0000 0010 0000	

Formats: B= binary
H= hexadecimal
D= decimal

9.5.2 Selection of PLC STATUS

1. Operator area key  Branches from any machine area menu to the basic menu of the data area
2. Softkey DIAGNOSIS
3. Softkey PLC STATUS

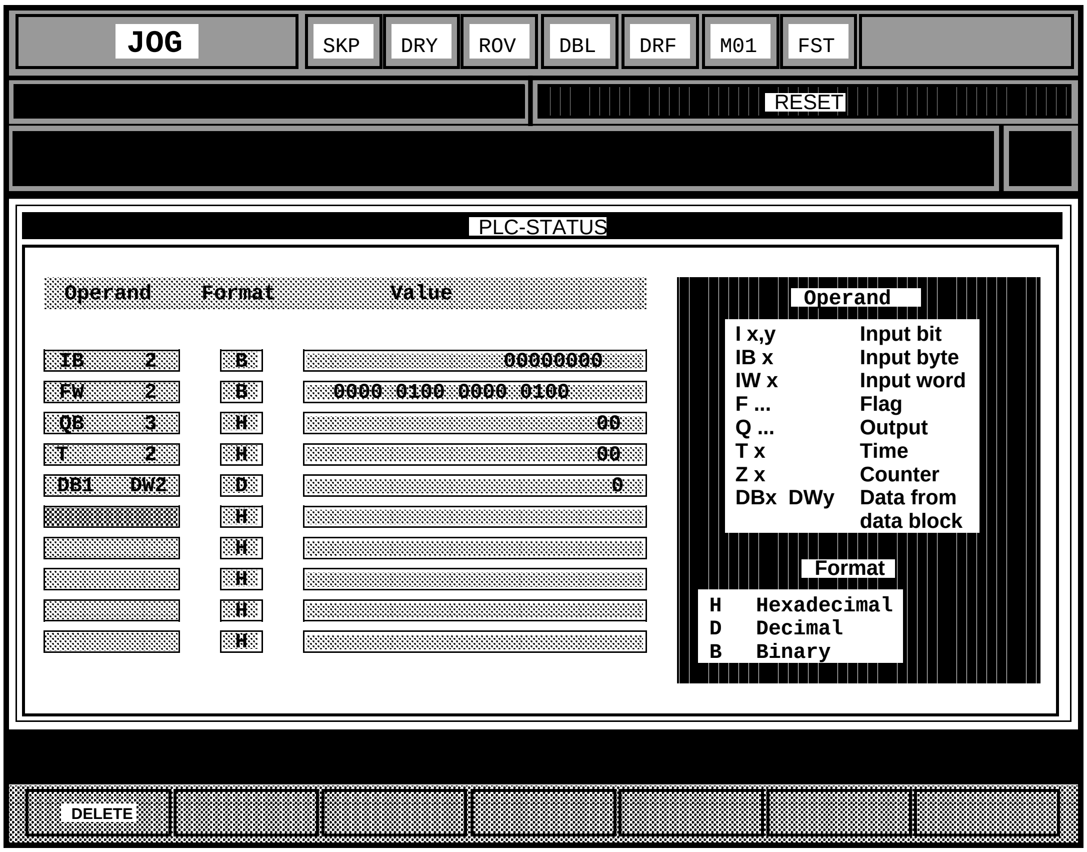
Note:

- Key:  Return to previous menu
- Key:  Return to basic menu of set mode in machine area
- The operands and format settings entered remain until the initialization mode is selected again (as from software version 4.1).

9.5.3 Reading and writing in the PLC status

The required operands are written consecutively in the opened input field and transferred one by one with the input key. The format or the value (only with inputs, outputs and flags) of the operands can be modified subsequently by direct input in the format or value control field. The following formats can be set for the value representation:

B =binary
H =hexadecimal
D =decimal



10 Data Backup with Programmer

10.1 General

On the SINUMERIK 805 all data and programs can be input and output with the PG 675/ PG 685/PG 750 devices via the V.24 (RS232 C) interface in conjunction with the relevant TRANS-PGIN software. The editors ED, WordStar or VEDIT are available for compiling and documenting part programs.

This Section describes the operating sequence for the SINUMERIK 805, data handling in conjunction with PG 675/PG 685/PG 750, the associated operating system and TRANS-PGIN/PCIN.RS

The following table illustrates the relationship between devices, operating system and order numbers:

Device	Operating system	Order No. Quick Reference	Order No. TRANS-PGIN/PCIN
PG 675	CP/M-86	C79000-M 500-C54-1	German: 6FC 3981 -7AJ English: -7BJ
PG 685	PCP/M-86	C79000-B85000-C352-01	German: 6FC 3981 -7AL English: -7BL
PG 750	MS-DOS 3.10	C79000-M8700-C426-01	German: 6FC 3981 -7AN English: -7BN

10.2 Diskette handling

The operating system is loaded when the device is switched on.

PG 675: CP/M-86: The operating system is loaded from the system diskette in drive A.

PG 685: PCP/M-86:
PG 750: MS-DOS 3.10: The operating system is loaded from the hard disk (if a diskette is inserted in drive A, the PG expects to locate the operating system on the diskette).

10.2.1 Formatting an empty diskette

Before data can be stored an a diskette, it must be formatted (note: write protection must be disabled).

PG 675: CP/M-86

The diskette to be formatted is inserted in drive B and formatted with the FORMAT program.

Call: A> **FORMAT** **Return** key

Response: CP/ M86 DISK FORMAT UTILITY VERSION 1.0
Type "C" to cancel
Unformatted disk in drive B: ? (Y/N)

Input: **Y** or **N** (Yes / No)
after entering Y, the system initiates the format routine for the
diskette in drive B:

Response: Format started

On conclusion, the system enquires whether a further diskette is to be formatted. Exit the format function by entering N for "No" and the Return key.

PG 685: PCP/ M-86

The diskette inserted in drive A is formatted with the DSKMAINT program.

Call : B> **DSKMAINT** **Return** key

The main menu of this program appears on the screen. Insert the diskette to be formatted in drive A. Press function key **f7** for the formatting routine. The formatting menu appears on the screen. Press key **f1** to select the diskette in drive A as the target diskette.

Response: Formatting the diskette in drive A:
The function erases any data on the target diskette in A.
Is this what you want to do (Y or N)?

Input: **Y** or **N** (Yes / No)
Following the Y input, the system initiates the format routine for
the diskette in drive A.

On conclusion, the system enquires whether a further disk is to be formatted. Enter N for "No" and press the Return key to exit from the format function and return to the main menu.

PG 750: MS-DOS 3.10

The diskette is formatted by means of the **FORMAT** program.

Call:
– For 1.2 MB: C> **Format A: /V** **Return** key
– For 360 KB: C> **Format A: /4 /V** **Return** key

Response: Insert new diskette in drive A: and press RETURN key when ready.
When the RETURN key is pressed, the system starts the formatting routine for
the diskette.
Response: Formatting operation running ...-
When formatting is complete, the following message appears:
Formatting operation running ... formatting complete

Prompt: Diskette/disk label
(11 characters, RETURN if no label desired)

After the diskette label has been entered and/or the RETURN key has been pressed, an inquiry appears asking whether a further diskette is to be formatted. The formatting function is exited by keying in N for ”No” and pressing the RETURN key.

10.2.2 Copying a diskette

For reasons of data security, it is always a good idea to create two diskettes (one working and one backup diskette).

PG675: CP/M-86

Diskettes can be copied with the **COPYDISK** program.

Call: A> **COPYDISK** **Return** key

Response: CP/ M86 FULL DISK COPY Utility
Version 2.0
Enter Source Disk (A-D) ?

Input: A(B) (Source drive)

Response: Destination Disk Drive (A-D) ?

Input: B(A) (Destination drive)

Response: Copying Disk A(B): to Disk B(A):
Is this what you want to do (Y/N)?

Input: **Y** or **N** (Yes / No)
After entering Y, the system initiates the copying routine from A (B) to B (A).

On conclusion, the system enquires whether a further diskette is to be copied. Enter N for "No" and press the Return key to exit from the copy function.

PG685: PCP/ M-86

Diskette copying with the **DSKMAINT** program.

Call: B> **DSKMAINT** **Return** key

The main menu of this program appears on the screen. Press function key **f3** for copying. Press key **f1** twice to select the source and destination drives (since there is only one diskette drive).

Response: Copying from diskette in drive A:
to diskette in drive A:
This function erases the data on the diskette in drive A:
Is this what you want to do (Y/N)?

Input: **Y** or **N** (Yes / No)

Response: Copying from the diskette in drive A:
to the diskette in drive A:
INSERT SOURCE DISKETTE AND PRESS ANY KEY

Insert the diskette to be copied and press any key.

Response: Copying from the diskette in drive A:
to the diskette in drive A:
INSERT DESTINATION DISKETTE AND PRESS ANY KEY

Insert the empty diskette and press any key.

The copying routine is executed in stages in this case, whereby the diskette being copied (source) and empty diskette (destination) are inserted alternately in the diskette drive. On conclusion, the system enquires whether a further diskette is to be copied. Press key **f8** to exit from the copy function and return to the main menu.

PG 750: MS-DOS 3.10

The diskette is copied by means of the **DISKCOPY** program.

Call: C> **DISKCOPY A: B:** **Return** key

Antwort: Insert source diskette in drive A
Insert destination diskette in drive B.
When ready, press any key.

The diskette to be copied is inserted in source drive A and a formatted blank diskette in destination drive B. The program starts the copying operation after any key has been pressed.

When copying is complete, an inquiry appears asking whether a further diskette is to be copied. The copying function is exited by inputting N for ”No”.

Note:

When copying is carried out with only one disk drive, this serves as both the source and destination drive. In this case, copying is carried out in steps, the diskette to be copied (source) and the blank diskette (destination) being inserted alternately in the disk drive.

10.2.3 Changing diskettes

With the PG675 the diskette has to be logged on with CTR C after each diskette change in order to permit writing on the new diskette. If this is omitted, processed data cannot be stored, because a write protection is activated by the diskette change (message: Bdos Error R/O).

With the PG 685/PG 750 the diskette does not have to be logged on with CTR C after a diskette change in order to write on the new diskette.

10.2.4 Listing a directory

The hard disk or diskette directory can be listed on the screen or output with the printer (hardcopy key) and the diskette status monitored with the following functions.

PG675: CP/ M-86

Call:		A> **DIR**	**Return** key
	or	A> **DIR B:**	**Return** key

The files stored on the diskette in drive A or B are listed without stating the storage size.

Call:		A> **STAT *.***	**Return** key
	or	A> **STAT B:*.***	**Return** key

The stored files are listed, stating the size of the individual files, the total storage space occupied and the storage space still free on the diskette. The diskette status "RW" (READ/WRITE) or "RO" (READ ONLY) is provided as additional information. 340 Kbytes are available on an empty diskette.

PG685: PCP/M-86

Call:		B> **DIR**	**Return** key
	or	B> **DIRS**	**Return** key
	or	B> **DIR A:**	**Return** key
	or	B> **DIRS A:**	**Return** key

The files stored on the hard disk or diskette in drive A are listed without stating the storage size. With the DIR command, the names of the files with the DIR attribute are listed. Files with the SYS attribute are listed with DIRS.

Call:		B> **DIR [SIZE]**	**Return** key
	or	B> **DIR A: [SIZE]**	**Return** key

The stored files are listed, stating the storage volume of the individual files as well as the total occupied storage capacity of the hard disk or diskette in drive A.

Call:		B> **SHOW**	**Return** key
	or	B> **SHOW A:**	**Return** key

Response: e.g. A: RW, free storage capacity 84K

The free storage space on the hard disk or diskette can be displayed with the command SHOW. The status is indicated as "RW" (READ/WRITE) or"RO" (READ ONLY). 694 Kbytes are available on an empty diskette.

PG 750: **MS-DOS 3.10**

Call: B(C)> **DIR [/p] [/w]** **Return** key

or B(C)> **DIR A(B): [/p] [/w]** **Return** key

The files stored in the current directory of the hard disk or the floppy in drive A(B) are listed. The size in bytes, the date and the time of day of the last processing are given for each file. The free storage space and the number of files in the directory are also shown.

The capacity of a blank diskette is 1.2 MB or 360 KB in the case of the PG 750.

Two switches can be used in conjunction with DIR:

The /p switch activates the page mode. In this mode, the output of the directory halts after one screen page until any key is pressed.
The /w switch activates the "wide" display. In this mode, the file names are output without the remaining file information. Five files are then displayed in each line.

10.3 File handling

Files are stored on diskette or hard disk. They are addressed by means of their file names.

The complete file name is made up of three parts:

1. Name of the drive
2. File name (basic name)
3. File type

Example: B> **VEDIT A: TESTPROG. SY8**

File type

File name

Name of drive

The file name comprises 1 to 8 characters. The file name is separated from the file type by a full stop. The file type comprises 1 to 3 characters. The file name and file type are freely selectable. They are allowed to contain all characters with the exception of certain special characters (see Quick Reference for the operating system of the device concerned).

The drive name must always be stated first when the stated file is not to be stored on the logged-on diskette. If the file is to be stored on the logged-on diskette drive, the name of the drive does not have to be stated.

10.3.1 Displaying a file

The contents of any file can be displayed on the screen with the command file **TYPE**. This command makes it easier to check the contents of a file because it is not necessary to run an editor.

TYPE <drive>:<file name> **Return** key

Example: **TYPE A:PC.DOC**

The screen display can be stopped and restarted with larger files.

PG 675:	CP/ M-86	stop with CTRL S, resume with CTRL Q
PG 685:	PCP/ M-86	stop with CTRL S, resume with CTRL W

In the case of the PG 750, the screen display can be called up page by page by applying the TYPE command:
TYPE <drive> : <file name> **|** More **Return** key
Example: TYPE A: PC.DOC **|** More

10.3.2 Copying files

Files can be copied with the command file **PIP**.

- Copying without changing the name
  PG 675: CP/ M-86

A>PIP B:=A:TEST.805	copy from A: to B:
A>PIP A:=B:TEST.805	copy from B: to A:

  PG 685: PCP/ M-86

B>PIP B:=A:TEST.805	copy from A: to hard disk
B>PIP A:=B:TEST.805	copy from hard disk to A:

  PG 750: MS-DOS 3.10

C>COPY TEST.810 A:	copy from hard disk C: to drive A:

- Copying and renaming
  PG 675: CP/ M-86

A>PIP TEXT.NEW=TEXT.OLD	on diskette in drive A:
A>PIP B: TEST.1=B:TEST0	on diskette in drive B:

  PG 685: PCP/ M-86

B>PIP TEXT.NEW=TEXT.OLD	on hard disk
B>PIP A:TEST.1=A:TEST0	on diskette in drive A:

  PG 685: MS-DOS 3.10

C>COPY TEXT.OLD=TEXT.NEW	from hard disk
C>COPY A: OLX.TEXT=A:NEW.TEXT	on diskette in drive A:

- I/O device as destination (NC or printer)
  PG 675: CP/ M-86

A>PIP LST:=B:TESTPROG.805	File on diskette in drive B:

PG 685: PCP/ M-86

B>PIP LST:=A:TESTPROG.805	File on diskette in drive A:

PG 750: MS-DOS 3.10

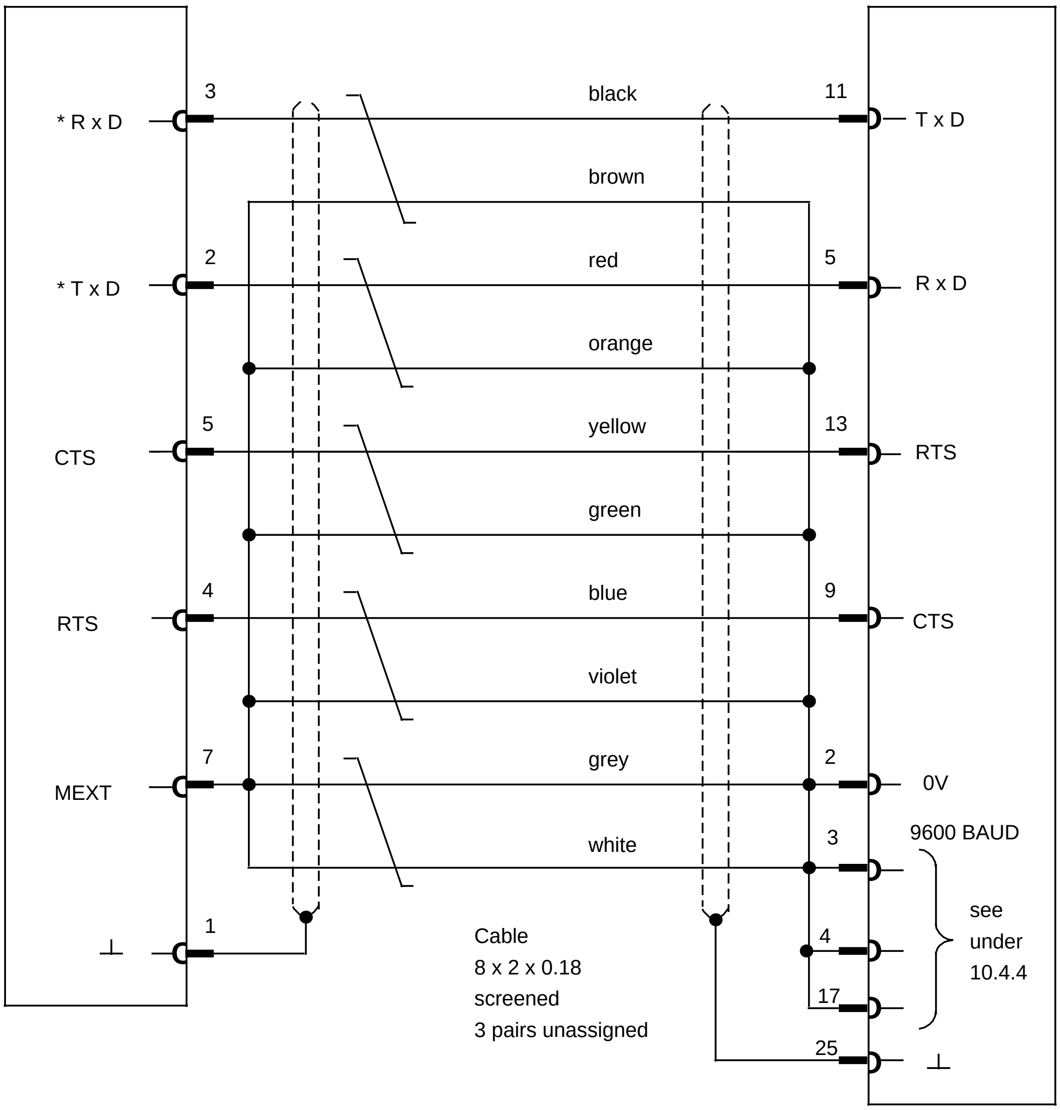
C>COPY TESTPROG COM 1	File on hard disk
C>COPY A:TESTPROG COM 1	File on diskette in drive 1:

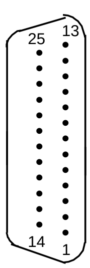
10.4 Data transfer NC PG

10.4.1 Cables

Cable name : Data line PG 675/PG 685/PG 635 (SINUMERIK PGIN)
Order No. : 6FC9 344-1A

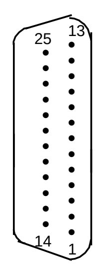
SINUMERIK 805	**PG 685**
PCP location : Central controller	**PG 675**
PCB conn. : Front-panel conn. X 122, 1st interface	**Connector**
X 132, 2nd interface	**Printer (V.24) (RS232 C)**





Connector
Position: 1 at bottom
25-way male
subminiature
Connection side
Housing with sliding
detent
6FC 9 341 - 2AA
Designation: NC

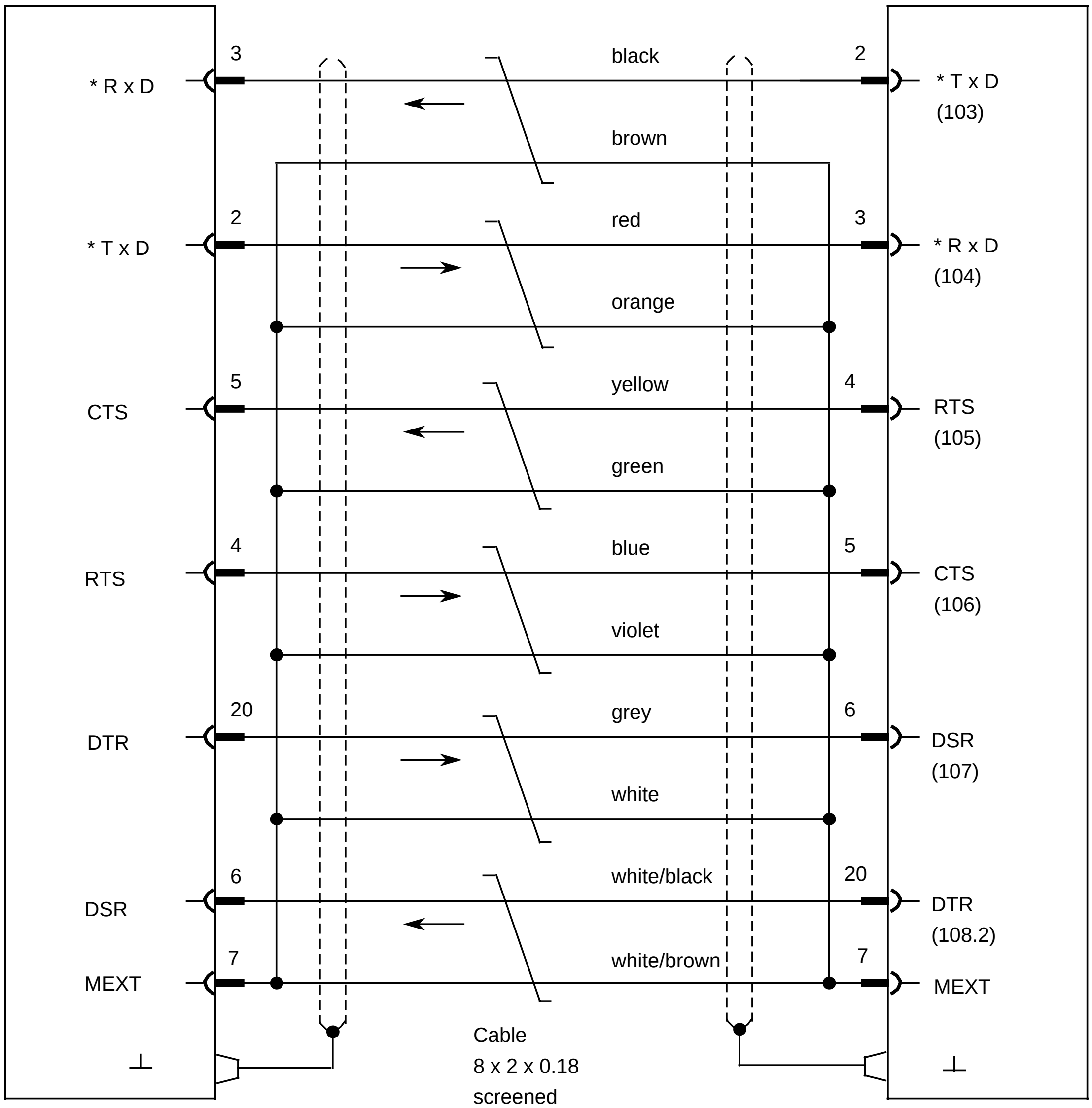
Connector
Position: 1 at bottom
25-way male
subminiature
connector
Connection side
Post Office housing
6FC 9 341 - 1ES
Designation: PG D



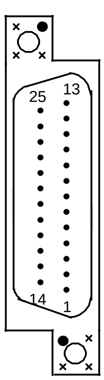
Data line NC PG (PGIN, PIP)

Cable name : PC (AT compatible); PG 750
Order No. : 6FC9 344-4R

SINUMERIK 805 **PG 750**
PCB location : Central controller
PCB conn. : Front panel conn. X 122, 1. interface,
X 132, 2. interface **(RS232 C (V.24)/modem)**

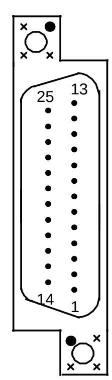


Cable
8 x 2 x 0.18
screened
2 pairs unassigned



Connector
Position: 1 at bottom
25-way male
subminiature
Connection side
Housing with sliding
detent
6FC9 341-2AA
Designation: NC

Connector
Position: 1 at bottom
25-way male
subminiature
Connection side
Post Office housing
6FC9 341-1ES
Designation PC



Data line NC *PG (PCIN)*

10.4.2 Interface parameters to SINUMERIK 805

The interface parameters for interface 1 and interface 2 (Option) are input in the DATA TRANSFER dialog.

Selection of the DATA TRANSFER dialog

1. Operator area key — Branches from any machine area menu to the basic menu of the data area.

2. Softkey DATA TRANSFER — The data transfer menu appears.

3. Softkey PARA-METER — The parameter menu of the selected interface appears.

4. The device type, baud rate, stop bits and parity can now be set to match the connected external device by means of softkeys. The other parameters have to be selected with the cursor keys ↑ and ↓. Now open the field with the edit key and enter the new value. The value is accepted after pressing the input key . The special functions must be selected with the cursor keys ↑ and → activated and deactivated with the +/- key.

5. Key ∧ — Return to data transfer main menu

Parameter	Values
Device type	PLC-PROG, RTS-LINE, Xon/Xoff, PTR. PD/PF
Baud rate	110, 150, 300, 600, 1200, 2400, 4800, 9600
Parity	none, even, odd
Stop bits	1/1.5/2
Xon	Start control character with Xon/ Xoff protocol
Xoff	Stop control character with Xon/ Xoff protocol

10.4.3 Interface parameters on the PG

The printer interface does not need to be initialized with the PG 675.

With the PG685, the printer interface for data transfer to the NC must be initialized to 7 data bits and even parity before being called:

DEVICE LPT0 [DAT=7] (7 data bits) Return key
DEVICE LPT0 [PAR=EVEN] (parity even) Return key

These inputs are not necessary if the **STARTUP.SUB** file supplied with the diskette is copied onto the system diskette of the PG635 or hard disk of the PG685. With each cold restart of the operating system, both DEVICE commands are then automatically executed by the **STARTUP.SUB** file.

On the PG750 the interface is initialized by calling the **MODE** command.

Examples: MODE COM1: 9600, e, 7, 2, p (PG 750)

Stop bits
Data bits
Parity
BAUD rate

This call is not necessary if the command is written into the AUTOEXEC.BAT file. The interface is then initialized automatically every time the operating system is restarted.

10.4.4 Other baud rates (for PG 635, PG 675, PG 685 only)

When using the data line as described under 10.4.1, the baud rate is set to 9600 baud as standard. For different baud rates, the connector to the printer interface must be modified as follows:

Pins (X Pin connected to pin 2)

Baud rate	3	4	17
9600	X	X	X
4800	X	0	X
2400	0	X	X
1200	X	0	0
600	0	X	0
300	X	X	0
110	0	0	X

10.4.5 Data initial identifiers

When data is output, the NC sents certain initial identifiers corresponding to the data type. When reading in from PG675/ PG685, the initial identifiers must exist in the file in the same form.

% MPFxxxx	CR LF	Identifier for main programs
% SPFxxx	CR LF	Identifier for subroutines
% T E A 1	CR LF	Identifier for NC machine data
% Z O A	CR LF	Identifier for zero offsets
% T E A 2	CR LF	Identifier for PLC machine data
% R P A	CR LF	Identifier for R parameter
% S E A	CR LF	Identifier for setting data

10.5 Procedure for transfer from SINUMERIK 805 to PG

a) Connect cable to PG 675/ PG 685: V.24 (RS232 C) interface PRINTER
PG 750: V.24 (RS232 C) interface COM 1

b) Connect cable to NC: V.24 (RS232 C) interface X 122 (interface 1)
V.24 (RS232 C) interface X 132 (interface 2, Option)

c) Load operating system:

CP/ M-86	PG 675
PCP/ M-86	PG 685
MS-DOS	PG 750

d) Initialize printer interface (also see 10.4.3)

e) Select DATA TRANSFER dialog and set the following parameters according to Section 10.4.2:

Device type:	RTS-LINE
Baud rate:	9600
Parity:	none
Stop bits:	2

Press the read-out softkey and branch to the DATA OUTPUT dialog.

f) Select the data type to be transferred using the cursor keys (↑ and ↓).

g) Program call for transfer:

PG 675:A>PGIN <drive>:<file name>
PG 685:B>PGIN <drive>:<file name>
PG 750:C>PCIN <drive>:<file name>

h) Start the PG by means of the RETURN key

i) Start the SINUMERIK 805 by means of the softkey: READ-OUT START

The stated NC programs are now stored under the specified file name on the specified drive on the PG.

During transfer, the received character is output on the PG screen and checked for overrun and frame errors (e.g. incorrect baud rate). If one of these errors occurs, the transfer is aborted and a corresponding text is displayed. The PGIN and PCIN data receive program can store programs with a maximum length of 256 Kbytes.

Data receive ends when:
1. 00HEX has been sent 40 times (output from NC)
2. The "*** " key on the PG 675/685 or the ”ESC” key on the PG 750 is pressed.
3. The number of received characters exceeds the limit of 256 Kbytes.

If the first character (except 00Hex) is a % or CR character, the data initial identifier is evaluated and the data type displayed on the PG screen after transfer.

After transferring main programs or subroutines, a directory with the transferred program numbers and the length of the individual programs is automatically created (see examples). The characters are counted in the same way as in the SINUMERIK.

After the transfer of other data, the data type is displayed but no directory is stored.

If the data initial identifier does not correspond to a known character sequence, the following display appears after the transfer:
"unknown data".

The received characters are nevertheless stored on the hard disk or diskette.

Examples:

Program call	Storage		
	In drive	File name	Directory name
PG675			
A>PGIN NAME	A:	NAME	NAME.DIR
A>PGIN B:NAME	B:	NAME	NAME.DIR
B>PGIN NAME	B:	NAME	NAME.DIR
B>PGIN A:NAME	A:	NAME	NAME.DIR
PG685			
A>PGIN NAME	A:	NAME	NAME.DIR
A>PGIN B:NAME	B:	NAME	NAME.DIR
B>PGIN NAME	B:	NAME	NAME.DIR
B>PGIN A:NAME	A:	NAME	NAME.DIR
PG750			
C>PCIN NAME	C:	NAME	NAME.DIR
C>PCIN A:NAME	A:	NAME	NAME.DIR
C>PCIN B:NAME	B:	NAME	NAME.DIR

When storing a file name with extension, DIR must not be given as extension because the directory is stored with this name.

The directory of the transferred main programs and subroutines can be output with the call TYPE <drive>:<file name>.DIR.

Example:

B>**TYPE A:TEST-L.DIR**

L	95	1609	CH	L	97	1178	CH	L	98	310	CH	L	801	33	CH
L	803	42	CH	L	804	42	CH	L	805	58	CH	L	806	90	CH
L	951	75	CH	L	970	107	CH	L	971	104	CH	L	981	58	CH
L	990	54	CH	L	999	12	CH								

Example:

B>**TYPE A:TEST-%.DIR**

% 120 105 CH % 22 105 CH

10.6 Procedure for transfer from PG to SINUMERIK 805

a) Connect cable to PG 675/PG 685: V.24 (RS232 C) interface PRINTER
PG 750: V.24 (RS232 C) interface COM1

b) Connect cable to NC: V.24 (RS232 C) interface X 122 (interface 1)
V.24 (RS232 C) interface X 132 (interface 2, Option)

c) Load operating system:

CP/ M-86	PG 675
PCP/ M-86	PG 685
MSDOS	PG 750

d) Initialize printer interface (also see 10.4.3)

e) Select DATA TRANSFER dialog and set the following parameters according to Section 10.4.2:

Device type: RTS-LINE
Baud rate: 9600
Parity: none
Stop bits: 2

Press the read-out softkey to branch to the DATA OUTPUT dialog.

f) Program call for transfer:

PG 675:A>PIP LST: = <drive>:<filename>[E]
PG 685:B>PIP LST: = <drive>:<filename>[E]
PG 750:C>COPY<drive>:<file name> COM1

[E]: with display of characters on the screen

g) Start the SINUMERIK 805 by means of the softkey: READ-IN START

h) Start the PG by means of the RETURN key

The stated file is now loaded in the NC.

If several files are to be transferred to the PLC, the PIP program can be called to avoid the repeated PIP system call with the PG675/ PG685.

Example:

1st part	B>**PIP**	**RETURN** key
2nd part	***LST:=<DRIVE>:<FILENAME>**	**RETURN** key

Only the second part of the call needs to be repeated with a new file name in each case.

On conclusion of the transfer, press the RETURN key to exit from the PIP-SYSTEM.

11 Description of Functions

11.1 Basic setting of zero offsets via PLC

Standard

G53 (deselect all ZO) and D0 (deselect TO) normally become effective on the control and the control actual value display after program end (M02/M30) or program abort (reset).

With the start of part program processing (AUTO/MDA), however, the standard program basic setting G54 is immediately effective on the control actual value system.

Allowance is made for the zero and tool offsets (D numbers) in the actual value display only if the "Workpiece-related actual-value-system" setting data is set.

When the function is activated:

The "Basic setting of zero offsets via PLC" function allows the user to define a different zero offset (G54-G57) as the program basic setting, i.e. when processing a part program this ZO specified by the PLC is effective immediately and not G54 as is otherwise the case.

However, this program basic setting also affects the actual value display in the reset state of the control, i.e. the selected zero offset is allowed for in the actual value display.

Also, the length compensation of the last selected D number is still allowed for in the actual value display.

If a part program is now processed, the zero offset specified by the PLC remains effective (exception: if G53 is specified by the PLC, G54 is automatically activated with NC Start). The tool offset is, however, immediately deselected by the basic setting D0.

Preconditions for activating the function:

- NC-MD bit 5148.1 must be set (active after POWER ON)
- The WORKPIECE-RELATED ACTUAL-VALUE SYSTEM function must be activated (setting data)
- Interface signals (QB86 bits 0 to 2) must be initialized accordingly.

The following table shows the interface signals (bit patterns) and their effect:

QB86 Bit 2 1 0	Activated basic setting	Description
0 0 0	G53	All zero offsets are deselected (independent of modes) After NC start, G54 is active as the program basic setting.
0 0 1	G53	Same as bit pattern 000
0 1 0	G54	G54 is activated as the basic setting in all modes
0 1 1	G55	G55 is activated as the basic setting in all modes
1 0 0	G56	G56 is activated as the basic setting in all modes
1 0 1	G57	G57 is activated as the basic setting in all modes

Note:

- A basic setting modification of the PLC does not become effective until after program end (M30/M02) or program abort (reset).
- The zero offsets programmed in the part program have priority in the usual way.

11.2 Output of cam signals

The OUTPUT OF CAM SIGNALS function is available as an option.

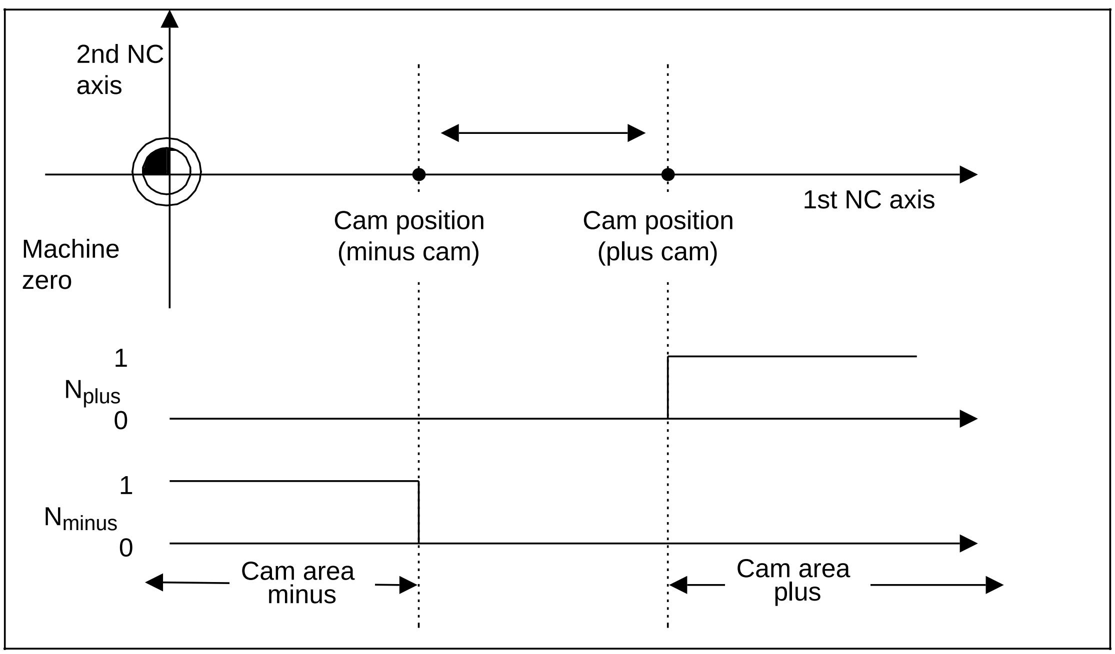
The **OUTPUT OF CAM SIGNALS** function generates **NC control signals** and is parameterized by means of R parameters and machine data. The R parameters contain the axis positions of the individual cams and are grouped together in a cam parameter block. Two of the total of eight cams form a **cam pair** in each case.

Precondition: The "Output of cam signals" option must be available.

Cam signals

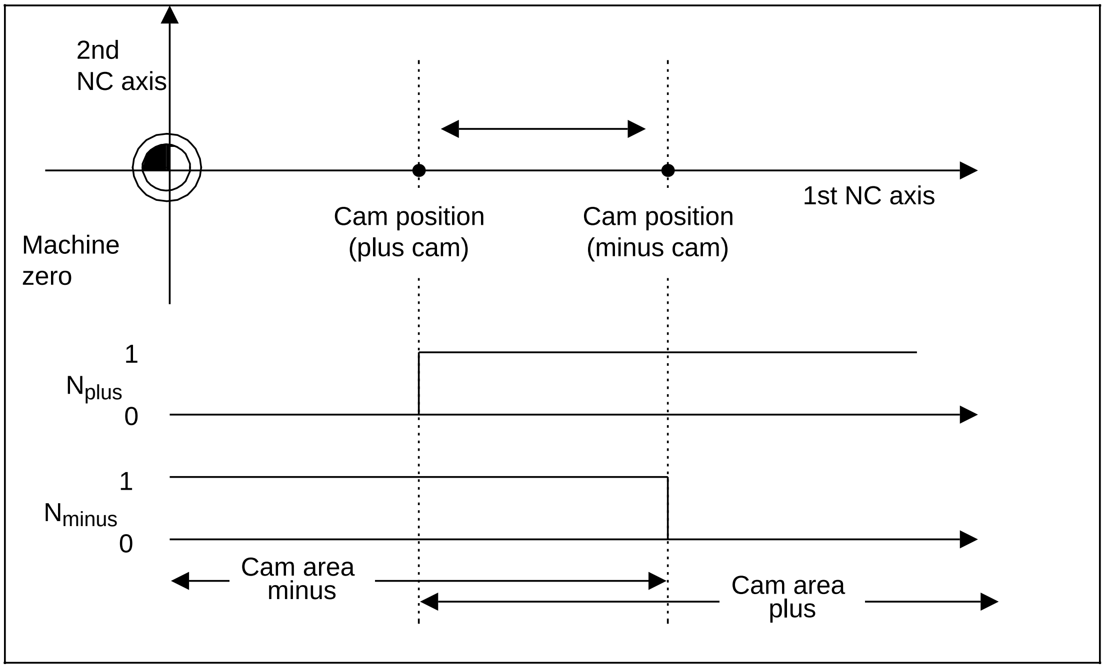
Cam signals are **control signals** of the NC. They represent a cam of infinite length that is activated in a certain approach direction at a defined location (cam position).

The NC control signal assigned to the cam via machine data is entered in the internal NC control signal image when the relevant cam area is reached and cancelled again on leaving the cam area.



Minus cam<plus cam

Note:
Option ”Cam signals output” is only functionable in combination with linear axes!



Plus cam<minus cam

Cam pair and cam area

A cam pair consists of a **plus cam** and a **minus cam**. The plus cam is assigned the axis area greater than its cam position and the minus cam the axis area smaller than its cam position.

The axis area assigned to the cam is referred to as the **cam area**.

Cam parameters

All cam parameters are grouped in an R parameter block. The R parameter block is referred to as a cam parameter block and contains the positions of eight cams, which are grouped into four **cam pairs**.
The cam positions must refer to the relevant machine system, in metric or inch units. The machine-related axis position can be read with @361.
The cam positions are not checked for the maximum traversing range.

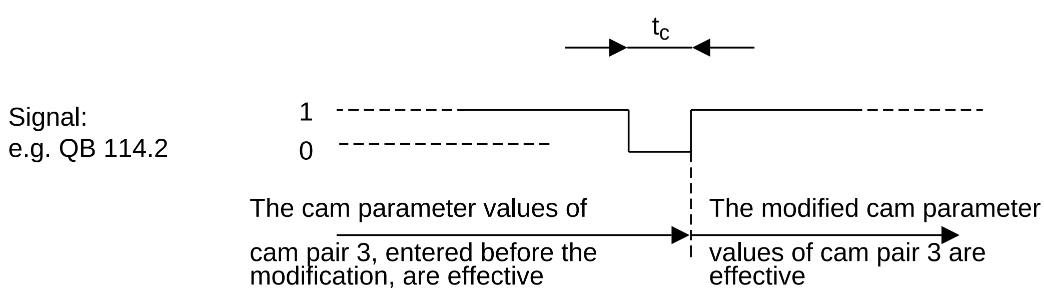
The beginning of the cam parameter block (Rxxx) is determined by means of NC MD 310.

Position minus cam 1	R xxx	Cam pair 1	Cam parameter block
Position plus cam 1	R xxx+1		
Position minus cam 2	R xxx+2	Cam pair 2	
Position plus cam 2	R xxx+3		
Position minus cam 3	R xxx+4	Cam pair 3	
Position plus cam 3	R xxx+5		
Position minus cam 4	R xxx+6	Cam pair 4	
Position plus cam 4	R xxx+7		

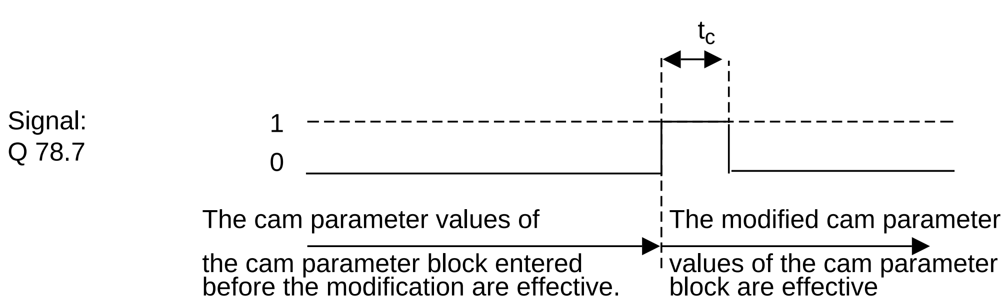
Cam parameter modifications

Modifications to parameter values in the cam parameter block do not become effective until the 0/1 edge of the following signals.

- Axis-specific
  CAM PAIR 1/2/3/4 ACTIVE (QB 110 bits 0-3, QB 114 ...)
  By deactivating cam pair 1, 2, 3 or 4 and reactivating via the NC PLC interface after one PLC cycle time, the cam parameter values corresponding to the cam pair become effective with the 0/1 edge of this signal.



- All
  TRANSFER ALL CAM VALUES (Q 78.7)
  By resetting and subsequent setting of the signal after one PLC cycle time, all parameter values in the cam parameter block become effective with the 0/1 edge.



Note:

t_c = 1 PLC cycle time

Assignment of NC control signal bits to cams

The NC control signal bits are assigned to the cams by means of NC MD 311 to 318 according to the table below. Bits of the 1st control signal byte (1.0 - 1.7 $\widehat{=}$ 10-17 or of the 2nd control signal byte (1.0 - 1.7 $\widehat{=}$ 20-27) can be assigned. These NC control signal bits are then mapped as flag bytes (1st control signal byte as FY 20, 2nd control signal byte as FY 21).

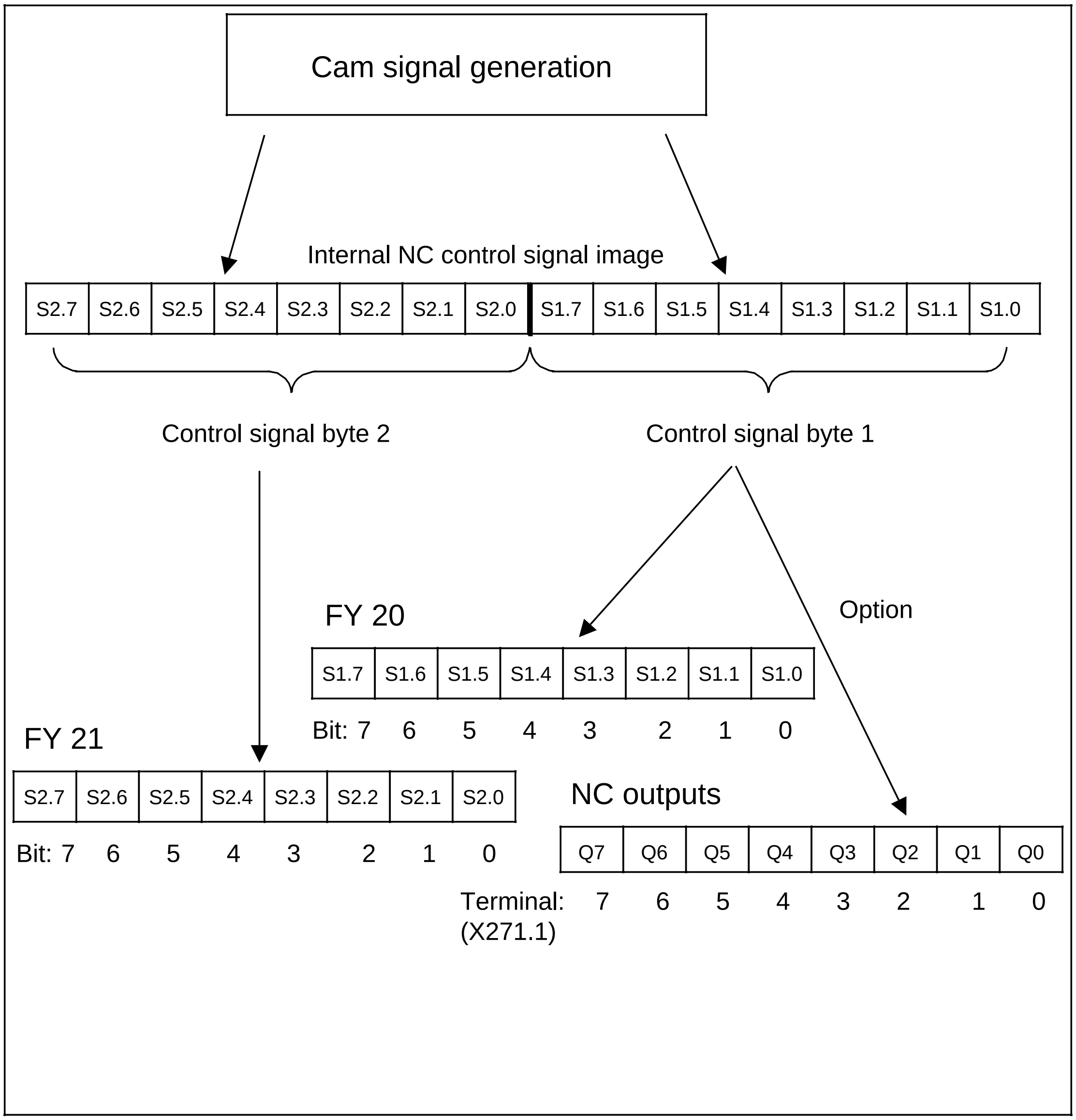
NC-MD No.	Designation		Input range
310	1st R parameter No. of the cam parameter block		0-991
311	NC control signal No. for minus cam	Cam pair 1	10-17 or 20-27
312	NC control signal No. for plus cam		10-17 or 20-27
313	NC control signal No. for minus cam	Cam pair 2	10-17 or 20-27
314	NC control signal No. for plus cam		10-17 or 20-27
315	NC control signal No. for minus cam	Cam pair 3	10-17 or 20-27
316	NC control signal No. for plus cam		10-17 or 20-27
317	NC control signal No. for minus cam	Cam pair 4	10-17 or 20-27
318	NC control signal No. for plus cam		10-17 or 20-27

Note:

The machine data become effective with POWER ON.

NC control signals FY 20, FY 21 and NC outputs Q0 to Q7

The internal NC control signal image (control signal bytes 1 and 2) is transferred to the PLC flag bytes FY 20 and FY 21.
The control signal byte 1 can also be output in the position control cycle via the NC outputs Q0 - Q7with the HIGH-SPEED NC INPUTS AND OUTPUTS option.



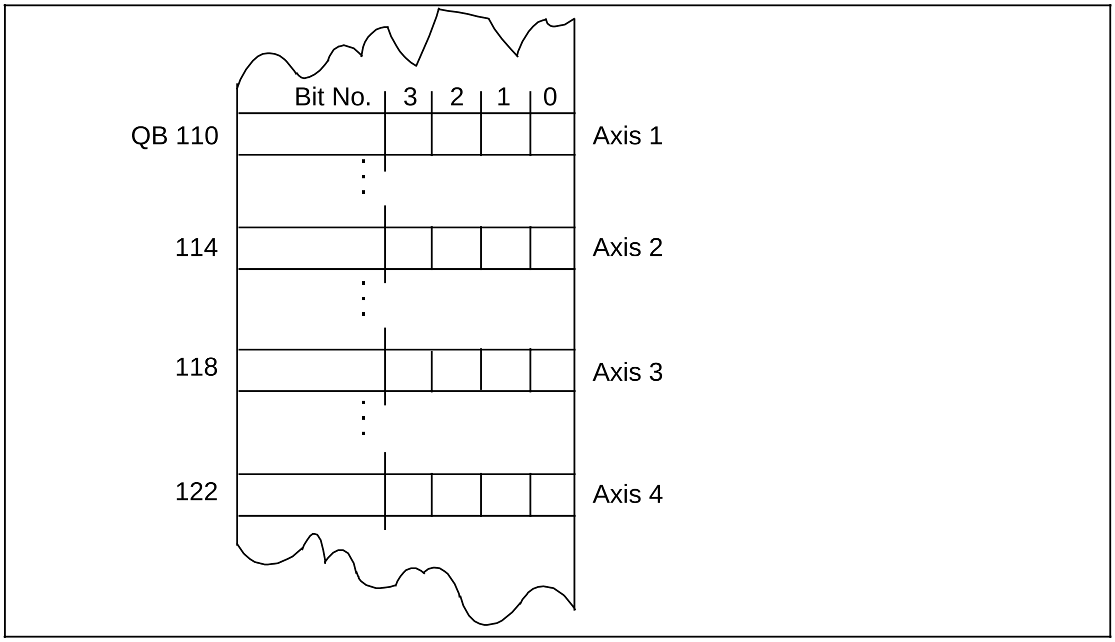
Note:

The ”HIGH-SPEED NC-INPUTS/OUTPUTS” function is an option.

Function activation

The OUTPUT CAM SIGNALS function generates NC control signals only in the activated state. When the function is deactivated, all of the NC control signals set by it are reset.

Activation of the axis-specific function for all cam pairs is via the NC/PLC interface as follows.



Activation of axis-specific function for cam pairs

Bit 3	Bit 2	Bit 1	Bit 0	Function
0	0	0	0	Cam pair function not active
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

Note:

- The cam signals function can be activated in all modes except PRESET and JOG-REFPOINT.
- A cam pair can be assigned to only one NC axis at a time.
- Several cam pairs can also be activated for 1 axis.
- Cam signals are output only after referring to the axes. Excepton: NC-MD 560* bit 4=1.
- The cam signals relate to the machine reference system.

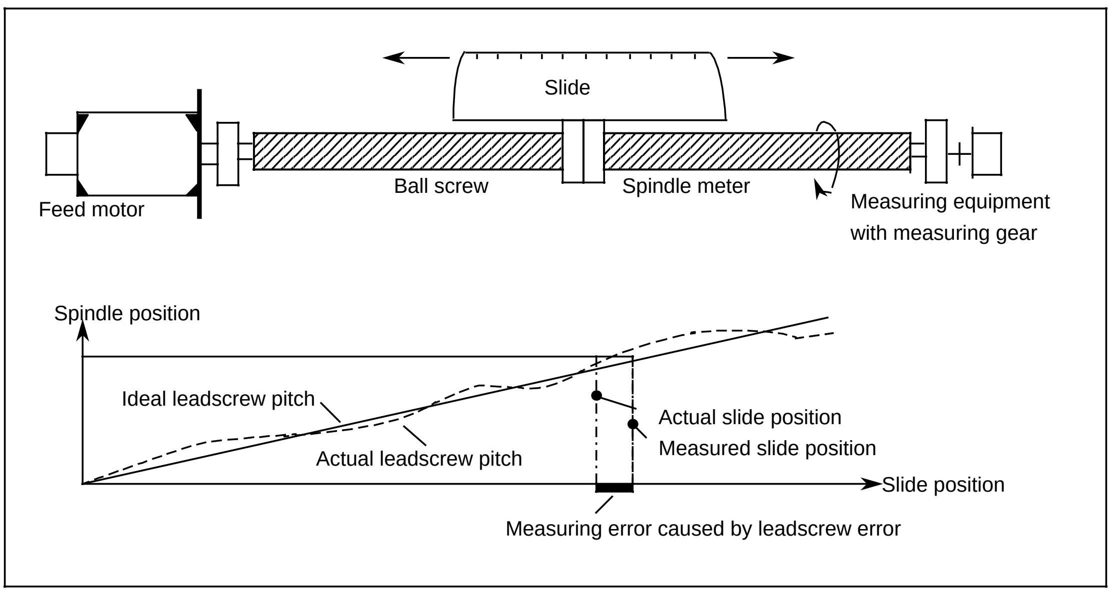
11.3 Leadscrew error compensation

The LEADSCREW ERROR COMPENSATION function is an option.

The principle of INDIRECT MEASUREMENT on NC machines assumes that the pitch of the ball screw is constant at all points within the traversing range so that the actual axis position can 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 (though comparatively small) and any other possible machine-dependent errors must be taken into account.

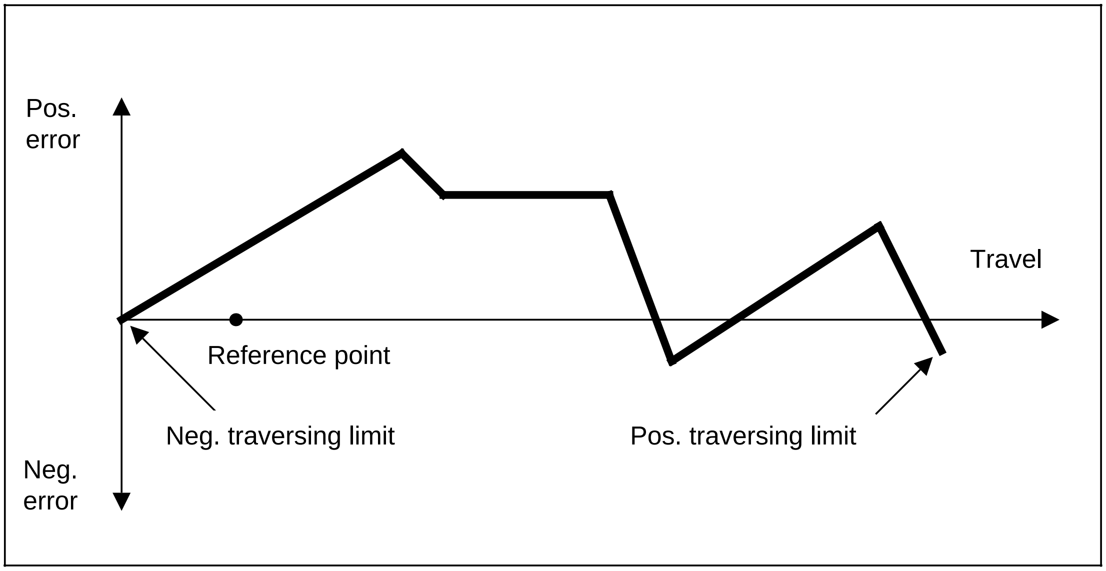
The cumulative error can be determined by plotting an error curve over the entire traversing range of the axis. The reference measuring system used must be a high-precision instrument, e.g. a laser interferometer. The dimensional deviation at the workpiece can be significantly reduced by inputting appropriate compensating values in the control at the installation stage.



Indirect measurement

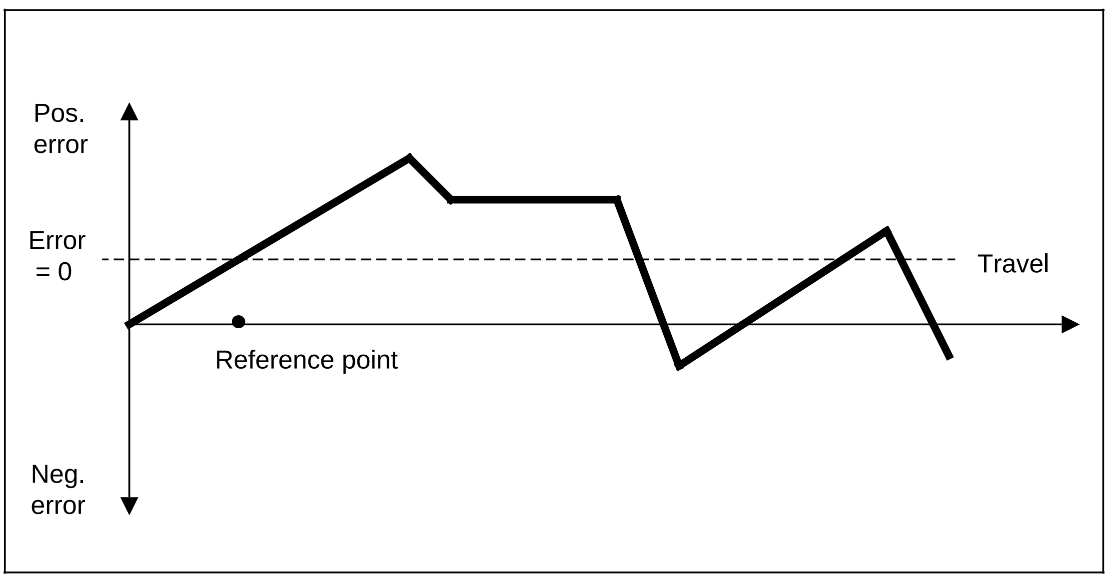
Measurement of leadscrew error in one axis

In order to synchronize the measuring system, the reference point must first be approached. This is followed by travel to the negative range limit of the axis, from which point an error curve is plotted in the positive direction with a precision instrument; the reference point must be marked on the curve.



Recorded error curve

Because compensation is not possible at the reference point, the error curve must be shifted so that the error becomes zero at the reference point.



Error curve with error=0 at reference point

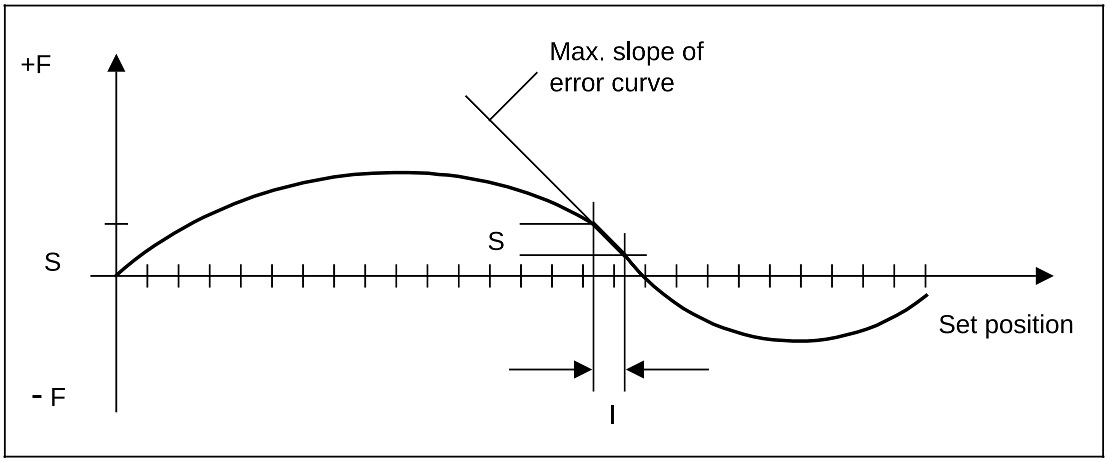
To compensate for the leadscrew error in both directions, a second error curve must be plotted from the positive to the negative range limit and shifted so that the error becomes zero at the reference point.

Spacing between 2 correction positions, compensation amount

A total of 1000 correction positions (1000 compensation points, input in MD 6000-6249) is available for all axes in the SINUMERIK 805. The spacing between 2 correction positions depends on the tolerance of the compensated leadscrew error curve, the actual leadscrew error and the number of possible compensation points.

The following method can be used to determine the spacing between 2 leadscrew error compensation points:

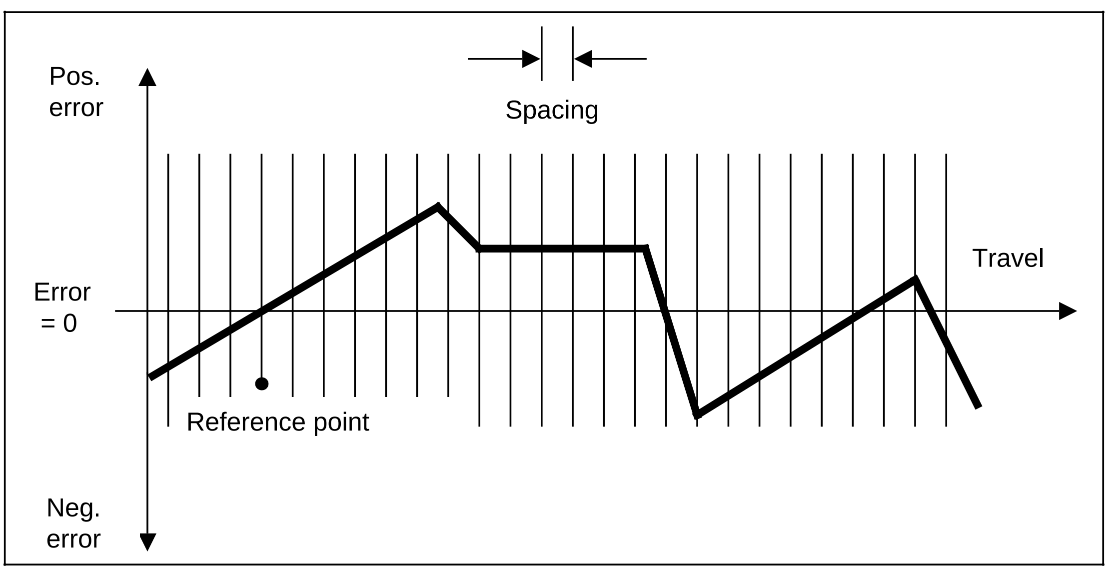
S	:	Compensation amount (e.g. 1/2 tolerance band)	=	MD 328*
I	:	Spacing between 2 correction positions	=	MD 324*



Determination of leadscrew error between 2 points

The point with the greatest leadscrew error is determined and the path (I) is established in which the specified compensation amount (S) is passed through.

The relevant compensation amount 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 to the ideal condition.

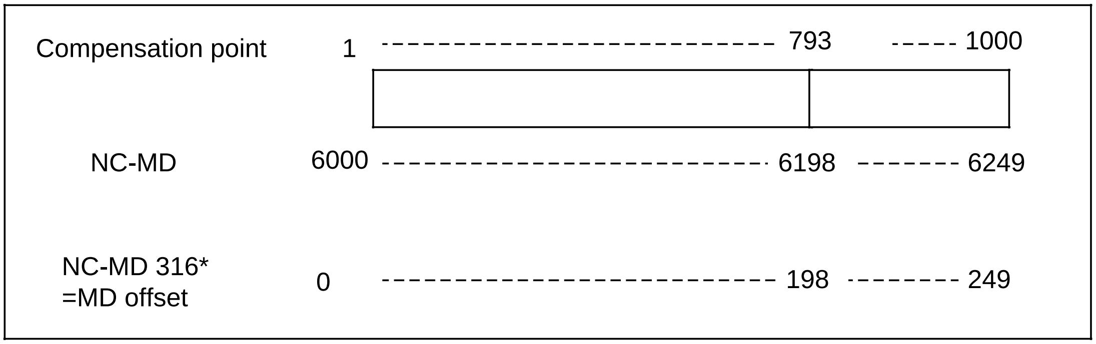


Plotting the error line through the compensation point

Reference point - compensation point

The number of compensation points to be supplied has thus been determined by the input spacing between 2 correction positions and the traversing area limits on the machine.

Since the leadscrew error compensation does not become effective until 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 compensation value at this point must be 0.



Determination of the compensation point as machine data value (MD)

Since the compensation point is not entered directly in MD 316*, but the MD offset (6125 : MD offset = 125) is entered, the reference point can be located only on compensation points 1, 5, 9, 13, 17, ...

MD No.	Bit 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	+ / -
- / / -								
- / / -								
6428	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	+ / -

Yes/No	+/-	
1	1	pos. comp.
1	0	neg. comp.
0	irrelevant	not comp.

Since 4 compensation points are available per machine data, only the last point to the right (bits 0 and 1) can be chosen as reference point.

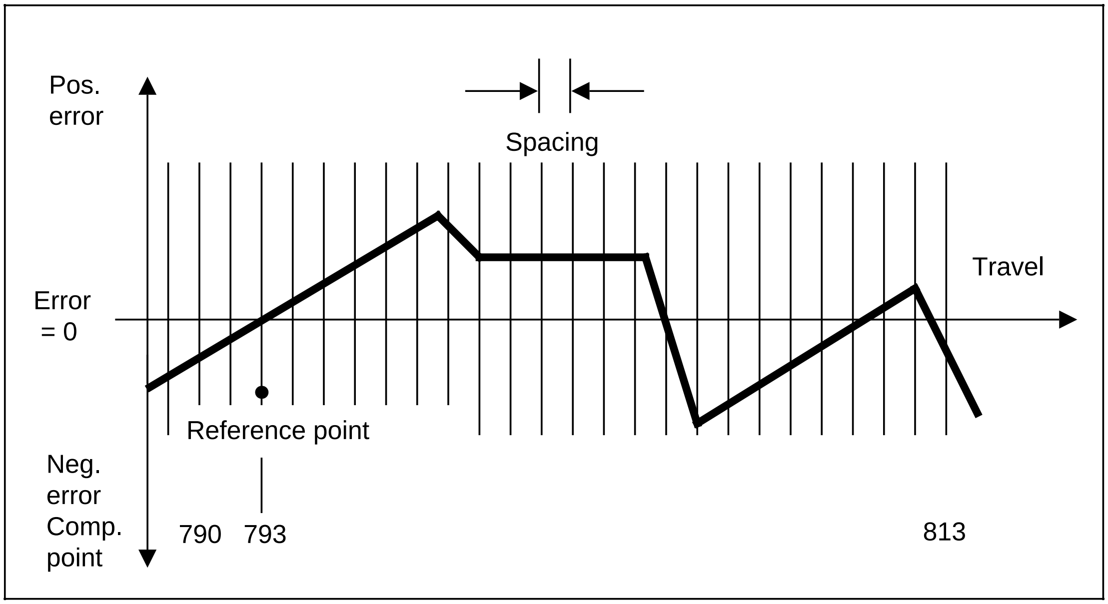
Example:

Reference point - compensation point 793 (=n·4+1)

MD offset= $\frac{793-1}{4}$ =198 $\left(\frac{\text{Comp. point-1}}{4} \right)$

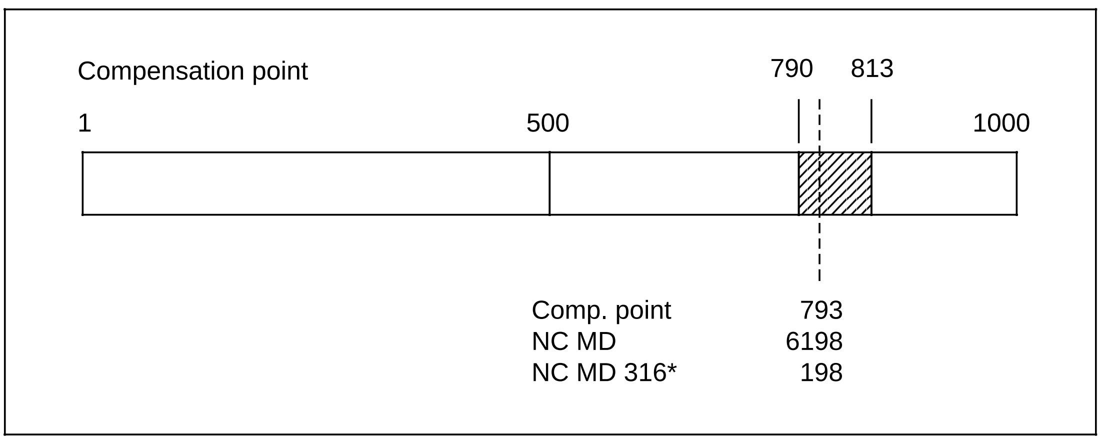
MD 316* has the value 198

As stated above, the reference point determines which of the possible 1000 compensation points are used for the axis concerned.



Determination of the compensation point by means of the reference point

If the reference point is assigned to compensation point 793, the 1000 compensation points are broken down as follows.



Determination of the compensation point as a machine data value

As can clearly be seen here, the reference point has determined the location of the hatched area of the compensation points used. The area ends at points 790 and 813 due to the spacing between the compensation points and the maximum traversing range of the axis.

If the leadscrew error compensation is used for serveral axes, the installation engineer must ensure when entering the MD that the compensation points do not overlap during traversing as no check is carried out in the control.

However, the gaps between the axes can be of any size, provided that the overall range of 1000 compensation points is not exceeded.

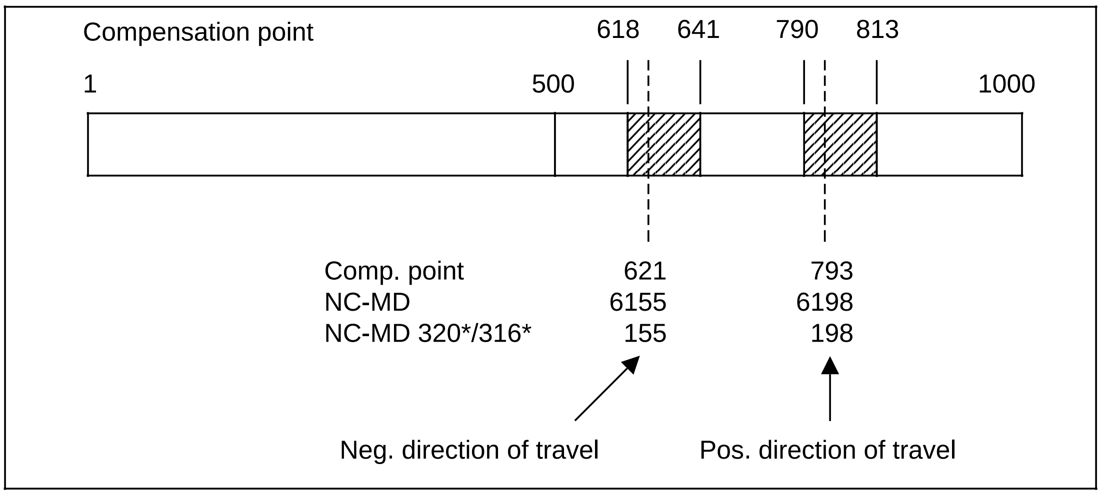
Direction-dependent leadscrew error compensation

Here, an error curve must be plotted from the positive to the negative direction.

In the case of ball screws, pre-stressing the screw nut yields an identical error curve irrespective of the plot direction during measurement. With worm drives, however, significant differences may arise between the positive and negative directions of travel. Consequently, an error curve must be plotted in the negative travel direction and input as compensation.

The procedure is similar to that for the positive traversing direction, ensuring that the compensation ranges do not overlap between the positive and negative traversing movements or between the axes. Since the reference point determines where the compensation points lie within the 1000 points in the case of this compensation curve as well, the reference point must be entered in NC MD 320* in encoded form (MD offset).

Example:



Determination of the compensation point as a machine data value

Machine data for leadscrew error compensation :

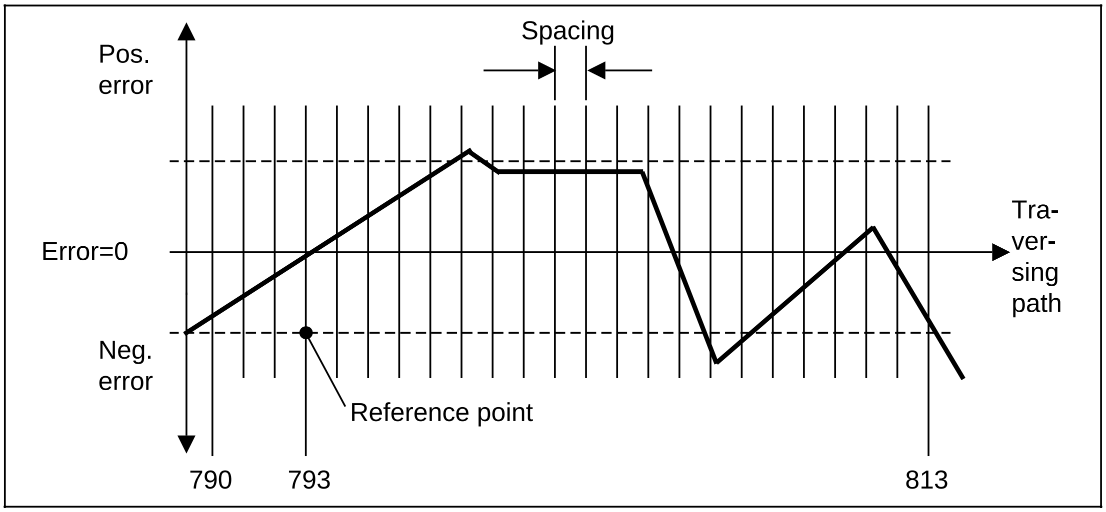
- MD 316* (Pos. compensation pointer)
- MD 320* (Neg. compensation pointer)
- MD 324* (Spacing between 2 leadscrew error compensation points)
- MD 328* (Compensation amount)
- MD 6000 - 6239 (Compensation points)

Any modification to the MD is active only after Power On and reference point approach. Since the compensation value at the compensation point must be processed as quickly as possible, the input acceleration (NC MD 276*) is not applicable in this case. Consequently, the compensation value (NC MD 328*) is limited to max. 100 units.

Note:

Both the direction-dependent and direction-independent leadscrew error compensations are Options and can be ordered with the order code H56.

Example:



Determination of the compensation point by means of the reference point

Axis 1 indicates the represented error curve; no compensation points have been used so far.

Reference point value 0
Max. negative traversing range - 35.000 mm
Max. positive traversing range 205.00 mm

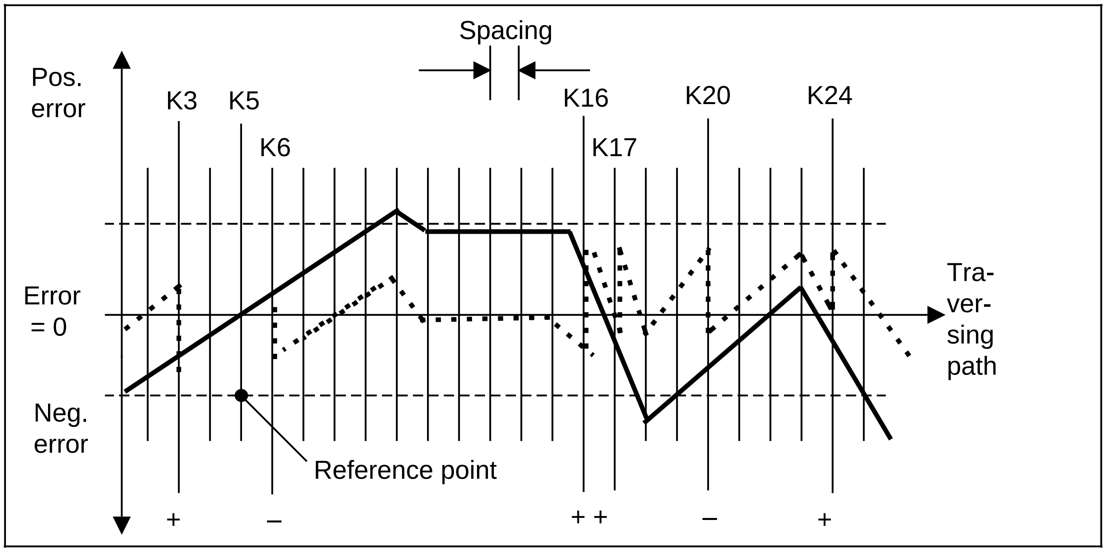
Determine the tolerance band (specified by machine manufacturer), e.g. 0.01 mm spacing between 2 leadscrew error compensation points, e.g. 10 mm.

$$A- = \frac{\text{235 mm traversing path/ max.-}}{\text{10 mm grid spacing}}$$ **3 compensation values**

$$A+ = \frac{\text{205 mm traversing path/ max.+}}{\text{10 mm grid spacing}}$$ **20 compensation values**

Number of total compensation values :
K =(A-) +(A+) + (Ref) = 3 + 20 + 1 **24 compensation values**

This results in NC-MD 3161 = 1 (NC-MD 6001), i.e. compensation point K5 is the point at which the reference point is located; no compensation is permitted here. When traversing by 10 mm in the negative direction, compensation point K4 is used for compensation purposes. Compensation point K6 is used when traversing by 10 mm in the positive direction.



Representation of the new error curve derived from the determined compensation points

- - -   Tolerance band e.g. 10 µm
- - - -   Compensation value e.g. 5 µm
▪ ▪ ▪ ▪ ▪   Compensated curve

Starting at the reference point in a negative direction, the error curve is within the tolerance band as far as the traversing path end. No compensation at all would be necessary. A better result is achieved with compensation at K3 positive. To remain as close as possible to error 0, compensation in the positive direction at K6 must be negative, at K16 and K17 positive, at K20 negative and at K24 positive. The new error curve would then have the path shown above.

The following machine data would have to be set:

- Option leadscrew error compensation
- NC MD 3161 = 1 (thus determining the reference point, K5)
- NC MD 3241 = 10000 (grid spacing 10 mm)
- NC MD 3281 = 5 (compensation value 5 µm)
- 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 K15 and K16)
- NC MD 6005 = 00 00 10 00 (negative compensation at K20)
- NC MD 6006 = 00 00 11 00 (positive compensation at K24)

11.4 Spindle control

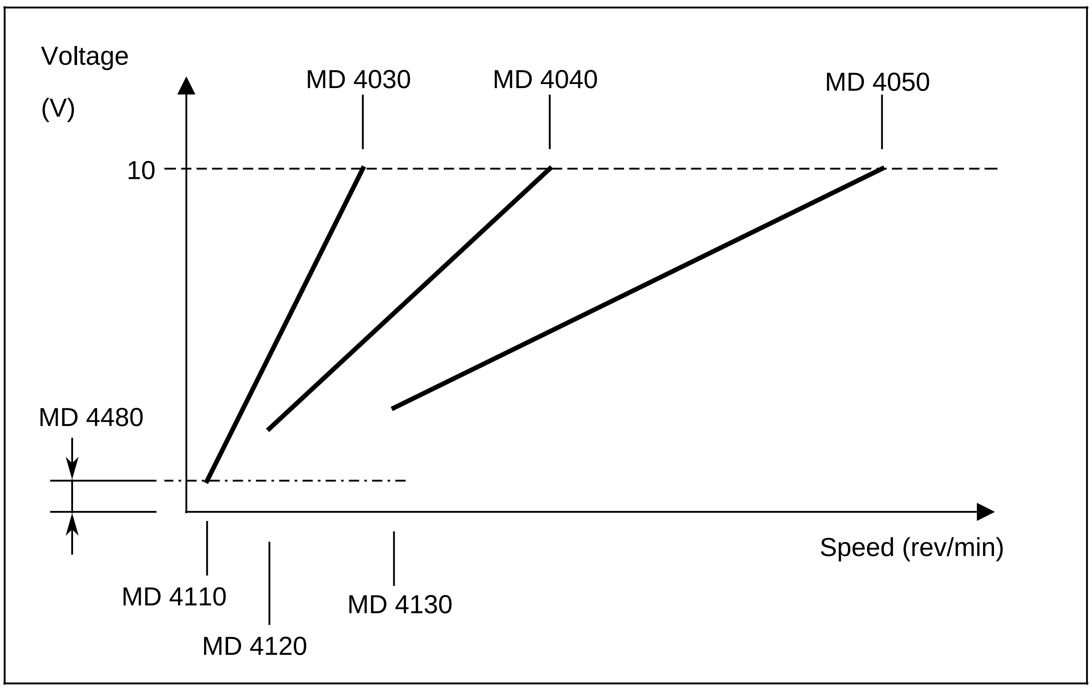
11.4.1 Corresponding MD

- MD 131 - 146 (Spindle override)
- MD 4000 - 4520 (Spindle data)
- ANALOG SPINDLE SPEED Option
- MD 5200 bits 0 to 7
- MD 5210 bits 1 to 7

11.4.2 S analog (M3, M4, M5)

Spindle installation is explained in Section 5.3.
On the SINUMERIK 805, output of the analog spindle speed is implemented fully in the NC, so that the PLC can be influenced only by means of special signals (see Section 11.4.4).

The "Automatic gear selection" function is also implemented in the NC, the correct gear being transmitted to the PLC depending on the programmed S value. The speed ranges of the maximum eight gears are defined by inputting the minimum and maximum speeds in the relevant NC MD.



Determination of speed range with min. and max. speed

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 if the programmed S value is no longer possible in the selected gear.

Because not all spindle drive units include a ramp function generator, one such generator has been integrated in the SINUMERIK 805 (unit 4 ms). The following enable signals are required for the spindle set value output:

- Q 100.7 SPINDLE ENABLE
- Q 100.6 SPINDLE SERVO ENABLE
- Setting data SPINDLE SPEED LIMITATION
- Q 100.5=0 SPECIFY SET VALUE ZERO
- Q 100.4=0 SPINDLE OVERRIDE EFFECTIVE

The set value output is controlled with the M functions M3, M4, M5. No set value is output with M5 (drift remains) but the spindle servo enable relay does not drop out, i.e. the spindle may drift if Q 100.6 is **not** cancelled.

11.4.3 M19 (oriented spindle stop)

The function M 19 must only be used for the NC function ”Oriented spindle stop”. It cannot be used like a normal M function.

Function M 19 (oriented spindle stop) is an option.

The oriented spindle stop function (M19 S .... LF) is intended to avoid additional external hardware requirements if the spindle is to be stopped in a specific position for a tool change or to engage gear.

In this case, the ROD encoder (1024 or 512 pulses per revolution) is used not only for speed control (G95, G96, G97) and thread cutting (G33, G34, G35) purposes but also as a position sensor, the zero mark serving as the position reference point (corresponding to 0 degrees).

With S analog (M3, M4, M5), the spindle is controlled by the NC; only with M19 is the position control loop closed by the NC. The pulses from the ROD encoder act as actual position values. Since a ROD encoder with 1024 or 512 pulses per revolution is required as the actual value system, a resolution of 360°/4096 (approx. 1/11 degree) can be achieved through 4-fold hardware multiplication (only approx. 2/11 degree in the case of a ROD encoder with 512 pulses).

The oriented spindle stop function is activated in the part program with "M19". The target position is stored as a setting data which can be set with manual input or "M19 S ..." programming in degrees.

The positioning range is 0.5 to 359.5 degrees with the NC function M19. If the oriented spindle stop is selected via the PLC, the positioning range is 0.1 to 359.9 degrees via the PLC, the positioning range is 0.1 to 359.9 degrees (NC MD 4520).

Positioning is carried out in the specified direction of rotation (M3, M4) or from rest with the shortest path. Positioning from rest after Power On is also possible if the target position is not 0 degrees.

The spindle can also be positioned with external devices if the ORIENTED SPINDLE STOP Option has not been set. In this case, M19 is output to the PLC as a normal auxiliary function (also a static or dynamic flag). MD 5200 bit 2 "Pulse generator available" has no significance in this context.

In the case of the ***NC-internal*** approach, there are two sequences (sequence A or sequence B) on the basis of which oriented spindle stop is integrated into the block sequence of the NC program.

With **sequence A**, the spindle stop is handled in a special part program block and a block change is not performed until the operation has terminated; axis movements at the same time as spindle positioning are not possible.

With **sequence B**, M19 is modal, even over several blocks. While the spindle is being positioned or held in the closed-loop position control, the axes can be moved, the program further processed or even a tool change performed.

The following applies to both sequences:

- Spindle servo enable (Q 100.6) must be present prior to M19.
- M19 S ... must be programmed in its own block without axis movements.
- Orientation is performed in the specified direction of rotation (M03/ M04)
- M19 is possible from rest (shortest path).
- The oriented spindle stop is initiated at the start of the block
- M19 is aborted or terminated by means of:
  - Cancel spindle enable (Q 100.7) (positioning is aborted, M19 remains)
  - Interface signal ACKNOWLEDGE M19 (Q 103.2) with PLC SPINDLE CONTROL (Q 103.0)
  - RESET, program end (M02/ M30) (depending on NC-MD 5200 bit 6, (no M19 abort with RESET))
  - EMERGENCY STOP
  - Measuring circuit fault
  - Faults resulting in shutdown of all axes
  - Cancelling of NC Ready 2
- M19 S ... can be entered and started with NC START in OVERSTORE.
- M19 is output as an auxiliary function at the PLC interface (static or dynamic flags).

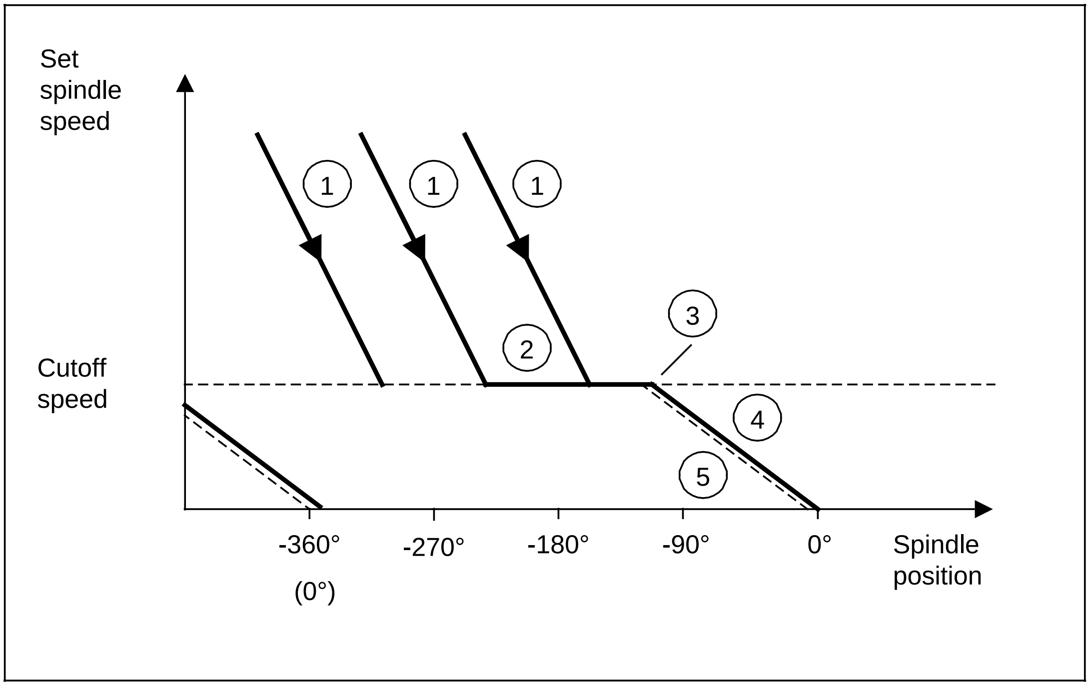
Special features of sequence A (NC-MD 5200 bit 5=0) M19 without axis movement

- A block change is performed after completion of the M19 function.
- Simultaneous traversing of the axes is not possible.
- A mode change during M19 is not possible.

Special features of sequence B (NC-MD 5200 bit 5=1) M19 with axis movement

- M 19 is modal even over several blocks.
- M 19 is terminated out of synchronization with the part program by
  - Cancelling spindle enable (Q 100.7)
  - Issuing ACKNOWLEDGE M19 signal (Q 103.2) PLC SPINDLE CONTROL (Q 103.0) must be active.
- M19 is terminated in synchronization with the part program by programming M03 or M04.
- The block change is performed after the delay of one PLC cycle.
- In the subsequent blocks, axes can be moved or a tool change performed at the same time as positioning or closed-loop position control.
- During active positioning (M19), the direction of rotation (M03/M04) must not be reversed otherwise positioning will be performed from an undetermined direction.

- M19 is also aborted or terminated by M03 or M04 in the following blocks.
- During M19, the operating mode can be changed; the position control loop remains closed and the axes can be traversed.
- If the PLC detects auxiliary function M19, it can prevent a block change by cancelling READ-IN ENABLE.
- If M19 is reselected before a previous M19 has been terminated by cancelling the spindle enable signal, the control operation is executed to the new spindle position and the NC approaches the new position by the shortest path irrespective of the specified direction of rotation; the spindle travel is less than 180° irrespective of the control characteristic.



Control characteristic with reselection of M19

a) Deceleration of the spindle from the programmed speed to the cutoff speed with the ramp characteristic specified by means of the acceleration time constant .

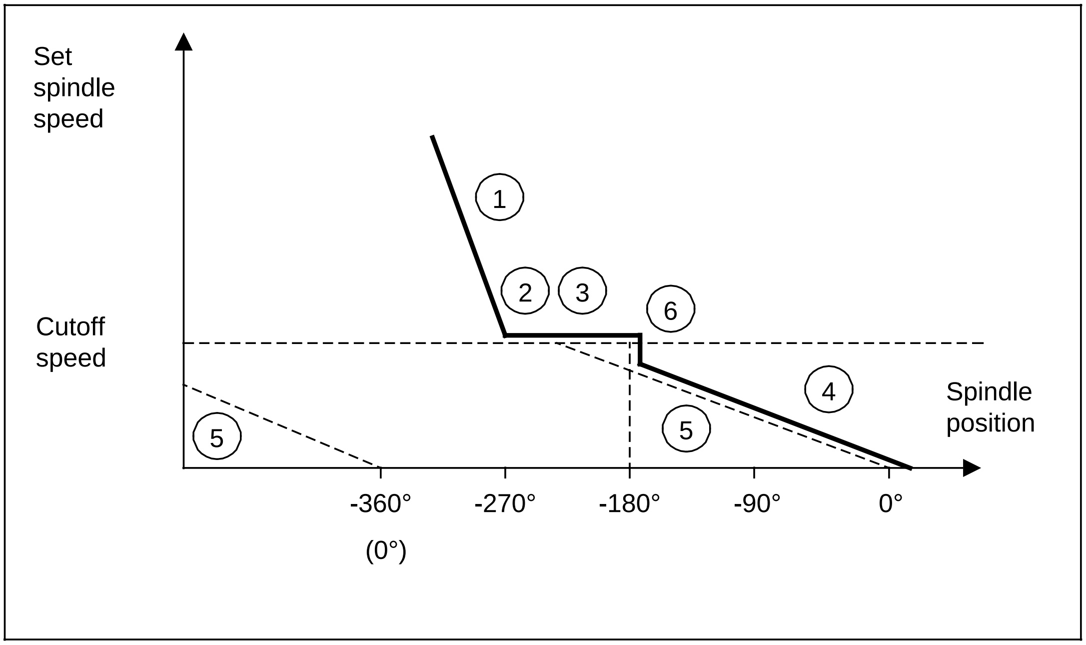
b) Continuation of traversing in the same direction of rotation at cutoff speed .

c) Point of intersection of gain characteristic with cutoff speed .
At this point the spindle position controller is switched on and the approach to the program spindle position is initiated along the gain characteristic .

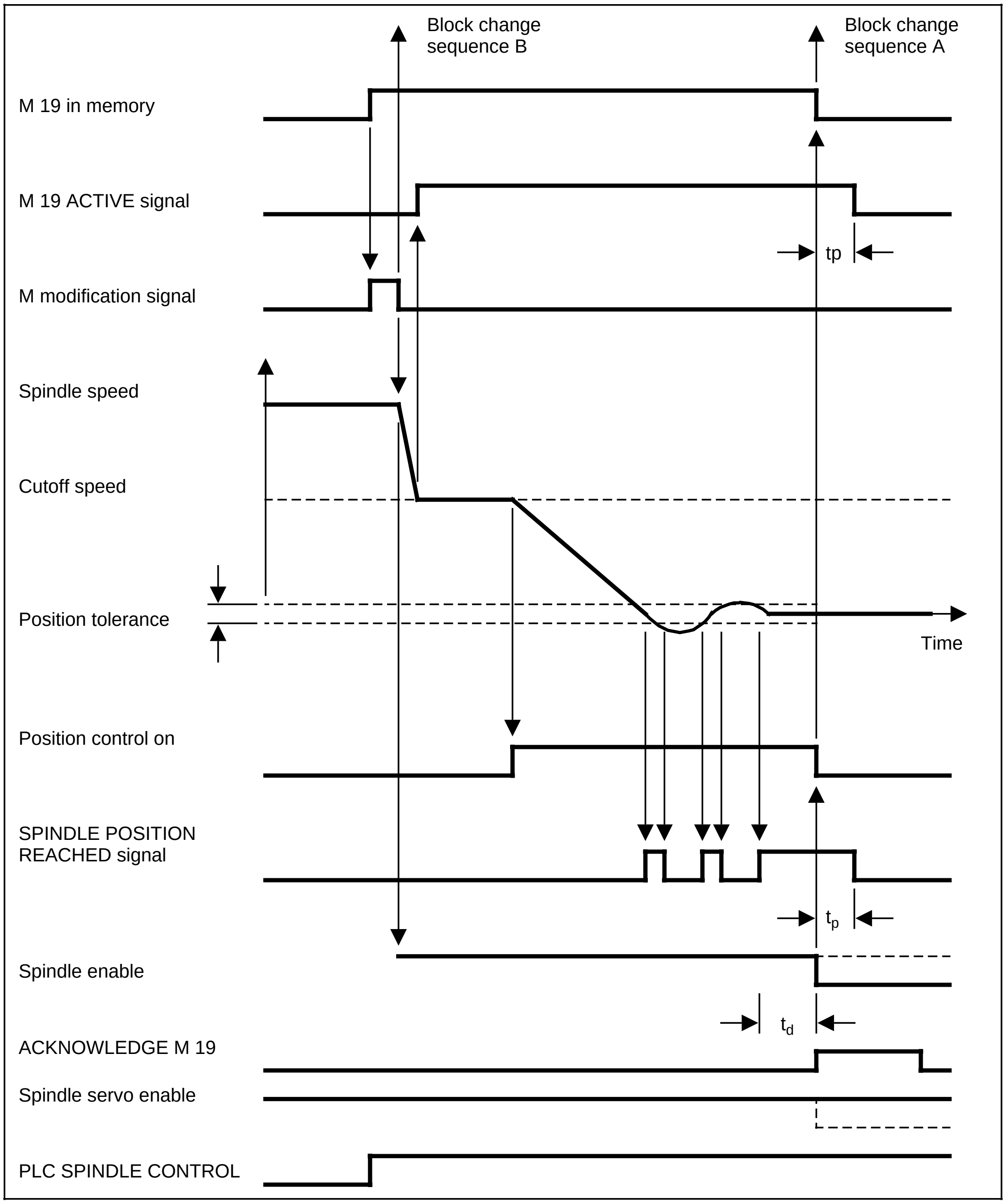
d) Output of the SPINDLE POSITION REACHED (I 114.4) message to the PLC if the actual spindle position has fallen short of the tolerance limit in MD 4430. However, the control continues to try to approach the programmed position with even greater accuracy, as is possible with the drift and slope of the gain characteristic.

e) M19 is considered to have been terminated when the SPINDLE ENABLE (Q 100.7) output signal is cancelled by the PLC or when the ACKNOWLEDGE M19 (Q 103.2) signal is issued depending on NC MD 5210.4 (PLC SPINDLE CONTROL Q103.0) must be present). In this case, the position control is interrupted but the spindle servo enable relay does not drop out (spindle can drift).

If the gain is selected so small that the point of intersection of the gain characteristic with the cutoff speed is more than 180° from the set position, a position 180° ahead of the set position is approached at the same speed after the cutoff speed is reached, followed by a jump to the approach curve .



Control characteristic with small gain selected



Signal sequence for M19 and NC-MD 5210.4 = 1 (acknowledge M19)

t_d .... Delay so that positioning is not aborted on overshoot. The delay must be implemented in the PLC program.

t_p .... Time delay 1 PLC cycle.

M19 from rest

If a SPINDLE STOP from the PLC is present at the start of a block with M19, the function is not immediately considered to be terminated but a block change is initiated only after the delay time of 1 PLC cycle has elapsed.

The PLC can then recognize auxiliary function M19, set the spindle enable signal and initiate spindle orientation from rest. Note that the spindle must be enabled by the PLC while the modification signal is available. If the spindle enable is cancelled late, M19 is taken to be a normal auxiliary function. The spindle will always approach the programmed position from rest over the shortest distance. The SET DIRECTION OF ROTATION CLOCKWISE (Q 100.7) signal has no significance.

Positioning accuracy

The target position is programmed in 0.1 degree with decimal point.
The accuracy of this position depends on the gain and drift. The maximum achievable accuracy is:

Pulse generator with 1024 pulses: $\frac{360}{1024}$ =approx. 0.1 degree

Pulse generator with 512 pulses: $\frac{360}{512 \cdot 4}$ =approx. 0.2 degree

M19 and RESET

NC MD 5200 bit 6 (no M19 abort with RESET) can be used to prevent M19 from being aborted with program end (M30/M2) or RESET (key). In this case, M19 is aborted only by means of cancelling the spindle enable, the ACKNOWLEDGE M19 (Q 103.2) signal from the PLC, alarms that cancel NC Ready 2, or EMERGENCY STOP.

Spindle enable with M19

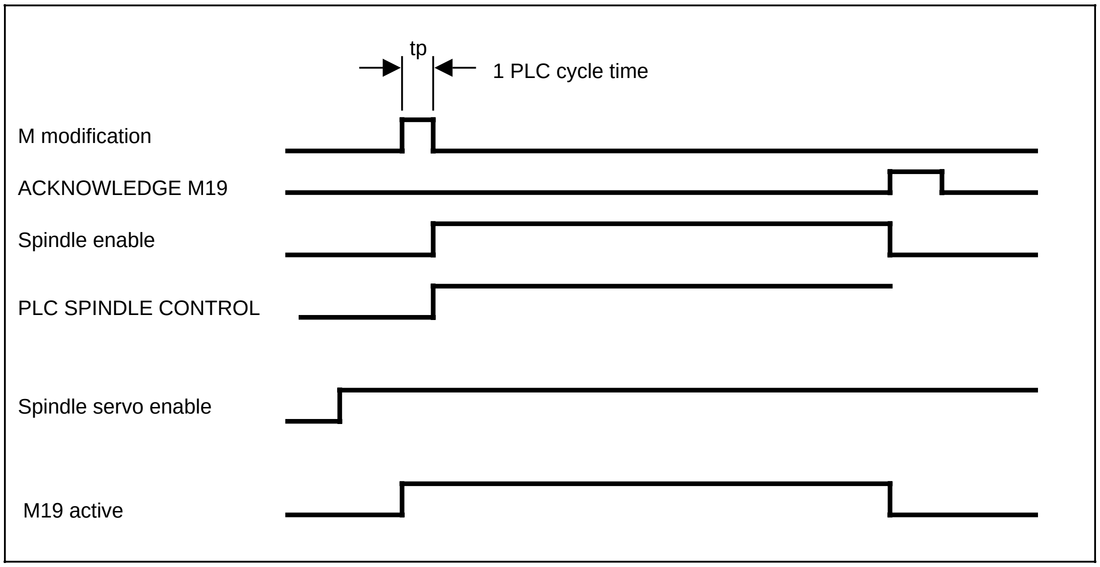
The SPINDLE ENABLE (Q 100.7) interface signal from the PLC assumes a second important significance with M19.

Not only does it switch the set spindle speed to zero, but it also terminates the M19 function (depending on MD 5210 bit 4).

If the SPINDLE POSITION REACHED signal is output by the NC during positioning, the PLC must cancel the spindle enable or issue ACKNOWLEDGE M19 if the M19 function is to be terminated. However, the spindle enable must not be cancelled until the spindle is in a transient condition. In the event of serious overshooting (very high gain), it is advisable to output the SPINDLE ENABLE signal to the NC after a delay, that is not until the SPINDLE POSITION REACHED signal is definitely present for a machine-specific time t_d.

Spindle servo enable with M19

The spindle servo enable (Q 100.6) cannot be used to control M19. In addition, it must be present prior to M19, i.e. the M modification signal can be used to set only the spindle enable, not the spindle servo enable.



Control curves for M19 and spindle servo enable

Position control direction with M19

If the spindle is to be switched from open-loop to closed-loop control with M19, the pulses from the ROD encoder must have the correct direction of rotation on reaching the control.

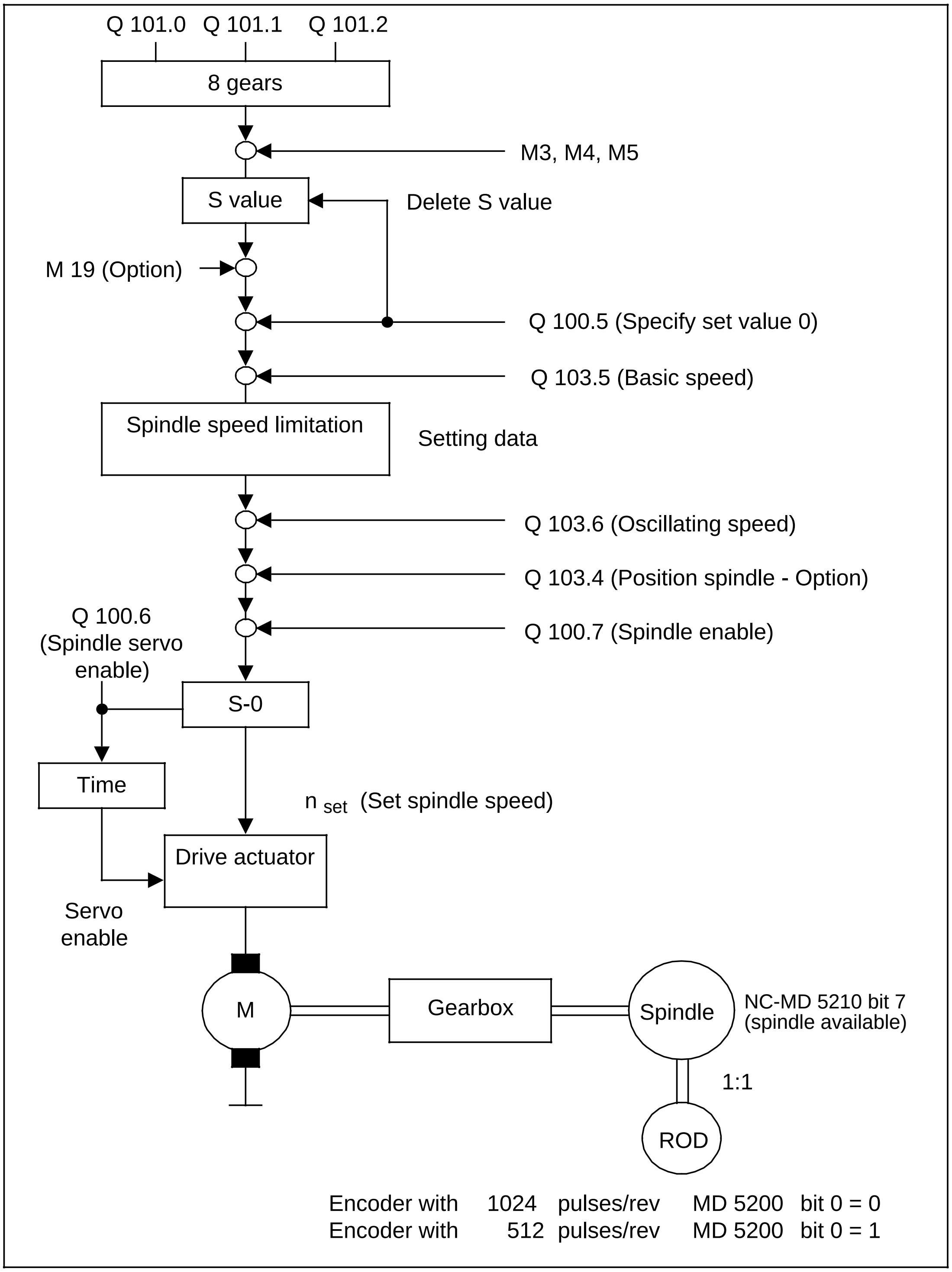
An incorrect position control direction is indicated by pronounced spindle oscillation at a position 180 degrees away from the programmed position. In this case, NC MD 5200 bit 1 must be inverted (actual value sign change).

M19 immediately after POWER ON (switching on)

Because the spindle value is not yet synchronized, the spindle is accelerated to cutoff speed. The zero mark of the spindle encoder is recorded and the M19 procedure is then initiated.

11.4.4 Spindle influencing by PLC

The flowchart below is intended to show the effect of the individual PLC interface signals on the spindle. The feedback pulses are not shown for reasons of clarity.
Automatic gear selection (Q 101.3) is described in detail in Interface Description Part 1 Signals.



Flowchart: spindle influencing by PLC interface signals

11.5 Rotary axis function

11.5.1 Corresponding data

All data as for linear axes, but with the following additions and supplements:

- NC MD 344* (Modulo value rotary axis for leadscrew error compensation)
- NC MD 560* bit 7 (Actual value display modulo 360º)
- NC MD 560* bit 3 (Rounding with rotary axis)
- NC MD 560* bit 2 (Rounding whole/half degrees)
- NC MD 564* bit 5 (Position control for rotary axis)
- NC MD 572* bit 2 (Rotary axis modulo 360° - programming)
- NC MD 572* bit 4 (Rotary axis full circle/semicircle programming)
- Alarm 100* (Grid spacing not permissible, leadscrew error compensation)
- Alarm 2064 (Program error with rotary axis)

11.5.2 Functional description

Various demands are made on a rotary axis depending on the machine type concerned. The rotary axis function is thus divided into 3 part functions, activated by means of machine data or programming.
The control can be adapted to the various machine types by combining the part functions.

"Rotary axis": NC-MD 564* Bit 5

This machine data defines the axis as a rotary axis. The display is absolute (1 revolution 360°, 2 revolutions 720° etc.) as are the @ functions. The axis is programmed as a linear axis. The units of the axis-specific NC MD are treated differently.
Unit 10^{-3} degrees with position control resolution 1/2 x 10^{-3} units input resolution 10^{-3} units.

Actual value display "modulo 360º": NC-MD 560* Bit 7

The display with the set bit is "modulo", i.e. the actual value display is reset to 0 after 359.999 degrees. The axis is programmed as a linear axis.

"Modulo programming": NC-MD 572* Bit 2

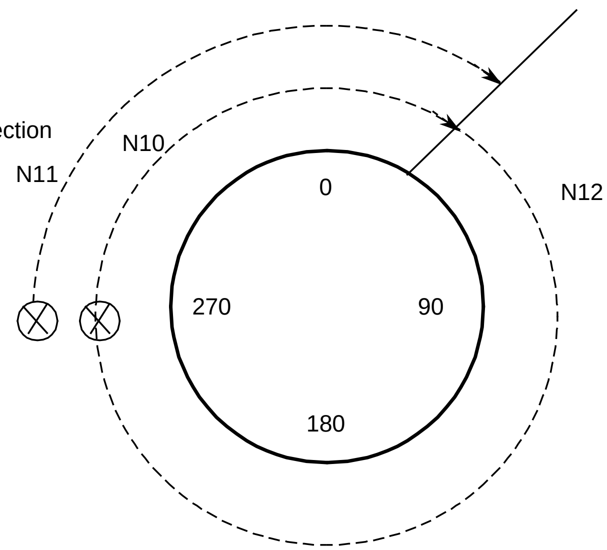
By setting this bit axis can be programmed as rotary axis.
The first traversing block of the rotary axis in a part program is always traversed with the shortest path. With the aid of the G68 function the block end value can always be approached with the shortest path.
G68 is modal and belongs to the G90/91 group. If "modulo programming" is not activated, G68 is treated like G90.
If the rotary axis is not to traverse the shorter path, it must be programmed with G90 and a sign.

Example: Axis at 270°

1) N10 G68 C10
   Traversing with shortest path

2) N11 G90 C10
   Traversing to end point in positive direction

3) N12 G90 C10
   Traversing to end point in negative direction



The "modulo 360°" and "modulo programming" machine data are permissible only with the "rotary axis" machine data.

Combination of part functions

Rotary axis	Modulo program	Modulo 360°	Remarks
0	0	0	Linear axis
1	0	0	Use
1	0	1	allowed
1	1	1	
1	1	0	
0	0	1	Use
0	1	1	not allowed
0	1	0	

”Rotary axis full circle/semicircle programming”: NC MD 572* bit 4

This bit is only active, if 572* bit 2=1.
If bit 4=1 a modulo calculation is performed again after calculating the offsets (ZO, NC, TO...).
If, for example, G90 is programmed, a movement of less than or equal to 360° in the programmed direction results.

Example of NC MD 572* bit 4

Prerequisite: NC MD 560* 7=1
NC MD 564* 5=1
NC MD 572* 2=1

		Path when:	
		Bit 4=0	Bit 4=1
N5	G90 G0 C0	–	–
N10	G01 C70 F1500	70	70
N15	C-5	-65	-65
N20	C0	355	355
N25	G55 C70 (G55 = 300)	370	10
N30	C-5	-65	-65
N35	C0	355	355
N40	M02		

Axis-specific machine data

If an axis is defined as a rotary axis (NC-MD 564* bit 5), the following is valid independent of NC-MD 5002 (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
1 unit = 10^{-3} degrees

b) 1 unit = 1 input resolution (reference system IS)
e.g. 1 input resolution = 10^{-3} degrees
1 unit = 10^{-3} degrees

All axis-specific machine data are stated in degrees with a rotary axis, e.g.: max. speed of a rotary axis = 15 rev/min.

15 rev/min x 360 degrees/rev = 5400 degrees/min
Input in NC-MD 280* = 5400 (1000 degrees/min)

11.6 Velocity overlay by handwheel pulses

The VELOCITY OVERLAY BY HANDWHEEL PULSES function
is available as an option
(provided as from software version 2.2)

In the case of special-purpose machines, it is often necessary to alter the programmed speed of an NC axis up to a certain axis position manually; for example, to bridge an allowance which is not given and thus reduce the machining time.

11.6.1 Operation

Using the VELOCITY OVERLAY BY HANDWHEEL PULSES, it is possible to produce velocity overlay for a single programmed axis in the AUTOMATIC and MDA modes.

According to the handwheel direction of rotation, the velocity of the NC axis can be either increased or reduced (max. to 0). It is not possible to reverse the axis movement or to overrun the programmed axis position.

The magnitude of the velocity overlay (or velocity offset) depends on the following factors.

- Handwheel pulse weighting
  This is specified in setting data 3 and can be altered via the operator interface in the INCREMENTAL DIMENSION window or in the NC program using a @ function. The following input values are permissible: 1, 10, 100.
- The number of handwheel pulses generated per unit of time.
- NC MD 280* maximum velocity in AUTOMATIC

11.6.2 Calculation of the velocity offset

The velocity is calculated by the following formula:

$$v_{offset} = \frac{v_{max} \cdot f \cdot b}{K} \cdot t$$

where K = 819175 if NC MD 5150.4 = 0
or K = 8191750 if NC MD 5150.4 = 1

v ...	Velocity of the axis
v_{max} ...	Maximum velocity of the axis (set in NC MD 280*)
f ...	Input frequency or handwheel pulses in Hz
b ...	Weighting factor (set in SD 3)
t ...	IPO cycle frequency in msec (presently 20 msec)

The maximum input frequency and the maximum velocity offset are shown in this table:

Weighting factor SD 3	NC MD 5150.4=0		NC MD 5150.4=1	
	Maximum attainable velocity in % of v_{max}	Maximum frequency [Hz]	Maximum attainable velocity in % of v_{max}	Maximum frequency [Hz]
1	31.13	12750	3.11	12750
10	99.98	4095	31.13	12750
100	99.98	409.5	99.98	4095

The input frequency must on no account exceed 12750 Hz. This means that the maximum possible velocity (set in MD 280*) cannot be attained for all weighting factors

The values given for the maximum input frequency are the maximum values that the system can accept and must not be exceeded as that would mean that the behaviour of the selected axis is no longer defined.

The critical input frequency is 50 Hz, this corresponds to the sampling frequency of the handwheel logic.

If NC machine data bit 5150.4 is set, the internal constant K is raised by a factor of 10 so that smaller velocities can be attained with lower input frequencies.

11.6.3 Activation

The VELOCITY OVERLAY BY HANDWHEEL PULSES function is activated via the axis-specific PLC/NC interface signal HANDWHEEL ACTIVE (e.g. Q 109.0 for 1st axis) under the following conditions:

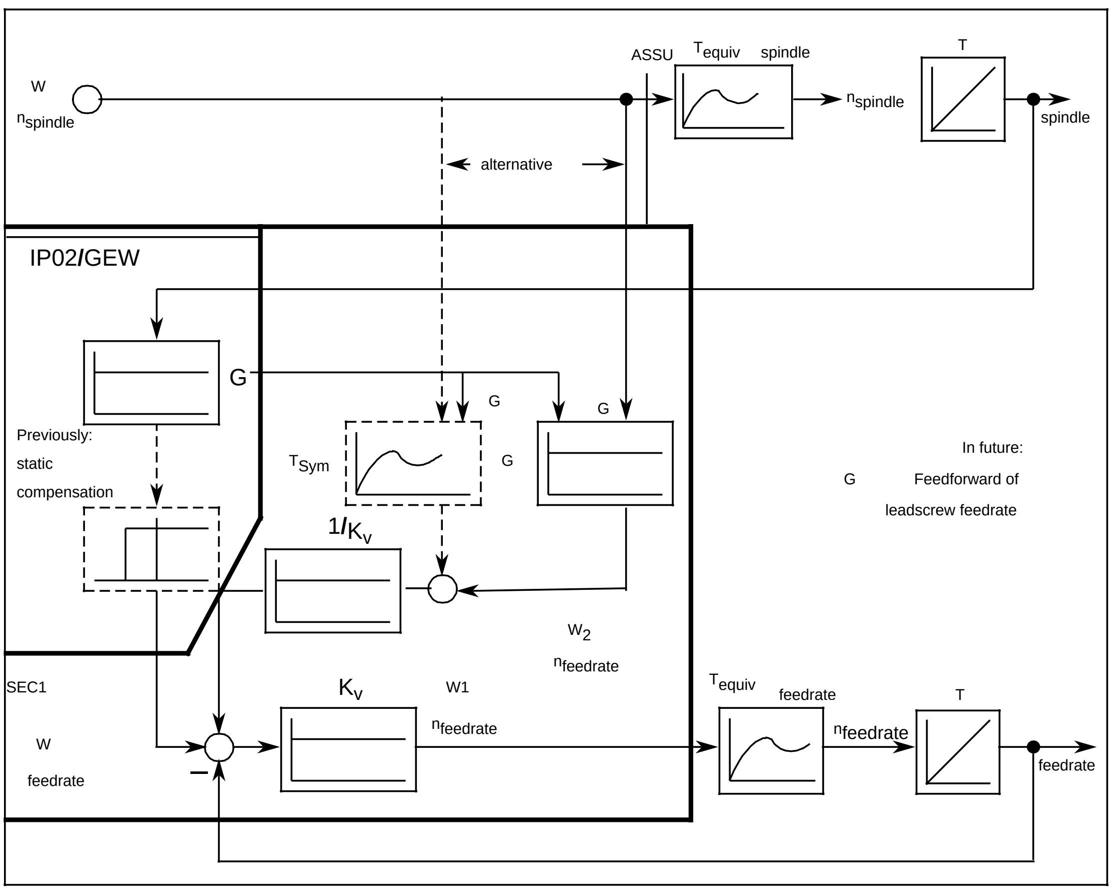
- DRF (differential resolver function) is not active.
- The dry run feedrate function (DRY) is not active.
- The preparatory function G00 is not active.
- Only one NC axis has been selected in the block to which the function is to be applied.
- The programmed feedrate is greater than zero.
- NC MD 5004.2=”1” (handwheel function enabled).
- The VELOCITY OVERLAY BY HANDWHEEL PULSES option is available.

11.7 Tapping with dynamic following error compensation

The TAPPING WITH DYNAMIC FOLLOWING ERROR COMPENSATION function is an option. (provided as from software version 3.1)

Brief description

- In tapping, because the feed axis is coupled to the main spindle actual value, the feedrate setpoint can only change with a delay of 1.75 IPO cycles. This results in a position deviation at the drill which can lead to tool breakage under certain operating conditions when the speed changes during reversal.
- The main innovation was, therefore, to make the feedrate setpoint dependent on the HSP setpoint, see block diagram.
- The spindle actual value has been retained. It is required to regulate actual value deviations on the controlled system (statically!). However, the problem mentioned above still applies when reversing. This has been improved by introducing a dynamic dead-time compensation and halving the influence active at the feedrate setpoint. The main disadvantage still applies, however, i.e. that all controlled-system influences act only after a delay of 38 ms.



Block diagram for tapping with dynamic compensation

Description of the new machine data

MD 256* **Difference time constant**

Unit:	0.1 ms			
Standard:	0.2 ms			
Input limits:	0.0 ms			No adaptation
	0.1 ms	to	2.7 ms	Time-lag element
	2.8 ms	to	8.2 ms	p element
	8.3 ms	(to	999.9) ms	pT2 element

With this machine data the dynamic behaviour (inertia) of the axis is adapted to the spindle (pT2 element).

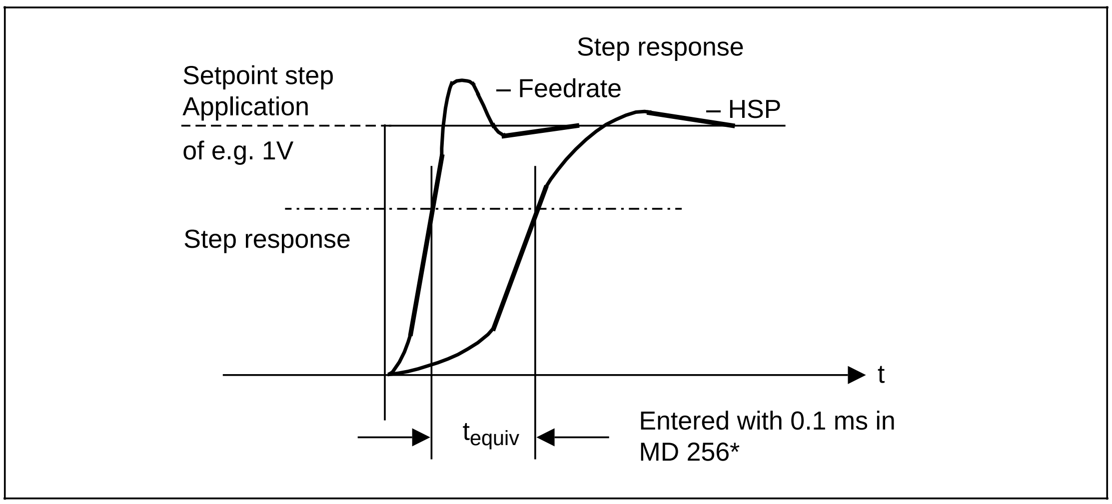
Note:

First determine the time constants of the feed axis and the main spindle and then enter the difference time constant T_{equiv} into machine data 256*.

Acquisition of the delay (T_{sym}) for the drilling axis

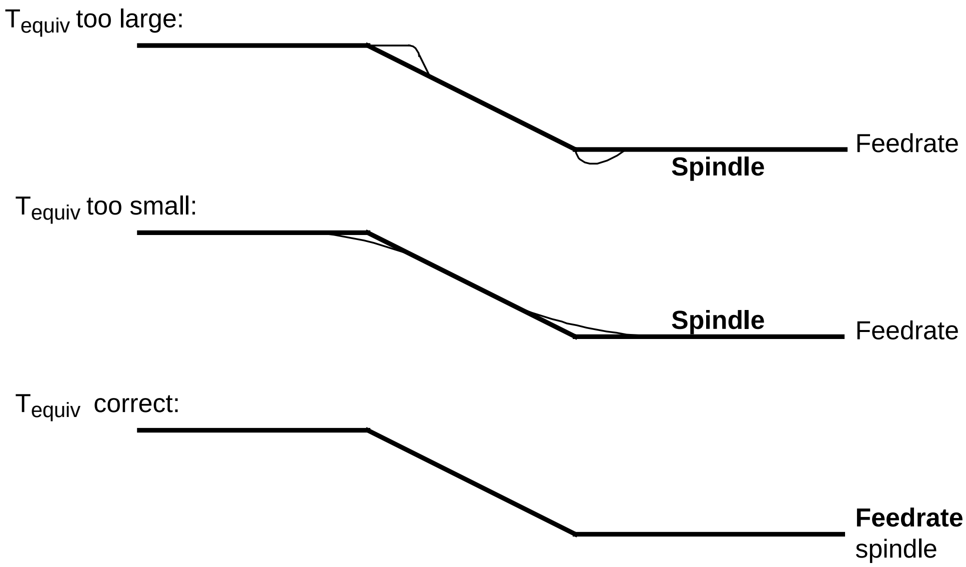
Here the dynamic response of the speed control-loop of the drilling axis is adapted to the HSP so that the actual value of the spindle and the axis agree.

T_{equiv} is ideally seen from the evaluation of the step response of the spindle and drilling axis.



This measurement must be performed when starting up the prototype. The value can be used for series production.

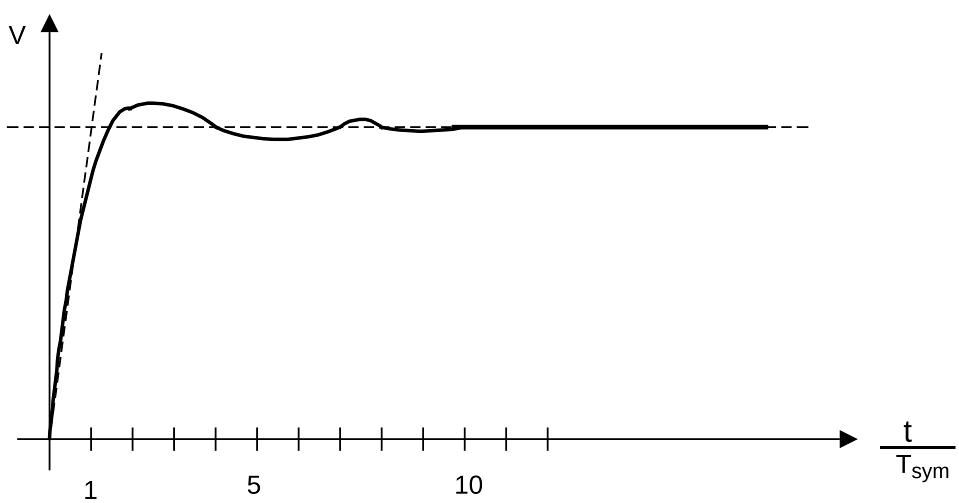
Checking the speed actual value variations



MD 360* Symmetrizing time constant (T_{sym})

Unit:	0.1 ms (Standard: 0.0 ms)			
Input limit:	0.0 ms	to	2.7 ms	Time-lag element
	2.8 ms	to	8.2 ms	p element
	8.3 ms	to	999.9 ms	pT2 element

With this machine data, issue of the feedrate setpoint on starting and braking is delayed (pT2 element, acceleration is completed within time 10xT_{sym}).



In order to be sure that the axis has accelerated before contact with the workpiece when tapping, a safety distance (s) must be taken into account in the program:

$$\boxed{s = 10 \cdot T_{sym} \cdot l \cdot n}$$

or as an adapted equation:

$$\boxed{s_{[mm]} = \frac{T_{sym\,[0.1\,ms]} \cdot l_{[mm]} \cdot n_{[rev/min]}}{6000}}$$

T_{sym} is input in 0.1 ms. This obviates mutiplication (*10) in the NC software (runtime optimization)

s	:	Thread run-in path (safety distance) [mm]
T_{sym}	:	Symmetrizing time constant [0.1 ms]
l	:	Thread pitch [mm]
n	:	Spindle speed (with which tapping is performed) [min^{-1}]

Example of calculation of the run-in path for M2 thread:

T_{sym} = 10 ms
l = 0.4 mm
n = 3000 rev/min

$$s = \frac{100 \cdot 0.4 \cdot 3000}{60\,000} = 2$$

s = 2 mm

Example of calculation of the run-in path for M20 thread:

T_{sym} = 10 ms
l = 2.5 mm
n = 500 rev/min

$$s = \frac{100 \cdot 2.5 \cdot 500}{60\,000} = 2.08$$

s = 2.08 mm

As can be seen from the two examples, the safety distance is practically the same regardless of whether M2 or M20 is being drilled.

The safety distance determined on start up must be entered in the programming guide for the machine.

The "knock" on starting and stopping the axis is audibly reduced after approx. 10 ms (MD 360*).

Note the following NC data

- **MD 220* Precise setting of backlash compensation**
- **MD 260* Multgain**
  For dynamic compensation the multgain *must* contain the exact compensation value with the drive.

- **MD 252* Servo gain factor K_V (factor)**
  On warm restart the servo gain factor is calculated for the compensation logic. The restart routine loads the first servo gain factor with a value other that zero.
  Thread axis must be defined as the first axis if different servo gain factors are used for the axes.
- **MD 520* bit 1**
- **MD 521* bit 1**
  The spindle bits sign inversion setpoint and sign inversion actual value have to be set so that a positive actual speed value appears on M3 programming in the display.
- **Spindle setting data for smoothing constant**
  For threads it must be zero.
- **Use tapping cycle L84 (contained in ”Standard Cycles” option).**
  This cycle has overrun path compensation.
  For a blind hole thread, the programmed thread, path must be reduced because the feed axis is rigidly coupled to the main spindle. An overrun path arises on reversal which is calculated in cycle L84 and is subtracted from the programmed path. The cycle also tests the final path and provides a minimum traverse path (=overrun path). If the path originally programmed is shorter, the cycle reduces the spindle speed until the overrun path is equal to the original thread path.

11.8 Connection of standard motors

The CONNECTION OF STANDARD MOTORS function is provided as from software version 4.1.

11.8.1 Corresponding data

NC MD 330-345:	Assignment NC control signals standard motor control signals
NC MD 380*:	Standard motor exact stop limit coarse
NC MD 384*:	Standard motor exact stop limit fine
NC MD 564*.4:	Standard motor axis
NC-MD 5151.7:	"Connection of standard motors"

11.8.2 Function description

With the CONNECTION OF STANDARD MOTORS function, standard motors equipped with incremental position encoders are controlled using contactors.

Standard motors which can be used include pole switchable three-phase asynchronous and d. c. motors with a variable speed range.

Axes with standard motors have a limited functional scope:

- Rapid speed/creep speed
- Clockwise/counterclockwise

The standard motors begin their axis movement at high velocity, switch to a lower velocity shortly before the final position (exact stop coarse) and approach the final position at this velocity.

In this way loading gantries can be driven, for example, because great positioning accuracy is not required.

Up to four axes can be driven as standard motor axes. In this way you can mix standard motor axes and normal axes in both configuration and programming.

Standard motor axes must be designed as linear axes.

For every axis four signals are required to control the contacts:

- RAPID SPEED
- CREEP SPEED
- CLOCKWISE
- COUNTERCLOCKWISE

These signals are carried from the NC to control signal bits which are then transferred to rapid NC outputs or to flag bits.

11.8.3 Programming standard motor axes

Standard motor axes are programmed in the same way as conventional NC axes except for the following restrictions.

Standard motor axes cannot interpolate with conventional NC axes, i.e. they reach their final position independently of the NC axes.
The following programming G functions do not work with standard motor axes:

- G02/G03 Circular interpolation
- G12/G13 Polar coordinate programming circular interpolation
- G16-G19 Plane selection with standard motor axis
- G33/G34/G35 Thread cutting
- G41/G42 Cutter/tool nose radius compensation
- G09/G60 Velocity reduction exact stop
- G62/G64 Continuous-path control
- G68 Absolute dimensioning rotary axis
- G92 Spindle speed setpoint limitation
- G94-G97 Feed control
- G110/G111 Polar coordinate programming centre point
- Gx47/Gx48 Soft approach/retract

The programmed feedrate does not only apply to standard motors. Only when all axes (standard motor axes and NC axes) are in position (exact stop) is the next block processed.

11.8.4 Traversing standard motor axes in JOG mode

Standard motor axes can be traversed in JOG mode by use of the axis direction keys $\boxed{+}$ or $\boxed{-}$. The standard motor axis then moves at creep speed. If the rapid traverse overlay key is also pressed the axis moves at rapid speed.

The handwheel function and traversing in JOG-INC mode is not possible with standard motor axes.

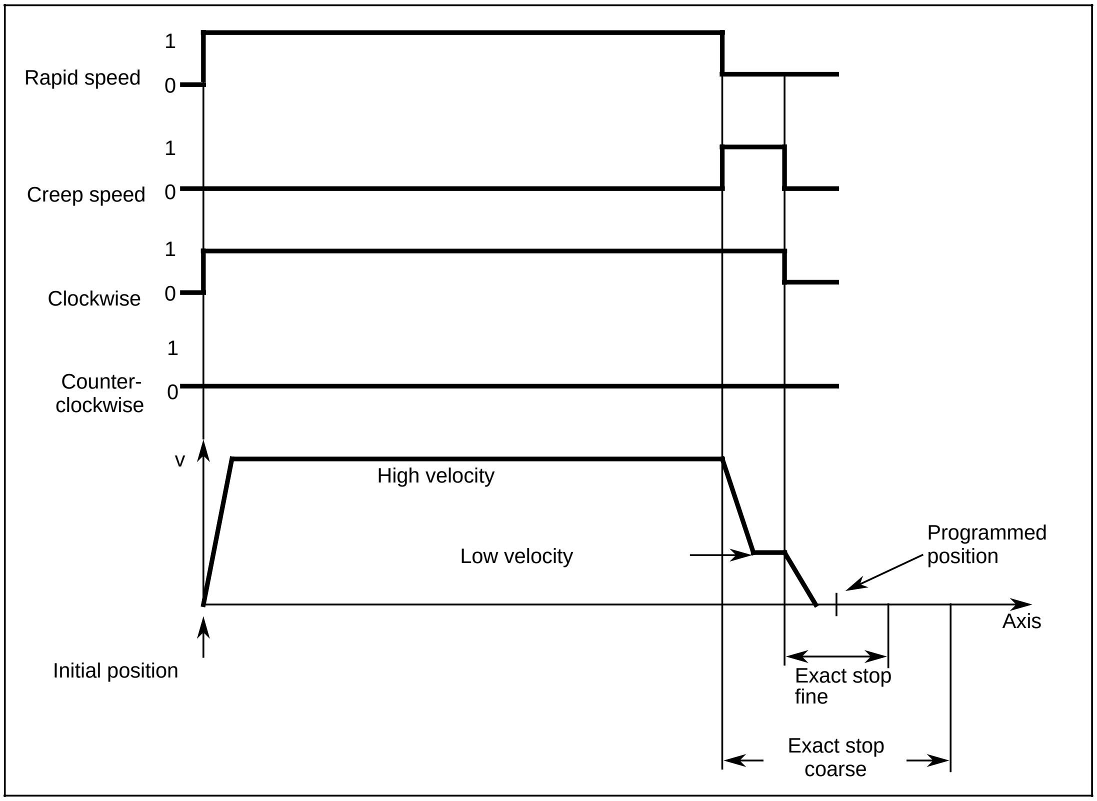
During reference point approach in JOG-REF mode the axis is traversed at creep speed.

11.8.5 How standard motor axes move

The velocity switchover points of the standard motor axes are defined by the exact stop limits coarse (NC MD 380*) and fine (NC MD 384*).

The standard motor axis moves from the initial position to the exact stop limit coarse of the final position at high velocity (RAPID SPEED). The control outputs the appropriate direction signal and the signal RAPID SPEED via the PLC outputs or via the rapid NC outputs. In this way the appropriate contacts etc. are operated.

When the axis reaches the exact stop limit its velocity is switched to the lower velocity (CREEP SPEED) (the RAPID SPEED signal is cancelled, the CREEP SPEED signal is switched through). The axis now moves with this velocity towards the exact stop window. When this exact stop window is reached the motor is switched off completely (the direction signal and the CREEP SPEED signal are cancelled).



If the exact stop limits are overtravelled by the standard motor (e.g. because of inertia) the following applies:

- If the standard motor axis overtravels the exact stop fine
  the motor reverses and travels back into the exact stop window at CREEP SPEED
- If the standard motor axis overtravels the exact stop coarse
  The motor stops and an alarm message is output

Reference point approach and actual value setting (PRESET) is possible with standard motor axes. During reference point approach the axis is moved at CREEP SPEED.

11.8.6 Activation of the function

For activation of the function the NC-MD 5151 bit 7 must be set to "1".

Bit 4=0	normal NC axis
Bit 4=1	standard motor axis

For every standard motor axis four output signals are required for control:

- RAPID SPEED
- CREEP SPEED
- CLOCKWISE
- COUNTERCLOCKWISE

These control signals are formed by the NC and stored as internal control signal bits.
But these control signal bits are also used by other functions (e.g. cam signals).

To permit flexible assignment of the control signals of the standard motors to the NC control signals, there is a machine data for every control signal with which a control signal bit is assigned.

In this way you can assign one of the NC control signals 1.0-1.7 and 2.0-2.7 to every control signal. Assignment of two NC control signals to a control signal is not possible.

NC MD 330: standard motor 1 RAPID SPEED
NC MD 331: standard motor 1 CREEP SPEED
NC MD 332: standard motor 1 CLOCKWISE
NC MD 333: standard motor 1 COUNTERCLOCKWISE

NC MD 334-337: standard motor 2

NC MD 338-341: standard motor 3

NC MD 342-345: standard motor 4

The image of control signal bits (control signal bytes 1 and 2) is placed in PLC flag bytes FY 20 and FY 21 every IPO cycle.

With option M26 RAPID NC INPUTS/OUTPUTS it is also possible to output control signal byte 1 (1.0 to 1.7) in position control cycles via the rapid NC outputs Q0-Q7.

The table below shows the correlation between input values and PLC and NC signals:

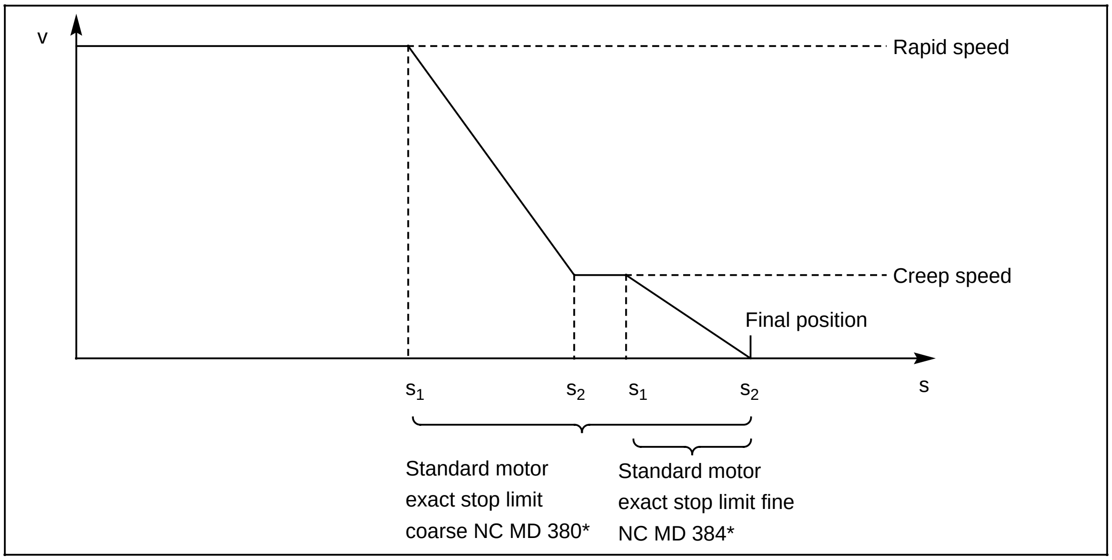
Input	Control signal bit	Flag bit	Rapid NC outputs
10	1.0	20.0	Q0
11	1.1	20.1	Q1
12	1.2	20.2	Q2
13	1.3	20.3	Q3
14	1.4	20.4	Q4
15	1.5	20.5	Q5
16	1.6	20.6	Q6
17	1.7	20.7	Q7
20	2.0	21.0	
21	2.1	21.1	
22	2.2	21.2	
23	2.3	21.3	
24	2.4	21.4	
25	2.5	21.5	
26	2.6	21.6	
27	2.7	21.7	

The PLC and NC signals are used to control the standard motors.

Separate MDs are used to define the exact stop limits of standard motors. The existing MDs for exact stop limits cannot be used because the input limits are too small.

NC-MD 380*: Standard motor exact stop limit coarse

NC-MD 384*: Standard motor exact stop limit fine



The values to be entered for the standard motor exact stop limits can be determined by measuring the braking paths of the loaded standard motor axes.

NC MD 380* standard motor exact stop limit coarse:
braking path rapid speed to creep speed + standard motor exact stop limit fine

NC MD 384* standard motor exact stop limit fine:
braking path creep speed to rest (brake etc.)

11.8.7 Comparison standard motor closed-loop-controlled axis

This Section describes the differences between closed-loop-controlled axes and standard motor axes. All functions and modes not mentioned are the same for both closed-loop-controlled axes and standard motor axes.

The measuring value acquisition system (including setting of the position control resolution) is identical for closed-loop-controlled axes and standard motor axes.

Setpoint output for a standard motor is digital. No analog setpoint is output for a standard motor (setpoint 0). All machine data concerning the analog setpoint are of no significance for a standard motor:

- MD 276* Acceleration
- MD 280* Maximum velocity
- MD 284* Reference point cutoff velocity
- MD 288* Jog feedrate
- MD 292* Jog rapid traverse
- MD 296* Reference point approach

The maximum velocity for a standard motor is limited to 45 m/s with a position control resolution of $0.5 \cdot 10^{-3}$ mm (see also Section 5.2.2).

11.8.8 Interface signals for standard motor axes

- The interface signals for standard motor axes have the same effect and must be switched in the same way as normal axes without function.
  Exception: The interface signal AXIS DISABLE has no function with standard-motor axes.
- The feedrate override is only active in position 0 for standard motors, all other positions are ignored.

Note:

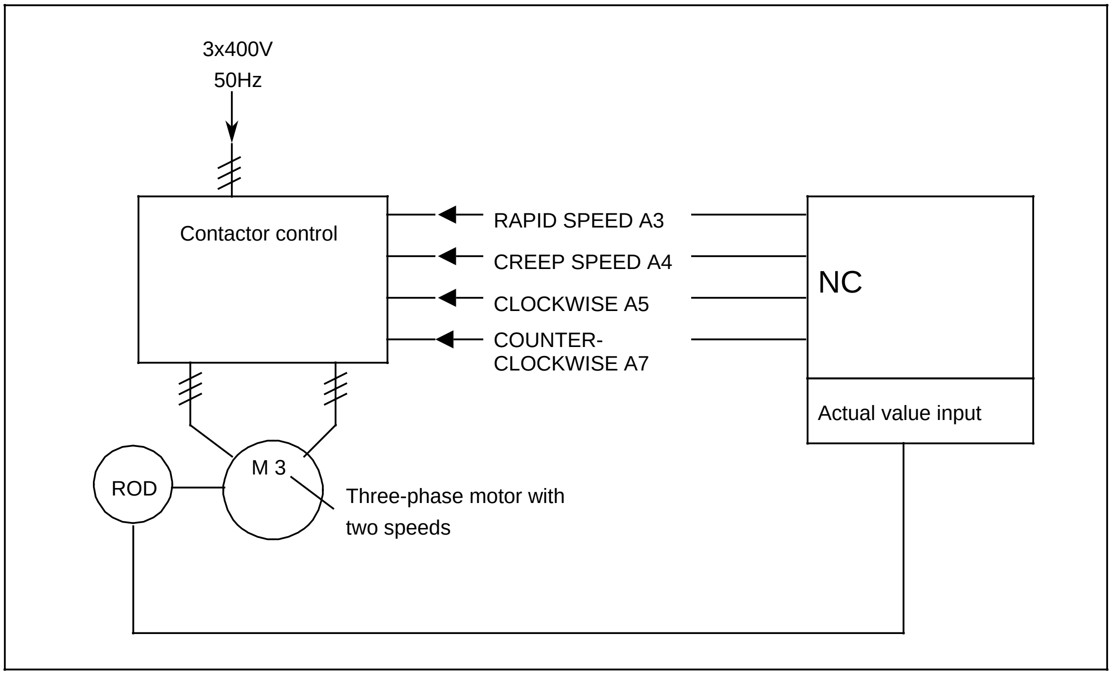
- All machine data are valid only after POWER ON.

Example:

The second axis of the control is to be a standard motor axis. The drive is a three-phase motor with two speeds. the control signals are output from rapid NC outputs Q3, Q4, Q5 and Q7.

The following machine data must be assigned:

- NC-MD 5151.7=1 Activate CONNECTION OF STANDARD MOTORS option
- NC MD 5641.1=1 (Identify second axis as standard motor)
- NC MD 334=13 (Standard motor 2 control signal RAPID SPEED is assigned to NC control signal 1.3)
- NC MD 335=14 (Standard motor 2 control signal CREEP SPEED is assigned to NC control signal 1.4)
- NC MD 336=15 (Standard motor 2 control signal CLOCKWISE is assigned to NC control signal 1.5)
- NC MD 337=17 (Standard motor 2 control signal COUNTERCLOCKWISE is assigned to NC control signal 1.7)
- Activate RAPID NC INPUTS/OUTPUTS option. NC control signals 1.0 to 1.7 are transferred to the rapid NC outputs and output.
- NC MD 3801=100000 (Standard value can be changed to meet requirements, e.g. the braking path from RAPID SPEED to CREEP SPEED is greater than the standard value.)
- NC MD 3041=10000 (Standard value can be changed to meet requirements, e.g. the braking path from CREEP SPEED to rest is greater than the standard value.)
- Calculate variable increment weighting (NC MD 364* and 368*) as for an NC axis and enter it.
- Switch PLC interface signals as for normal NC axis.



Example: Standard motor axis

11.9 Rapid M functions

The RAPID M FUNCTIONS function is an option

(provided as from software version 4.1).

11.9.1 Corresponding machine data

NC MD 350-381: Assignment of M functions   NC control signal bits

NC MD 5151.1: Reset M function on exact stop

NC MD 5151.2: Reset M function on last partial setpoint from IPO (last chord)

NC MD 5151.3: No rapid M function transfer to PLC

NC MD 5152.0-3: Reset test 1st to 4th axis

Option "Rapid NC inputs/outputs"

Option "Rapid M functions"

11.9.2 Function description

Using this function, M functions can be used for rapid control of outputs bypassing the NC-PLC interface.

Control of the outputs or flags is performed using the two NC control signal bytes (1.0-1.7 and 2.0-2.7).

M functions are assigned to the control signal bits on installation as setting or resetting conditions. The time at which the reset conditions take effect can still be influenced via machine data.

Because the NC control signals are transferred to the flags bits in IPO cycles or to the rapid NC outputs (option) in position control cycles, these signals can be influenced using M functions.
NC control signals are reset not only by reset M functions but also by RESET, EMERGENCY STOP, M02 and M30.

Rapid M function output can be enabled or disabled from the PLC via interface bit Q 80.0. This disable can also be cancelled during block execution (Q 80.0 ≙ 0 means disable).

11.9.3 Activation of the function

Prerequisite: the RAPID M FUNCTION option

The M functions are assigned to the NC control signal bits in NC MD 350 to 381. Every control signal bit has an M function that sets it and an M function which resets it. Not all the NC control bits need be used.

Any assignment is valid. An M function can even be assigned to several control signal bits and perform setting and resetting functions at the same time.

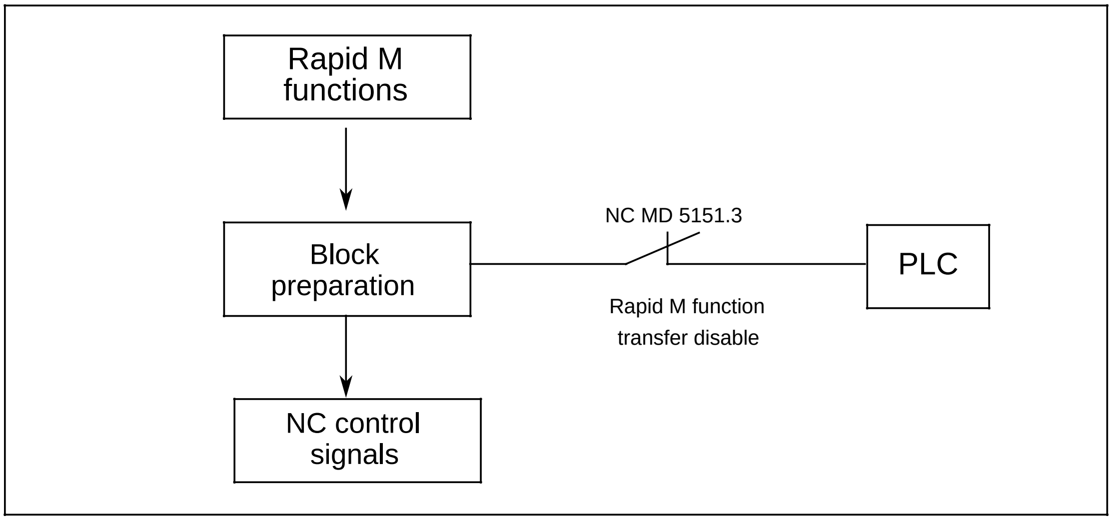
All M functions of the range M0 to M99 can be assigned.

The assigned M functions are called rapid M functions in the following text.

				Option
MD No.	**Meaning**	**NC control signal bit**	**Flag bit**	**Rapid NC output**
350	M function for setting	1.0	20.0	Q0
351	M function for resetting			
352	M function for setting	1.1	20.1	Q1
353	M function for resetting			
354	M function for setting	1.2	20.2	Q2
355	M function for resetting			
356	M function for setting	1.3	20.3	Q3
357	M function for resetting			
358	M function for setting	1.4	20.4	Q4
359	M function for resetting			
360	M function for setting	1.5	20.5	Q5
361	M function for resetting			
362	M function for setting	1.6	20.6	Q6
363	M function for resetting			
364	M function for setting	1.7	20.7	Q7
365	M function for resetting			
366	M function for setting	2.0	21.0	
367	M function for resetting			
368	M function for setting	2.1	21.1	
369	M function for resetting			
370	M function for setting	2.2	21.2	
371	M function for resetting			
372	M function for setting	2.3	21.3	
373	M function for resetting			
374	M function for setting	2.4	21.4	
375	M function for resetting			
376	M function for setting	2.5	21.5	
377	M function for resetting			
378	M function for setting	2.6	21.6	
379	M function for resetting			
380	M function for setting	2.7	21.7	
381	M function for resetting			

If rapid M functions are now used in an NC block, the NC must wait for the acknowledgement signal from the PLC "M functions received" before it can execute the next block. This can cause a delay of up to one PLC cycle.

To prevent this delay NC MD 5151.3 was created. If this bit is set to "1", the rapid M functions are no longer transferred to the PLC. The NC then no longer has to wait for the acknowledgement signal and block execution is speeded up.



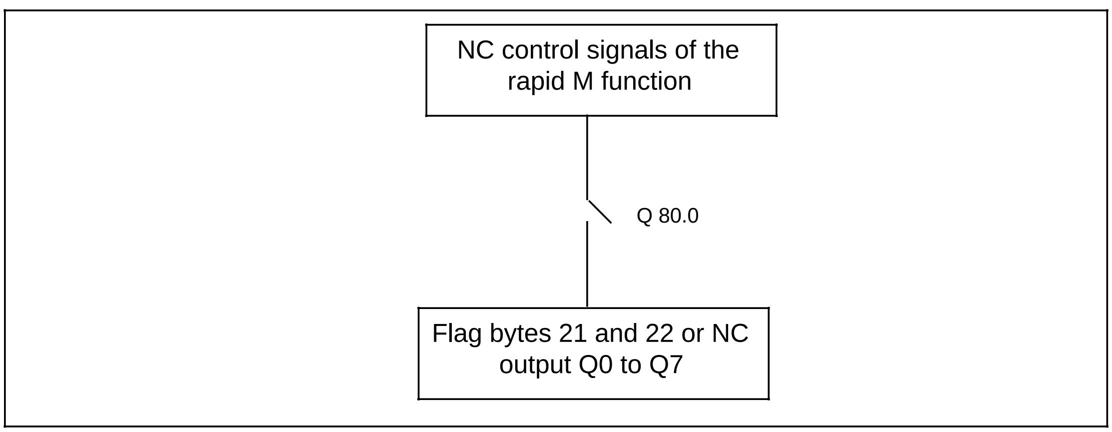
M functions with a fixed meaning (M00, M01, M02, M03, M04, M05, M17, M19, M30, M36, M37) must therefore not be defined as rapid M functions, because they can then no longer be transferred to the PLC and evaluated there when NC MD 5151.3 is set.

Rapid M function output can be influenced on the PLC side by NC-PLC interface bit Q 80.0. This bit is an enable input for the function.

Q 80.0 = 1 Output of the programmed rapid M functions to the flags and NC outputs is possible.

Q 80.0 = 0 Output of the programmed rapid M functions to the flags and NC outputs is disabled.

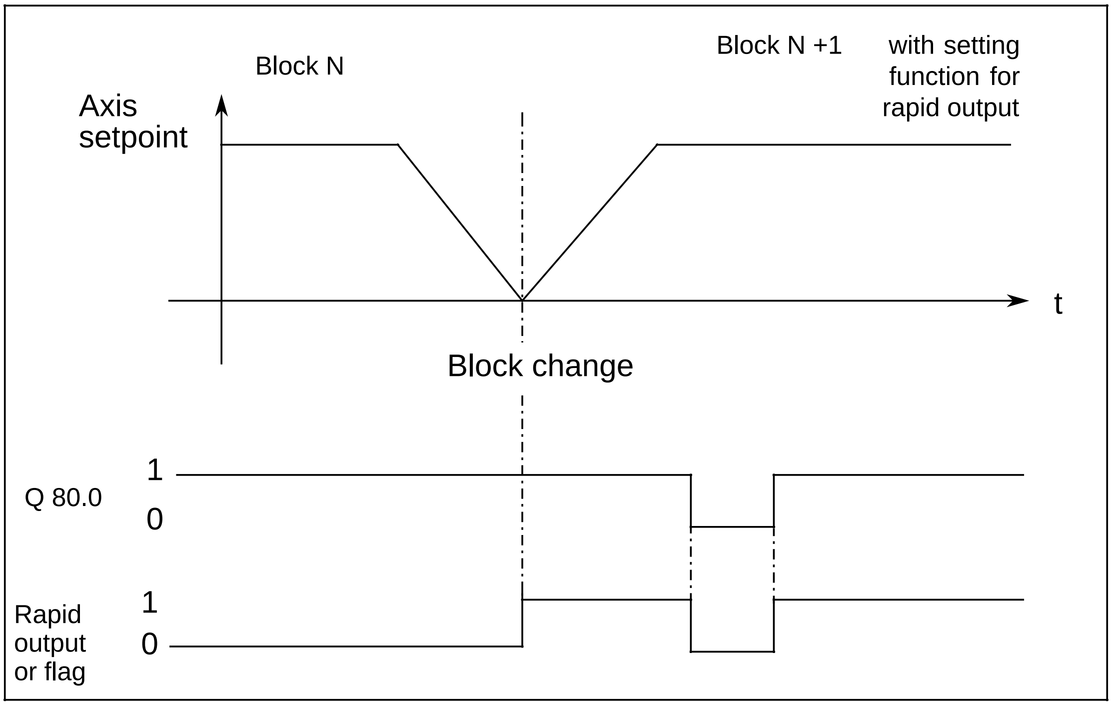
In this way it is possible that flags and NC outputs set by rapid M functions might sooner or later be reset by the PLC (application: laser on/off on NC STOP, feed hold etc.).



11.9.4 Activation of setting/resetting M functions

Setting function:

The setting functions are always active at the beginning of a block even if the beginning of the block and the beginning of the axis motion do not coincide (e.g. if feedrate is not enabled). They are active at the beginning of the block even without axis motion.



Resetting function:

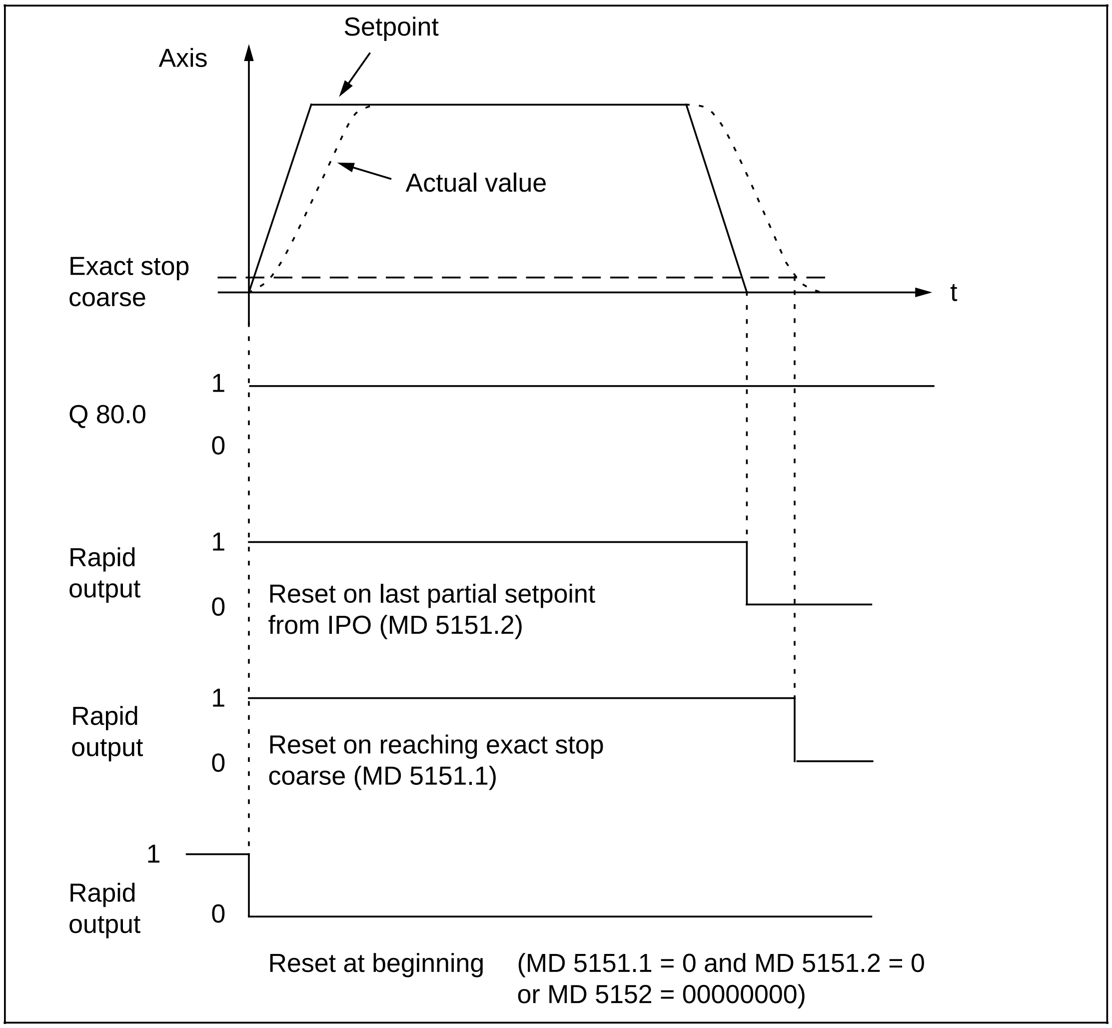
The time at which the resetting functions can be influenced by NC machine data.

- NC MD 5151.1 — The resetting function is executed when all axes specified in NC MD 5152 have reached the exact stop limit coarse (NC MD 204*).
- NC MD 5151.2 — The resetting function is executed when all axes specified in NC MD 5152 have received the last partial setpoint from the interpolator (last chord of the curved path); i.e. the axes have reached their calculated programmed position.
- If both NC MD 5151.1 and 5151.2 are equal to zero, the resetting function is executed at the beginning of the block.
- If NC MD bits 5152.0 to 5152.3 are equal to zero, the resetting function is executed at the beginning of the block.

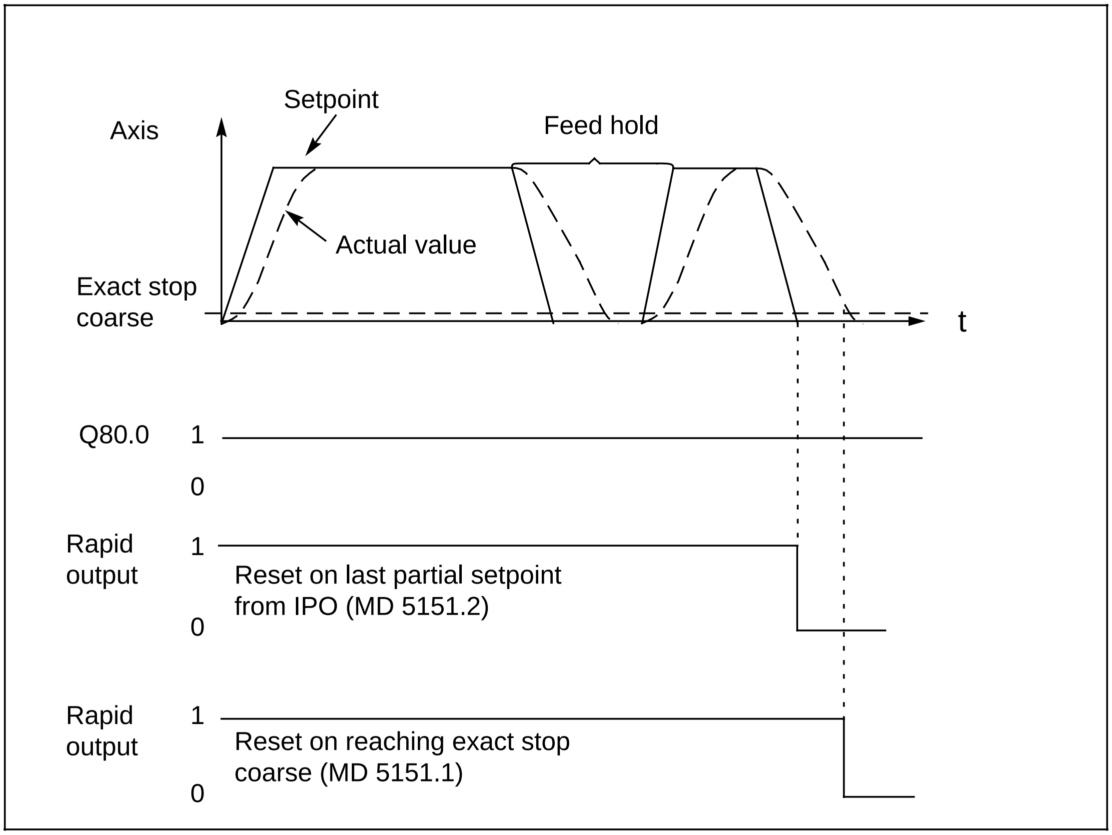
The NC MD bits 5152.0 to 5152.3 define which axes are checked out before the resetting function is performed.

- NC MD 5152.0 1st axis is checked for resetting
- NC MD 5152.1 2nd axis is checked for resetting
- NC MD 5152.2 3rd axis is checked for resetting
- NC MD 5152.3 4th axis is checked for resetting

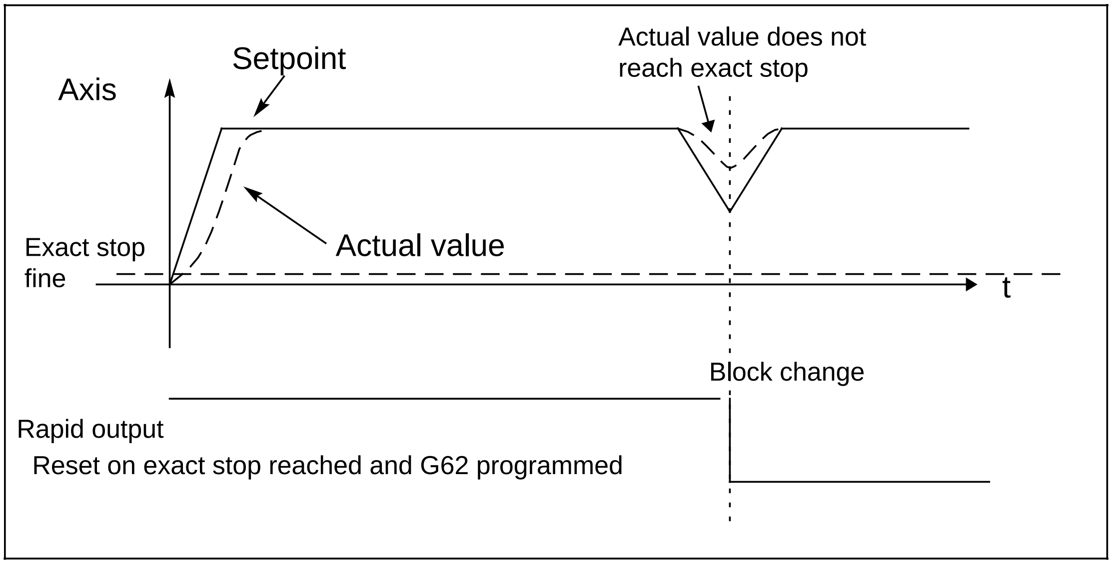
Changes to these NC MD bits (5152.0 to 3) are active immediately. They can therefore be changed by @ commands in the part program.



If, in the middle of a block, the feedrate is cancelled or the feedrate override is turned to zero so that the conditions for the output of the reset functions defined in MD 5151 are met, the reset functions will not become active in the middle of a block. A temporary reset could be achieved by influencing the enable input Q 80.0.



If G62 or G64 is programmed in a block (continuous-path control), the travelling axes do not come into the exact stop. If a rapid M function (reset function) is programmed, it is not executed until the end of the block.



11.10 Second handwheel

The "Second handwheel" function is an option

(provided as from software version 4.1).

11.10.1 Corresponding machine data

NC MD 5004.2 Enable handwheel

Option "Second handwheel"

Option "External handwheel on the fifth measuring circuit"

11.10.2 Description of function

This function can be used to operate a second handwheel for axis control on the SINUMERIK where there is already a first handwheel.

The second handwheel has the same functionality as the first handwheel (travel in JOG mode, DRF function, velocity overlay in MDA and AUTOMATIC modes).
Increment weighting is the same for both handwheels.

Both handwheels can be used at the same time but must be assigned to different axes. Each handwheel can be assigned to only one axis.

The first handwheel can be the external handwheel (option, connected to the fifth measuring circuit) or the handwheel in the handheld unit can be used.
The second handwheel must be connected to an actual value submodule without EXE (6FX1 145-3BA), that must be inserted in the fourth or fifth submodule slot.

The following should be observed:

- If the fourth submodule slot is already being used for an axis, the actual value submodule for the second handwheel must be inserted in the fifth slot.
- If the SINEC L2 submodule is inserted in the fifth submodule slot, the actual value submodule for the second handwheel can only be inserted in the fourth submodule slot.

Only handwheels with the order numbers 6FC9 320-5DC AND 6FC9 320-5DB can be used with this function because only these generate all four signals (A, $\overline{A}$, B, $\overline{B}$).

11.10.3 Activation of the function

- Actual value submodule without EXE must be inserted in the fourth or fifth submodule slot as pulse input for the second handwheel.
- NC MD 5004.2 (handwheel enabled) must be set to "1".
- "Second handwheel" option must be set.
- Optionally:
  – "External handwheel" option must be set if the first handwheel is connected to the fifth measuring circuit (already on the main board).
  – A further bit must be set if the first handwheel is the handwheel in the handheld unit.

The second handwheel must be assigned to the chosen axis by PLC NC signals:

Q109.1	axis 1
Q113.1	axis 2
Q117.1	axis 3
Q121.1	axis 4

It is important to make sure that the second handwheel is not assigned to several axes at once nor to the same axis as the first handwheel. Double assignments and other invalid assignments must be detected in the user PLC program because no NC alarm is output to warn of this.

11.11 SINEC L2 interface

This function is an option

(available as from software version 4.1).

Notes on the structure and functionality are to be found in the following documentation:

SINUMERIK 805 Function Manual SINEC L2 Interface	Order number: 6ZB5 410-0DQ02-0AA0

11.12 3 analog setpoint outputs

The 3 ANALOG SETPOINT OUTPUTS function is available as an option

(as from SW version 4.2).

11.12.1 Corresponding data

NC-MD 161-163	Drift compensation for analog outputs 1 -3
NC-MD 5148.2	Own RESET for analog outputs
NC-MD 5148.3	Programmed analog output in V
AB 104 bit 0-2	Setpoint/servo enable analog outputs
AB 104 bit 6	RESET for analog specifications
AB 105 bit 0-2	Setpoint specification from PLC
AB 105 bit 3-5	Invert analog voltage
DB 28	Data block for ANALOG output
Option	"3 analog setpoint outputs

11.12.2 Description of function

For many machine tools it is necessary to operate an auxiliary spindle in addition to the main spindle (e.g. for a driven tool). Since they must not be positioned, these spindles do not require an encoder. To control their speed only a voltage in the range of -10 to +10 V for the drive actuator is required.

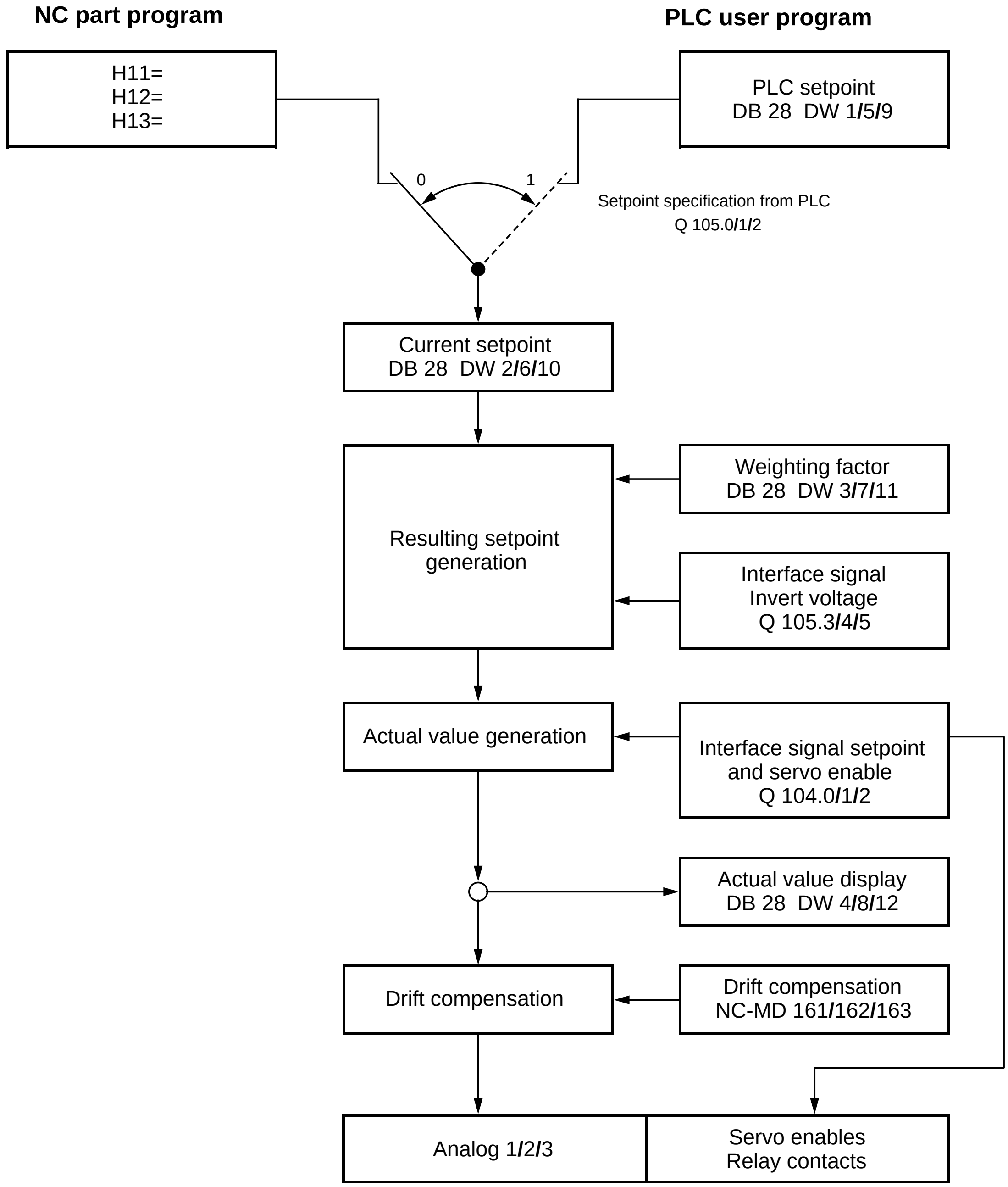
By means of the setpoint output module (servo command module, 6FX1132-5BA02) that can be plugged onto the 4th or 5th slot, 3 additional analog setpoint outputs can be controlled via the part program (special auxiliary functions H11=; H12=; H13=) or via the PLC. These 3 setpoint outputs operate at an output resolution of 1.22 mV in the range of -10 and +10 V. Only one setpoint output submodule can be implemented for one SINUMERIK 805 control.

Via a PLC output, the user decides for each analog output whether the setpoint specification is to be taken from the NC part program or from the PLC. Each analog output is additionally assigned a weighting factor to influence the setpoint voltage.

The setpoint specifications, the weighting factors and the voltage actual values are entered in a data block DB28. The DB28 is automatically generated during the power-up phase if it does not already exist. If it exists the data contents are not modified.

Cyclic in the IPO cycle, the system fetches the setpoint specifications from the PLC or NC, links this value with the relevant weighting factor and assigns the corresponding analog output with this value. The analog output must then be enabled via PLC signals (SETPOINT AND SERVO ENABLE). The specified values can be inverted by means of the INVERT ANALOG VOLTAGE function.

The component drift of the analog outputs can be compensated via NC-MD 161 to 163. The compensation is only effective if the analog output is active.



The hardware of the setpoint output submodule is described in
SINUMERIK 805 Interface Part 2, Connection Conditions.

Explanation of the DB 28

DW 0	reserved	
DW 1	PLC setpoint 1	Analog output 1
DW 2	Current setpoint 1	
DW 3	Weighting factor 1	
DW 4	Analog value1	
DW 5	PLC setpoint 2	Analog output 2
DW 6	Current setpoint 2	
DW 7	Weighting factor 2	
DW 8	Analog value 2	
DW 9	PLC setpoint 3	Analog output 3
DW 10	Current setpoint 3	
DW 11	Weighting factor 3	
DW 12	Analog value 3	

PLC setpoint: With PLC setpoint specifications, the setpoint must be entered in these data words.

Value range:
8000H to 0000H correspond to -10 V to 0 V
0000H to 7FFFH correspond to 0 V to+10 V

Beispiele:		
	7FFFH = 10 V	8000H = -10 V
	3FFFH = 5 V	C000H = -5 V
	1FFFH = 2.5 V	E000H = -2.5 V
	0001H = 0.305 mV	FFFFH = -0.305 mV

Current setpoint: Here, the system enters the setpoint (NC or PLC setpoint) selected by the PLC via the outputs 105.0/1/2.

Value range:
-10000(dec) to +10000(dec) correspond to -10 V to +10 V
D8F0(hex) to 2710(hex) correspond to-10 V to+10 V(with hexadecimal and binary representation the negative values are represented as two's complement)

Weighting factor: The weighting factor to be entered here, is multiplied with the current setpoint. The result is the output voltage. The maximum output voltage remains ±10 V.

Value range:
0 to 64(hex) correspond to 0% to100%
0 to100(dec.) correspond to 0% to100%

Analog value: In this data word the control enters the analog value which is to be measured as voltage at the analog output.

Value range: as current setpoint.

Notes:

- This data can be displayed in the PLC status display.
- The analog voltage is output at an output resolution of 1.22 mV.

11.12.3 Programming the analog outputs

11.12.3.1 Programming the analog outputs via the part program

In the part program the 3 analog outputs can be controlled via the following H functions (special auxiliary functions):

H11= (value) for analog output 1

H12= (value) for analog output 2

H13= (value) for analog output 3

The value range is programmed either in V or mV. This depends on NC-MD 5148 bit 3.

NC-MD 5148.3=1: Unit of value range is V -10.000 to+10.000
Example: H11=6.534 6.534 V analog output 1

NC-MD 5148.3=0: Unit of value range is mV -10000 to+10000
Example: H11=-3241 -3.241 V analog output 1

If the value specification is incorrect, the voltage is reduced to the maximum voltage (-10 V or +10 V).

The H11=, H12= and H13 auxiliary functions are special auxiliary functions. They cannot be overstored, are not displayed and are not entered in the PC-PLC interface. If not setpoint submodule is implemented, they are regarded just like standard auxiliary functions. These 3 special auxiliary functions can be programmed either individually or together in any order in a block. Another 6 auxiliary functions can be programmed in addition to these three special auxiliary functions (see NC Programming Instructions). The new setpoint specifications from the part program are always output at the beginning of the block.

11.12.3.2 Programming the analog outputs via the PLC

If an analog output is to be preset by the PLC, the PLC must set the interface signal SETPOINT SPECIFICATION FROM PLC. The setpoint must then be entered in the DB28 in the data word DW1/5/9.

Value range: 8000H to 0000H correspond to-10 V to0 V
0000H to 7FFFH correspond to0 V to+10 V

Example

The 2nd analog output is to output a voltage of 3.42 V. The corresponding value in hexadecimal representation is obtained by applying the following formula:

$$\frac{U_X\,[\mathrm{mV}] \cdot 32\,767}{10\,000} = \text{Analog value} \qquad \frac{3420 \cdot 32\,767}{10\,000} = 11206_{Dec} = 2BC6H$$

Hence 2BC6H must be assigned to the data word 5 in DB28.

PLC program:

```
    :
C DB28
L KH 2BC6
T DW5
    :
```

In the case of a negative voltage value, the one's complement of the hexadecimal number must be generated additionally.

Example

The 1st analog output is to output a voltage of -4.452 V.

$$\frac{4452 \cdot 32\,767}{10\,000} = 14587.87_{Dec} = 38FBH = 0011\ 1000\ 1111\ 1011$$

One's complement: 1100 0111 0000 0100
Hexadecimal number: C704H

C704H must be assigned to data word 1 of DB28.

PLC program:

```
    :
C DB28
L KH C704
T DW1
    :
```

11.12.4 RESET behaviour

By means of machine data you can select whether the analog specifications programmed with H11= to H13= are to be deleted by the NC or the PLC.

NC-MD 5148 bit 2=0: M02/M30 and RESET delete the specifications programmed with H11= bis H13=.

NC-MD 5148 bit 2=1: The setpoint programmed with H11= bis H13 = can be deleted by the PLC with A104.6 when the control is in the RESET state.

On RESET and EMERGENCY STOP, the setpoints given by the PLC (DB28 DW1/5/9) are not overwritten with 0 by the system and remain unchanged. If the user wishes them to be overwritten he must effect this himself in his PLC program.

The analog outputs on the module are treated just as the digital outputs of the central I/Os, i.e. they are switched off while the PLC is powering up and in the PLC stop state.

Note:

The setpoint output module hardware outputs a voltage via the analog outputs when the control is switched on or off. Therefore, the servo enables (relay contacts) of the respective analog outputs must be used as enable signals for the units on the output side (e.g. drive actuator).

11.13 Operator control and monitoring via external PC

The OPERATOR CONTROL AND MONITORING VIA EXTERNAL PC function is available as an option (as from SW version 4.2).

11.13.1 Corresponding data

Option	”Operator control and monitoring via external PC (B36)”
MB24 bit5	PC LINK ACTIVE
AB79 bit6	SCREEN DARK

11.13.2 General

The SINUMERIK 805 is often used without operator panel and monitor for transfer lines, loading facilities, etc. In some cases, however, as for example in installation and start-up, servicing or program modification, an operator control and display facility is required. For these the NC can be operated via a personal computer (PC). For this purpose the PC requires a special program package SIN805PC. It is connected to the RS232C (V.24) interface of the SINUMERIK 805 via a cable (max. length 30 m) (Option C62 "2nd RS232C (V.24) interface" is not required). Via this interface, message frames are transmitted by means of 3964-R procedure.

Two levels of operation are possible:

- Start-up of the SINUMERIK 805 via the PC (PC software SIN805PC (6FC9383-7AY10-4AA0) required)
- Start-up and normal operation of the SINUMERIK 805 via PC (option B36 is required in addition to the PC software).

11.13.3 Preconditions for operation

- Hardware:
  - IBM-compatible PC (386SX processor) with at least 2 Mbyte RAM
  - 2 Mbyte free hard disk capacity
  - At least 540 Kbyte free main memory in the 640 Kbyte area
  - VGA display with at least 16 color or grey shades
  - Paradise-compatible graphics card or graphics card with ET4000-compatible chip set
  - NC-PC connecting cable: 6FC9344-1B (25-way SUB-D socket for PC)
    6FC9344-4T (9-way SUB-D socket for PC)
- Software:
  - MS-DOS 5.0 operating system and the SIN 805PC program package on the PC
  - Software version 4.2 on the SINUMERIK 805

For further information on start-up of the SIN805PC program package please refer to the README file in the program package.

11.13.4 Start-up via PC

The scope of functions corresponds to the initialization mode of the SINUMERIK 805. An exception is that the second interface cannot be selected because it is already being used for connecting the PC.

For start-up, the PC-SINUMERIK 805 cable connection must be established before starting the PC program and before powering up the control. Furthermore, the following conditions must be met:

- The start-up switch must be in position 2, i.e. the battery backup must not have been active since the last power off.
- No operator keyboard connected.

11.13.5 Normal operation via PC

The full scope of functions of the SINUMERIK 805 is available here with the following exceptions:

- The 2nd RS232C(V.24) interface cannot be selected.
- Machine control panel keys of the operator panel (AUTOMATIC, MDA, TEACH-IN, JOG, RESET, SINGLE BLOCK, NC-START, NC-STOP) may not be simulated on the PC for reasons of safety. Selection must be implemented separately via the PLC.

The PC-SINUMERIK 805 cable connection can be interrupted and re-established at any time without an error message being output. In the case of line faults or when the control does not respond, the PC automatically branches to the version screen of the SINUMERIK 805. The control continues operation without error message, merely the PC OPERATION ACTIVE flag (F24.5) is reset. Now, the PC tries to re-establish the connection to the control. As soon as the cable connection between PC and control is re-established and data exchange takes place, the PC OPERATION ACTIVE flag (F24.5) is set again. The basic display of the currently selected mode appears on the PC.

The interface signal KEYBOARD DISABLE (Q 7.7) has no function during operation with the PC. By means of the interface signal SCREEN DARK also the PC monitor can be switched dark.

Note:
Serial data transmission leads to higher response and refresh times as compared to the directly linked operator panels (times depend on the screen contents). The actual values are updated faster than the block information.The time required by several functions (e.g. tracking and simulating key, menu and window codes) is modified by the data transmission to the PC.

Switchover to other SINUMERIK 805

If the PC is to be used as operator control unit for several controls, the connecting line can be switched from one control to the other via an RS232C (V.24) switch (see Interface Description Part 2, Connection Conditions). The signal KEYBOARD DISABLE (Q79.7) must not be transmitted to the NCs.

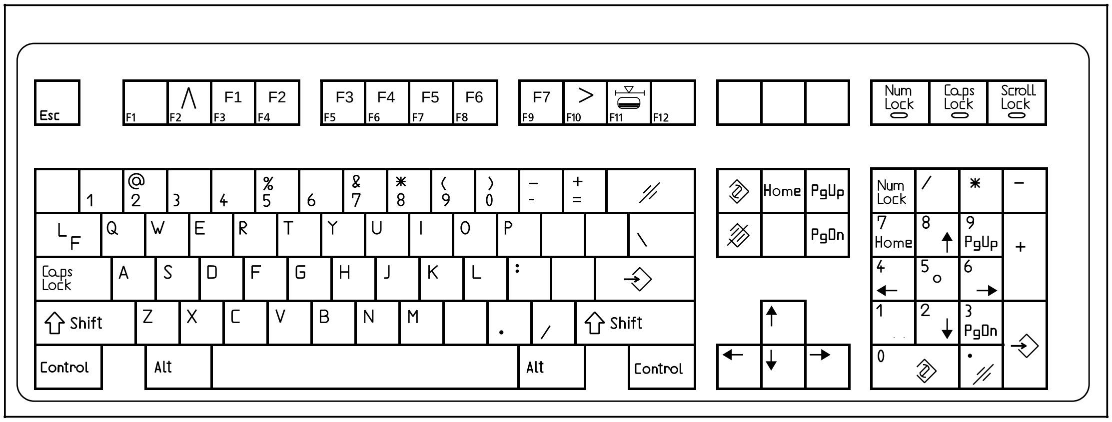
11.13.6 Operation

Operation of the control via the PLC is analog to the standard operation as described in the Operator's Guide. Some keys of the M2 keyboard are preset with special characters which are not available as a standard, but which are required for operation of the NC.

The SIN805PC program package is exited by pressing the ESC key.

The upper case letters A-Z and the lower case letters a,b,c,d,e,f from the alphabet are supported.

The figure below shows the keyboard assignment of the M2 keyboard for this application.



Note:
The international (English or American) character set must be preset on the PC, otherwise the special characters are on other keys or are not displayed.

12 Alarms

12.1 General

The control contains permanently active monitors which detect malfunctions in the NC, interface controller and machine at such an early stage that damage to the workpiece, tool or machine is largely ruled out.

In the event of a malfunction, machining is first interrupted and the drives shut down, the cause of the fault being stored and displayed as an alarm. At the same time, the PLC is informed that an NC alarm is present.

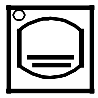
Monitors exist for the following:

- Read-in
- Format
- Measuring circuit cables
- Position encoder and drive
- Contour
- Spindle speed
- Enable signals
- Voltage
- Temperature (DMP submodules only)
- Microprocessor
- Serial interfaces
- Data transfer between NC and PLC
- Condition of back-up battery
- System program memory
- User program memory

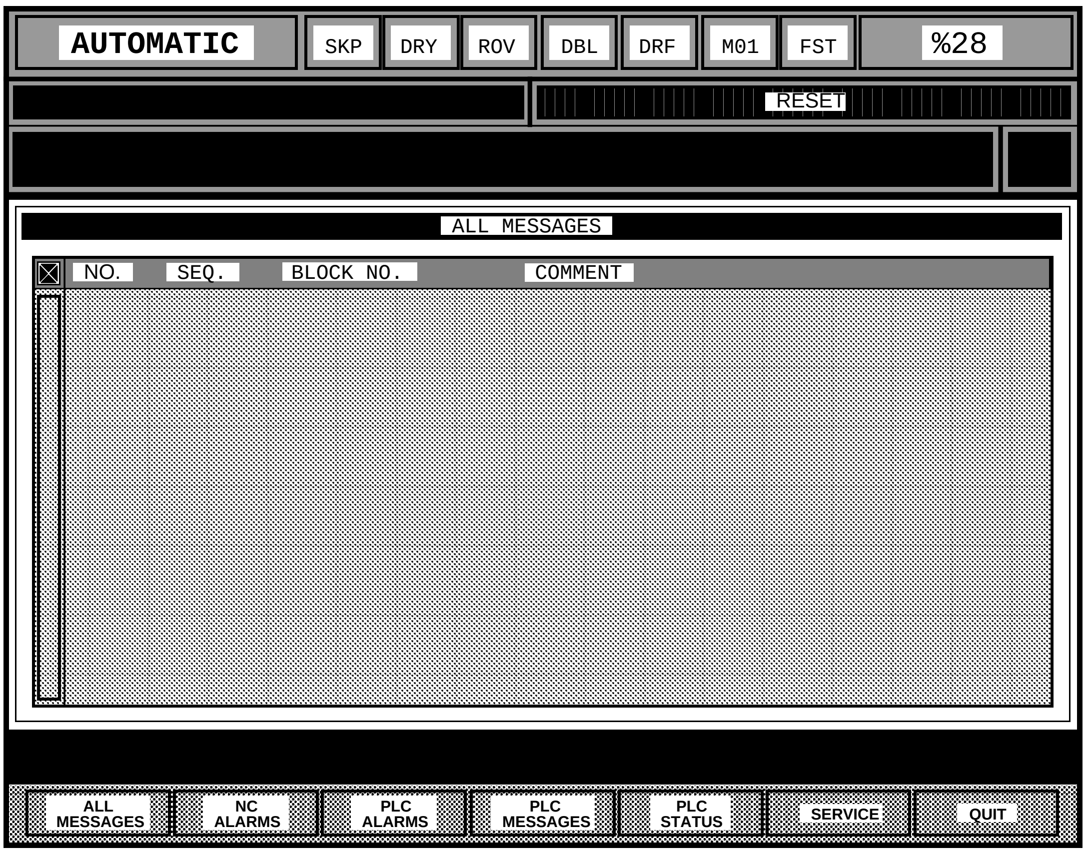
The PLC user also has an additional 64 PLC alarms and 64 PLC messages at his disposal. The associated texts are transferred to the buffered storage area of the control via the V.24 (RS232 C) interface.

12.2 Display of alarms and messages

In the event of a fault, the NC can identify and display several different alarms and messages at the same time.
However, only the lowest number with associated text is displayed in the alarm and message field. On the SINUMERIK 805, a list of all alarms and messages can be called as follows:

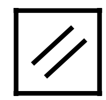
1. Operator area key:  Branches from any machine area menu to the basic menu of the data area.

2. Softkey: DIAGNOSIS



- The block number indicates the NC part program block in which the fault occurred.
- The ordinal number (SEQ.) indicates the sequence in which the alarms occurred. The ordinal numbers range from 1 to 99. The counter is reset when the control is switched on (POWER ON).
- The number (NO.) indicates the alarm number.
- The special alarm groups (NC alarms, PLC alarms, PLC messages) can be called by pressing the appropriate softkey.

12.3 Overview of alarms and messages / clear mode

Type	Numbers	Groups		Clear as follows:	
NC alarms	1...15 40...99 132* 136* 1)	Power On alarms		Switch control off and on	POWER ON
	16 : 39	V.24 (RS232 C) alarms		1. Select data area 2. Press DATA TRANSFER softkey 3. Press STOP softkey	STOP
	100* : 196* 1)	Axis-specific	Reset alarms	Press RESET key on operator keyboard	
	2000 : 2999	Gen-eral			
	3000 : 3999	Acknowledge alarms		Press QUIT softkey	QUIT
	4000 : 4999	Standard Cycle alarms			
	5000 : 5099	User Cycle alarms			
PLC alarms	6000 : 6063	User alarms		Press QUIT softkey	QUIT
	6100 : 6166	PLC system and programming alarms		Switch control off and on	POWER ON
PLC messages	7000 : 7063	User messages		No acknowledgement/clearing necessary	

1): The * stands for:
"0" for alarms in axis 1
"1" for alarms in axis 2
"2" for alarms in axis 3
"3" for alarms in axis 4

12.4 Alarm list

1	Battery alarm! Do not switch off! Change battery!	POWER ON
Cause: Scan: Explanation: Remedy: **Note:**	Voltage of back-up battery too low – At POWER ON – Cyclically Renew battery (see Section 3.1.6, Installation Instructions). The battery voltage has dropped to such a level that buffering of the user memories is guaranteed only for a short remaining period. If this alarm is output while the control is running, it can be acknow-ledged with the RESET key when the battery has been changed. Renew battery (see Instruction Manual). Dispose of old batteries as special waste. ***Do not switch off*** control before changing the battery otherwise risk of data loss!	

2	Operator panel error	POWER ON
Cause: Scan:	Operator keyboard not ready, cable break Cyclically	

3	PLC stop	POWER ON
Cause: Scan: Effect: Explanation: Remedy:	PLC not ready; PLC components defective (DMP module) Cyclically – NC START disabled – Setpoint relays drop out (Setpoint 0) – NC Ready 2 cancelled – Servo enable cancelled after time in MD 156 has expired (servo enable relays drop out) – NC/ PLC interface rendered inactive – Resetting of all PLC outputs Cyclical and interrupt-driven operation of the PLC is interrupted. Travel with the machine is not possible. No block list is created on start-up with hardware faults. Read out the cause of the interrupt (I STACK) with the PG (programmer).	

4	Unit system not allowed	POWER ON
Scan: Effect: Explanation: Remedy:	– With POWER ON – After modifying MD Conversion factor assumed to be 1 An impermissible combination of measuring system units (position control resolution) and input system units (conversion factor greater than 10) has been selected in MD 5002. Correct MD bit 5002 and switch control off and on.	

7	**EPROM error**	POWER ON
Scan: Effect: Explanation: Remedy:	Cyclically – NC START disabled – Setpoint relays drop out (setpoint 0) – NC Ready 2 cancelled – Servo enable cancelled after time in MD 156 has expired (servo enable relays drop out) An error was detected when verifying the check sums Consult the service organization	

8	**Wrong axes or spindle**	POWER ON
Scan: Effect: Explanation:	After MD modification – NC START disabled – Setpoint relay drops out (setpoint 0) – NC Ready 2 cancelled Illegal assignment entered in MD 200* or MD 400*. ***Correct:*** (0000) Axis or spindle not available at machine (permissible only with NC-MD bit 564*.7="0" (for axes)) 0100 0200 0300 0400 0500	
Remedy:	See Section 8 (MD description for MD 200* and MD 400*)	

9	**NC control signals invalid**	POWER ON
Scan: Effect: Explanation Remedy:	At POWER ON – NC START disabled – NC Ready 2 cancelled The input limits for NC MD 311-318 (cam signals), NC MD 330-345 (standard motors) or NC MD 350-381 (rapid M functions) were violated or values entered incompatible with one another (e.g. double assignment by standard motors and cam signals). Check the following MD: – NC MD 311-318 (cam signals) – NC MD 330-345 (standard motors) – NC MD 350-381 (rapid M functions)	

10	L2 module has broken down	POWER ON
Cause: Effect: Remedy:	No response from L2 submodule Data traffic from/to L2 submodule no longer possible POWER ON reset	

11	Option standard motor does not exist	POWER ON
Scan: Effect: Explanation: Remedy:	On POWER ON The set bit NC MD 564*.4 (standard motor) is ignored. The axis is not being run as a standard motor but as a normal NC axis. "Connection of standard motors" option missing – Retrofit the option – Check NC MD 564*.4 (standard motor)	

12	It's not permitted to connect both 1st and 2nd handwheels	POWER ON
Scan: Effect: Explanation: Remedy:	At POWER ON NC-PLC interface signal NC Ready 2 is cancelled An impermissible connection combination of handwheels was entered. Connection combination according to description of function (Installation Instructions Section 11).	

13	RAM error	POWER ON
Scan: Effect: Remedy:	At POWER ON Error in RAM area of module – Format user memory and part program in initialization mode – Replace central controller	

16	**Parity error (RS232)**	STOP
Effect:	– V.24 (RS232 C) transmission interrupted – Last block declared invalid	
Explanation:	The alarm can be activated only if parity is selected. The parity of the started character (8 data bit and 1 parity bit) is incorrect.The alarm has nothing to do with the V.24 (RS232 C) character parity error for ISO or EIA tape (Alarm 23)	
Remedy:	– Check parameters of V.24 (RS232 C) interface – Test external device	

17	**Overflow error (RS232)**	STOP
Effect:	– V.24 (RS232 C) transmission interrupted – Last block declared invalid.	
Explanation:	The external device has transmitted a new character although the NC has not yet processed the old character	
Remedy:	– Check parameters of V.24 (RS232 C) interface – Test external device	

18	**Frame error (RS232)**	STOP
Effect:	– V.24 (RS232 C) transmission interrupted – Last block declared invalid	
Explanation:	– The number of stop bits is incorrect – Wrong baud rate – Number of data bits is wrong	
Remedy:	– Check parameters of V.24 (RS232 C) interface – Test external device – Number of data bits: 7 data +1 parity (set from external device)	

19	**External I/O device not ready (RS232)**	STOP
Effect:	No files are read in	
Explanation:	Low-level DSR signal from external device	
Remedy:	– Activate external device – Do not use DSR	

22	**Time monitoring (RS232)**	STOP
Explanation:	– The NC cannot output a character for 60 seconds -- external device blocks CTS (clear to send) signal for more than 60 s -- when control signals (DC1-DC4) are used, no DC1 transmission by external device for 60 s – The NC has not received a character for 60 seconds.	
Remedy:	– Check external device and switch on – Check and insert cable – Switch off time watchdog in parameter menu	

23	**Character parity error (RS232)**	STOP
Cause:	Tape dirty or damaged	
Effect:	– V.24 (RS232 C) transmission interrupted – Last block declared invalid	
Explanation:	Depending on the definition of program start "%" or "EOR", the NC automatically specifies ISO or EIA code, and thus the character parity, after this character has been received. When the subsequent characters were checked, it was found that one character did **not** have the specified parity.	
Remedy:	Check tape and/or data on diskette	

24	**Invalid EIA character (RS232)**	STOP
Effect:	– Data transmission interrupted – Last block declared invalid	
Explanation:	An EIA character with correct parity has been read in but the character is **not** defined in the EIA code.	
Remedy:	Check tape: Check EIA code for "@" and EIA code for ":"	
Note:	As the "=" character is not defined in the EIA code, the following data cannot be read in: – %TEA1 (NC machine data); – %TEA2 (PLC machine data); – %RPA (R parameters); – %TOA (tool offsets); – %ZOA (zero offsets); – Main programs and subroutines with R parameter calculations	

26	**Part program block > 120 characters (RS232)**	STOP
Cause: Effect: Remedy:	The read-in part program block has more than 120 characters. Only the actually stored characters are counted (no blanks, no CR, ...) – Data transfer interrupted – Last block not stored Split block into 2 or more blocks	

27	**Data input disabled (RS232)**	STOP
Cause: Effect: Remedy:	"Cycle disable" interface signal is present; or NC/PLC machine data texts or L2 data read in without password input. No data stored – Reset Q 78.3 via PLC status – Enter password (enquiry appears when changing machine data)	

28	**Ring (circular) buffer overflow (RS232)**	STOP
Effect: Explanation: Remedy:	– V.24 (RS232 C) transmission interrupted – Last blocks declared invalid The transmission rate is so high that the number of characters read in exceeds the number that can be processed by the NC. When the program is re-transmitted, the defective program must first be erased. – RTS signal has no effect on the input device (RTS effects input device stop) – Transmission rate (baud rate) too high	

29	**Block too long (max. 254 characters) (RS232)**	STOP
Cause: Effect: Remedy:	The read-in block has more than 254 characters. All the read-in characters (e.g. blanks) are also counted. – V.24 (RS232 C) transmission interrupted – Last block not stored Split block into 2 or more blocks.	

30	**Part program memory full (RS232)**	STOP
Cause: Effect: Remedy:	The maximum storage area for the part program is occupied – Data transmission interrupted – Last block not stored Erase programs that are not longer required and reorganize memory.	

31	No further part program input (RS232)	STOP
Cause:	The maximum number of programs specified by means of machine data has been reached.	
Remedy:	– Erase programs that are no longer required and reorganize memory – Modify MD 8 and reformat part program memory Sequence: a. "INITIALIZATION" MODE b. "Format user data" softkey c. "Format part program memory" softkey This also erases all programs.	

32	Data format error (RS232)	STOP
Cause:	– Permissible number of decades after an address is incorrect – Decimal point in wrong position – Part programs or subroutines are not correctly defined or terminated (observe header) – NC expects an "=" character, but this character is not defined in the EIA code.	
Effect:	Data transmission interrupted, last block not stored	
Remedy:	Check data to be read in	

33	Stored program differs from inputted program (RS232 C)	STOP
Cause:	Read-in and stored program not identical with same program number	
Effect:	No data stored	
Remedy:	Erase old program or rename old program	
Explanation:	If an existing program with the same program number is read in again, the two programs are compared. If they differ, Alarm 33 is triggered.	

34	Operator error (RS232) interface	STOP
Cause:	Data transmission initiated at the NC and the PLC issues a second start signal	
Effect:	No data read in	
Remedy:	Stop data input and restart	

35	SIEMENS reader error (RS232)	STOP
Cause: Scan: Effect: Remedy:	Error message from Siemens tape reader Only if the setting data for the Siemens reader are set – Data transmission interrupted – Last block not stored – Restart data transmission – If error occurs again, replace Siemens reader	

104*	D/A converter limit has been reached	
Scan: Effect: Explanation: Remedy:	Cyclically No direct effect. The error is included in the following error Alarm 156* The set value at the DAC is higher than input in MD 268* (max. DAC set value). No further increase in set value possible. – Operate at lower speed – Check actual values (encoder) – Check MD 268* – Check drive actuator – Check MD 364* and MD 368*	

108*	Overflow part actual value (pulse weighting)	
Scan: Effect: Explanation: Remedy:	With each axis movement (also in follow-up operation) – NC START disabled – Setpoint relay drops out (setpoint 0) – NC Ready 2 cancelled – Servo enable cancelled after time in MD 156 has expired (servo enable relays drop out) – Follow-up operation – Machine actual value is lost (wrong position) The part actual value is multiplied by the control. An error resulted in register overflow with high-speed axis traversing. The reference point was then lost. – Reduce max. speed – Check MD for variable increment weighting (MD 364* and MD 368*)	

112*	Clamping monitors (zero speed control)
Cause:	– Wrong position control direction – Mechanically clamped axis forced out of position – Fault on control device (actuator), tacho-generator, motor, mechanical components or NC measuring circuit hardware. – Standard motor axis has overtravelled exact stop limit coarse (NC MD 380*)
Scan:	– At standstill – During clamping – During deceleration
Effect:	– NC START disabled – Set value 0 – Servo enable cancelled after time in MD 156 has expired (servo enable relay drops out) – Follow-up operation
Explanation:	During positioning, the following error could not be reduced more rapidly than the time input in MD 156. During clamping, the limit specified in MD 212* was exceeded. The standard motor cannot stop within defined exact stop limit.
Remedy:	– MD212* (clamping tolerance) must be greater than MD204* (coarse exact stop limit). – MD156 (servo enable cutoff delay) must be large enough to ensure that the following error can be suppressed within this time. – Check exact stop limits coarse and fine for standard motor. Check standard motor brake.

116*	Contour monitoring
Scan:	During processing in automatic mode but **not**: – when accelerating – when braking – at speeds less than in MD 336* (contour speed)
Effect:	– NC START disabled – Set value 0 – Servo enable cancelled after time in MD 156 has expired (servo enable relay drops out) – Follow-up operation
Explanation:	Tolerance band MD 332* exceeded at a speed greater than in MD 336*. During acceleration or braking, the axis did not reach the new speed within the time specified by the K_V factor. – Increase tolerance band MD 332*
Remedy:	– Check K_V factor – Check optimization of speed controller – Check drive actuator

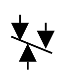
132*	**Control loop hardware**	POWER ON
Scan: Effect: Explanation: Remedy:	Cyclically – NC START disabled – Setpoint relay drops out – NC Ready 2 cancelled – Servo enable cancelled after time in MD 156 has expired (servo enable relay drops out) – Follow-up operation Measuring circuit differential signals – are not in phase – are short-circuited to frame – are missing altogether – Check that measuring circuit connector has been inserted (insert measuring circuit short-circuit connector to check whether the measuring circuit module is in order) – Check differential signals with oscilloscope – Exchange encoders	

136*	**Measuring system dirty**	POWER ON
Scan: Effect: Explanation: Remedy:	Cyclically NC START disabled. Processing of the active program is completed. On measuring systems with contamination signal (e.g. EXE), an error is signalled by the measuring system to the NC Check measuring system	

140*	**Encoder monitoring - axis**	
Scan: Effect: Explanation: Remedy:	Cyclically NC Ready 2 cancelled The measuring circuit has detected too many changes of direction within an IPO cycle. possibly caused by interference on the actual value cable. Check the measuring cycle and cable run.	

148*	**Software limit switch plus**
152*	**Software limit switch minus**
Scan: Effect: Explanation: Remedy:	With each axis movement – NC START disabled – Set value 0 The alarm is active only after reference point approach. Software limit switch 1 or 2 triggered depending on PLC interface signal "2nd software limit switch active". – Departure from limit switch in reverse direction – Check MD 224*, 228*, 232*, 236*

156*	**Speed command value too high**
Scan: Effect: Explanation: Remedy:	Cyclically – NC START disabled – Set value 0 – Servo enable cancelled after time in MD 156 has expired (servo enable relay drops out) – Follow-up operation – Speed output in control is higher than specified in MD 264* – Motor could not follow set speed input – Check whether value in MD 264* is greater than in MD 268* – Check drive – Check measuring system – Earthing neutral point at NC? – Check drive actuator – Check position control direction (set/actual values interchanged?)

160*	**Drift too high**
Scan: Effect: Explanation: Remedy:	Cyclically – NC START disable – "+" or "–"character in the  field – No traversing movement possible The drift to be compensated by the NC has risen above approx. 500 mV – Perform drift compensation Operator input: -- Select service menu in data area -- Press DRIFT COMPENSATION ...softkey for the required axis – Check whether drift was correctly adjusted on the drive unit – Check drive actuator – Check earthing arrangement

168*	**Servo enable for trav. axis not received**
Scan: Effect: Explanation: Remedy:	With each axis movement – NC START disabled – Set value 0 – Servo enable cancelled after time in MD 156 has expired (servo enable relay drops out) – Follow-up operation Axis-specific servo enable cancelled by PLC user program during traversing movement Check PLC program

172*	**Working area limit plus**
176*	**Working area limit minus**
Scan: Effect: Explanation: Remedy: Note:	During processing in automatic mode During axis traversing in JOG mode – NC START disabled – Set value 0 Working area limitation in setting data has been reached – Check working area limitation in setting data – Check program Working area limitation in JOG mode only when NC-MD 5003 bit 6 is set.

184*	**Stop behind reference point cam**
Scan: Effect: Explanation: Remedy:	During reference point traversing – NC START disabled – Set value 0 – Reference point not reached The axis was stopped between the reference cam and the zero point of the measuring system during reference point approach. Repeat reference point approach.

2000	Emergency Stop
Scan:	Cyclically
Effect:	– NC start disabled – Setpoint 0 – Controller enable cancelled after time in MD 156 has expired (controller enable relays drop out) – Follow-up operation
Explanation:	The Emergency Stop signal is sent from the PLC to the NC
Remedy:	– Check using PLC-STATUS whether Q 78.1=0 – Check whether Emergency Stop cam is traversed or Emergency Stop button is operated – Check the PLC program
Note:	According to statutory regulations, the Emergency Stop status must be selected both by the control (software) and by the hardware (with relays).

2031	Evaluation (weighting) factor too high (MD 388*)
Scan	With each axis movement
Effect:	– NC start disabled – Setpoint 0 – processing stop
Explanation:	Check MD 388*

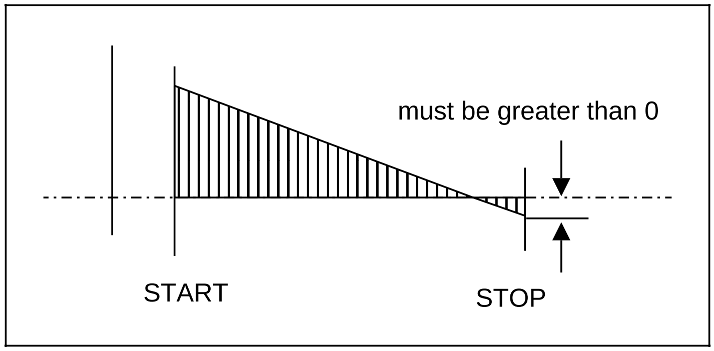
2032	Stop during threading
Effect:	– Set value 0 – NC START disabled
Explanation:	A stop has occurred in the revolutional feedrate during thread cutting, resulting in destruction of the thread.

2034	Speed reduction area
Explanation:	The software pre-limit switch has been overrun and the axes braked to reduction speed
Remedy:	– Check program – MD0: pre-limit switch – MD1: speed behind pre-limit switch (reduction speed)

2035	Programmed feed rate too high
Explanation:	The programmed speed is greater than the maximum path speed resulting from the maximum speeds of the axes
Remedy:	– Program slower path speed – Check MD 280* max. path speed – Check MD 296* when approaching reference point

2036 **G35 thread lead decr. error**

Scan:	During thread cutting
Significance:	The pitch decrease in the thread is so great that a diameter of 0 or less would result at the end of the thread.



Remedy:	Program smaller pitch decrease or shorter thread.

2037 **Progr. S-value too high**

Explanation:	The programmed spindle speed "S" is greater than "12 000"
Remedy:	Program slower spindle speed (S value limited to "12 000" in the control).

2039 **Reference point not reached**

Scan:	In AUTOMATIC/MDA mode after NC START
Effect:	NC START disabled
Significance:	The reference point was not approached in all defined axes
Remedy:	– Approach reference point in axes concerned – Set NC-MD 5004 bit 3 (NC START without reference point) ***Caution:*** No software limit switches effective. – Set NC-MD 560* bit 4. The approach to reference point can then be suppressed for one or more specific axes. ***Caution:*** No software limit switches apply in these axes.

2041	Program not in memory
Effect:	NC START disabled
Explanation:	– Preselected program not available in the memory – Subroutine called in program not available in the memory.
Remedy:	Look at "main program" and/or "subroutine" directories

2042	Parity error in memory
Scan:	During processing in automatic mode
Explanation:	One or more characters are deleted in the memory so that they can no longer be recognized (these characters are output as "?")
Effect:	NC START disabled
Remedy:	– Correct program in EDITOR or, if applicable, delete complete block and input again – With a large number of "?" the complete memory may have been erased; in this case check the battery and reformat the part program memory

2046	Block > 120 characters
Scan:	During processing in automatic mode
Effect:	NC START disabled
Explanation:	An "LF"is corrupted in the memory, producing a block of more than 120 characters
Remedy:	Insert "LF" or delete entire block

2047	Option not available
Effect:	NC START disabled
Explanation:	A program that is not contained in the control function complement has been programmed.
Remedy:	Correct program, check MD

2048	Circle endpoint error (circle centre error)
Effect:	NC START disabled
Significance:	– Programmed circle end point not on circle – End point is displaced by more than the limit input in MD 7 – No geometry in the 1st block of the contour subroutine with L95 stock removal cycle
Remedy:	Correct program

2057	Option thread/feedrate per rev. not available
Significance:	– A thread has been programmed with G33, G34, G35 although this function is **not** implemented in the control. – Revolutional feedrate G95 has been programmed
Remedy:	– Correct program – Check MD

2058	Option 3D interpolation not available
Explanation:	– 3 axes programmed simultaneously – Programmed block results in movement of 3 axes
Remedy:	– Correct program – Check MD

2059	Program error G92
Explanation:	– Use of an illegal address character – G92 programmed with address "P"
Remedy:	G92 is allowed only with address "S" (programmed spindle speed limitation)

2060	TO, ZO program error
Significance:	– Unavailable tool offset number selected – Selected zero offset or tool offset value too large – Type (P1) of called tool offset defined with 0

2061	General program error
Effect:	NC START disabled
Remedy:	– Select "Current block display" image and check block **after** the active block.

2062	Feed missing / not programmed
Cause:	– No F value programmed – F value too small (machine data) – Programmed revolutional feedrate G95 too great – No revolutional feedrate programmed. – An axis was programmed as a simultaneous axis. However, no simultaneous feed applies for this axis at present.
Remedy:	Program feedrate correctly

2063	Thread lead too high
Effect:	NC START disabled
Explanation:	Thread pitch of more than 400 mm/rev (16 inches/rev) programmed
Remedy:	– Program smaller thread pitch – Possibly run program on a machine with SINUMERIK 850 (max. speed 2000 mm/rev)

2064	Rounding error for rotary axis
Scan:	During processing in AUTOMATIC/MDA mode
Explanation:	In the case of rounding to half or full degrees with a rotary axis, the control monitors the programmed positions to ensure that rounding has been correctly performed.
Effect:	– NC START disabled – Programmed path in block is **not** traversed
Remedy:	– Program correct position in rotary axis – Check MD 560* bits 2 and 3
Note:	In the JOG and JOG-INC modes, the control automatically rounds to valid values; in the AUTOMATIC and MDA modes, the control monitors only the programmed positions and does not round automatically.

2065	Programmed position behind sw limit switch
Scan:	During processing in AUTOMATIC/MDA mode
Effect:	– NC START disabled – Programmed path is **not** traversed
Explanation:	The programmed end position of the block is behind the software limit switch.
Remedy:	– Check program – Check MD224*, 228*, 232*, 236* depending on PLC interface signal "2nd software limit switch active"

2066	**Thread lead increase/decrease too high**
Scan:	During processing in AUTOMATIC/MDA
Effect:	NC START disabled
Explanation:	Thread pitch increase or decrease of more than 16 mm/rev (0.6 inch/rev) programmed
Remedy:	Program smaller thread pitch increase/decrease

2067	**Max. speed of an axis = 0**
Scan:	During processing in AUTOMATIC / MDA
Effect:	NC START disabled
Explanation:	The maximum speed of an axis programmed in the block is ZERO.
Remedy:	Check MD 280*

2068	**Programmed position behind working area limit**
Scan:	During processing in AUTOMATIC MDA
Effect:	– NC START disabled – Programmed path is **not** traversed
Explanation:	The programmed end position of the block is behind the working area limitation in one or more axes
Remedy:	– Check working area limitation (positive and negative) – Modify working area limitation with G25/G26 in the program

2072	**Incorrect input value (blueprint prog.)**
Explanation:	Value input not calculable for contour definition calculation

2073	**No intersection point (blueprint prog.)**
Explanation:	No intersection is obtained with programmed values when calculating contour definition

2074	**Incorrect angle value (bluepring prog.)**
Explanation:	– Angle programmed greater than or equal to 360° – Angle value not practical for defined contour

2075	Incorrect radius value (blueprint prog.)
Explanation:	– Radius too large – Radius not permitted with defined contour

2076	Incorrect G02 / G03 (blueprint prog.)
Explanation:	– Circle direction **not** possible with defined contour

2077	Incorrect block sequence (blueprint prog.)
Explanation:	Several blocks are required for calculating contour definition: – Block sequence incorrect – Data not sufficient (under-determined) ***Example:*** N10...B15 LF N20...G3 I20 LF

2078	Incorrect input parameter (blueprint prog.)
Explanation:	– Programmed parameter sequence not allowed – Parameter sequence incomplete for defined contour ***Example:*** N10...X60 B15 LF (Z axis missing) N20...X90 B10 LF

2081	Program block with TRC/CRC not allowed
Explanation:	With tool nose/cutter radius compensation (G41/G42) selected, the following functions must not be programmed: G33, G34, G35, G58,G59, G92, M19 S...,
Remedy:	– Program G40 first – Cancel with G41/G42 D00 (CRC/TNRC)

2082	**CRC not determinable**
Significance:	Axes of selected CRC plane do not exit
Remedy:	– Check MD 548*, 550*, 552* (basic setting of G16) – Select correct plane with G16

2152	**Spindle speed too high**
Scan:	Only when MD 520* bit 2 is set (encoder available)
Explanation:	The spindle speed is higher than specified in the data (see MD 4450)
Remedy:	– Program lower S value – MD 403* - 410* (max. spindle speed for gears 1 to 8) – MD 445* (tolerance band for max. spindle speed) – MD 451* (max. spindle speed) – Gear correctly selected by PLC? – G92 S... wrongly programmed for v constant

2153	**Control loop error (spindle)**
Scan:	Cyclically
Effect:	– NC START disabled – Setpoint relay drops out Setpoint 0 – NC Ready 2 cancelled – Spindle servo enable is cancelled after time in MD 4470 has expired
Explanation:	As for Alarm 132*
Remedy:	As for Alarm 132*

2154	**Measuring system dirty (spindle)**
Scan:	Cyclically
Explanation:	On measuring systems with contamination signal, the measuring system has signalled an error to the NC
Effect:	NC START disabled
Remedy:	Check measuring system

2155	**Option M 19 not available**
Scan:	During processing in AUTOMATIC / MDA
Effect:	NC START disabled
Explanation:	"M19 S ..." programmed in part program although this function is not available
Remedy:	– Correct program – Retrofit "M19" Option

2171	Approach not possible
Explanation:	The control supplements max. one axis in the programmed plane. Where two axes must be supplemented in the programmed plane, no start-up is possible
Remedy:	– Check NC program for complete axis programming in approach block – Programming deselection block immediately after selection block is not allowed (no calculable tangent).

2172	Retract not possible
Explanation:	See Alarm 2171
Remedy:	– Check NC program for complete axis programming in approach block – With G48 deselection movement programmed (shutdown and start-up), a start-up movement must be programmed

2173	Wrong approach / retract plane
Explanation:	The select/deselect movements of the smooth approach/retract function are executed with reference to the selected plane G16, G17, G18, G19.
Remedy:	Check whether a plane change is programmed after the selection or in the deselection block in the NC program

3000	General program error	QUIT
Explanation:	A general non-accurate programming error has been made in a block in the program. ***Example:*** – The programmed axis is not available at the machine – Incorrect interpolation parameters programmed	
Remedy:	Check the faulty block in the part program. The number of the block is shown under block number in the "Messages" menu.	

3001	More than 5 geometry parameters	QUIT
Explanation:	More than 5 geometry parameters such as axes, interpolation parameters, radii, angles etc. have been programmed in the block	
Remedy:	As for Alarm 3000	

3002	Polar radius programming error	QUIT
Explanation:	Programming of the following omitted in block with polar/radius programming: – angle – radius – centre point coordinates	
Remedy:	As for Alarm 3000	

3003	Invalid address	QUIT
Explanation:	– The programmed address is not defined in the machine data. The axis names for basic setting plane G16 (MD 548*, 550*, 552*) do not correspond to the defined axis designations (MD 568*)	
Remedy:	– As for Alarm 3000 – Correct the machine data	

3004	CL800 error	QUIT
Explanation:	– @ function not available – Incorrect address after @ – Number of addresses after @ incorrect – Values in K, R or P not permissible – Number of decades too high – No decimal point allowed – Jump address incorrectly defined – System memory location (NC-MD, PLC-MD, TO, ...) not available – Bit number too high – Sine or cosine angle incorrectly stated	
Remedy:	– @ according to Programming Guide – Only K, R and P addresses allowed – Jump addresses: forwards with "+" backwards with " – " – Check validity of values in stated addresses – If applicable, select decoding single block (DEC-SBL) and check program again	

3005	Blueprint prog. error	QUIT
Explanation:	The coordinates in blueprint programming have been defined in such a way that no intersection is produced	
Remedy:	As for Alarm 3000	

3006	**Wrong block structure**	QUIT
Explanation:	– more than 3 M functions programmed in the block – more than 1 S function programmed in the block – more than 1 T function programmed in the block – more than 1 H function programmed in the block – more than 4 aux. functions programmed in the block – more than 3 axes with G00 / G01 programmed in the block – more than 2 axes with G02 / G03 programmed in the block – G04 programmed with addresses other than "X" or "F" – M19 programmed with addresses other than "S" – Incorrect or no interpolation parameters with G02 / G03 (MD 304*) – the special auxiliary functions for the analog output have been programmed incorrectly.	
Remedy:	As for alarm 3000	

3007	**Error in programming setting data**	QUIT
Explanation:	– G25 / G26 programmed – G92 programmed with an address other than "S" – M19 programmed with an address other than "S"	
Remedy:	As for alarm 3000	

3008	**Subroutine error (M17 missing, ...)**	QUIT
Explanation:	– Subroutine call without number of passes "P" – M30 programmed as program end – M17 missing at program end – 4th nesting depth activated (Only 3 subroutine levels possible on the SINUMERIK 805) – M17 programmed in main program	
Remedy:	As for Alarm 3000	

3009	**Error in part program/part program type**	QUIT
Explanation:	Of no significance on the SINUMERIK 805	

3010	**Intersection error**	QUIT
Significance:	This error can occur in conjunction with stock removal cycle L96 if: – Contour program programmed without G0, G1, G2, G3 – @ 714 programmed in contour program – Incorrect plane in contour program – No intersection found – More than quarter circle programmed in contour program – No geometry in first block of contour program of L95 stock removal cycle	
Remedy:	As for Alarm 3000	

3011	**Too many axes programmed/axes programmed twice**	QUIT
Explanation:	– An axis has been programmed twice in the same block – More axes have been programmed than are available on the machine	
Remedy:	As for Alarm 3000	

3012	**End block in the memory not available**	QUIT
Explanation:	– Program not terminated with M02 / M30 / M17. – Block number stated in the jump (@ 100, 11x, 12x, 13x) was not found in the specified direction. – On block search with calculation, the sought block number is not in the program.	
Remedy:	As for Alarm 3000	

3015	**Rotary axis not allowed**	QUIT
Explanation:	– A rotary axis was programmed as a simultaneous axis although that is not permitted. – A standard motor axis was defined as a rotary axis.	
Remedy:	– Change NC program so that the rotary axis is no longer addressed as a simultaneous axis. – Deselect rotary axis definition	

3016	External data input error	QUIT
Effect:	Data transfer interrupted	
Explanation:	With external data input from the PLC to the NC: – Code incorrect – Value too great – Dimensional identifier impermissible – Option not available	
Remedy:	– Check PLC program – Check NC MD, PLC MD	

3018	Distance from contour too large	QUIT
Scan:	After NC Start (AUTOMATIC)	
Effect:	- Machining stop	
Explanation:	After returning to the circle, the distance to the circle contour is too great (MD 9)	
Remedy:	Observe MD 9, approach closer to the contour	

3019	Option 2nd V.24 not available	QUIT
Explanation:	The 2nd V.24 (RS 232 C) interface has been activated by the PLC or softkey without the Option being available	
Remedy:	– Implement data transfer via the 1st V.24 (RS 232 C) interface – Retrofit Option C62 (2nd V.24 (RS 232 C) interface)	

3020	Option not available	QUIT
Explanation:	A function has been programmed that is not available in the control	
Remedy:	– As for Alarm 3000 – Retrofit Option	

3021	TRC/CRC contour error	QUIT
Scan:	With TNRC/CRC selected ***NOT:*** – in selection block – in deselection block	
Explanation:	Correction calculation produces a traversing movement opposing the programmed movement.	

3072	Alarm text not available	QUIT
	(available soon)	

3081	CRC not selected for approach	QUIT
Explanation:	The "Smooth approach to and exit from contour" function is possible only with cutter radius compensation effective. G41/G42 D0 is considered as selected in this case.	
Remedy:	Select CRC	

3200	L2 bus parameter not set	QUIT
Cause:	Softkey has be pressed to transfer a link into the link list although the bus parameters have not been set.	
Effect:	SINEC L2 submodule does not go to the bus	
Remedy:	Enter bus parameters completely	

3201	L2 link running	QUIT
Cause:	Softkey has been pressed to transfer changed bus parameters to the L2 submodule although a link is still working with the old bus parameters.	
Effect:	Changed bus parameters are not transferred.	
Remedy:	Switch the existing link inactive.	

3202	Overstep of value area	QUIT
Cause:	A bus parameter or link parameter has an impermissible value (value range exceeded or defined twice)	
Effect:	Changed values were not transferred into L2 submodule.	
Remedy:	Correct values	

4100	No D No. active	QUIT
Explanation:	TNRC/CRC selected without stating a D No. within a standard cycle	
Remedy:	Check part program	

4101	Tool radius = 0	QUIT
Explanation:	Cutter radius stated as 0. This leads to errors with standard cycles.	
Remedy:	Enter radius in D No.	

4102	Cutter radius too great	QUIT
Explanation:	Use of this cutter would lead to contour errors with some standard cycles	
Remedy:	Program different cutter	

4103	Tool too wide	QUIT
Explanation:	Grooving tool too wide for standard grooving cycle	

4120	No direction of spindle rotat. programmed	QUIT
Explanation:	No direction of spindle rotation programmed before calling standard cycle	
Remedy:	Modify part program	

4121	Spindle not in tolerance range	QUIT
Explanation:	If spindle speed fluctuation is too great in conjunction with standard cycle	
Remedy:	Check drive actuator MDs	

4140	Machined part diameter too small	QUIT
Explanation:	The machined part diameter was input too small when parameterizing a standard cycle	
Remedy:	Check part program	

4180	Option not available	QUIT
Explanation:	The called standard requires an Option that is not available in the control	
Remedy:	Retrofit Option	

4200	**Check definition R (Nxxx)**	QUIT
Explanation: Remedy:	Initialization parameter incorrectly defined Define initialization parameter correctly	

5000 ⋮ 5099	**User cycle alarm**	QUIT
Cause: Remedy:	Alarm called in user cycle with help of @ 4C0 Check the cycle	

6000 ⋮ 6063	**PLC user alarms**	QUIT
Explanation: Remedy:	Initiation bit set in PLC user program Determined by manufacturer	

6100	**Signal converter missing**	POWER ON
Cause: Effect: Remedy:	Load or transfer command to non-available I/Os, e.g. L PB, T PB PLC STOP Check I/O addressing and/or STEP 5 program	

6101	**Illegal MC5 code**	POWER ON
Cause: Effect: Remedy:	STEP 5 command cannot be interpreted PLC STOP – Check and/or reload PLC program – Analyze I STACK	

6102	**Illegal MC5 parameter**	POWER ON
Cause: Effect: Remedy:	Impermissible parameter type (I, Q, F, C, T) or parameter value PLC STOP – Check PLC program – Analyze I STACK	

6103	Transfer to missing DB	POWER ON
Cause: Effect: Remedy:	L DW or T DW without prior "opening" (C DB ...) of a data block PLC STOP Check PLC program Check I STACK	

6105	Missing MC5 block	POWER ON
Cause: Effect: Explanation: Remedy:	A block has been called that is not available in the control (OB, PB, SB, FB). PLC STOP e.g. OB2 not available Input missing block	

6106	Missing data block	POWER ON
Cause: Effect: Remedy:	A data block has been called that is not available in the control PLC STOP Input missing DB.	

6107	Invalid segment LIR/ TIR	POWER ON
Cause: Effect: Explanation: Remedy:	LIR: Segment No. 0 to A permissible TIR: Segment No. 0 to 6 permissible. PLC STOP See PLC Programming Guide Correct program.	

6108	Invalid segment TNB/TNW	POWER ON
Cause: Effect: Explanation: Remedy:	Source: Segment No. 0 to A permissible Target: Segment No. 0 to 6 permissible. PLC STOP See PLC Programming Guide Correct program.	

6109	Overflow block stack	POWER ON
Cause: Effect: Explanation: Remedy:	Nesting depth greater than 12. PLC STOP e.g. when a block calls itself Correct program.	

6110	Overflow interrupt stack	POWER ON
Cause: Effect: Explanation: Remedy:	More than two I STACK entries PLC STOP Cyclic program (OB1) is interrupted by alarm program (OB2) and alarm program interrupts itself See processing delay OB2, Alarm 6162.	

6111	MC5 command STS	POWER ON
Cause: Effect: Explanation:	STS command programmed in FB PLC STOP Immediate termination of STEP 5 program processing	

6112	MC5 command STP	POWER ON
Cause: Effect: Explanation:	STP command programmed PLC STOP PLC STOP on termination of STEP 5 program processing	

6113	Illegal MC5 timer / counter	POWER ON
Cause: Effect: Remedy:	STEP 5 timer or counter not available or not enabled by MD PLC STOP – Correct program – Modify PLC MD 6.	

6114	Function macro	POWER ON
Cause: Effect: Remedy:	Error in an assembler function block (basic program) PLC STOP See Programming Guide, Function Macros.	

6115	System commands disabled	POWER ON
Cause: Effect: Remedy:	Programmed command LIR, TIR, TNB, TNW. PLC STOP Set PLC MD 2003 bit 4 (enable system commands)	

6116	MD 0000: Alarm byte No.	POWER ON
Cause: Effect: Remedy:	PLC MD 0 set greater than 31. PLC STOP Correct MD	

6117	MD 0001: CPU load	POWER ON
Cause: Effect: Remedy:	PLC MD 1 greater than 20 %. PLC STOP Correct MD	

6118	MD 0003: Alarm run time	POWER ON
Cause: Effect: Remedy:	PLC MD 3 greater than 2500 μs. PLC STOP Correct MD	

6119	MD 0005: Cycle time	POWER ON
Cause: Effect: Remedy:	PLC MD 5 greater than 320 ms. PLC STOP Correct MD	

6121	MD 0006: Last MC5 time	POWER ON
Cause: Effect: Remedy:	PLC MD 6 greater than 31. PLC STOP Correct MD	

6124	Gap in MC5 memory	POWER ON
Cause: Effect: Remedy:	Discontinuous sequence of valid and invalid blocks PLC STOP Overall reset and reload the PLC program	

6125	**Dual assignment of inputs**	POWER ON
Cause:	An input address has been used twice (overlapping of two DMP module input areas)	
Effect:	PLC STOP depending on PLC MD 2003 bit 2	
Remedy:	Check PLC MD 10-19	

6126	**Dual assignment of outputs**	POWER ON
Cause:	An output address has been used twice (overlapping of two DMP module output areas)	
Effect:	PLC STOP depending on PLC MD 2003 bit 2	
Remedy:	Check PLC MD 10-19	

6127	**Alarm byte missing**
Cause:	Selected alarm input byte not available as hardware
Effect:	PLC STOP
Remedy:	– Change PLC MD 0 – Set address decoding for alarm byte

6130	**Synchro error basic program**	POWER ON
Cause:	Synchronization pattern no longer correct with assembler function blocks	
Effect:	PLC STOP	
Remedy:	PLC GENERAL RESET, reload PLC program if applicable	

6131	**Synchro error MC5 program**	POWER ON
Cause:	Synchronization pattern no longer correct with STEP 5 program blocks	
Effect:	PLC STOP	
Remedy:	PLC GENERAL RESET, reload PLC program	

6132	**Synchro error MC5 data**	POWER ON
Cause:	Synchronization pattern no longer correct with STEP 5 data blocks	
Effect:	PLC STOP	
Remedy:	PLC GENERAL RESET, reload PLC program	

6133	Illegal block basic program	POWER ON
Effect: Remedy:	PLC STOP Exchange system software	

6134	Illegal block MC5 program	POWER ON
Effect: Remedy:	PLC STOP PLC GENERAL RESET, reload PLC program	

6135	Illegal block MC5 data	POWER ON
Effect: Remedy:	PLC STOP PLC GENERAL RESET, reload PLC program	

6136	Summing error MC5 block	POWER ON
Effect: Remedy:	PLC STOP PLC GENERAL RESET, reload PLC program	

6137	Summing error basic program	POWER ON
Effect: Remedy:	PLC STOP Exchange system software	

6138	No response from MPC	POWER ON
Cause: Effect: Remedy:	Cable break, wrong submodule No. set or similar PLC STOP depending on PLC MD 2003 bit 2 Check cable and/or carrier module	

6139	MPC transfer error	POWER ON
Cause: Effect: Remedy:	Same submodule No. set with 2 DMP submodules PLC STOP depending on PLC MD 2003 bit 2 Check submodule No.	

6140	PLC MD 10 - MD 19: DMP address start wrong	POWER ON
Cause: Effect: Remedy:	Incorrect input in PLC MD 10-19 PLC STOP depending on PLC MD 2003 bit 2 Check PLC MD 10-19	

6149	Stop, using softkey PG	POWER ON
Cause: Effect: Remedy:	Stop command via PG. PLC STOP • PLC Start via PG, • Power On.	

6150	Timeout: User memory	POWER ON
Effect: Explanation: Remedy:	PLC STOP (S5 program) Analyze error fine coding, see Programming Guide	

6152	Timeout: LIR / TIR	POWER ON
Cause: Effect: Explanation: Remedy:	Attempted access to addresses that are not available PLC STOP See Programming Guide Check segment and offset address. Hardware available?	

6153	Timeout: TNB / TNW	POWER ON
Cause: Effect: Explanation: Remedy:	Faulty programming or use of TNB / TNW. PLC STOP See Programming Guide – Check source and target address for admissibility. – Addresses available?	

6154	Timeout: L PB / L PW / T PB / T PW	POWER ON
Cause: Effect: Remedy:	Load or transfer command to I/O device that has failed. PLC STOP Check I/O device or change modules	

6155	Timeout: Substitution operation	POWER ON
Effect:	PLC STOP	
Remedy:	Check PLC program.	

6156	Timeout: Not interpretable	POWER ON
Cause:	Timeout not definable by system program	
Effect:	PLC STOP	
Remedy:	– Analyze error fine diagnosis – PLC GENERAL RESET, reload PLC program	

6157	Timeout: JU FB / JC FB	POWER ON
Cause:	In the resident function macros, attempts are made to access addresses that are not available.	
Effect:	PLC STOP	
Remedy:	Check hardware	

6158	Timeout: on I/O transfer	POWER ON
Cause:	Central I/O devices no longer respond	
Effect:	PLC STOP	
Explanation:	Central I/O devices are covered during start-up. No alarm if the + 24.V supply fails.	
Remedy:	Exchange central controller	

6159	Runtime exceeded STEP 5 program	POWER ON
Cause:	The max. running time in PLC MD 1 has been exceeded.	
Effect:	PLC STOP depending on PLC MD 2003 bit 1.	
Explanation:	Analyze diagnosis DB.	
Remedy:	– Increase MD 1 CPU load rises – Set MD 2003 bit 6 Cycle time increases – Optimize PLC program time	

6160	Runtime exceeded OB2	POWER ON
Cause:	The max. running time in PLC MD 3 has been exceeded.	
Effect:	PLC STOP, depending on PLC MD 2003 bit 0.	
Explanation:	Analyze DB diagnosis.	
Remedy:	– Increase MD 3 – Optimize OB2 time.	

6161	**Cycle time exceeded**	POWER ON
Cause: Effect: Explanation: Remedy:	The max. running time in PLC MD 5 has been exceeded PLC STOP ***Note:*** Bit commands have a processing time of only approx. 1µs. – Increase MD 5 – Optimize PLC program time.	

6162	**Processing delay OB2**	POWER ON
Cause: Effect: Explanation: Remedy:	The alarm program (OB2) has interrupted itself PLC STOP, depending on PLC MD 2003 bit 0 Analyze diagnosis DB Optimize OB2 time, i.e. reduce the active processing time of the alarm program	

6163	**Time supervisor (monitoring) PLC network**	POWER ON
Cause: Effect: Remedy:	After 20 PLC cycles data received from L2 submodule have still not been transferred to the PLC by a RECEIVE job. Display dependent on PLC MD 2002 bit 2 Check the PLC program, especially the RECEIVE job in question.	

6164	**DMP protection function output (short-circuit)**	POWER ON
Cause: Remedy:	Short-circuit at a DMP module output Analyze diagnosis DB1	

6165	**DMP 24V supply for logic not O.K.**	POWER ON
Cause: Remedy:	Failure of 24V supply or voltage below other threshold (15V) Check power supply	

6166	**DMP overtemperature (> 63 deg. C)**	POWER ON
Cause: Remedy:	Overtemperature in DMP module Analyze diagnosis DB1	

7000 : 7063	**PLC user messages**
Cause:	Initiation bit set in PLC user program

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Suggestions

Corrections

For Publication/Manual:
SINUMERIK 805
Software version 4
Installation Instructions
Service Documentation

Installation Guide

Order No.: 6ZB5 410-0CX02-0AA3
Edition: May 1993

From:

Name

Company/Dept.

Address

Telephone /

Should you come across any printing errors when reading this publication, please notify us on this sheet. Suggestions for improvement are also welcome.

Suggestions and/or corrections

Siemens AG
Automation Group
Automation Systems
for Machine Tools, Robots
and Special-Purpose Machines
91050 Erlangen

Siemens Aktiengesellschaft

Order No.: 6ZB5 410-0CX02-0AA3
Printed in the Federal Republic of Germany
251/222076 IA 05920.2

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in automation:
Siemens