HEIDENHAIN

Technical Manual

iTNC 530

NC software 340 420-01
340 421-01

February 2002

363 812-21 · 5 · 2/2002 · Printed in Germany · Subject to change without notice

Foreword

This Technical Manual has been written for all machine tool manufacturers and distributors. It contains all of the information necessary for the mounting, electrical connection, commissioning and PLC programming of HEIDENHAIN contouring controls.
Every time the hardware or software of HEIDENHAIN's contouring control is updated, you will receive a set of supplementary pages free-of-charge. Always sort these pages into your Technical Manual immediately. In this way, your manual will always be up-to-date.
You can use extracts from this manual to supplement your machine documentation. If you increase the size of the manual format (17 cm x 24 cm) by the factor 1.225, you will have DIN A4 format.
No documentation can be perfect. To stay up to date, documentation must change constantly. It also thrives on your comments and suggestions for improvement. Please help us by sending us your ideas.

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1 Update Information

1.1 General Information

You will receive Update Information supplements for the iTNC 530 at irregular intervals.

Please file this information here.

2 Introduction

2 Introduction

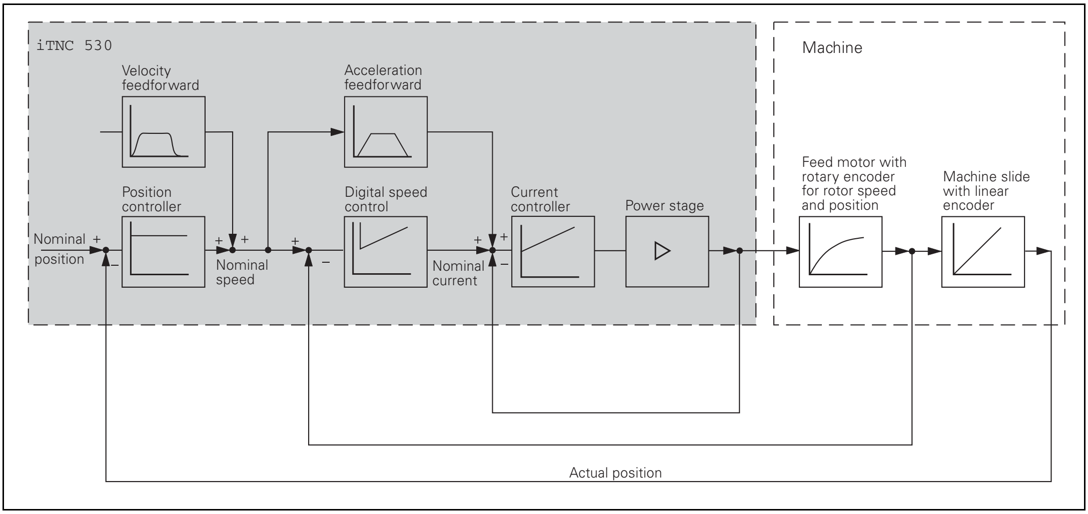
2.1 General Information

HEIDENHAIN contouring controls are designed for use with milling, drilling and boring machines as well as machining centers.

The **iTNC 530** features integral digital drive control and controls the power stages via PWM signals.

Integration of the drive controllers in the iTNC 530 offers the following advantages:

- All the software is contained centrally in the NC; this means that the individual components of the NC such as feed axes, spindle, NC or PLC are optimally matched.
- High control quality, because the position controller, speed controller and current controller are combined into one unit.
- The same functions are available for commissioning, optimizing and diagnosing feed drives as well as spindles.

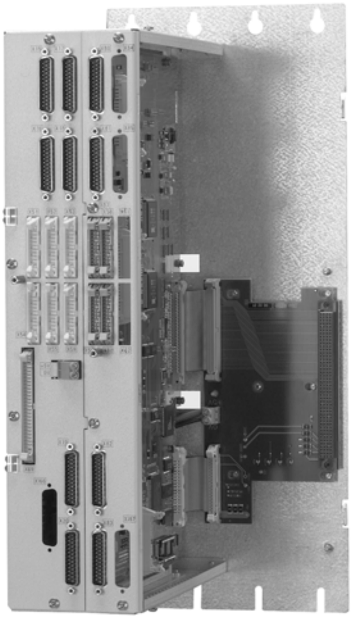
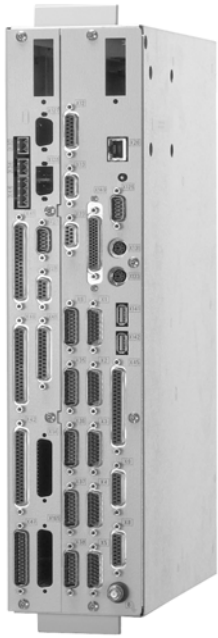


The **iTNC 530** offers digital control for up to five or nine axes and for spindle speeds up to 40 000 rpm.

The **iTNC 530** is designed for connection of a compact or modular inverter system. Thus, together with HEIDENHAIN motors, a complete control package including servo drive can be supplied (see Technical Manual "Inverter Systems and Motors").

2.2 Overview of Components

2.2.1 Main Computer, Controller Unit, Power Supply Unit

The iTNC 530 comprises 2 components: ■ Main computer MC 422 (MC = Main Computer) ■ CC 422 controller unit (CC = Controller Computer)	 CC 422/10 control loops  MC 422/10 position encoder inputs

Main computer (Standard version)	Signal inputs	Id. Nr. of MC for BF 120 display unit	Id. Nr. of MC for BF 150 display unit
MC 422			
5 position encoder inputs	Position: 1 V_{PP}/EnDat	359 629-0x	359 630-0x
10 position encoder inputs		359 632-0x	359 633-0x

Main computer (Export version)	Signal inputs	Id. Nr. of MC for BF 120 display unit	Id. Nr. of MC for BF 150 display unit
MC 422 E			
5 position encoder inputs	Position: 1 V_{PP}/EnDat	359 629-5x	359 630-5x
10 position encoder inputs		359 632-5x	359 633-5x

Controller unit	Signal inputs	Id. Nr. of CC 422
CC 422		
Max. 6 speed control loops (4 control loops enabled)	Speed: 1 V_{PP}/EnDat	359 651-xx
Option 5th control loop		353 902-01
Option 6th control loop		353 903-01
Max. 10 speed control loops (7 control loops enabled)		359 652-xx
Option 8th control loop		354 540-01
Option 9th control loop		353 904-01
Option 10th control loop		353 905-01

Designation of MC 422 and CC 422

ID numbers of MC 422 and CC 422

Basic ID number	359 632-01
Variant	

The basic ID number indicates hardware differences.
This first digit of the variant number indicates hardware changes.

Variant	Changes in the MC 422
xxx xxx-y1	Initial version

Variant	Changes to CC 422
xxx xxx-01	Initial version
xxx xxx-02	Controller modified

UV 105 Power Supply Unit

The UV 105 serves to supply the power to the CC 422 if a non-HEIDENHAIN inverter is used, or, if required, to supply additional power if a HEIDENHAIN inverter is used, See "Power Supply for the iTNC 530" on page 3 – 12.

If a non-HEIDENHAIN inverter system is used, the adapter connector is connected to X69 of the UV 105.

The cover for the UV 105 and the adapter connector for X69 are included in the items supplied.

Id. Nr. 344 980-xx	UV 105
Id. Nr. 349 211-01	Adapter connector for X69

Variant	Changes to UV 105
xxx xxx-01	Initial version
xxx xxx-02	Modification for multiple-row configuration

2.2.2 Monitors and Keyboard Units

<table>
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TE 420 Operating Panel

The IV and V keys are snap-ons, and can be switched, See "Key symbols" on page 2 – 11.
Id. Nr. 313 038-11

Horizontal rows to match the design of the flat-panel display
Id. Nr. 316 343-01

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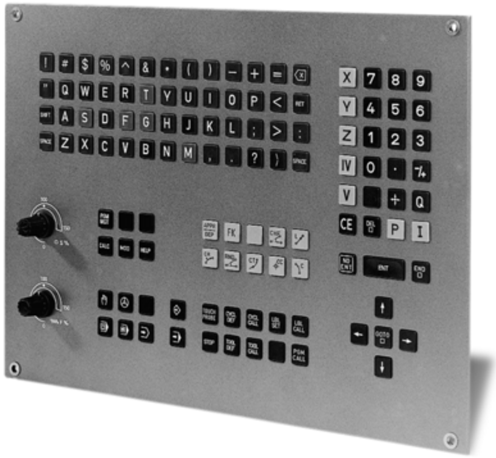

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Visual display unit **BF 150**

15.1-inch color flat panel display (1024 x 768 pixels) with the following keys:

- 1 x 8 soft keys, 1 x 6 soft keys for PLC
- 3 x soft keys for switching soft-key rows
- Screen layout
- Operating-mode switchover

Id. Nr. 353 522-02

Horizontal rows depending on design
Id. Nr. 339 516-02 (at bottom)
Id. Nr. 339 516-04 (at top)

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Visual display unit **BF 120**

10.4-inch color flat panel display (640 x 480 pixels) with the following keys:

- 8 soft keys
- 2 x soft keys for switching soft-key rows
- Screen layout
- Operating-mode switchover

Id. Nr. 313 506-02

BTS 1x0 Screen-Keyboard Switching Unit

With the BTS 1x0, it is possible to connect two monitors and two operating panels to an MC 422.

Id. Nr. 353 544-01	BTS 150 (2 x BF 150)
Id. Nr. 329 965-02	BTS 120 (2 x BF 120)

MB 420 Machine Operating Panel

Machine operating panel with snap-on (switchable) keys,
See “Key symbols” on page 2 – 11.

Key assignment:

- Emergency stop
- Machine control voltage
- NC start, NC stop
- 5 axis keys
- Rapid traverse
- Coolant
- Spindle start
- Spindle stop
- 7 keys for machine functions
  - FN 1 to FN 5 (standard assignment)
  - Retract axis, tool change, unlock tool, menu selection→, unlock door, rinse water jet, chip removal (assignment for HEIDENHAIN basic PLC program)

Id. Nr. 283 757-33	Standard assignment:
Id. Nr. 293 757-45	Machine key assignment for HEIDENHAIN basic PLC program

2.2.3 Handwheels

HR 410 Handwheel

Portable handwheel with snap-on (switchable) keys, See "Key symbols" on page 2 – 11.

Key assignment:

- Keys for selection of 5 axes
- Keys for traverse direction
- Keys for preset feeds
- Key for actual value position capture
- Three keys for machine functions (definable via PLC)
  - Spindle right, Spindle left, Spindle stop
  - NC start, NC stop, Spindle start (corresponds to the HEIDENHAIN basic PLC program)
- Two permissive buttons
- Emergency stop
- Magnetic holding pads

Id. Nr. 296 469-44	HR 410 handwheel (Spindle right, Spindle left, Spindle stop)
Id. Nr. 296 469-45	HR 410 handwheel (NC start, NC stop, Spindle start)
Id.-Nr. 312 879-01	Connecting cable to cable adapter (spiral cable 3m)
Id. Nr. 296 467-xx	Connecting cable for cable adapter (normal cable)
Id. Nr. 296 687-xx	Connecting cable for cable adapter (metal armor)
Id. Nr. 296 466-xx	Adapter cable to MC 422
Id. Nr. 281 429-xx	Extension to adapter cable
Id. Nr. 271 958-03	Dummy plug for emergency-stop circuit

HR 130 Handwheel

Panel-mounted handwheel

Id. Nr. 254 040-05	With ergonomic knob, radial cable outlet

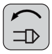
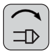
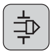
HRA 110 Handwheel Adapter

For connecting up to three **HR 150** handwheels with the TNC.
The axes and the subdivision factor are selected via rotary switch.

Id. Nr. 261 097-03	HRA 110
Id. Nr. 257 061-09	HR 150 Cable Outlet radial
Id. Nr. 270 908-01	Handwheel selection switch

2.2.4 Key symbols

Key symbols for the spindle

Key	Designation Print/Background Id. Nr.	Key	Designation Print/Background Id. Nr.
	Spindle stop White/Red 330 816-08		Spindle start White/Green 330 816-09
	Spindle direction left Black/Gray 330 816-40		Spindle direction right Black/Gray 330 816-41
	Spindle stop White/Red 330 816-47		Spindle start White/Green 330 816-46
	Clamp the axis Black/Gray 330 816-48		

Key symbols with axis designations

Key	Designation Print/Background Id. Nr.	Key	Designation Print/Background Id. Nr.
X	X Black/Orange 330 816-24	Y	Y Black/Orange 330 816-36
Z	Z Black/Orange 330 816-25	A	A Black/Orange 330 816-42
B	B Black/Orange 330 816-26	C	C Black/Orange 330 816-23
U	U Black/Orange 330 816-43	V	V Black/Orange 330 816-38
W	W Black/Orange 330 816-45	IV	IV Black/Orange 330 816-37

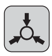
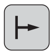
Key symbols for axis direction keys of the principle axes

Key	Designation Print/Background Id. Nr.	Key	Designation Print/Background Id. Nr.
	X – Black/Gray 330 816-63		X+ Black/Gray 330 816-64
	X– <– Black/Gray 330 816-18		X+ –> Black/Gray 330 816-17
	X’– –> Black/Gray 330 816-0W		X’+ <– Black/Gray 330 816-0V
	X– <– Black/Gray 330 816-0N		X+ –> Black/Gray 330 816-0M
	Y – Black/Gray 330 816-67		Y + Black/Gray 330 816-68
	Y’– –> Black/Gray 330 816-21		Y’+ <– Black/Gray 330 816-20
	Y– <– Black/Gray 330 816-0P		Y+ –> Black/Gray 330 816-0R
	Y– –> Black/Gray 330 816-0D		Y+ <– Black/Gray 330 816-0E
	Z – Black/Gray 330 816-65		Z + Black/Gray 330 816-66
	Z– <– Black/Gray 330 816-19		Z+ –> Black/Gray 330 816-16
	Z’– –> Black/Gray 330 816-0L		Z’– <– Black/Gray 330 8160K

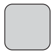
Key symbols for axis-direction keys for rotary and secondary linear axes

Key	Designation Print/Background Id. Nr.	Key	Designation Print/Background Id. Nr.
A–	A– Black/Gray 330 816-95	A+	A+ Black/Gray 330 816-96
B–	B– Black/Gray 330 816-97	B+	B+ Black/Gray 330 816-98
C–	C– Black/Gray 330 816-99	C+	C+ Black/Gray 330 816-0A
U–	U– Black/Gray 330 816-0B	U+	U+ Black/Gray 330 816-0C
V–	V – Black/Gray 330 816-70	V+	V+ Black/Gray 330 816-69
W–	W– Black/Gray 330 816-0G	W+	W+ Black/Gray 330 816-0H
IV–	IV – Black/Gray 330 816-71	IV+	IV + Black/Gray 330 816-72

Key symbols for machine functions

Key	Designation Print/Background Id. Nr.	Key	Designation Print/Background Id. Nr.
SPEC FCT	Special function Black/Gray 330 816-0X	FCT A	Function A White/Black 330 816-30
FCT B	Function B White/Black 330 816-31	FCT C	Function C White/Black 330 816-32
FN 1	Function 1 Black/Gray 330 816-73	FN 2	Function 2 Black/Gray 330 816-74
FN 3	Function 3 Black/Gray 330 816-75	FN 4	Function 4 Black/Gray 330 816-76
FN 5	Function 5 Black/Gray 330 816-77		Unlock door Black/Gray 330 816-78
	Unlock door Black/Gray 330 816-79		Coolant Black/Gray 330 816-80
	Coolant (internal) Black/Gray 330 816-0S		Coolant (external) Black/Gray 330 816-0T
	Rinse water jet Black/Gray 330 816-81		Spotlight Black/Gray 330 816-82
	Chip removal Black/Gray 330 816-83		Chip conveyor Black/Gray 330 816-84
	Tool change Black/Gray 330 816-89		Tool changer left Black/Gray 330 816-85
	Tool changer right Black/Gray 330 816-86		Unlock tool Black/Gray 330 816-87
	Unlock tool Black/Gray 330 816-88		Lock tool Black/Gray 330 816-94
	Lock tool Black/Gray 330 816-0U		Retract axis Black/Gray 330 816-91

Other key symbols

Key	Designation Print/Background Id. Nr.	Key	Designation Print/Background Id. Nr.
	No symbol –/Black 330 816-01		No symbol –/Gray 330 816-61
	NC start White/Green 330 816-11		NC stop White/Red 330 816-12
	NC start White/Green 330 816-49		NC stop White/Red 330 816-50
	Feed rate 1 Black/Gray 330 816-33		Feed rate 2 Black/Gray 330 816-34
	Rapid traverse Black/Gray 330 816-35		Permissive key White/Green 330 816-22
	Permissive key Black/Gray 330 816-90		Actual position capture White/Black 330 816-27
	– White/Black 330 816-28		+ White/Black 330 816-29
	Menu selection –> Black/Gray 330 816-92		Menu selection <– Black/Gray 330 816-93
	0 Black/Gray 330 816-0Y		

2.2.5 Touch probe systems

TT 130 Tool Touch Probe Touch-trigger probe for measuring tools. Id. Nr. 296 537-xx TT 130 Id. Nr. 335 332-xx Adapter cable for connection to the MC 422	
TS 220 Touch Probe Touch-trigger probe with cable connection for workpiece setup and measurement during machining. Id. Nr. 293 488-xx TS 220 Id. Nr. 274 543-xx Adapter cable for connection to the MC 422	

TS 632 Touch Probe Touch-trigger probe with infrared transmission, for workpiece setup and measurement during machining.	 

Id. Nr. 331 397-xx	TS 632
Id. Nr. 346 322-xx	EA 632 receiver unit
Id. Nr. 346 323-xx	EA 652 receiver unit
Id. Nr. 354 656-xx	APE 652 Interface Electronics for connecting two EA 652 to the MC 422
Id. Nr. 310 197-xx	Adapter cable for connecting the EA 632 or the APE 511 to the MC 422

2.2.6 Other Accessories

PLC input/output unit **PL 410 B**
For the expansion of PLC inputs and outputs

Id. Nr. 263 371-12	64 inputs 31 outputs
Id. Nr. 263 371-02	64 inputs 31 outputs 4 analog inputs ± 10 V 4 inputs for Pt 100 thermistors

PL 405 B PLC Input/Output Unit

Id. Nr. 263 371-22	32 inputs 15 outputs

Further components	Id. Nr.
Adapters for encoder signals	
TTL (HEIDENHAIN layout)/1 V_{PP}	317 505-01
TTL (SIEMENS layout)/1 V_{PP}	317 505-02
11 μA_{PP} to MC 422	317 505-05
11 μA_{PP} /1 V_{PP}	313 119-01

2.2.7 Documentation

Items supplied with the control include:

- 1 User's Manual for conversational programming
- 1 User's Manual for ISO programming
- 1 Pilot (brief user's programming guide)

The HEIDENHAIN inverters and motors for the iTNC 530 are described in the Technical Manual "Inverter Systems and Motors".

The components required for operating the iTNC 530 with non-HEIDENHAIN inverter systems are described in "Technical Information for Operation of SIMODRIVE and POWER DRIVE Inverter Systems".

2.3 Brief Description

Technical data	iTNC 530
MC 422	
	■ Processor: AMD K6/2 with 266 MHz ■ 64 MB SDRAM ■ 5 or 10 position encoder inputs 1 V_{PP} or EnDat ■ Unambiguous identification of MC 422 through SIK (**S**ystem **I**dentification **K**ey)
CC 422	
	All speed encoder inputs 1 V_{PP} or EnDat
	■ 6 speed encoder inputs with 1 V_{PP} or EnDat for axes and spindles Basic version: 4 speed control loops ■ 10 speed encoder inputs with 1 V_{PP} or EnDat for axes and spindles Basic version: 7 speed control loops
Options	
	Control loops can be enabled by entering a code number. Basic version with 4 control loops: ■ Options for control loops 5 and 6 Basic version with 7 position control loops: ■ Options for control loops 8, 9 and 10
Display	
	■ 15.1-inch TFT color flat-panel display ■ 10.4-inch TFT color flat-panel display
Program memory	
	Hard disk with > 6 gigabytes
Input resolution and display step	
	Up to 0.1 µm for linear axes Up to 0.0001° for angular axes
Interpolation	
Straight line	5 of 9 axes
Straight lines (with MC 422 E[a])	4 of 9 axes
Circle	■ 2 of 9 axes ■ 3 of 9 axes with tilted working plane
Helix	Superposition of circular and straight paths
Interpolation	
Spline	Cubic splines can be executed
Block processing time	
	0.5 ms

a. Export version

Machine Integration	iTNC 530
Feedback control	
Position loop resolution	$\frac{\text{Signal period}}{1024}$
Cycle time, position controller	1.8 ms
Cycle time, speed controller	600 µs
Cycle time, current controller	Minimum 100 µs
Feed rate	$\frac{6000}{\text{No. of pole pairs}} \cdot$ Ballscrew pitch $\cdot$ rpm ■ Up to 60 m/min for encoders with 20 µm grating period ■ Up to 300 m/min for encoders with 100 µm grating period
Rotational speed	CC 422/6: $\frac{\text{60 000 rpm}}{\text{No. of pole pairs}}$ +5 control loops CC 422/6: $\frac{\text{80 000 rpm}}{\text{No. of pole pairs}}$ +3 control loops CC 422/10: $\frac{\text{80 000 rpm}}{\text{No. of pole pairs}}$ +9 control loops
Error compensation	
	■ Linear and nonlinear axis error ■ Backlash ■ Reversal spikes during circular movements ■ Offset ■ Thermal expansion ■ Stiction ■ Sliding friction

Machine Integration	iTNC 530
Monitoring functions	
	■ Amplitude of encoder signals ■ Edge separation of encoder signals ■ Absolute position for encoders with distance-coded reference marks ■ Following error ■ Movement monitoring ■ Standstill monitoring ■ Nominal speed value ■ Checksum of safety-related functions ■ Power supply ■ Buffer battery ■ Operating temperature ■ Cycle time of the PLC program ■ Motor current ■ Motor temperature ■ Temperature of power stage ■ DC-link voltage
Integral PLC	
PLC memory	Hard disk
Main memory (RAM)	512 KB
PLC cycle time	12.5 ms (can be set)
PLC inputs 24 Vdc	56 (additional inputs as option)
PLC outputs 24 Vdc	31 (additional outputs as option)
Analog inputs ±10 V	3 (additional analog inputs as option)
Analog outputs ±10 V	13
Inputs for thermistors	3 (additional inputs as option)
Commissioning aids	
	■ Oscilloscope ■ Trace function ■ Table function ■ Logic diagram ■ Log
Interfaces	
	■ One each RS-232-C/V.24 and RS-422/V.11 with max. 115Kbps ■ Expanded interface with LSV-2 protocol for external operation of the iTNC over the interface with HEIDENHAIN software TNCremo. ■ Fast Ethernet interface 100 BaseT

Accessories	iTNC 530
Electronic Handwheels	■ One portable HR 410 handwheel, or ■ One panel-mounted HR 130 handwheel, or ■ Up to 3 HR 150 panel-mounted handwheels via the HRA 110 handwheel adapter
Touch probe systems	■ TS 220 triggering 3-D touch probe with cable connection, or ■ TS 632 triggering 3-D touch probe with infrared transmission, or ■ TT 130 triggering 3-D touch probe for tool measurement
Data transfer software	TNCremoNT, TNCremo
PLC development software	PLCdesign (comprises PLCdesign, TNCremo, TNCremoNT, CycleDesign and TNCopt)
Software for generating cycle structure	CycleDesign
PLC input/output unit	Up to four PL 410 B or one PL 405 B
	PL 410 B version 1: Additional 64 PLC inputs and 31 PLC outputs per PL PL 410 B version 2: Additional 64 PLC inputs and 31 PLC outputs as well as 4 analog inputs ± 10 V and 4 inputs for thermistors per PL PL 405 B: Additional 32 PLC inputs and 15 PLC outputs per PL

User functions	iTNC 530
Programming	HEIDENHAIN conversational and ISO
Position data	■ Nominal positions for straight lines and circles in Cartesian or polar coordinates ■ Absolute or incremental dimensional data ■ Display and input in mm or inches ■ Display of handwheel path during machining with handwheel superpositioning
Tool compensation	■ Tool radius in the working plane and tool length ■ Radius compensated contour look ahead for up to 99 blocks (M120) ■ Three-dimensional tool radius compensation for editing tool data at a later date without a renewed program computation
Tool tables	Multiple tool tables with any number of tools
Cutting-data tables	For automatic calculation of spindle speed and feed rate from tool-specific data (cutting speed, feed rate per tooth)
Constant cutting speed	■ With respect to the path of the tool center ■ With respect to the cutting edge (M109, M110, M111)
Parallel operation	Creating a program with graphical support while another program is being run
3-D machining	■ Feed rate reduction during plunging (M103) ■ Jerk-free path control ■ HSC filter ■ 3-D tool compensation through surface-normal vectors ■ Automatic compensation of machine geometry when working with tilted axes (M114, M115, M128, M129, M130) ■ Changing the angle of the tilting head with the electronic handwheel during program run. The position of the tool tip does not change. ■ Tool perpendicular to contour ■ Tool radius compensation perpendicular to traversing and tool direction ■ Spline interpolation
Rotary table machining	■ Programming a contour on a cylindrical surface as if on a plane ■ Feed rate in mm/min (M116)
Contour elements	■ Straight line ■ Chamfer ■ Circular path ■ Circle center ■ Circle radius ■ Tangentially connected arc ■ Corner rounding
Approaching and departing the contour	■ Via straight line: tangential or perpendicular ■ Via circle
FK free contour programming	FK free contour programming in HEIDENHAIN conversational format with graphic support for workpiece drawings not dimensioned for NC

User functions	iTNC 530
Program jumps	■ Subroutines ■ Program-section repeat ■ Any desired program as subroutine
Fixed cycles	■ Drilling/boring cycles for drilling, peck drilling, reaming, boring, counterboring, tapping with or without floating tap holder ■ Cycles for milling internal and external threads ■ Roughing and finishing rectangular and circular pockets ■ Cycles for face milling plane and oblique surfaces ■ Cycles for milling linear and circular slots ■ Hole patterns on circle and line ■ Contour pockets — also contour parallel ■ Contour train ■ In addition, OEM cycles — special cycles written by the machine-tool builder — can be integrated.
Coordinate transformation	■ Datum shift, rotation, mirroring ■ Scaling factor (axis-specific) ■ Tilting the working plane
Q parameters — programming with variables	■ Mathematical functions =, +, –, *, /, sin α, cos α, angle α of sin α and cos α, $\sqrt{a}$, $\sqrt{a^2 + b^2}$ ■ Logical comparisons (=, ≠, <, >) ■ Parentheses ■ tan α, arc sin, arc cos, arc tan, a^n, e^n, ln, log, absolute value of a number, constant π, negation, truncation before or after decimal point ■ Functions for calculating a circle
Programming aids	■ Pocket calculator ■ Context-sensitive help function for error messages ■ Graphic support for the programming of cycles ■ Comment blocks in the NC program
Actual position capture	Actual positions can be transferred directly into the part program
Test graphics	Graphical simulation before a program run, also while another program is being run ■ Plan view, view in three planes, 3-D view ■ Magnification of details
Programming graphics	In the **Programming and Editing** operating mode, the contours of the NC blocks are drawn (2-D pencil-trace graphics), also while another program is being run
Machining graphics	Graphical simulation of executed program in plan view, three planes and 3-D view

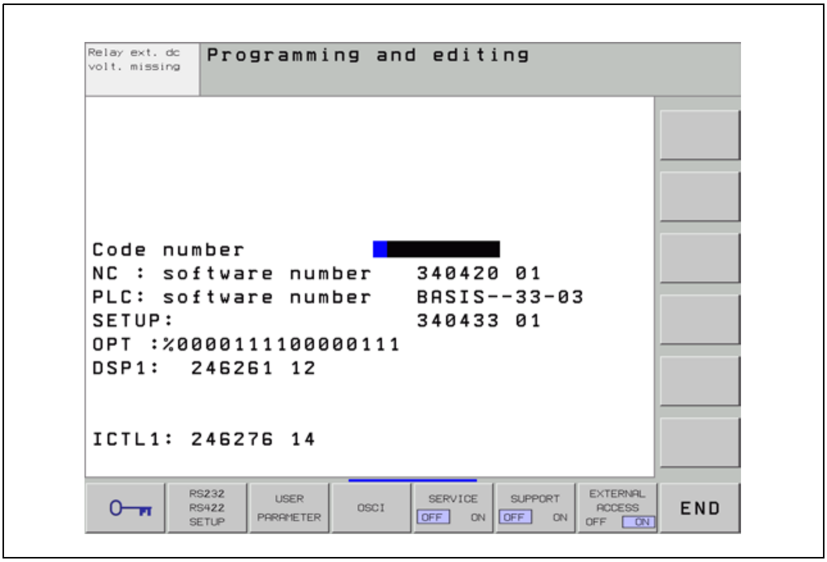
User functions	iTNC 530
Machining time	■ Calculation of machining time in the `Test Run` mode of operation. ■ Display of current machining time in the program run modes of operation
Returning to the contour	■ Mid-program startup in any block in the program, returning the tool to the calculated nominal position to continue machining ■ Program interruption, leaving and returning to the contour
Datum tables	Multiple datum tables
Pallet tables	Tool-oriented or workpiece-oriented execution of pallet tables with any number of entries for selection of pallets, part programs and datums
Touch probe cycles	■ Touch probe calibration ■ Compensating workpiece tilt manually and automatically ■ Setting the datum manually and automatically ■ Automatic workpiece measurement ■ Cycles for automatic tool measurement

2.4 Software

2.4.1 Designation of the Software

The iTNC 530 features a separate software for the NC and the PLC. The NC software is identified with an eight-digit number.

If you press the MOD key in any operating mode, you can display the ID numbers of the NC software, the DSP software (DSP1, DSP2) and the current-controller software (ICTL1, ICTL2).



Type

The iTNC 530 is shipped with the following NC software version:

Standard	Export
340 420-xx	340 421-xx

Due to restrictions on the export of the iTNC 530, HEIDENHAIN can also supply a special export version. This export version differs from the standard control though the installed NC software type. HEIDENHAIN releases a new NC software type whenever it introduces extensive new functions.

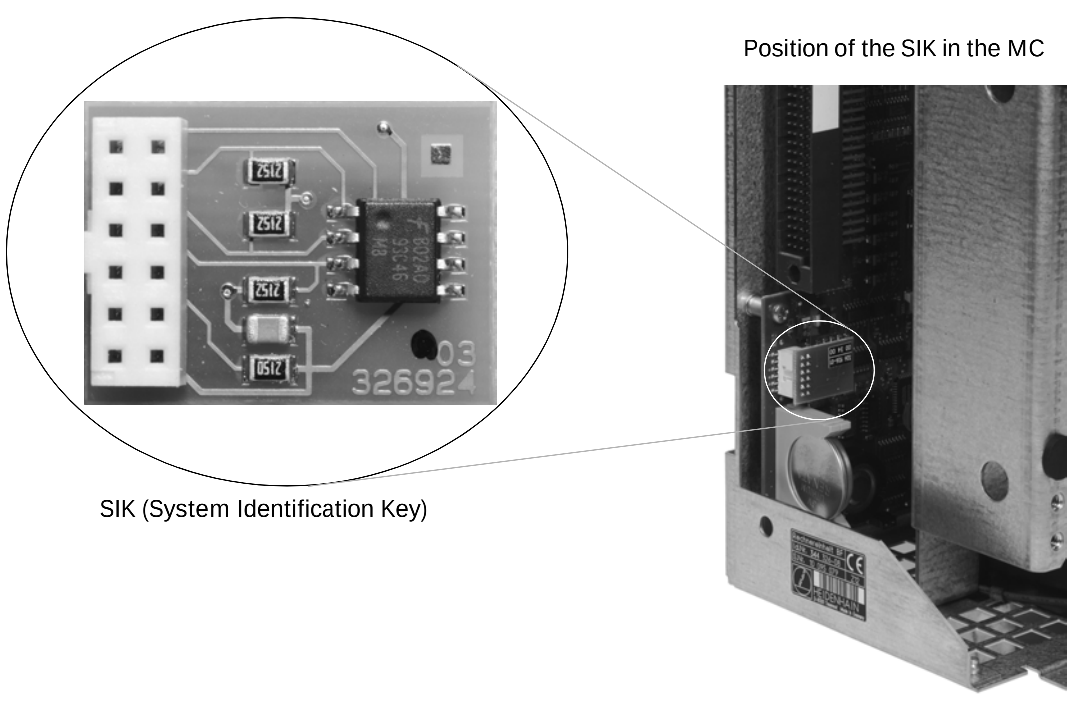
2.4.2 PLC Software

The PLC software is stored on the hard disk of the TNC. You can order a PLC basic program directly from HEIDENHAIN. With the PLC development software **PLCdesign**, the PLC program can very easily be adapted to the requirements of the machine.

2.4.3 Enabling Additional Control Loops

For each MC 422, only the minimum number of control loops is enabled. If you need additional control loops, you must enable them by entering a code number. These additional control loops are not bound to a certain machine parameter index.. The definition as to whether a control loop is used is entered as a value ≠ 0 in MP120.x (nominal speed value outputs to the axes) and MP121.x (nominal speed value outputs to the spindles).

Each MC 422 can be clearly identified by the SIK (System Identification Key).



If you wish to enable additional control loops, please contact HEIDENHAIN for the code number. After you have informed us of the SIK number, we can give you the required code number.

You will find the SIK number on the outside of the MC 422 housing (below the ID label) and on the SIK board.

Note

If you replace the MC 422, you must also replace the SIK in order to ensure that the enabled control loops will also be enabled on the new MC 422.

To enable additional control loops, proceed as follows:

- While in the **Programming and Editing** operating mode, press the MOD key.
- Enter the SIK code number and confirm your entry with the ENT key.

The following display will appear:

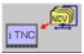
Display	Meaning
SIK ID:	SIK number
Control Type:	Control model (=iTNC 530)
General Key:	Enter the master code number 65535 to enable all options for the duration of two weeks. **NONE**: Master code number has not been entered yet. **dd.mm.yyyy**: Date up to which all options will be enabled. It is not possible to enable the control loops once more by entering the master code number. **EXPIRED**: The two weeks since the master code number has been entered have expired.
Option column	Description of the individual options
Active column	YES: Option is enabled NO: Option is not enabled
Keycode column	Enter the code number for enabling an option.

- Select the row containing the option to be enabled with the arrow keys. Options that have not been enabled yet are identified by the entry **NO** in the **Active**column.
- Enter the code number for enabling the option in the **Keycode** column and confirm your entry by pressing the ENT key. HEIDENHAIN will be able to give you the code number after having been informed of the SIK number.
- Press the END soft key. The iTNC carries out a reset.
- If the code number is correct, the enabled option is identified by the entry **YES** in the **Active** column.
- After enabling all required options, reset the control.

To display the corresponding number of machine-parameter indexes:

- In OEM.SYS, enter the code word **PWMPARAMETER =** followed by the required number of machine-parameter indexes MP2xxx.y for the current and speed controller.
- In OEM.SYS, enter the code word **AXISNUMBER =** followed by the required number of remaining machine-parameter indexes.

2.4.4 NC software exchange

Soft key	Function
	Convert the files on the hard disk from binary format to ASCII format and save nonvolatile markers in the PLCMEM.A file.
	Convert the files on the hard disk from binary format to ASCII format and save nonvolatile markers in the PLCMEM.A file.
COPY SAMPLE FILE	Copy cutting-data tables, tables for tilting-axis geometry, and tables of M-function macros from the SYS partition into the corresponding directories of the TNC or PLC partition.
	Activate or delete existing NC software.
	Exchange the NC software.

Note

The NC software must be exchanged only by trained personnel.

For exchanging the NC software, HEIDENHAIN provides packed files(*.zip) with the NC software. The packed files are transferred to the hard disk of the control and unpacked. The packed files remain on the hard disk of the control.

Procedure for exchanging the NC software

Before exchanging the NC software, ensure that the free space on the hard disk of the MC 422 is at least 50% the size of the occupied space. If that is not the case, you must save the files to a PC, e.g., with the TNCremoNT data-transfer software for PCs.

Note

When the control starts, it checks whether there is enough space on the hard disk for system files. If not, the error message **`Too many setup files`** appears. In this event, delete any unnecessary setup files from the hard disk.
(See “Deleting the packed files of existing NC software” on page 2 – 33.)

- While in the **`Programming and Editing`** operating mode, press the MOD key.
- Enter the code number 95148 and confirm your entry with the ENT key.

- If you want to use the Ethernet interface for transferring the NC software from a PC, proceed as follows:
  - While in the **Machine-parameter programming** mode, press the PGM MGT key.
  - Press the NETWORK soft key.
  - Select the PC to be connected with the cursor keys and press the MOUNT DEVICE soft key.
  - To exit the list of network drives, press the END soft key.
  - To exit the program management, press the END soft key.
- While in the **Machine-parameter programming** mode, press the MOD key.
- Press the UPDATE DATA soft key.
- The name and path of a log file can be entered after **Path =** in the header.
- Press the BIN → ASC soft key to convert the files on the hard disk from binary to ASCII format.

Equivalent file name extensions in binary and ASCII format					
.H	.H%	.I	.I%	.T	.T%
.TCH	.TC%	.D	.D%	.P	.P%
.PNT	.PN%	.COM	.CO%	.CMA	.CM%

- Press the NCV → iTNC soft key.
- In the upper part of the window, you select the folder containing the *.zip file of the new NC software. The folder contents are displayed in the lower part of the window.
- To switch to the lower part of the window, press the FILES soft key. To return to the upper part of the window, use the PATH soft key. In the lower part of the window, select the *.zip file of the new NC software with the cursor keys and press ENT. Following that, the NC software exchange will start.
- All NC software versions that exist in the control are shown in the following list box.
- Select the new NC software with the arrow keys and press the SELECT soft key. The selected NC software is marked with an asterisk "*" in the **Sel** column. Confirm your selection with the YES soft key. The control activates the selected NC software and carries out a reset. With the END key, the NO soft key or the END soft key, you exit the list box without making a new selection.
- If required, complete or delete the machine parameters.
- While in the **Programming and Editing** operating mode, press the MOD key.
- Enter the code number 95148 and confirm your entry with the ENT key.

- While in the **`Machine-parameter programming`** mode, press the MOD key.
- Press the UPDATE DATA soft key.
- Press the ASC → BIN soft key to reconvert the files on the hard disk from ASCII format into binary format.
- Read-in files which you had saved to a PC.
- The NC software exchange is completed.
- With the COPY SAMPLE FILES soft key, the HEIDENHAIN standard tables for cutting data, the tables for tilting-axis geometry, and the table of M-function macros can be copied into the corresponding directories.

Activating an existing NC software

Before activating an existing NC software, ensure that the free space on the hard disk of the MC 422 is at least 50% the size of the occupied space. If that is not the case, you must save the files to a PC, e.g., with the TNCremoNT data-transfer software for PCs.

- While in the **Programming and Editing** operating mode, press the MOD key.
- Enter the code number 95148 and confirm your entry with the ENT key.
- While in the **Machine-parameter programming** mode, press the MOD key.
- Press the UPDATE DATA soft key.
- The name and path of a log file can be entered after **Path =** in the header.
- Press the BIN → ASC soft key to convert the files on the hard disk from binary to ASCII format.

Equivalent file name extensions in binary and ASCII format					
.H	.H%	.I	.I%	.T	.T%
.TCH	.TC%	.D	.D%	.P	.P%
.PNT	.PN%	.COM	.CO%	.CMA	.CM%

- Press the NCVer soft key.
- All NC software versions that exist in the control are shown in the following list box.
- Select the NC software to be activated with the arrow keys and press the SELECT soft key. The selected NC software is marked with an asterisk "*" in the **Sel** column. Confirm your selection with the YES soft key. The control activates the selected NC software and carries out a reset. With the END key, the NO soft key or the END soft key, you exit the list box without making a new selection.
- If required, complete or delete the machine parameters.
- While in the **Programming and Editing** operating mode, press the MOD key.
- Enter the code number 95148 and confirm your entry with the ENT key.
- While in the **Machine-parameter programming** mode, press the MOD key.
- Press the UPDATE DATA soft key.
- Press the ASC → BIN soft key to reconvert the files on the hard disk from ASCII format into binary format.
- The activation of the NC software is completed.
- With the COPY SAMPLE FILES soft key, the HEIDENHAIN standard tables for cutting data, the tables for tilting-axis geometry, and the table of M-function macros can be copied into the corresponding directories.

Deleting the packed files of existing NC software

- While in the **Programming and Editing** operating mode, press the MOD key.
- Enter the code number 95148 and confirm your entry with the ENT key.
- While in the **Machine-parameter programming** mode, press the MOD key.
- Press the UPDATE DATA soft key.
- Press the NCVer soft key.
- All NC software versions that exist in the control are shown in the following options display.
- Select the NC software to be deleted with the arrow keys and press the DELETE soft key to delete all packed NC software files. The currently active NC software is marked with an asterisk "*" in the **Sel** column. Confirm your selection with the YES soft key. With the NO soft key or the END soft key, you exit the list box without deleting an NC software.

Note

If the packed files of an NC software, including the currently active software, are deleted, the respective software cannot be activated via the list box any longer. The software concerned must then again be transferred to the control
(See "Procedure for exchanging the NC software" on page 2 – 29).
The deletion of the packed files of the currently active NC software has no other effects.

Entries in the log file

If errors occur during conversion, the TNC will display error messages and log them in the log file. During the NC software switch, the name and path of a log file can be entered in the header after **Path =**; the extension *.A must be used. If no entry is made in this line, the file TNC:\CVREPORT.A is created.

Each error message contains

- Error message
- Error number
- Error cause
- File concerned

Example:

```
====================================================
ERROR              :REMANENT PLC DATA NOT RESTORED
ERRNO              :2
ERROR MESSAGE      :Program name not found
FILE               :PLCMEM.A
====================================================
```

Error message	Meaning
CANNOT OPEN DIRECTORY	File could not be opened.
REMANENT PLC DATA NOT RESTORED	No access to the file PLCMEM.A.
NOT ENOUGH SPACE	Too little free space on the hard disk
CONVERSION BIN ASC FAILED	A binary file has an incorrect format (e.g., binary format from an old NC software)
CONVERSION ASC BIN FAILED	An ASCII file on the hard disk is incorrect

2.4.5 Data Backup

HEIDENHAIN provides a data backup program called TNCBACK.EXE free of charge.

HEIDENHAIN recommends that the machine manufacturer use the software TNCBACK.EXE to save all his **machine-specific data** to a floppy disk, and that he supply the disk with the machine. The disk must also contain the program TNCBACK.EXE.

The customer, too, can save his TNC data before exchanging the control. It is also advisable that the customer save all of the files and programs created on the TNC at regular intervals. Data backup is described in detail in the "Readme" file, which is included on the disk.

2.5 Software Releases

2.5.1 NC software 320 420-xx

NC software 320 420-01

Release: 10/2001

Initial version

3 Mounting and Electrical Installation

3 Mounting and Electrical Installation

3.1 General Information

Warning

Keep the following in mind during mounting and electrical installation:

- National regulations for power installations
- Interference and noise immunity
- Conditions of operation
- Mounting attitude

3.1.1 Degrees of Protection

The following components fulfill the requirements for IP54 (dust and splash-proof protection).

- Visual display unit (when properly installed)
- Keyboard unit (when properly installed)
- Machine operating panel (when properly installed)
- Handwheel

3.1.2 Electromagnetic Compatibility

This unit fulfills the requirements for Class A according to EN 55022 and is intended for operation in industrially zoned areas.

Protect your equipment from interference by observing the following rules and recommendations.

Likely sources of interference

Noise is mainly produced by capacitive and inductive coupling from electrical conductors or from device inputs/outputs, such as:

- Strong magnetic fields from transformers or electric motors
- Relays, contactors and solenoid valves
- High-frequency equipment, pulse equipment and stray magnetic fields from switch-mode power supplies
- Power lines and leads to the above equipment

Protective measures

- Keep a minimum distance of 20 cm from the MC 422, CC 422 and its leads to interfering equipment.
- Keep a minimum distance of 10 cm from the MC 422, CC 422 and its leads to cables that carry interference signals. For cables in metallic ducting, adequate decoupling can be achieved by using a grounded separation shield.
- Shielding according to EN 50 178
- Use potential compensating lines with 6 mm^2 cross-sections
- Use only genuine HEIDENHAIN cables, connectors and couplings

3.2 Shipping Brace of the Hard Disk

The hard disks of the MC 422 are fitted with a shipping brace. The shipping brace consists of two screws, which are used to secure the hard disk to the housing of the MC 422. There are also two additional free threaded holes in the housing, into which the screws are inserted after the hard disk has been released.

When is it necessary to use the shipping brace?

- Before beginning operation, the shipping brace of the hard disk must be removed and the screws inserted in the storage holes.
- The shipping brace for the hard disk is not required when the machine is being transported.
- Should servicing become necessary (i.e. the MC 422 is being shipped on its own), the hard disk must be secured with the shipping brace.

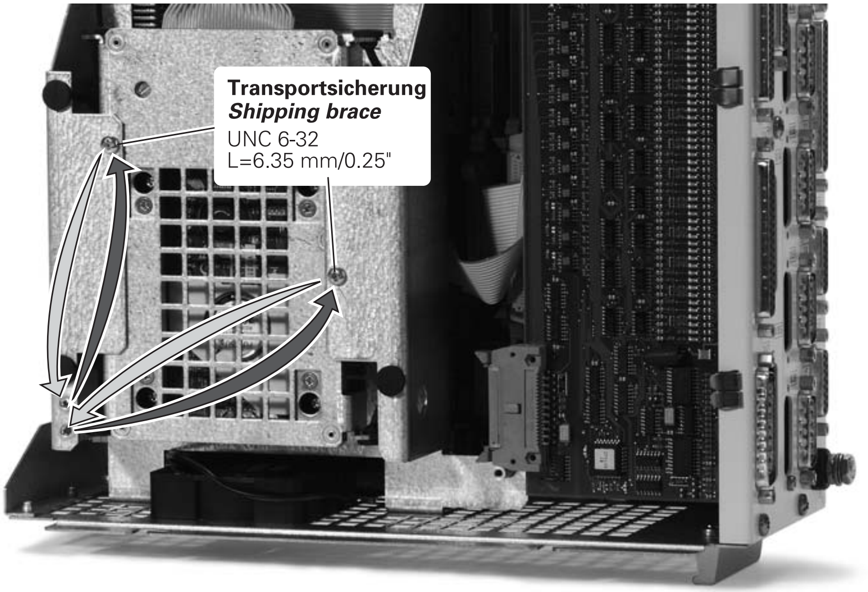
Achtung!
Note!

Vor Inbetriebnahme Schrauben für die **Transportsicherung** der Festplatte entfernen und in die freien Gewindebohrungen einschrauben.

*Before beginning operation, release the **shipping brace** of the hard disk by removing the screws from the locking holes and screwing them into the storage holes.*

Im Servicefall Festplatte vor dem Transport mit den Schrauben sichern.

***Before shipping the unit**, secure the hard disk by reinserting the screws.*



3.3 Environmental conditions

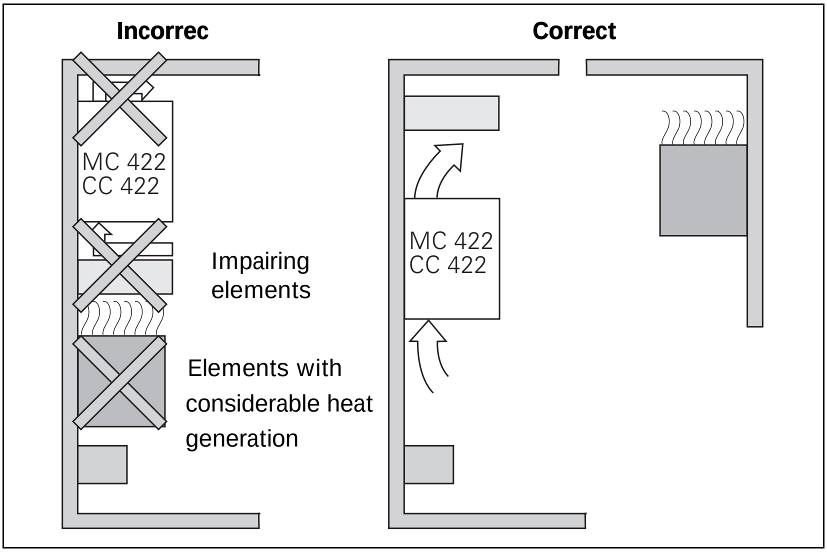
3.3.1 Heat Generation and Cooling

The permissible ambient temperature in operation is between 0 °C and 45 °C. Any deviation from this will impair the operating safety of the machine.
The permissible storage temperature is between –35 °C and +65 °C.

The following measures can ensure adequate heat removal:

- Provide sufficient space for air circulation.
- Build in a fan to intensify the natural convection. The fan should extract the warm air from the MC 422 and CC 422. There must be no pre-warmed air blown into the unit. The warmed air should flow over surfaces that have good thermal conductivity to the external surroundings.
- For a closed steel housing without assisted cooling, The proposed value for heat conduction is 3 Watts/m^2 of surface per °C air temperature difference between inside and outside.
- Use of a heat exchanger with separate internal and external circulation.

HEIDENHAIN advises against blowing external air through the control cabinet to replace the internal air. Electronic assemblies may be adversely affected by fine dust or vapors. If no other method of cooling is possible, then ensure that the fan extracts the warmed air from the electrical cabinet and that the air drawn in is adequately filtered. Regular servicing of the filter is essential.



3.3.2 Humidity

Permissible humidity:

- Maximum 75% in continuous operation
- Maximum 95% for not more than 30 days a year (randomly distributed)

In tropical areas it is recommended that the iTNC 530 not be switched off, so as to avoid dew deposition on the circuit boards.

3.3.3 Mechanical Vibration

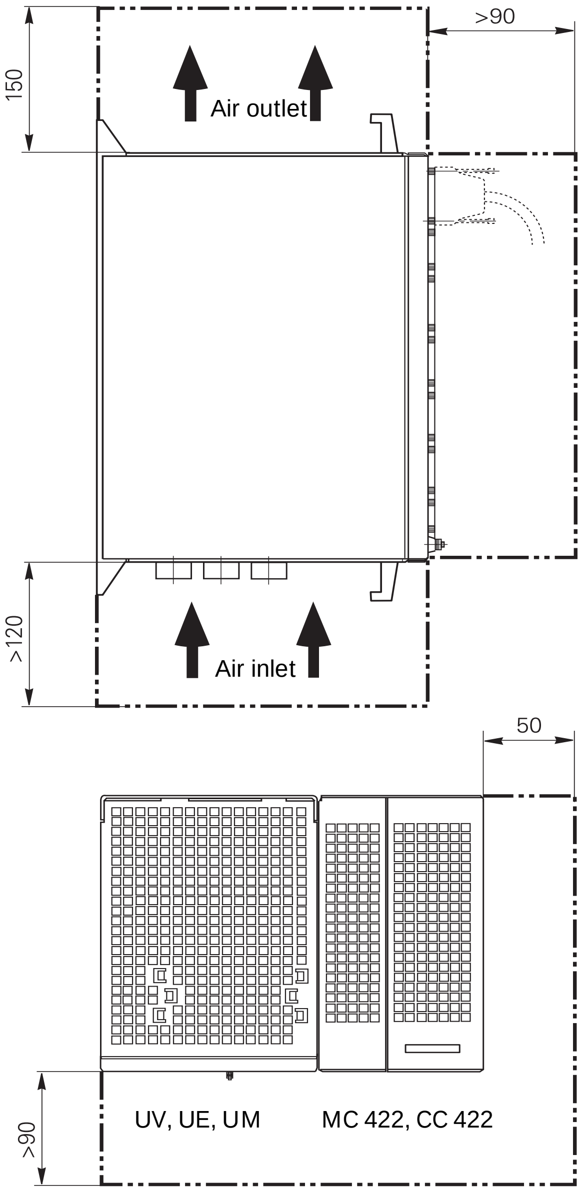
Permissible vibration:	± 0.075 mm, 10 to 41 Hz 5 m/s^2, 41 Hz to 500 Hz
Permissible shock:	50 m/s^2, 11 ms

Permissible shock with shipping brace for hard disk: 300 m/s^2, 11 ms

3.3.4 Mounting Attitude of MC 422, CC 422, UV xxx, UM xxx, UE 2xx B

Warning

When mounting, please observe proper minimum clearance, space requirements, length and position of the connecting cables.



Leave space for air circulation! Temperatures of > 150 °C are possible with UE 21x B with integral braking resistor; Do not mount any temperature-sensitive components!

Leave space for servicing!

Free space for air circulation and servicing!

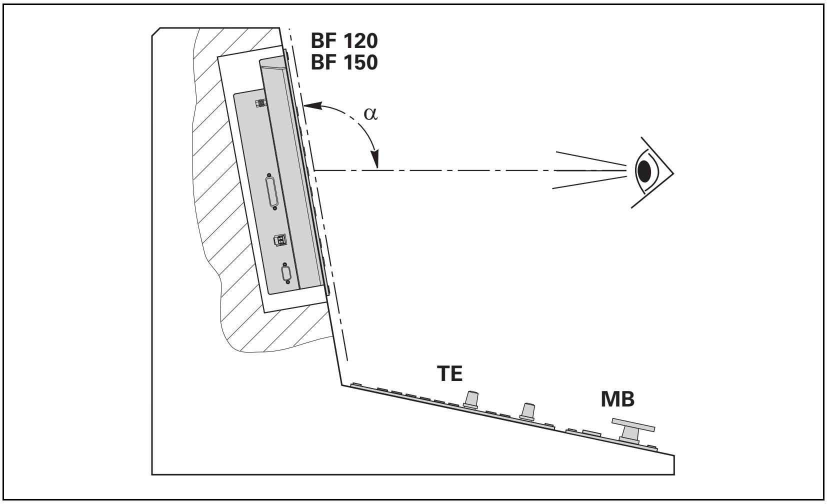
Leave space for servicing and connecting cable!

3.3.5 Mounting Position of Screen

BF 120, BF 150

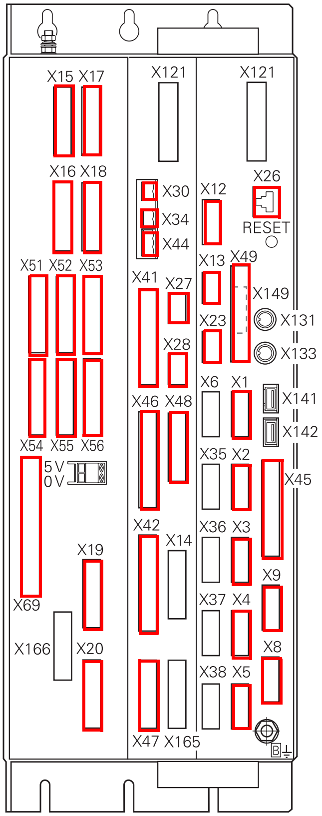
The BF 120 and BF 150 flat-panel displays must be viewed with a slight backward slant.

▶ During installation, ensure a viewing angle of 150° > α > 90°.



3.4 Connection Overview for iTNC 530

MC 422 M/5 position encoder inputs and CC 422 with 6 speed control loops

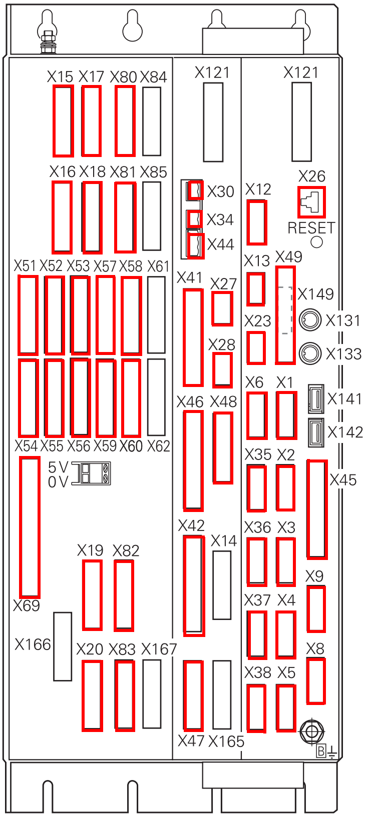


X150 at bottom of housing

X1 to X5	Position encoder 1 V_{PP}
X35 to X38	Vacant
X15 to X20	Speed encoder 1 V_{PP}
X51 to X60	PWM output (power stage of motor)
X8, X9	Nominal value output, analog
X12	TS touch trigger probe
X13	TT 130 touch trigger probe
X23	Handwheel
X26	Ethernet data interface
X27	RS-232-C/V.24 data interface
X28	RS-422/V.11 data interface
X30	24 V reference signal for spindle
X34	24 V for control-is-ready signal output
X41	PLC output
X42	PLC input
X44	24 V PLC supply voltage
X45	Keyboard unit (TE 4xx)
X46	Machine operating panel
X47	PLC expansion (PL 4xxB)
X48	PLC analog input
X149 (X49)	BF 150 (BF 120) visual display unit
X69	Power supply
X121, X125	Reserved
X127, X128	Reserved
X131, X133	Reserved
X141, X142	Reserved
X165, X166	Reserved
5V/0V	Power supply for processor
X150	Axis-specific drive release 1 to 6
B	Signal ground
⏚	Equipment ground (YL/GN)

Warning

Do not engage or disengage any connecting elements while the unit is under power!



X150, X151 at bottom of housing

X1 to X6	Position encoder 1 V_{PP}
X35 to X38	Position encoder 1 V_{PP}
X15 to X20	Speed encoder 1 V_{PP}
X80 to X83	Speed encoder 1 V_{PP}
X84, X85	Vacant
X51 to X60	PWM output (power stage of motor)
X61, X62	Vacant
X8, X9	Nominal value output, analog
X12	TS touch trigger probe
X13	TT 130 touch trigger probe
X23	Handwheel
X26	Ethernet data interface
X27	RS-232-C/V.24 data interface
X28	RS-422/V.11 data interface
X30	24 V reference signal for spindle
X34	24 V for control-is-ready signal output
X41	PLC output
X42	PLC input
X44	24 V PLC supply voltage
X45	Keyboard unit (TE 4xx)
X46	Machine operating panel
X47	PLC expansion (PL 4xxB)
X48	PLC analog input
X149 (X49)	BF 150 (BF 120) visual display unit
X69	Power supply
X121, X125	Reserved
X127, X128	Reserved
X131, X133	Reserved
X141, X142	Reserved
X165, X166, X167	Reserved
5V/0V	Power supply for processor
X150	Axis-specific drive release 1 to 6
X151	Axis-specific drive release 7 to 10
B	Signal ground
⏚	Equipment ground (YL/GN)

Warning

Do not engage or disengage any connecting elements while the unit is under power!

3.5 Power Supply for the iTNC 530

The UV 1x0 or the UV 105 power supply unit supplies the iTNC 530 with power.
Power is supplied through X69 and, with the UV 105, in addition through a 5 V terminal on the CC 422.

For information on the UV 1x0 supply units, refer to the Technical Manual "Inverter Systems and Motors."

Whether the UV 1x0 supply unit is sufficient or whether a UV 105 is needed as additional equipment, depends on the current consumption of the used units.

Device	Load capacity
UV 1x0, UE 2xx B	8.50 A
UV 105	20.00 A

Device	Current consumption
MC 422	4.80 A
CC 422/6 control loops	1.50 A
CC 422/10 control loops	3.00 A
LS, LB	0.15 A
ERN, ROD, RON	0.20 A
ECN, EQN, ROC, ROQ, RCN	0.25 A (+0.085 A with line drop compensator)[a]
LC 181	0.30 A (+0.085 A with line drop compensator)[a]

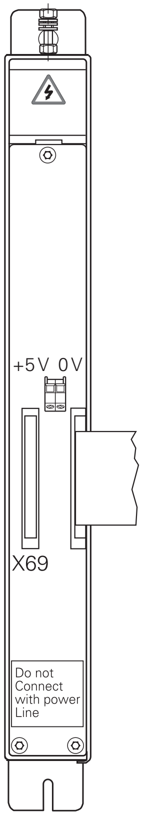
a. For cable lengths > 10 m between the logic unit and the encoders with EnDat interfaces, a line drop compensator is required (efficiency = 75 %).

Example:

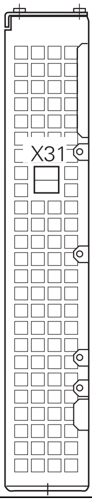
Device	Current consumption
MC 422	4.80 A
CC 422/6 control loops	1.50 A
3 x LS for X, Y, Z	0.45 A
3 x ERN for X, Y, Z	0.6 A
1 x ERN for spindle	0.2 A
2 x ROD for B, C	0.4 A
2 x ERN for B,C	0.4 A
Total	8.35 A < 8.50 A

For this application, an UV 105 is not needed.

Connection overview UV 105



Conductor bar	Power supply over U_Z
Free cable	5 V power supply for CC 422 (to 5 V terminal on CC 422)
Free ribbon cable	Power supply for CC 422 (to X69 on CC 422)
X69	Status signals from UV 1x0



X31	Power supply

Warning

Do not engage or disengage any connecting elements while the unit is under power!

X69: NC supply voltage and control signals

> **Note**
>
> For the NC to be able to evaluate the status signals of the UV 1x0 power supply units, connector X69 must be connected by ribbon cable with X69 of the UV 105.
> Since non-HEIDENHAIN inverters do not send any status signals, an adapter connector (Id. Nr. 349 211-01) must be connected to X69 on the UV 105. This connector is delivered with the UV 105.

Pin layout:

Ribbon connector, 50-pin	Assignment	Ribbon connector, 50-pin	Assignment
1a to 5b	+5 V	16b	GND
6a to 7b	+12 V	17a	RDY.PS
8a	+5 V (low-voltage separation)	17b	GND
8b	0 V (low-voltage separation)	18a	ERR.ILEAK
9a	+15 V	18b	GND
9b	-15 V	19a	PF.PS.AC (only UV 120, UV 140, UV 150, UR 2xx)
10a	UZAN	19b	GND
10b	0 V	20a	Do not assign
11a	IZAN	20b	GND
11b	0 V	21a	Do not assign
12a	RES.PS	21b	GND
12b	0 V	22a	Do not assign
13a	PF.PS.ZK	22b	GND
13b	GND	23a	Reserved (SDA)
14a	ERR.UZ.GR	23b	GND
14b	GND	24a	Reserved (SLC)
15a	ERR.IZ.GR	24b	GND
15b	GND	25a	RES.LE
16a	ERR.TMP	25b	GND

5-V connection of the UV 105

Pin layout:

Wire color of 5 V connection	5 V terminal on the CC 422
Black	0V
Red	+5V

X31: Supply voltage of the UV 105

Supply voltage: 400 V ± 10 %

Pin layout:

Connecting terminal	Assignment
U	U[a]
V	V
⏚	Equipment ground (YL/GY)

a. Connecting cable: 1.5 mm^2, shielded

Note

The supply voltage at terminals U and V must:

- be supplied via an isolating transformer (300 VA, basic isolation in accordance with EN 50 178 or VDE 0550) for non-HEIDENHAIN inverters and regenerative HEIDENHAIN inverter systems (UV 120, UV 140, UV 150, UR 2xx).
- There is no need for an isolating transformer if non-regenerative HEIDENHAIN inverter systems are used.

Supply of the UV 105 with U_Z

The UV 105 is powered with dc-link voltage U_Z through

- the conductor bars (for HEIDENHAIN inverter systems).
- a cable which is connected instead of the conductor bar (for non-HEIDENHAIN inverter systems).

The dc-link voltage is monitored by the control, See "Monitoring of the Power Supply Unit" on page 6 – 168.

3.6 Power Supply for PLC Outputs

The PLC of the iTNC 530 as well as the PL 410 B/PL 405 B are powered by the 24 Vdc control voltage of the machine (in accordance with VDE 0551).

The control voltage must be smoothed with a minimum 1000 µF at a rated current capacity of 150 µF/A. At a current load of e.g. 15 A, this corresponds to a capacity of 2250 µF.

EN 61 131-2:1994 permits:

- 5% alternating voltage component is permissible
- Minimum absolute value 19.2 Vdc
- Maximum absolute value 30 Vdc

Warning

Use only original replacement fuses.

Power consumption

If half of the outputs are switched at the same time, the following are the values for power consumption:

MC 422:	48 W
PL 410 B:	approx. 460 W
PL 405 B:	approx. 235 W

Nominal operating current per output

MC 422:	0.125 A (with a simultaneity factor of 0.5)
PL 410 B:	2 A (with max. current consumption of 20 A)
PL 405 B:	2 A (with max. current consumption of 20 A)

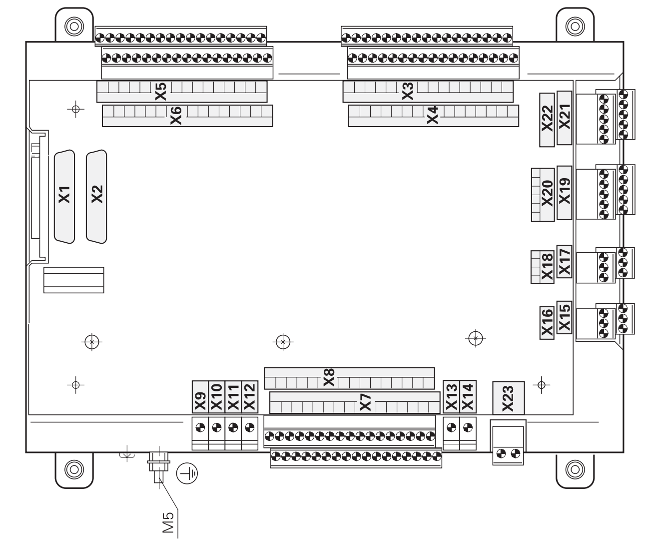
X44: PLC supply voltage

Pin layout on the MC 422:

Connection terminal	Assignment	PLC outputs
1	+24 V can be switched off via EMERGENCY STOP	O24 to O30 control-is-ready signal
2	+24 V can be switched off via EMERGENCY STOP	O16 to O23
3		O0 to O15
4	0 V	

3.6.1 Supply Voltage for PLC Outputs on the PL 4xx B

Connection overview



X9 to X14: Supply voltage

Pin layout on the PL 410 B:

Terminal	Assignment	PL 1	PL 2	PL 3	PL 4
X9	0 V				
X10	+24 Vdc logic power supply and for control-is-ready signal				
X11	+24 Vdc power supply for outputs	O32 – O39	O64 – O71	O128 – O135	O160 – O167
X12	+24 Vdc power supply for outputs	O40 – O47	O72 – O79	O136 – O143	O168 – O175
X13	+24 Vdc power supply for outputs	O48 – O55	O80 – O87	O144 – O151	O176 – O183
X14	+24 Vdc power supply for outputs	O56 – O62	O88 – O94	O152 – O158	O184 – O190

Pin layout on the PL 405 B:

Terminal	Assignment	PL 1	PL 2	PL 3	PL 4
X9	0 V				
X10	+24 Vdc logic power supply and for control-is-ready signal				
X13	+24 Vdc power supply for outputs	O48 – O55	O80 – O87	O144 – O151	O176 – O183
X14	+24 Vdc power supply for outputs	O56 – O62	O88 – O94	O152 – O158	O184 – O190

X23: Power supply for the analog inputs on the PL 410 B

The PL 410 B input/output unit is also available with additional analog inputs and inputs for Pt 100 thermistors. The power supply must comply with EN 50 178, 5.88 requirements for ”low voltage electrical separation.”

Terminal	Assignment
1	+24 Vdc as per EN 50 178, 5.88
2	+0 V

3.7 Power Supply for Control-Is-Ready Signal

X34: Power supply for control-is-ready signal

The control-is-ready signal output is powered by 24 Vdc provided by the UE 2xx B inverter or the UV1xx power supply unit. The voltage is connected with terminal X34.

Pin layout:

Connecting terminal X34	Assignment	Connection when using a HEIDENHAIN inverter
1	+24 V	X72/1
2	0 V	X72/2

3.8 Power Supply for the Display Units

Power supply with basic insulation in accordance with EN 50 178:

Connecting terminal X1	Assignment
1	+24 V
2	0 V

Power consumption: BF 120: 15 W
BF 150: 25 W

3.9 Buffer Battery

Danger

When exchanging the buffer battery, remember:

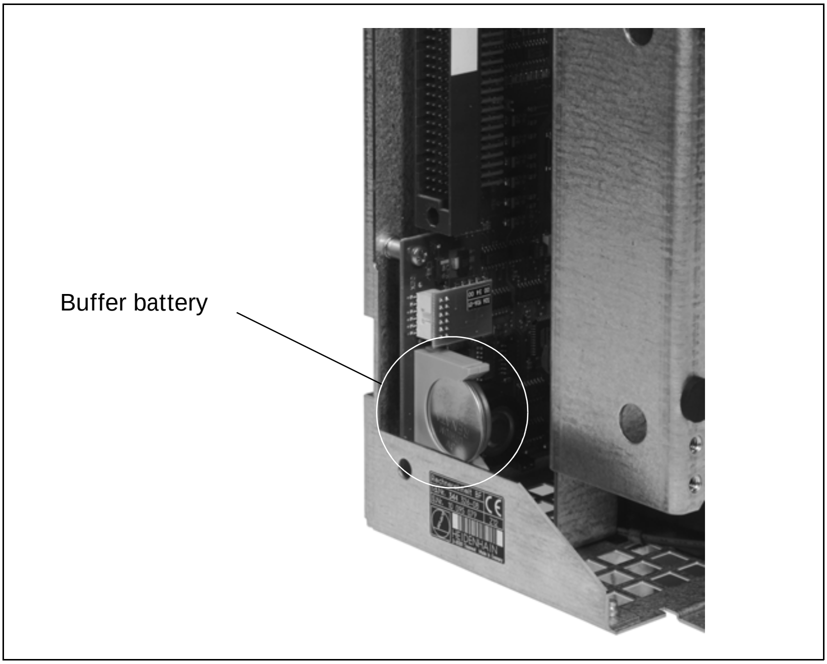
- Switch off the machine and the iTNC 530.
- The buffer battery may be exchanged only by trained personnel.

Battery type: 1 lithium battery, type CR 2450N (Renata), Id. Nr. 315 878-01

If the voltage of the buffer battery falls below 2.6 V the error message **`Exchange buffer battery`**. If the voltage does not exceed 2.6 V, the error message is reactivated after 30 minutes.

To exchange the battery:

- The buffer battery is located on the rear side of the MC 422.
- Exchange the battery; the new battery can be inserted in only one position.


Buffer battery

3.10 Drive Controller Enable

A drive controller can be enabled by the NC software only if the controller is enabled with 24 V on X150/X151 **and** on X42, pin 33.

X150, X151: Drive controller enabling for axis groups

The connecting terminals X150 and X151 are located on the bottom of the CC 422.

Pin layout:

Terminal X150/X151	Assignment of X150	Assignment of X151
1	+24 V[a]; drive controller enabling for axis group 1	Reserved, do not assign
2	+24 V[a]; drive controller enabling for axis group 2	Reserved, do not assign
3	+24 V[a]; drive controller enabling for axis group 3	Reserved, do not assign
4	Reserved, do not assign	Reserved, do not assign
5	Reserved, do not assign	Reserved, do not assign
6	Reserved, do not assign	Reserved, do not assign
7	Reserved, do not assign	Reserved, do not assign
8	Reserved, do not assign	Reserved, do not assign
9	0 V	Reserved, do not assign

a. Maximum current consumption 10 mA.

X42/33: Global drive controller enable

Pin layout:

D-sub connctn. (male) 37-pin	Assignment
..	..
33	+24 V (drive controller enable)
..	..

3.11 Encoder Connections

3.11.1 General Information

HEIDENHAIN contouring controls are designed for use with incremental linear and angular encoders as measuring systems. The encoder signals are interpolated 1024-fold.
Encoders with one reference mark or distance-coded reference marks and with EnDat interface are permissible.
HEIDENHAIN recommends the use of absolute encoders with EnDat interface or the use of encoders with distance-coded reference marks because they greatly reduce the traverse distance required to establish the absolute position.

Please use only HEIDENHAIN encoder cables, connectors and couplings. For maximum cable lengths, see “Cable Overview” at the end of this chapter.

	Position encoder	**Speed encoder**
Signal amplitude	EnDat, 1 V_{PP}	EnDat, 1 V_{PP}
Input frequency	1 V_{PP}: 50 kHz/350 kHz (can be set with MP)	350 kHz

11 μA_{PP} encoders can be connected through the adapter plug with the Id. Nr. 317 505-05.

Note

Keep in mind the line count of the speed encoders when choosing the motors:

$$x = \frac{f \cdot 60 \cdot 1000}{n}$$

x: line count of the speed encoder
f: maximum input frequency
n: maximum speed

Example:
f = 350 kHz; n = 10 000 rpm

$$x = \frac{350 \cdot 60 \cdot 1000}{10000} \approx 2048$$

3.11.2 Input of Position Encoder

X1 to X6, X35 to X38: Position encoder 1 V_{PP}

Pin layout:

MC 422		Adapter cable 309 783-xx Adapter cable 310 199-xx			Encoder	
Male	**Assignment**	**Female**	**Color**	**Female**	**Male**	**Color**
1	+5 V (U_P)	1	Brown/Green	12	12	Brown/Green
2	0 V (U_N)	2	White/Green	10	10	White/Green
3	A+	3	Brown	5	5	Brown
4	A–	4	Green	6	6	Green
5	Do not assign	5				
6	B+	6	Gray	8	8	Gray
7	B–	7	Pink	1	1	Pink
8	Do not assign	8				
9	+5 V (sensor line)	9	Blue	2	2	Blue
10	R+	10	Red	3	3	Red
11	0 V (sensor line)	11	White	11	11	White
12	R–	12	Black	4	4	Black
13	0 V	13				
14	Do not assign	14	Violet	7	7	Violet
15	Do not assign	15				
Hsg.	External shield	Hsg.	External shield	Hsg.	Hsg.	External shield

Note

The interface complies with the requirements of EN 50 178 for “low voltage electrical separation.”

X1 to X6, X35 to X38: Position encoder with EnDat interface

Pin layout:

MC 422		Adapter cable 332 115-xx			Connecting cable 323 897-xx				Adapter cable 313 791-xx		
Male	**Assign-ment**	**Female**	**Color**	**Female**	**Male**	**Color**	**Fem.**		**Male**	**Color**	**Fem.**
1	+5 V (U_P)	1	Brown/ Green	7	7	Brown/ Green	7	Line drop compensator 336 697-02, if required	7	Brown/ Green	5b
2	0 V (U_N)	2	White/ Green	10	10	White/ Green	10		10	White/ Green	6a
3	A+	3	Green/ Black	15	15	Green/ Black	15		15	Green/ Black	2a
4	A–	4	Yellow/ Black	16	16	Yellow/ Black	16		16	Yellow/ Black	2b
5	Data	5	Gray	14	14	Gray	14		14	Gray	3b
6	B+	6	Blue/ Black	12	12	Blue/ Black	12		12	Blue/ Black	1a
7	B–	7	Red/ Black	13	13	Red/ Black	13		13	Red/ Black	1b
8	$\overline{\text{Data}}$	8	Pink	17	17	Pink	17		17	Pink	3a
9	+5 V (sensor line)	9	Blue	1	1	Blue	1		1	Blue	6a
10	Free	10		3	3	Red	3		3		
11	0 V (sensor line)	11	White	4	4	White	4		4	White	6b
12	Free	12		2	2	Black	2		2		
13	Internal shield	13	Internal shield	11	11	Internal shield	11		11	Internal shield	
14	Clock	14	Violet	8	8	Violet	8		8	Violet	4a
15	$\overline{\text{Clock}}$	15	Yellow	9	9	Yellow	9		9	Yellow	4b
Hsg.	Housing	Hsg.	External shield	Hsg.		External shield			Hsg.	Ext. shield	

Note

The interface complies with the requirements of EN 50 178 for “low voltage electrical separation.”

3.11.3 Input of Speed Encoder

X15 to X20, X80 to X85: Speed encoder 1 V_{PP}

Pin layout:

CC 422		Adapter cable 289 440-xx			Connecting cable 336 847-xx		
Male	**Assignment**	**Female**	**Color**	**Female**	**Male**	**Color**	**Female**
1	+5 V (U_P)	1	Brown/Green	10	10	Brown/Green	10
2	0 V (U_N)	2	White/Green	7	7	White/Green	7
3	A+	3	Green/Black	1	1	Green/Black	1
4	A–	4	Yellow/Black	2	2	Yellow/Black	2
5	0 V						
6	B+	6	Blue/Black	11	11	Blue/Black	11
7	B–	7	Red/Black	12	12	Red/Black	12
8	0 V	8	Internal shield	17	17	Internal shield	17
9	Do not assign						
10	Do not assign						
11	Do not assign						
12	Do not assign						
13	Temperature +	13	Yellow	8	8	Yellow	8
14	+5 V (U_P)	14	Blue	16	16	Blue	16
15	Do not assign						
16	0 V (U_N)	16	White	15	15	White	15
17	R+	17	Red	3	3	Red	3
18	R–	18	Black	13	13	Black	13
19	C+	19	Green	5	5	Green	5
20	C–	20	Brown	6	6	Brown	6
21	D+	21	Gray	14	14	Gray	14
22	D–	22	Pink	4	4	Pink	4
23	Do not assign						
24	0 V						
25	Temperature–	25	Violet	9	9	Violet	9
Hsg.	Housing	Hsg.	External shield	Hsg.	Hsg.	External shield	Hsg.

Note

The interface complies with the requirements of EN 50 178 for “low voltage electrical separation.”

X15 to X20, X80 to X85: Speed encoder with EnDat interface

Pin layout:

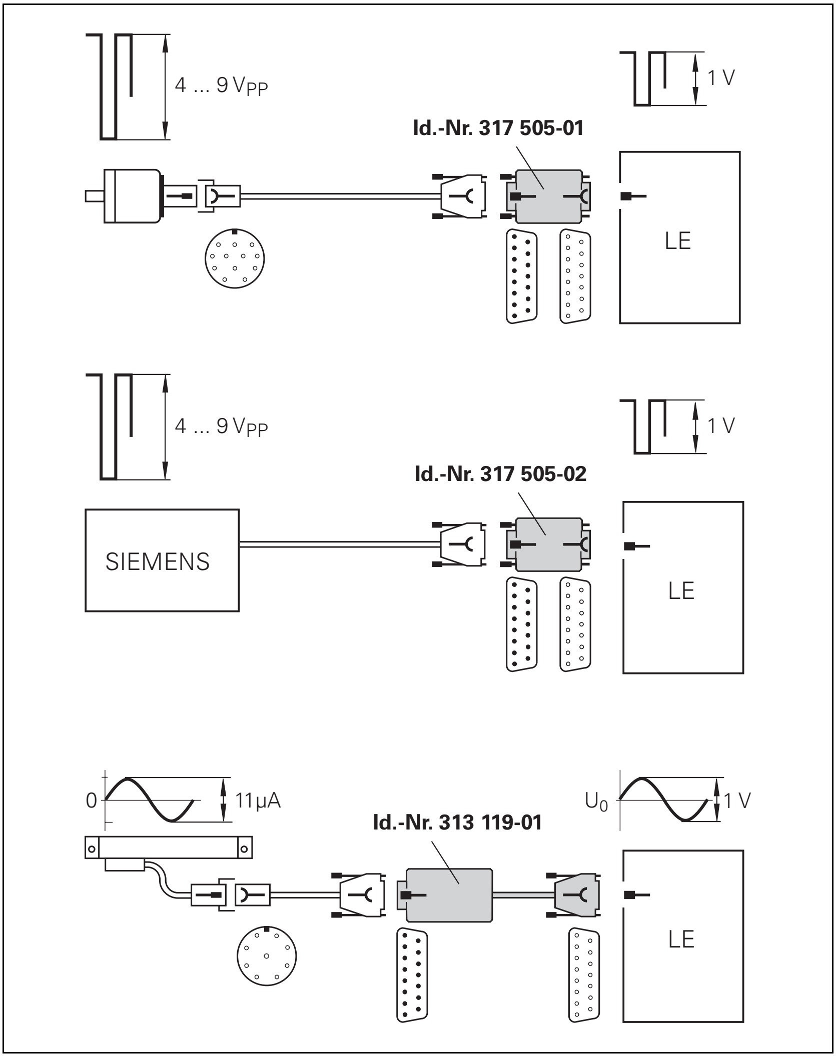
CC 422		Adapter cable 336 376-xx				Connecting cable 340 302-xx		
Male	**Assignment**	**Female**	**Color**	**Female**		**Male**	**Color**	**Female**
1	+5 V (U_P)	1	Brown/Green	10	Line drop compensator 336 697-01, if required	10	Brown/Green	10
2	0 V (U_N)	2	White/Green	7		7	White/Green	7
3	A+	3	Green/Black	1		1	Green/Black	1
4	A–	4	Yellow/Black	2		2	Yellow/Black	2
5	0 V							
6	B+	6	Blue/Black	11		11	Blue/Black	11
7	B–	7	Red/Black	12		12	Red/Black	12
8	0 V	8	Internal shield	17		17	Internal shield	17
9	Do not assign							
10	Clock	10	Green	5		5	Green	5
11	Do not assign							
12	$\overline{\text{Clock}}$	12	Brown	14		14	Brown	14
13	Temperature +	13	Yellow	8		8	Yellow	8
14	+5 V (sensor line)	14	Blue	16		16	Blue	16
15	Data	15	Red	3		3	Red	3
16	0 V (sensor line)	16	White	15		15	White	15
17	Do not assign							
18	Do not assign							
19	Do not assign							
20	Do not assign							
21	Do not assign							
22	Do not assign							
23	$\overline{\text{Data}}$	23	Black	13		13	Black	13
24	0 V							
25	Temperature–	25	Violet	9		9	Violet	9
Hsg.	Housing	Hsg.	External shield	Hsg.		Hsg.	External shield	Hsg.

Note

The interface complies with the requirements of EN 50 178 for “low voltage electrical separation.”

3.12 Adapters for Encoder Signals

Encoder signals with 11 μA_{PP} or TTL levels can be adapted to the 1 V_{PP} interface with HEIDENHAIN adapter connectors.



Note

Please note:

- The adapters adjust only the levels, not the signal shape.
- The contamination signal of the square-wave encoder cannot be evaluated.
- A square-wave signal can be subdivided no more than 4-fold.

Adapter connector TTL (HEIDENHAIN)/ 1 V_{PP}

Pin layout of D-sub connector (female) and D-sub connector (male):

D-sub connctr. (female) 15-pin	Assignment	D-sub connection (male) 15-pin	Assignment
1	+5 V (U_P)	1	+5 V (U_P)
2	0 V (U_N)	2	0 V (U_N)
3	A+	3	U_{a1}
4	A–	4	$–U_{a1}$
5	0 V	5	0 V
6	B+	6	U_{a2}
7	B–	7	$–U_{a2}$
8	0 V	8	0 V
9	+5 V	9	+5 V
10	R+	10	U_{a0}
11	0 V	11	0 V
12	R–	12	$–U_{a0}$
13	0 V	13	0 V
14	$–U_{aS}$	14	$–U_{aS}$
15	Not assigned	15	Not assigned

Adapter connector TTL (SIEMENS)/ 1 V_{PP}

Pin layout of D-sub connector (female) and D-sub connector (male):

D-sub connctr. (female) 15-pin	Assignment	D-sub connection (male) 15-pin	Assignment
1	Not assigned	1	Not assigned
2	0 V	2	0 V
3	A+	3	U_{a1}
4	A–	4	$–U_{a1}$
5	Not assigned	5	Not assigned
6	B+	6	U_{a2}
7	B–	7	$–U_{a2}$
8	Not assigned	8	Not assigned
9	Not assigned	9	Not assigned
10	R+	10	Not assigned
11	Not assigned	11	Not assigned
12	R–	12	U_{a0}
13	Not assigned	13	$–U_{a0}$
14	Not assigned	14	Not assigned
15	Not assigned	15	Not assigned

Adapter connector 11 μA_{PP} / 1 V_{PP}

Pin layout of D-sub connector (female) and D-sub connector (male):

D-sub connctr. (female) 15-pin	Assignment	D-sub connection (male) 15-pin	Assignment
1	+5 V (U_P)	1	+5 V (U_P)
2	0 V (U_N)	2	0 V (U_N)
3	A+	3	0°+
4	A–	4	0°–
5	0 V	5	0 V
6	B+	6	90°+
7	B–	7	90°–
8	0 V	8	0 V
9	+5 V	9	+5 V
10	R+	10	R+
11	0 V	11	0 V
12	R–	12	R–
13	0 V	13	0 V
14	Not assigned	14	Not assigned
15	Not assigned	15	Not assigned

3.13 Motor Power Stage Connection

The iTNC 530 is connected with HEIDENHAIN or non-HEIDENHAIN inverters through a PWM interface.
For a description of the HEIDENHAIN inverter systems, refer to the Technical Manual "Inverter Systems and Motors". The components required for operation of the iTNC 530 with non-HEIDENHAIN inverter systems are described in the manual "Technical Information for the Operation of SIMODRIVE and POWER DRIVE Inverter Systems".

The individual PWM outputs are assigned to different controller groups, See “Maximum spindle speed” on page 6 – 14 and “PWM Frequency” on page 6 – 223.

The following applies for the output signals to the power stage:

Logic level:	5 V
Analog signals I_{ACTL}:	±7.5 V
PWM frequency:	MP2180 can be used to set it at 3.33 kHz, 4.16 kHz or 5 kHz

X51 to X62: PWM-Output

Pin layout:

Ribbon cable connector 20-pin	**Assignment**
1a	PWM U1
1b	0 V U1
2a	PWM U2
2b	0 V U2
3a	PWM U3
3b	0 V U3
4a	$\overline{\text{SH2}}$
4b	0 V (–SH2)
5a	$\overline{\text{SH1B}}$
5b	0 V ($\overline{\text{SH1B}}$)
6a	+IIST 1
6b	–IIST 1
7a	0 V (analog)
7b	+IIST 2
8a	–IIST 2
8b	0 V (analog)
9a	Do not assign
9b	Do not assign
10a	$\overline{\text{Temp. warning}}$
10b	Ready

Note

The interface complies with the requirements of EN 50 178 for “low voltage electrical separation.”

3.14 Analog Input

The MC 422 and the PLC input/output board PL 410 B have analog inputs and inputs for Pt 100 thermistors.

The PL 410B is available with and without analog inputs.

	Analog inputs (±10 V)	**Inputs for Pt 100 thermistors**
MC 422, X48	3	3
PL 405 B	–	–
PL 410 B (263 371-02)	4	4

Analog inputs

Voltage range:	–10 V to +10 V
Input resistance:	> 250 kΩ
Resolution (W480, W482, W484):	100 mV
Resolution (Module 9003):	10 mV (MC 422) 100 mV (PL 410 B)
Internal value range:	–100 to +100, at a resolution of 100 mV -10 to +10, at a resolution of 10 mV

Inputs for Pt 100 thermistors:

Constant current:	5 mA
Temperature range:	0 °C to 100 °C
Resolution (W486, W488, W490):	0.5 °C
Resolution (Module 9003):	0.1 °C (MC 422) 0.5 °C (PL 410 B)
Internal value range:	0 to 200, at a resolution of 0.5 °C 0 to 1000, at a resolution of 0.1 °C

X48: Analog input (PLC) on the MC 422

Pin layout:

Warning

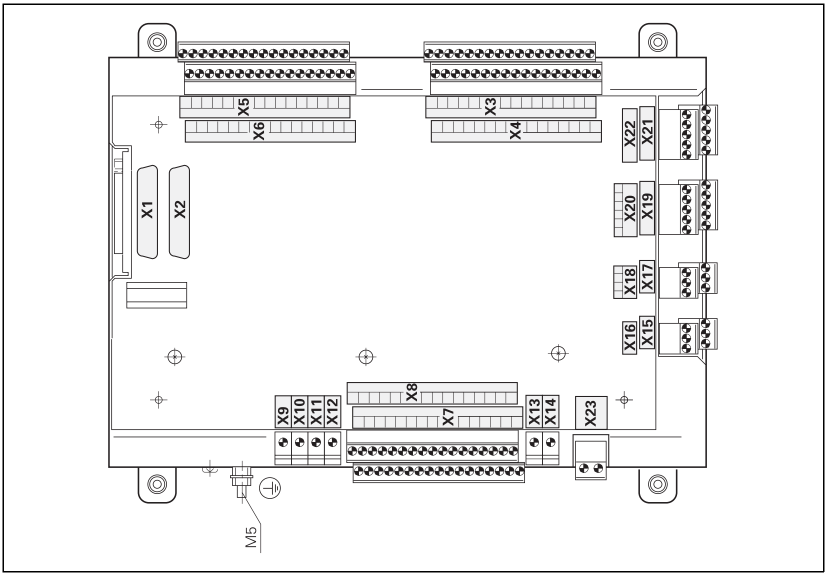
Remember to connect the analog inputs with the correct polarity!

D-sub connection (female) 25-pin	Assignment
1	I_1+ Constant current for Pt 100
2	I_1– Constant current for Pt 100
3	U_1+ Measuring input for Pt 100
4	U_1– Measuring input for Pt 100
5	I_2+ Constant current for Pt 100
6	I_2– Constant current for Pt 100
7	U_2+ Measuring input for Pt 100
8	U_2– Measuring input for Pt 100
9	I_3+ Constant current for Pt 100
10	I_3– Constant current for Pt 100
11	U_3+ Measuring input for Pt 100
12	U_3– Measuring input for Pt 100
13	Do not assign
14	Analog input 1: –10 V to +10 V
15	Analog input 1: 0 V (reference potential)
16	Analog input 2: –10 V to +10 V
17	Analog input 2: 0 V (reference potential)
18	Analog input 3: –10 V to +10 V
19	Analog input 3: 0 V (reference potential)
20 to 25	Do not assign
Housing	External shield

Note

The interface complies with the requirements of EN 50 178 for “low voltage electrical separation.”

Connection overview for the PL 410 B



X15 to X18: Analog input on the PL 410 B

Pin layout

Connecting terminals	Assignment
1	-10 V to +10 V
2	0 V (ref. potential)
3	Shield

Note

The interfaces comply with the requirements of EN 50 178 for "low voltage electrical separation."

X19 to X22: Connection for Pt 100 on the PL 410 B

Pin layout:

Connecting terminals	Assignment
1	I + Constant current for Pt 100
2	U + Measuring input for Pt 100
3	U – Measuring input for Pt 100
4	I – Constant current for Pt 100
5	Shield

Note

The interfaces comply with the requirements of EN 50 178 for "low voltage electrical separation."

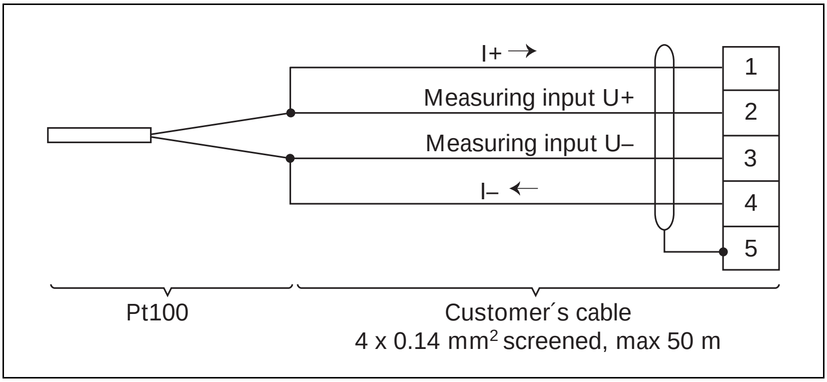
Connection of analog voltage

Characteristics of the connecting cable:

- Shielding
- 2 conductors with 0.14 mm^2
- Maximum length 50 meters

Connection of the Pt 100 thermistor inputs

- Configure the thermistor connection as a "four-conductor circuit":



3.15 Analog Nominal Value Output

Output:	±10 V
Maximum load of outputs:	2 mA
Maximum capacity:	2 nF

13 analog outputs are available:

- Connection X8: Analog output 1 to 6
- Connection X9: Analog output 7 to 12

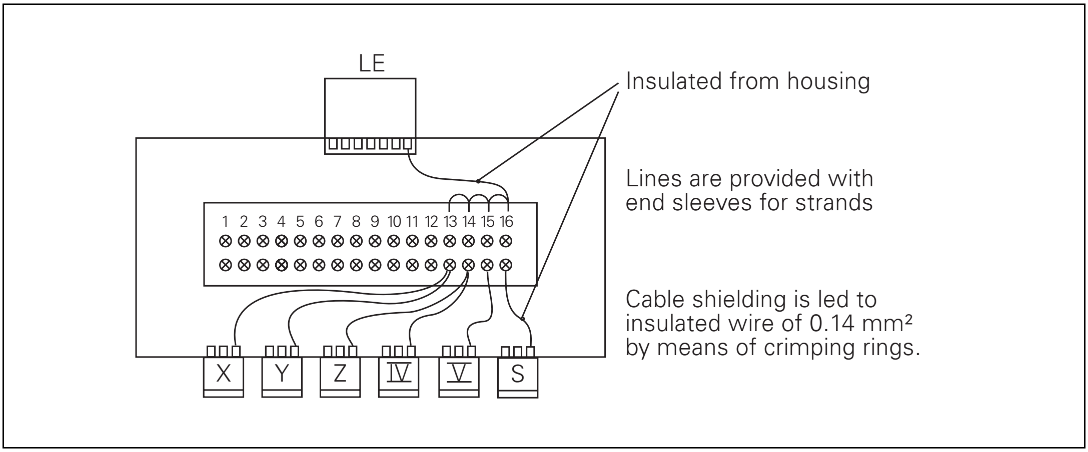
PLC analog output The PLC analog outputs can be controlled through Module 9130.

3.15.1 Nominal Value Output

Please note:

- For analog axes and analog spindle, use MP120.x and MP121.x to assign the corresponding analog outputs on terminal X8 or X9 to the nominal speed outputs.
- The connecting cables to the nominal value outputs must not have more than one intermediate terminal.
- If you must branch to physically separate servo inputs, the connection must be made in a grounded terminal box, e.g. Id. Nr. 251 249-01 from HEIDENHAIN.
  The housing of the terminal box must be electrically connected with the frame of the machine.
- The 0 V connections of the nominal-value-difference inputs must be connected with the signal ground. Cross section $\geq$ 6 mm^2
- Use only original HEIDENHAIN cables and connecting elements.

The following wiring plan is suggested for shielding the terminal box:



Example for pin assignment in the terminal box:

Connecting terminals	Axis/Spindle	Assignment
1	Nominal value in X axis	±10 V
2		0 V
3	Nominal value in Y axis	±10 V
4		0 V
5	Nominal value in Z axis	±10 V
6		0 V
7	Nominal value in axis 4	±10 V
8		0 V
9	Nominal value in axis 5	±10 V
10		0 V
11	Spindle nominal value	±10 V
12		0 V
13 to 16	Shield connection	

X8: Analog output 1 to 6

For connecting cables, see “Cable Overview” at the end of this chapter.

Pin layout on the MC 422 and connecting cables:

MC 422		**Connecting cable**	
D-sub connctn. (female) 15-pin	**Assignment**	**D-sub connctr. (male) 15-pin**	**Color**
1	Analog output 1: ±10 V	1	Brown
2	Do not assign	2	Brown/Green
3	Analog output 2: ±10 V	3	Yellow
4	Analog output 5: ±10 V	4	Red/Blue
5	Analog output 3: ±10 V	5	Pink
6	Analog output 5: 0 V	6	Gray/Pink
7	Analog output 4: ±10 V	7	Red
8	Analog output 6: ±10 V	8	Violet
9	Analog output 1: 0 V	9	White
10	Do not assign	10	White/Gray
11	Analog output 2: 0 V	11	Green
12	Do not assign	12	
13	Analog output 3: 0 V	13	Gray
14	Analog output 4: 0 V	14	Blue
15	Analog output 6: 0 V	15	Black
Housing	External shield	Housing	External shield

X9: Analog output 7 to 13

For connecting cables, see "Cable Overview" at the end of this chapter.

Pin layout on the MC 422 and connecting cables:

MC 422		Connecting cable	
D-sub connctn. (female) 15-pin	**Assignment**	**D-sub connctr. (male) 15-pin**	**Color**
1	Analog output 7: ±10 V	1	Brown
2	Do not assign	2	Brown/Green
3	Analog output 8: ±10 V	3	Yellow
4	Analog output 11: ±10 V	4	Red/Blue
5	Analog output 9: ±10 V	5	Pink
6	Analog output 11: 0 V	6	Gray/Pink
7	Analog output 10: ±10 V	7	Red
8	Analog output 12: ±10 V	8	Violet
9	Analog output 7: 0 V	9	White
10	Do not assign	10	White/Gray
11	Analog output 8: 0 V	11	Green
12	Do not assign	12	
13	Analog output 9: 0 V	13	Gray
14	Analog output 10: 0 V	14	Blue
15	Analog output 12: 0 V	15	Black
Housing	External shield	Housing	External shield

3.16 Touch Probe Systems

The following touch probes can be connected to the iTNC 530:

- TS 220, a touch-trigger probe with cable connection for workpiece setup and measurement during machining.
- TS 632, a touch-trigger probe with infrared transmission for workpiece setup and measurement during machining
- TT 130, a touch probe for workpiece measurement

For suitable connecting cables, see “Cable Overview” at end of chapter.

3.16.1 Triggering Touch Probe for Workpiece Measurement

X12: Touch probe connection

Note

The interface complies with the requirements of EN 50 178 for “low voltage electrical separation.”

Pin layout for TS 220:

MC 422		**Adapter cable 274 543-xx**			**TS 220**	
Female	**Assignment**	**Male**	**Color**	**Pin**	**Pin**	**Color**
1	0 V (internal shield)	1				
2	Do not assign	2				
3	Ready	3	Pink	4	4	
4	Start	4				
5	+ 15 V ± 10% (U_P), max. 100 mA	5	Gray	3	3	
6	+5 V ±5% (U_P), max. 100 mA	6	Brown/ Green	2	2	Brown
7	$\overline{\text{Battery warning}}$	7	Gray			
8	0 V (U_N)	8	White/Green	1	1	White
9	Trigger signal	9	Green	5	5	Green
10	$\overline{\text{Trigger signal}}$[a]	10	Yellow	6	6	Yellow
11 to 15	Do not assign	11 to 15				
Hsg.	External shield	Hsg.	External shield	Hsg.		

a. Stylus at rest means logic level HIGH.

Pin layout for TS 632 with EA 632:

MC 422		Adapter cable 310 197-xx			EA 632 346 322-xx		TS 632
Female	**Assignment**	**Male**	**Color**	**Female**	**Male**	**Color**	
1	0 V (internal shield)	1	White/ Brown	7	7	White/ Brown	
2	Do not assign						
3	Ready	3	Gray	5	5	Gray	
4	Start	4	Yellow	3	3		
5	+ 15 V ± 10% (U_P), max. 100 mA	5	Brown	2	2	Brown	
6	+5 V ±5% (U_P), max. 100 mA						
7	$\overline{\text{Battery warning}}$	7	Blue	6	6	Blue	
8	0 V (U_N)	8	White	1	1	White	
9	Trigger signal						
10	$\overline{\text{Trigger signal}}$[a]	10	Green	4	4	Green	
11 to 15	Do not assign						
Hsg.	External shield	Hsg.	External shield	Hsg.	Hsg.		

a. Stylus at rest means logic level HIGH.

Two EA 652 can be connected to the MC 422 via the APE 652. This is necessary for example on large machines or on machines with swivel heads.

Pin layout for TS 632 with two EA 652 via the APE 652:

MC 422	Adapter cable 310 197-xx	APE 652 354 656-xx		Connecting cable 336 157-xx			EA 652 346 323-xx		TS 632
		Male	**Female**	**Male**	**Color**	**Female**	**Male**	**Color**	
See TS 632 with EA 550 for the layout		7	7	7	White/ Brown	7	7	White/ Brown	
		5	5	5	Gray	5	5	Gray	
		3	3	3	Yellow	3	3		
		2	2	2	Brown	2	2	Brown	
		6	6	6	Blue	6	6	Blue	
		1	1	1	White	1	1	White	
		4	4	4	Green	4	4	Green	
		Hsg.	Hsg.	Hsg.	External shield	Hsg.	Hsg.		

3.16.2 Triggering Touch Probe for Tool Measurement

X13: Connection of the touch probe

Pin layout on the MC 422:

Note

The interface complies with the requirements of EN 50 178 for "low voltage electrical separation."

Pin layout on adapter cable and touch probe:

MC 422		Adapter cable 335 332-xx			TT 130 296 537-xx	
Female	**Assignment**	**Male**	**Color**	**Female**	**Male**	**Color**
1	Ready	1	Pink	6	6	
2	0 V (U_N)	2	White/Green	1	1	White
3	Do not assign	3				
4	+15 V ± 5% (U_P)	4	Brown/Green	2	2	Brown
5	Do not assign	5		5	5	
6	Do not assign	6				
7	+5 V ± 5% (U_P)	7				
8	Trigger signal	8	Brown	3	3	Green
9	$\overline{\text{Trigger signal}}$[a]	9	Green	4	4	Yellow
–	–	–	–	7	7	
Hsg.	External shield	Hsg.	External shield	Hsg.	Hsg.	

a. Stylus at rest means logic level HIGH.

3.17 Data Interfaces

Please note:

- Max. cable length with Ethernet is 400 m (shielded), 100 m (unshielded).
- Maximum cable length with RS-232-C/V.24 is 20 meters.
- Maximum cable length with RS-422-C/V.11 is 1000 meters.

For connecting cables, see "Cable Overview" at the end of this chapter.

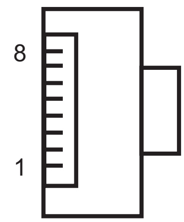
X26: Ethernet interface RJ45 port

Maximum data transfer rate:
Approx. 2 to 5 Mbps (depending on file type and network utilization)

Maximum cable length, shielded: 100 m

RJ-45 connection (female) 8-pin	Assignment
1	TX+
2	TX-
3	REC+
4	Do not assign
5	Do not assign
6	REC-
7	Do not assign
8	Do not assign
Housing	External shield

Face of the connector:



Note

The interface complies with the requirements of EN 50 178 for "low voltage electrical separation."

Meaning of the LEDs on the Ethernet interface X26:

LED	Status	Meaning
Green	Blinks	Interface is active
	Off	Interface is inactive
Yellow	On	100-Mb network
	Off	10-Mb network

X27: RS-232-C/V.24 data interface

Pin layout:

> **Note**
>
> The interface complies with the requirements of EN 50 178 for "low voltage electrical separation."

Adapter block 25-pin:

MC 422		Connecting cable 365 725-xx			Adapter block 310 085-01		Connecting cable 274 545-xx		
Male	**Assignment**	**Female**	**Color**	**Female**	**Male**	**Female**	**Male**	**Color**	**Female**
1	Do not assign	1		1	1	1	1	White/ Brown	1
2	RXD	2	Yellow	3	3	3	3	Yellow	2
3	TXD	3	Green	2	2	2	2	Green	3
4	DTR	4	Brown	20	20	20	20	Brown	8
5	Signal GND	5	Red	7	7	7	7	Red	7
6	DSR	6	Blue	6	6	6	6		6
7	RTS	7	Gray	4	4	4	4	Gray	5
8	CTR	8	Pink	5	5	5	5	Pink	4
9	Do not assign	9					8	Violet	20
Hsg.	External shield	Hsg.	External shield	Hsg.	Hsg.	Hsg.	Hsg.	External shield	Hsg.

Adapter block 9-pin:

MC 422		Connecting cable 355 484-xx			Adapter block 363 987-02		Connecting cable 366 964-xx		
Male	**Assignment**	**Female**	**Color**	**Male**	**Female**	**Male**	**Female**	**Color**	**Female**
1	Do not assign	1	Red	1	1	1	1	Red	1
2	RXD	2	Yellow	2	2	2	2	Yellow	3
3	TXD	3	White	3	3	3	3	White	2
4	DTR	4	Brown	4	4	4	4	Brown	6
5	Signal GND	5	Black	5	5	5	5	Black	5
6	DSR	6	Violet	6	6	6	6	Violet	4
7	RTS	7	Gray	7	7	7	7	Gray	8
8	CTR	8	White/ Green	8	8	8	8	White/ Green	7
9	Do not assign	9	Green	9	9	9	9	Green	9
Hsg.	External shield	Hsg.	External shield	Hsg.	Hsg.	Hsg.	Hsg.	External shield	Hsg.

X28: RS-422/V.11 Data Interface

Pin layout:

MC 422		Connecting cable 355 484-xx			Adapter block 363 987-01	
Female	**Assignment**	**Male**	**Color**	**Female**	**Male**	**Female**
1	RTS	1	Red	1	1	1
2	DTR	2	Yellow	2	2	2
3	$\overline{\text{RXD}}$	3	White	3	3	3
4	$\overline{\text{TXD}}$	4	Brown	4	4	4
5	Signal GND	5	Black	5	5	5
6	CTS	6	Violet	6	6	6
7	DSR	7	Gray	7	7	7
8	RXD	8	White/ Green	8	8	8
9	TXD	9	Green	9	9	9
Hsg.	External shield	Hsg.	External shield	Hsg.	Hsg.	Hsg.

Note

The interface complies with the requirements of EN 50 178 for “low voltage electrical separation.”

3.18 Handwheel Input

The following handwheels can be used with HEIDENHAIN contouring controls:

- HR 130 Panel-Mounted Handwheel
- HR 150 Panel-Mounted Handwheels via the HRA 110 handwheel adapter
- HR 410 Portable Handwheel

X23: Handwheel input

Pin layout:

D-sub connection (female) 9-pin	Assignment
1	CTS
2	0 V
3	RTS
4	+12 V
5	Do not assign
6	DTR
7	TxD
8	RxD
9	DSR
Housing	External shield

Note

The interface complies with the requirements of EN 50 178 for “low voltage electrical separation.”

3.18.1 HR 410 Portable Handwheel

The HR 410 is a portable electronic handwheel with the following functions:

- Keys for the selection of 5 axes
- Traverse direction keys
- Keys for 3 preset feed rates for latched traverse
- Actual-position-capture key
- 3 machine-function keys to be defined by the machine tool builder
- 2 permissive buttons
- EMERGENCY STOP button
- Holding magnets

Pin layout

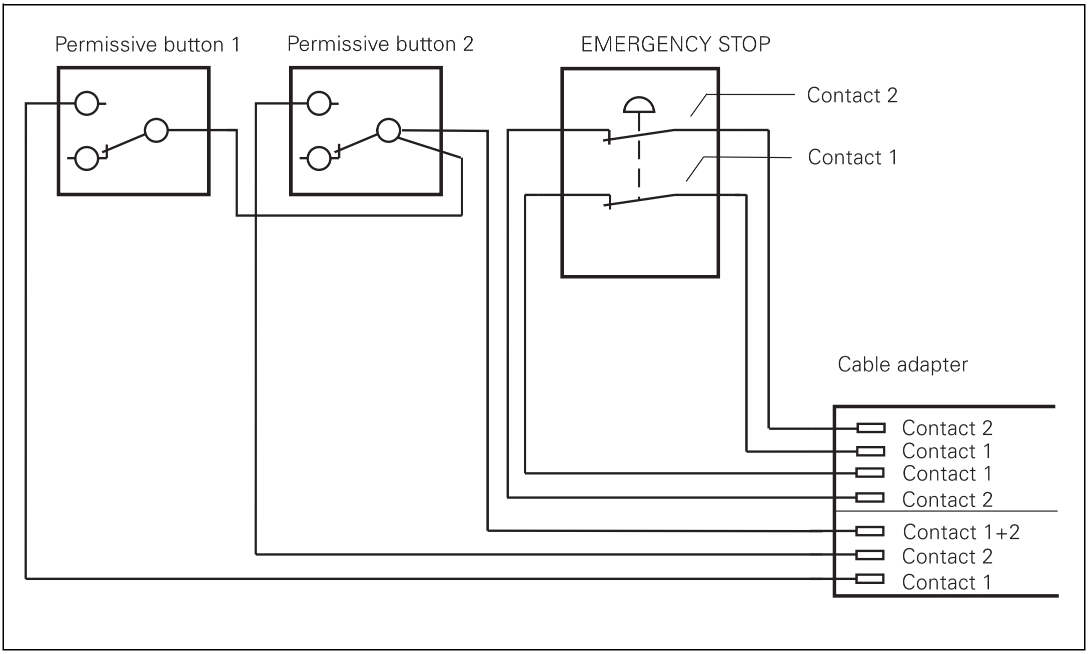
Pin layout for the various extension cables, adapter cables, connecting cables, and the handwheel:

Extension cable Id. Nr. 281 429-xx			**Adapter cable Id. Nr. 296 466-xx**			**Connecting cable see above**			**HR 410 Id. Nr. 296 469-01**	
D-sub Connector (male) 9-pin		**D-sub connctr. (female) 9-pin**	**D-sub Connector (male) 9-pin**		**Coupling on mounting base (female) (5+7)-pin**	**Cnnctr. (male) (5+7)-pin**		**Cnnctr. (female) (5+7)-pin**	**Connector (male) (5+7)-pin**	
Housing	Shield	Housing	Housing	Shield	Housing	Housing	Shield	Housing	Housing	Shield
2	White	2	2	White	E	E	White	E	E	
4	Brown	4	4	Brown	D	D	Brown	D	D	
6	Yellow	6	6	Yellow	B	B	Yellow	B	B	
7	Gray	7	7	Gray	A	A	Gray	A	A	
8	Green	8	8	Green	C	C	Green	C	C	
					6	6	BK	6	6	
					7	7	RD/BL	7	7	
					5	5	Red	5	5	
					4	4	Blue	4	4	
					2	2	WH/ GN	2	2	
					3	3	BN/ GN	3	3	
					1	1	GY/PK	1	1	
				WH/ BN	3	Contact 1 + 2				
				WH/ YL	2	Contact 2 (left) permissive button				
				WH/ GN	1	Contact 1 (right)				
				WH/ BL	1	Contact 1				
				WH/ RD	2	Contact 1 EMERGENCY STOP				
				YL/BK	3	Contact 2				
				WH/ BK	4	Contact 2				

The adapter includes plug-in terminal strips for the contacts of the EMERGENCY STOP button and permissive button (max. load 24 Vdc, 1.2 A).

The plug-in terminal strips are supplied together with the adapter cable. If you have an immediate need for these terminal strips, they can be ordered in advance. See the “Additional components” table below.

Internal wiring of the contacts for the EMERGENCY STOP and permissive buttons:



Additional components	Id. Nr.
Dummy plug for EMERGENCY STOP circuit	271 958-03
Connecting cable	
Spiral cable	312 879-01
Normal cable	296 467-xx
Metal armor	296 687-xx
Plug-in terminal strips for advance ordering	
3-pin terminal block	266 364-06
4-pin terminal block	266 364-12

3.18.2 HR 130 Panel-Mounted Handwheel

Standard cable length for the HR 130 is 1 meter.

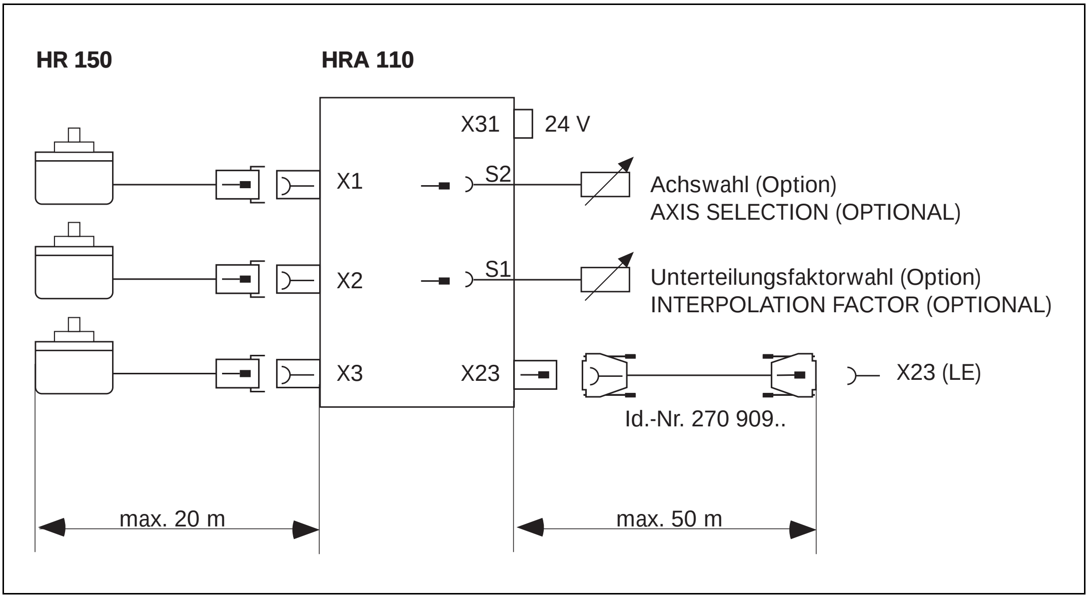
Pin layout for extension cable and handwheel:

Extension cable Id. Nr. 281 429-xx			HR 130 Id. Nr. 254 040-xx	
D-sub connctr. (male) 9-pin		**D-sub connctr. (female) 9-pin**	**D-sub connctr. (male) 9-pin**	
Housing	Shield	Housing	Housing	Shield
2	White	2	2	White
4	Brown	4	4	Brown
6	Yellow	6	6	Yellow
8	Green	8	8	Green
7	Gray	7		

3.18.3 HRA 110 Handwheel Adapter

With the handwheel adapter you can connect two or three HR 150 panel-mounted handwheels to the TNC.

The first and second handwheels are assigned to the X and Y axes. The third handwheel can be assigned either through a selection switch (option) or with MP7645.



An additional switch enables you to select, for example, the interpolation factor for the handwheel. In the PLC you must evaluate the current position of the handwheel selection switch and activate the corresponding interpolation factor with Module 9036.

X1 to X3: Inputs on the HRA 110 for the HR 150

Pin layout:

HRA 110	
Connection (female) 9-pin	**Assignment**
1	I_1 +
2	I_1 –
5	I_2 +
6	I_2 –
7	I_0 –
8	I_0 +
3	+5 V
4	0 V
9	Internal shield
Housing	External shield

X23: Connection to MC 422

Pin layout on the HRA 110:

HRA 110	
D-sub connection (female) 9-pin	**Assignment**
1	RTS
2	0 V
3	CTS
4	+12 V ± 0.6 V (U_V)
5	Do not assign
6	DSR
7	RxD
8	TxD
9	DTR
Housing	External shield

X31: HRA 110 supply voltage

Pin layout on the HRA 110:

Warning

The power supply of the PLC must not be used simultaneously for the HRA 110, otherwise the metallic isolation of the PLC inputs/outputs would be bridged.

HRA 110	
Connecting terminal	**Assignment**
1	+ 24 Vdc as per IEC 742 (VDE 551)
2	0 V

Maximum current consumption 200 mA.

3.19 Input: Spindle Reference Signal

If you mount a HEIDENHAIN encoder directly onto the spindle — without a transmission — you must not wire this input.

If you use the X30 input for evaluation of the reference signal, then adjust this function with MP3143.

X30: Reference signal for spindle

Pin layout:

Connecting terminal	Assignment
1	+24 V
2	0 V

3.20 Switching Inputs 24 Vdc (PLC)

3.20.1 Input Signals and Addresses

Input signals of the switching inputs on the MC 422 and the PL 4xx B:

Voltage range	**MC 422**	**PL 4xx B**
"1" signal: U_i	13 V to 30.2 V	
"0" signal: U_i	-20 V to 3.2 V	

Current ranges	**MC 422**	**PL 4xx B**
"1" signal: I_i	3.8 mA to 8.9 mA	2.5 mA to 6 mA
"0" signal: I_i when U_i = 3.2 V	1.0 mA	0.65 mA

Addresses of the switching inputs at:

Address	**Number**	**Device**
I0 to I31	31 + Control-is-ready signal	MC 422, X42 (PLC input)
I128 to I152	25	MC 422, X46 (machine operating panel)
I64 to I127 I64 to I95	64 32	First PLC input/output board PL 410B First PLC input/output board PL 405B
I192 to I255 I192 to I223	64 32	Second PLC I/O board PL 410B Second PLC I/0 board PL 405B
I256 to I319 I256 to I287	64 32	Third PLC input/output board PL 410B Third PLC input/output board PL 405B
I320 to I383 I320 to I351	64 32	Fourth PLC input/output board PL 410B Fourth PLC input/output board PL 405B

X42: PLC inputs on the MC 422

Pin layout:

MC 422		Connecting cable Id. Nr. 244 005-xx, Id. Nr. 263 954-xx	
D-sub connctn. (female) 37-pin	**Assignment**	**D-sub connctn. (male) 37-pin**	
1	I0	1	Gray/Red
2	I1	2	Brown/Black
3	I2	3	White/Black
4	I3 Control-is-ready signal acknowledgement	4	Green/Black
5	I4	5	Brown/Red
6	I5	6	White/Red
7	I6	7	White/Green
8	I7	8	Red/Blue
9	I8	9	Yellow/Red
10	I9	10	Gray/Pink
11	I10	11	Black
12	I11	12	Pink/Brown
13	I12	13	Yellow/Blue
14	I13	14	Green/Blue
15	I14	15	Yellow
16	I15	16	Red
17	I16	17	Gray
18	I17	18	Blue
19	I18	19	Pink
20	I19	20	White/Gray
21	I20	21	Yellow/Gray
22	I21	22	Green/Red
23	I22	23	White/Pink
24	I23	24	Gray/Green
25	I24	25	Yellow/Brown
26	I25	26	Gray/Brown
27	I26	27	Yellow/Black
28	I27	28	White/Yellow
29	I28	29	Gray/Blue
30	I29	30	Pink/Blue
31	I30	31	Pink/Red
32	I31	32	Brown/Blue
33	I32 Drive enable	33	Pink/Green
34	Do not assign	34	Brown

MC 422		Connecting cable Id. Nr. 244 005-xx, Id. Nr. 263 954-xx	
D-sub connctn. (female) 37-pin	**Assignment**	**D-sub connctn. (male) 37-pin**	
35	0 V (PLC) Test output; do not assign	35	Yellow/Pink
36	0 V (PLC) Test output; do not assign	36	Violet
37	0 V (PLC) Test output; do not assign	37	White
Housing	External shield	Housing	External shield

3.20.2 PLC Inputs on the PL 410 B

X3 to X6: PLC inputs

Pin layout on the PL:

X3				
Terminal	**Assignment**			
	PL 1	**PL 2**	**PL 3**	**PL 4**
1	I64	I192	I256	I320
2	I65	I193	I257	I321
3	I66	I194	I258	I322
4	I67	I195	I259	I323
5	I68	I196	I260	I324
6	I69	I197	I261	I325
7	I70	I198	I262	I326
8	I71	I199	I263	I327
9	I72	I200	I264	I328
10	I73	I201	I265	I329
11	I74	I202	I266	I330
12	I75	I203	I267	I331
13	I76	I204	I268	I332
14	I77	I205	I269	I333
15	I78	I206	I270	I334
16	I79	I207	I271	I335

X4				
Terminal	**Assignment**			
	PL 1	**PL 2**	**PL 3**	**PL 4**
1	I80	I208	I272	I336
2	I81	I209	I273	I337
3	I82	I210	I274	I338
4	I83	I211	I275	I339
5	I84	I212	I276	I340
6	I85	I213	I277	I341
7	I86	I214	I278	I342
8	I87	I215	I279	I343
9	I88	I216	I280	I344
10	I89	I217	I281	I345
11	I90	I218	I282	I346
12	I91	I219	I283	I347
13	I92	I220	I284	I348
14	I93	I221	I285	I349
15	I94	I222	I286	I350
16	I95	I223	I287	I351

X5				
Terminal	**Assignment**			
	PL 1	**PL 2**	**PL 3**	**PL 4**
1	I96	I224	I288	I352
2	I97	I225	I289	I353
3	I98	I226	I290	I354
4	I99	I227	I291	I355
5	I100	I228	I292	I356
6	I101	I229	I293	I357
7	I102	I230	I294	I358
8	I103	I231	I295	I359
9	I104	I232	I296	I360
10	I105	I233	I297	I361
11	I106	I234	I298	I362
12	I107	I235	I299	I363
13	I108	I236	I300	I364
14	I109	I237	I301	I365
15	I110	I238	I302	I366
16	I111	I239	I303	I367

X6				
Terminal	**Assignment**			
	PL 1	**PL 2**	**PL 3**	**PL 4**
1	I112	I240	I304	I368
2	I113	I241	I305	I369
3	I114	I242	I306	I370
4	I115	I243	I307	I371
5	I116	I244	I308	I372
6	I117	I245	I309	I373
7	I118	I246	I310	I374
8	I119	I247	I311	I375
9	I120	I248	I312	I376
10	I121	I249	I313	I377
11	I122	I250	I314	I378
12	I123	I251	I315	
13	I124	I252	I316	I380
14	I125	I253	I317	I381
15	I126	I254	I318	I382
16	I127	I255	I319	I383

3.20.3 PLC Inputs on the PL 405 B

X3, X4: PLC inputs

Pin layout on the PL:

X3				
Terminal	**Assignment**			
	PL 1	**PL 2**	**PL 3**	**PL 4**
1	I64	I192	I256	I320
2	I65	I193	I257	I321
3	I66	I194	I258	I322
4	I67	I195	I259	I323
5	I68	I196	I260	I324
6	I69	I197	I261	I325
7	I70	I198	I262	I326
8	I71	I199	I263	I327
9	I72	I200	I264	I328
10	I73	I201	I265	I329
11	I74	I202	I266	I330
12	I75	I203	I267	I331
13	I76	I204	I268	I332
14	I77	I205	I269	I333
15	I78	I206	I270	I334
16	I79	I207	I271	I335

X4				
Terminal	**Assignment**			
	PL 1	**PL 2**	**PL 3**	**PL 4**
1	I80	I208	I272	I336
2	I81	I209	I273	I337
3	I82	I210	I274	I338
4	I83	I211	I275	I339
5	I84	I212	I276	I340
6	I85	I213	I277	I341
7	I86	I214	I278	I342
8	I87	I215	I279	I343
9	I88	I216	I280	I344
10	I89	I217	I281	I345
11	I90	I218	I282	I346
12	I91	I219	I283	I347
13	I92	I220	I284	I348
14	I93	I221	I285	I349
15	I94	I222	I286	I350
16	I95	I223	I287	I351

3.21 Switching Outputs 24 Vdc (PLC)

Output signals and addresses

The switching outputs are transistor outputs with current limitation.

Please note:

- Permissible load: Resistive load—inductive load only with quenching diode parallel to inductance
- Short circuiting of **one** output is **permissible**. **No more than one** output may be short-circuited **at one time.**
- No more than half the PLC outputs may be driven at the same time (simultaneity factor 0.5)

Output signals:

	MC 422	PL 4xx B
Min. output voltage for “1” signal	3 V below supply voltage	
Nominal operating current per output	0.125 A (simultaneity factor 0.5)	2.0 A (at max. PL current consumption of 20 A)

Note

The switching outputs need a minimum load of 5 mA.
They conform to EN 61131-2.

Addresses:

Address	Number	Device
O0 to O30	31	MC 422, X41 (PLC output)
O0 to O7	8	MC 422, X46 (machine operating panel)
O32 to O62	31	First PLC input/output unit
O64 to O94	31	Second PLC input/output unit
O128 to O158	31	Third PLC input/output unit
O160 to O190	31	Fourth PLC input/output unit

X41: PLC outputs on the MC 422

Pin layout:

MC 422		Connecting cable Id. Nr. 244 005-xx Id. Nr. 263 954-xx	
D-sub conntctn. (female) 37-pin	**Assignment**	**D-sub conntr. (male) 37-pin**	
Power via X44, pin 3; can be switched off with EMERGENCY STOP			
1	O0	1	Gray/Red
2	O1	2	Brown/Black
3	O2	3	White/Black
4	O3	4	Green/Black
5	O4	5	Brown/Red
6	O5	6	White/Red
7	O6	7	White/Green
8	O7	8	Red/Blue
9	O8	9	Yellow/Red
10	O9	10	Gray/Pink
11	O10	11	Black
12	O11	12	Pink/Brown
13	O12	13	Yellow/Blue
14	O13	14	Green/Red
15	O14	15	Yellow
16	O15	16	Red
Power via X44, pin 2; can be switched off with EMERGENCY STOP			
17	O16	17	Gray
18	O17	18	Blue
19	O18	19	Pink
20	O19	20	White/Gray
21	O20	21	Yellow/Gray
22	O21	22	Green/Red
23	O22	23	White/Pink
24	O23	24	Gray/Green
Power via X44, pin 1; **cannot** be switched off with EMERGENCY STOP			
25	O24	25	Yellow/Brown
26	O25	26	Gray/Brown
27	O26	27	Yellow/Brown
28	O27	28	White/Yellow
29	28	29	Gray/White

MC 422		Connecting cable Id. Nr. 244 005-xx Id. Nr. 263 954-xx	
D-sub connctn. (female) 37-pin	**Assignment**	**D-sub connctr. (male) 37-pin**	
30	O29	30	Pink/Blue
31	O30	31	Pink/Red
32, 33	Do not assign	32	Brown/Blue, Pink/Green
34	Control is ready	34	Brown
35, 36, 37	Do not assign	35	Yellow/Pink, Violet, White
Housing	External shield	Housing	External shield

X7, X8: PLC outputs on the PL 410 B

Pin layout on the PL:

X7				
Terminal	**Assignment**			
	PL 1	**PL 2**	**PL 3**	**PL 4**
1	O32	O64	O128	O160
2	O33	O65	O129	O161
3	O34	O66	O130	O162
4	O35	O67	O131	O163
5	O36	O68	O132	O164
6	O37	O69	O133	O165
7	O38	O70	O134	O166
8	O39	O71	O135	O167
9	O40	O72	O136	O168
10	O41	O73	O137	O169
11	O42	O74	O138	O170
12	O43	O75	O139	O171
13	O44	O76	O140	O172
14	O45	O77	O141	O173
15	O46	O78	O142	O174
16	O47	O79	O143	O175

X8				
Terminal	**Assignment**			
	PL 1	**PL 2**	**PL 3**	**PL 4**
1	O48	O80	O144	O176
2	O49	O81	O145	O177
3	O50	O82	O146	O178
4	O51	O83	O147	O179
5	O52	O84	O148	O180
6	O53	O85	O149	O181
7	O54	O86	O150	O182
8	O55	O87	O151	O183
9	O56	O88	O152	O184
10	O57	O89	O153	O185
11	O58	O90	O154	O186
12	O59	O91	O155	O187
13	O60	O92	O156	O188
14	O61	O93	O157	O189
15	O62	O94	O158	O190
16	Control is ready			

X8: PLC outputs on the PL 405 B

Pin layout on the PL:

X8				
Terminal	**Assignment**			
	PL 1	**PL 2**	**PL 3**	**PL 4**
1	O48	O80	O144	O176
2	O49	O81	O145	O177
3	O50	O82	O146	O178
4	O51	O83	O147	O179
5	O52	O84	O148	O180
6	O53	O85	O149	O181
7	O54	O86	O150	O182
8	O55	O87	O151	O183
9	O56	O88	O152	O184
10	O57	O89	O153	O185
11	O58	O90	O154	O186
12	O59	O91	O155	O187
13	O60	O92	O156	O188
14	O61	O93	O157	O189
15	O62	O94	O158	O190
16	Control is ready			

3.22 PL 4xx B PLC Input/Output Units

Up to four PL 4xxB can be connected to the TNC.

The PL 410 B is available with and without analog inputs.

Device	Id. Nr.	Switching inputs 24 Vdc	Switching outputs 24 Vdc	Analog inputs (± 10 V)	Inputs for Pt 100 thermistors
PL 410 B	263 371-12	64	31	–	–
PL 410 B	263 371-02	64	31	4	4
PL 405 B	263 371-22	32	15	–	–

No more than one PL 405 B may be used. If connecting through a PL 410 B, the PL 405 B must be connected last.

X47: PLC expansion on the MC 422

Pin layout:

MC 422		Conn. cable Id. Nr. 289 111-xx / Id. Nr. 317 788-xx			1. PL 410 B/PL405 B	
D-sub connctn. (male) 25-pin	**Assignment**	**D-sub connector (female) 25-pin**		**D-sub connctr. (male) 25-pin**	**X1 D-sub connctn. (female) 25-pin**	**Assignment**
1	0 V	1	Brown, yellow, pink, red, violet	1	1	0 V
2	0 V	2	Red/blue, brown/green, yellow/brown, gray/ brown, pink/brown	2	2	0 V
3	0 V	3	Brown/Blue, Brown/Red, Brown/Black, Yellow/Gray, Yellow/Pink	3	3	0 V
4	Do not assign	4	Gray/Green	4	4	Serial IN 2
5	$\overline{\text{Address 6}}$	5	White/Green	5	5	$\overline{\text{Address 6}}$
6	INTERRUPT	6	Pink/Green	6	6	INTERRUPT
7	$\overline{\text{RESET}}$	7	Green/Blue	7	7	$\overline{\text{RESET}}$
8	$\overline{\text{WRITE EXTERN}}$	8	White/Blue	8	8	$\overline{\text{WRITE EXTERN}}$
9	WRITE EXTERN	9	White/Red	9	9	WRITE EXTERN
10	$\overline{\text{Address 5}}$	10	Gray/Pink	10	10	$\overline{\text{Address 5}}$
11	$\overline{\text{Address 3}}$	11	Blue	11	11	$\overline{\text{Address 3}}$
12	$\overline{\text{Address 1}}$	12	Green	12	12	$\overline{\text{Address 1}}$
13	Do not assign	13		13	13	Do not assign
14	PCB identifier 3	14	Yellow/blue, pink/blue, yellow/black	14	14	+12 V
15	PCB identifier 4	15	Yellow/red, gray/red, pink/red	15	15	+12 V

MC 422		Conn. cable Id. Nr. 289 111-xx / Id. Nr. 317 788-xx			1. PL 410 B/PL405 B	
D-sub conntn. (male) 25-pin	**Assignment**	**D-sub connector (female) 25-pin**		**D-sub connctr. (male) 25-pin**	**X1 D-sub connctn. (female) 25-pin**	**Assignment**
16	Do not assign	16	Gray/Blue	16	16	PCB identifier 2
17	Do not assign	17	Green/Black	17	17	PCB identifier 1
18	$\overline{\text{Address 7}}$	18	White/Yellow	18	18	$\overline{\text{Address 7}}$
19	Serial IN 1	19	White/Black	19	19	Serial IN 1
20	EMERGENCY STOP	20	Green/Red	20	20	EMERGENCY STOP
21	$\overline{\text{Serial OUT}}$	21	White/Gray	21	21	$\overline{\text{Serial OUT}}$
22	Serial OUT	22	White/Pink	22	22	Serial OUT
23	$\overline{\text{Address 4}}$	23	Black	23	23	$\overline{\text{Address 4}}$
24	$\overline{\text{Address 2}}$	24	Gray	24	24	$\overline{\text{Address 2}}$
25	$\overline{\text{Address 0}}$	25	White	25	25	$\overline{\text{Address 0}}$
Housing	External shield	Housing	External shield	Housing	Housing	External shield

X2: PLC expansion PL 4xxB on the PL 410 B

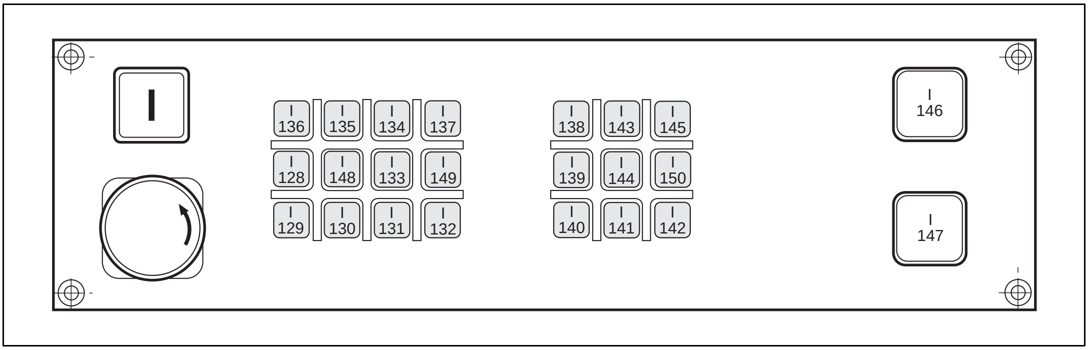
Pin layout:

PL 410 B		Conn. cable Id. Nr. 289 111-xx / Id. Nr. 317 788-xx			PL 410 B PL 405 B on the PL 410 B	
D-sub connctn. (male) 25-pin	**Assignment**	**D-sub connector (female) 25-pin**		**D-sub connctr. (male) 25-pin**	**X1 D-sub connctn. (female) 25-pin**	**Assignment**
1	0 V	1	Brown, yellow, pink, red, violet	1	1	0 V
2	0 V	2	Red/blue, brown/green, yellow/brown, gray/ brown, pink/brown	2	2	0 V
3	0 V	3	Brown/Blue, Brown/ Red, Brown/Black, Yellow/Gray, Yellow/Pink	3	3	0 V
4	Do not assign	4	Gray/Green	4	4	Serial IN 2
5	$\overline{\text{Address 6}}$	5	White/Green	5	5	$\overline{\text{Address 6}}$
6	INTERRUPT	6	Pink/Green	6	6	INTERRUPT
7	$\overline{\text{RESET}}$	7	Green/Blue	7	7	$\overline{\text{RESET}}$
8	$\overline{\text{WRITE EXTERN}}$	8	White/Blue	8	8	$\overline{\text{WRITE EXTERN}}$
9	WRITE EXTERN	9	White/Red	9	9	WRITE EXTERN
10	$\overline{\text{Address 5}}$	10	Gray/Pink	10	10	$\overline{\text{Address 5}}$
11	$\overline{\text{Address 3}}$	11	Blue	11	11	$\overline{\text{Address 3}}$
12	$\overline{\text{Address 1}}$	12	Green	12	12	$\overline{\text{Address 1}}$
13	Do not assign	13		13	13	Do not assign
14	PCB identifier 4	14	Yellow/blue, pink/ blue, yellow/black	14	14	+12 V
15	PCB identifier 3	15	Yellow/red, gray/red, pink/red	15	15	+12 V
16	PCB identifier 2	16	Gray/Blue	16	16	PCB identifier 2
17	PCB identifier 1	17	Green/Black	17	17	PCB identifier 1
18	$\overline{\text{Address 7}}$	18	White/Yellow	18	18	$\overline{\text{Address 7}}$
19	Serial IN 1	19	White/Black	19	19	Serial IN 1
20	EMERGENCY STOP	20	Green/Red	20	20	EMERGENCY STOP
21	$\overline{\text{Serial OUT}}$	21	White/Gray	21	21	$\overline{\text{Serial OUT}}$
22	Serial OUT	22	White/Pink	22	22	Serial OUT
23	$\overline{\text{Address 4}}$	23	Black	23	23	$\overline{\text{Address 4}}$
24	$\overline{\text{Address 2}}$	24	Gray	24	24	$\overline{\text{Address 2}}$
25	$\overline{\text{Address 0}}$	25	White	25	25	$\overline{\text{Address 0}}$
Housing	External shield	Housing	External shield	Housing	Housing	External shield

3.23 Machine Operating Panel

For machines with up to four axes, HEIDENHAIN offers the MB 420 machine operating panel. It is installed below the TNC operating panel. There is a version of the MB 420 available with a standard set of keys (see connector layout for X46). On the underside of the machine operating panel are two terminal strips bearing the PLC inputs I151 and I152 as well as the PLC outputs O0 to O7.

Assignment of PLC inputs to the keys of the MB 420:



X3: PLC inputs

Pin layout:

Terminal	Assignment
1	I151
2	I152
3	+24 V

X4: PLC outputs

Pin layout:

Terminal	Assignment
1	O0
2	O1
3	O2
4	O3
5	O4
6	O5
7	O6
8	O7
9	0 V

X46: PLC inputs and outputs

PLC inputs I128 to I152 and PLC outputs O0 to O7 are on connection X46 of the machine operating panel. The reference potential (PLC) for outputs O0 to O7 is connected to pins 34 and 35.

Pin layout on the MC 422, connecting cables and machine operating panel:

Warning

PLC inputs I128 to I152 must be driven only with the power supply from pins 36 and 37, since this power supply is internally protected (PLC power supply from X44 connection 2).

MC 422		Connecting cable Id. Nr. 263 954-xx			MB 420	
D-sub connection (female) 37-pin	**Assign-ment**	**D-sub connctr. (male) 37-pin**		**D-sub connctr. (female), 37-pin**	**D-sub connctn. (male) 37-pin**	**Key**
1	I128	1	Gray/Red	1	1	X –
2	I129	2	Brown/Black	2	2	Y –
3	I130	3	White/Black	3	3	Z –
4	I131	4	Green/Black	4	4	IV –
5	I132	5	Brown/Red	5	5	V –
6	I133	6	White/Red	6	6	X+
7	I134	7	White/Green	7	7	Y +
8	I135	8	Red/Blue	8	8	Z +
9	I136	9	Yellow/Red	9	9	IV +
10	I137	10	Gray/Pink	10	10	V+
11	I138	11	Black	11	11	Tool change
12	I139	12	Pink/Brown	12	12	Unlock tool
13	I140	13	Yellow/Blue	13	13	Menu selection
14	I141	14	Green/Blue	14	14	Unlock door
15	I142	15	Yellow	15	15	Chip removal
16	I143	16	Red	16	16	Spindle On
17	I144	17	Gray	17	17	Spindle Off
18	I145	18	Blue	18	18	Coolant
19	I146	19	Pink	19	19	NC start
20	I147	20	White/Gray	20	20	NC stop
21	I148	21	Yellow/Gray	21	21	Rapid traverse
22	I149	22	Green/Red	22	22	Retract axis
23	I150	23	White/Pink	23	23	Rinse water jet
24	I151	24	Gray/Green	24	24	Via X3
25	I152	25	Yellow/Brown	25	25	Via X3

MC 422		Connecting cable Id. Nr. 263 954-xx			MB 420	
D-sub connection (female) 37-pin	**Assign-ment**	**D-sub connctr. (male) 37-pin**		**D-sub connctr. (female), 37-pin**	**D-sub connctn. (male) 37-pin**	**Key**
26	O0*	26	Gray/Brown	26	26	Via X4
27	O1*	26	Yellow/Black	27	27	Via X4
28	O2*	28	White/Yellow	28	28	Via X4
29	O3*	29	Gray/Blue	29	29	Via X4
30	O4*	30	Pink/Blue	30	30	Via X4
31	O5*	31	Pink/Red	31	31	Via X4
32	O6*	32	Brown/Blue	32	32	Via X4
33	O7*	33	Pink/Green	33	33	Via X4
34, 35	0 V (PLC)	34, 35	Brown, Yellow/Pink	34, 35	34, 35	
36, 37	+24 V (PLC)	36	Violet, white	36, 37	36,37	
Housing	Ext. shield	Housing	External shield	Housing	Housing	

3.24 TNC Keyboard Unit

X1: Connection of soft keys on the visual display unit with the TNC keyboard

Pin layout:

Connector (male) 9-pin	Assignment
1	SL0
2	SL1
3	SL2
4	SL3
5	Do not assign
6	RL15
7	RL14
8	RL13
9	RL12

X45: TNC Keyboard (TE 420)

Pin layout:

MC 422		Connecting cable Id. Nr. 263 954-xx			TE 420 313 038-xx
D-sub connctn. (female) 37-pin	Assignment	D-sub cnnctr. (male) 37-pin		D-sub cnnctr. (female) 37-pin	X2: D-sub connctn. (male) 37-pin
1	RL0	1	Gray/Red	1	1
2	RL1	2	Brown/Black	2	2
3	RL2	3	White/Black	3	3
4	RL3	4	Green/Black	4	4
5	RL4	5	Brown/Red	5	5
6	RL5	6	White/Red	6	6
7	RL6	7	White/Green	7	7
8	RL7	8	Red/Blue	8	8
9	RL8	9	Yellow/Red	9	9
10	RL9	10	Gray/Pink	10	10
11	RL10	11	Black	11	11
12	RL11	12	Pink/Brown	12	12
13	RL12	13	Yellow/Blue	13	13
14	RL13	14	Green/Blue	14	14
15	RL14	15	Yellow	15	15
16	RL15	16	Red	16	16
17	RL16	17	Gray	17	17
18	RL17	18	Blue	18	18
19	RL18	19	Pink	19	19
20	SL0	20	White/Gray	20	20
21	SL1	21	Yellow/Gray	21	21

MC 422		**Connecting cable Id. Nr. 263 954-xx**			**TE 420 313 038-xx**
D-sub connctn. (female) 37-pin	**Assignment**	**D-sub cnnctr. (male) 37-pin**		**D-sub cnnctr. (female) 37-pin**	**X2: D-sub connctn. (male) 37-pin**
22	SL2	22	Green/Red	22	22
23	SL3	23	White/Pink	23	23
24	SL4	24	Gray/Green	24	24
25	SL5	25	Yellow/ Brown	25	25
26	SL6	26	Gray/Brown	26	26
27	SL7	26	Yellow/Black	27	27
28	RL19	28	White/Yellow	28	28
29	RL20	29	Gray/Blue	29	29
30	Do not assign	30	Pink/Blue	30	30
31	RL21	31	Pink/Red	31	31
32	RL22	32	Brown/Blue	32	32
33	RL23	33	Pink/Green	33	33
34	Spindle override	34	Brown	34	34
35	Feed rate override (wiper)	35	Yellow/Pink	35	35
36	+5 V override potentiometer	36	Violet	36	36
37	0 V override potentiometer	37	White	37	37
Housing	External shield	Housing	External shield	Housing	Housing

3.25 Flat-Panel Display

X3: Connection of screen soft keys

X3 Soft keys (See "TNC Keyboard Unit" on page 3 – 71).

X49: BF 120 flat-panel display

Pin layout:

MC 422, X49		Connecting cable Id. Nr. 340 300-xx			BF 120, X2
D-sub connctn. (female) 62-pin	**Assign-ment**	**D-sub connctr. (male) 62-pin**		**D-sub connector (female) 62-pin**	**D-sub connctn. (male) 62-pin**
1	0 V	1	Gray/Black	1	1
2	CLK.P	2	Brown/Black	2	2
3	HSYNC	3	Green/Black	3	3
4	$\overline{\text{BLANK}}$	4	Orange/Black	4	4
5	VSYNC	5	Blue/Black	5	5
6	0 V	6	Green/White	6	6
7	R0	7	Orange/White	7	7
8	R1	8	Brown/White	8	8
9	R2	9	Gray/White	9	9
10	R3	10	Blue/White	10	10
11	0 V	11	Violet/White	11	11
12	G0	12	Violet/Brown	12	12
13	G1	13	Violet/Green	13	13
14	G2	14	Violet/Orange	14	14
15	G3	15	Violet/Blue	15	15
16	0 V	16	Red/Gray	16	16
17	B0	17	Red/Brown	17	17
18	B1	18	Yellow/Gray	18	18
19	B2	19	Yellow/Brown	19	19
20	B3	20	Yellow/Green	20	20
21	0 V	21	Free	21	21
22	0 V	22	Black/Gray	22	22
23	$\overline{\text{CLP.P}}$	23	Black/Brown	23	23
24	$\overline{\text{HSYNC}}$	24	Black/Green	24	24
25	BLANK	25	Black/Orange	25	25
26	$\overline{\text{VSYNC}}$	26	Black/Blue	26	26
27	0 V	27	White/Green	27	27
28	$\overline{\text{R0}}$	28	White/Orange	28	28
29	$\overline{\text{R1}}$	29	White/Brown	29	29

MC 422, X49		**Connecting cable Id. Nr. 340 300-xx**			**BF 120, X2**
D-sub connctn. (female) 62-pin	**Assign-ment**	**D-sub connctr. (male) 62-pin**		**D-sub connector (female) 62-pin**	**D-sub connctn. (male) 62-pin**
30	$\overline{\text{R2}}$	30	White/Gray	30	30
31	$\overline{\text{R3}}$	31	White/Blue	31	31
32	0 V	32	Gray/Violet	32	32
33	$\overline{\text{G0}}$	33	Brown/Violet	33	33
34	$\overline{\text{G1}}$	34	Green/Violet	34	34
35	$\overline{\text{G2}}$	35	Orange/Violet	35	35
36	$\overline{\text{G3}}$	36	Blue/Violet	36	36
37	0 V	37	Gray/Red	37	37
38	$\overline{\text{B0}}$	38	Brown/Red	38	38
39	$\overline{\text{B1}}$	39	Gray/Yellow	39	39
40	$\overline{\text{B2}}$	40	Brown/Yellow	40	40
41	$\overline{\text{B3}}$	41	Green/Yellow	41	41
42	0 V	42	Free	42	42
43	$\overline{\text{DISP.}}$ $\overline{\text{LOW}}$	43	Red/Blue	43	43
44	DISP. LOW	44	Blue/Red	44	44
45	$\overline{\text{DISP.ON}}$	45	Red/Orange	45	45
46	DISP.ON	46	Orange/Red	46	46
47	C0	47	Green/Red	47	47
48	C1	48	Red/Green	48	48
49	C2	49	Orange/Yellow	49	49
50	C3	50	Yellow/Orange	50	50
51	C4	51	Yellow/Blue	51	51
52	C5	52	Blue/Yellow	52	52
53 to 56	Do not assign	53 to 56	Free	53 to 56	53 to 56
57 to 62	0 V	57 to 62	Free	57 to 62	57 to 62
Housing		Housing		Housing	Housing

X149: BF 150 flat-panel display

Pin layout:

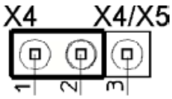
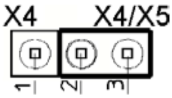
MC 422, X149		Connecting cable Id. Nr. 353 545-xx			BF 150, X2
D-sub connctn. (female) 44-pin	**Assignment**	**D-sub connctr. (male), 44-pin**		**D-sub connctr. (female), 44-pin**	**D-sub connctn. (male) 44-pin**
1	A7M	1		1	1
2	A6M	2	White/Brown	2	2
3	A5M	3	White/Green	3	3
4	A4M	4	Red/Gray	4	4
5	A3M			5	5
6	CLKM	6	Red/Blue	6	6
7	A2M	7	White/Orange	7	7
8	A1M	8	Red/Brown	8	8
9	A0M	9	Red/Green	9	9
10	LVDSGND	10	Red/Orange	10	10
11	HWK_GND	11	Orange/Red	11	11
12	HWK0	12	White/Blue	12	12
13	HWK1	13	Blue/White	13	13
14	HWK2	14	White/Gray	14	14
15	HWK3	15	Gray/White	15	15
16	A7P	16		16	16
17	A6P	17	Brown/White	17	17
18	A5P	18	Green/White	18	18
19	A4P	19	Gray/Red	19	19
20	A3P			20	20
21	CLKP	21	Blue/Red	21	21
22	A2P	22	Orange/White	22	22
23	A1P	23	Brown/Red	23	23
24	A0P	24	Green/Red	24	24
25	Not assigned			25	25
26	Not assigned			26	26
27	Not assigned			27	27
28	Not assigned			28	28
29	Not assigned			29	29
30	Not assigned			30	30
31	LVDSGND			31	31
32	LVDSGND			32	32
33	LVDSGND			33	33

MC 422, X149		Connecting cable Id. Nr. 353 545-xx			BF 150, X2
D-sub connctn. (female) 44-pin	**Assignment**	**D-sub connctr. (male), 44-pin**		**D-sub connctr. (female), 44-pin**	**D-sub connctn. (male) 44-pin**
34	LVDSGND			34	34
35	LVDSGND			35	35
36	LVDSGND			36	36
37	LVDSGND			37	37
38	LVDSGND			38	38
39	LVDSGND			39	39
40	Not assigned			40	40
41	Not assigned			41	41
42	Not assigned			42	42
43	Not assigned			43	43
44	Not assigned			44	44
Housing		Housing		Housing	Housing

3.26 BTS 1x0 Monitor/Keyboard Switch Unit

Two monitors (BTS 110: 2 x BF 120, BTS 150: 2 x BF 150) and two TE 420 keyboards can be connected to an MC 422 with the BTS 1x0.

The two monitors are always active. Switchover between the two keyboard units is realized by a 24 V switching input on the BTS 1x0.
A jumper on the PCB is used to determine which potentiometer should be active. The jumper is on the upper PCB next to the ID plate.

Jumper setting	Active potentiometers
	Always keyboard 1 (at X4)
	Currently active keyboard

X1, X2, X4,
X5 to X7: Monitor and keyboard connections

Refer to the Sections "TNC Operating Panel" and "Flat-Panel Display" for the pin layouts of the individual connections.

Connection designation	Monitor/Keyboard
X1	Input BF 120 or BF 150
X2	Input TE 420
X4	1st output TE 420
X5	Second output TE 420
X6	First output BF 120 or BF 150
X7	Second output BF 120 or BF 150

☞ **Note**

The interfaces comply with the requirements of EN 50 178 for “low voltage electrical separation.”

X3: Switching between keyboards

Depending on the signal at X3, one of the keyboards at X4 or X5 is activated:

Signal at X3		Active keyboard
Terminal 1	Terminal 2	
0 V	0 V	At X4
+24 V	0 V	At X5

X8: Supply voltage for BTS 1x0

Pin layout:

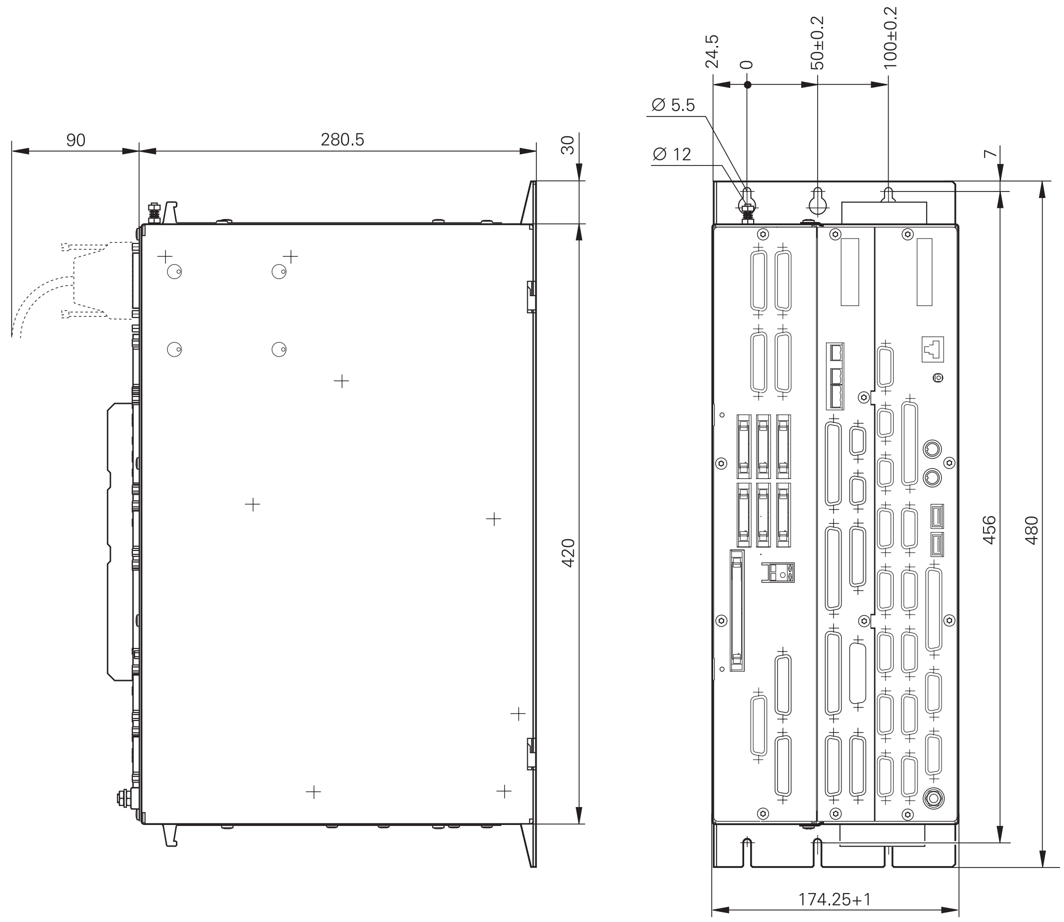
Connecting terminal	Assignment
1	+24 V
2	0 V

3.27 Dimensions

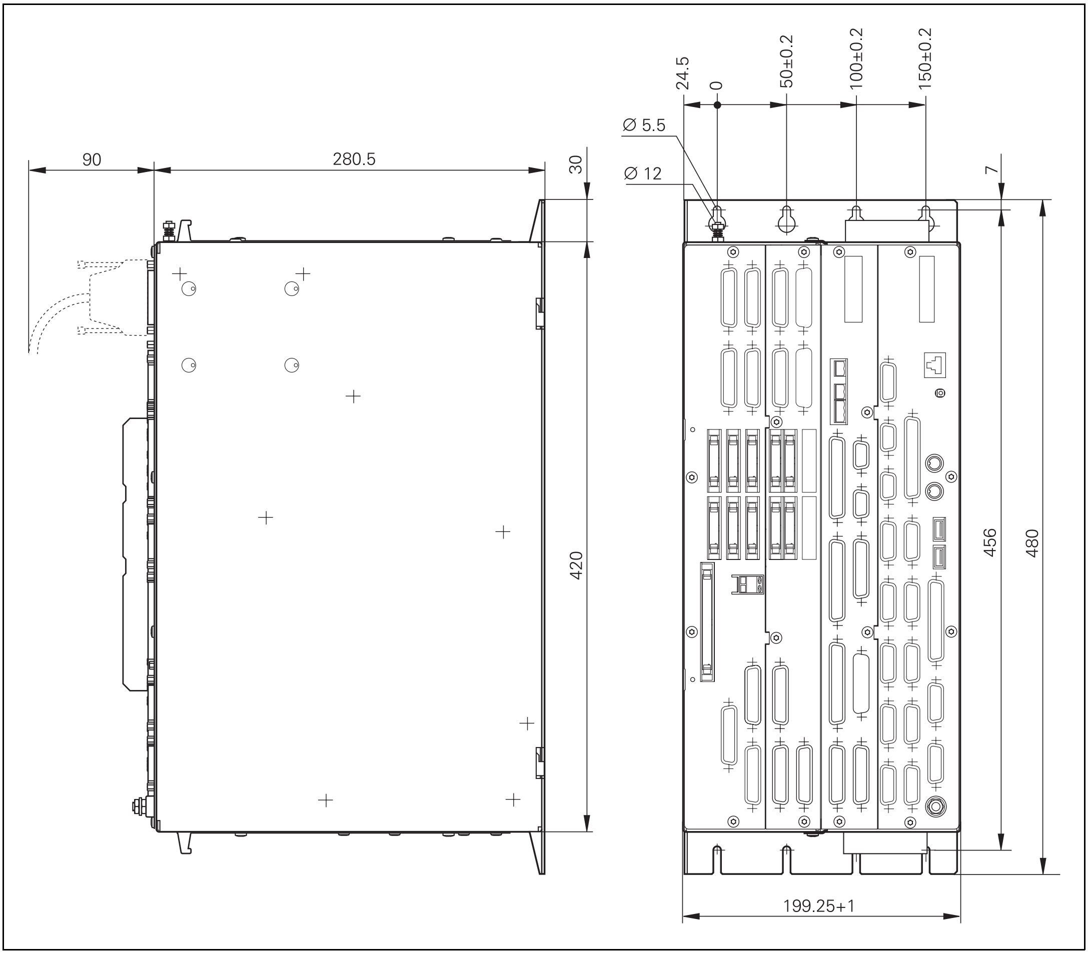
Note

All dimensions in [mm].

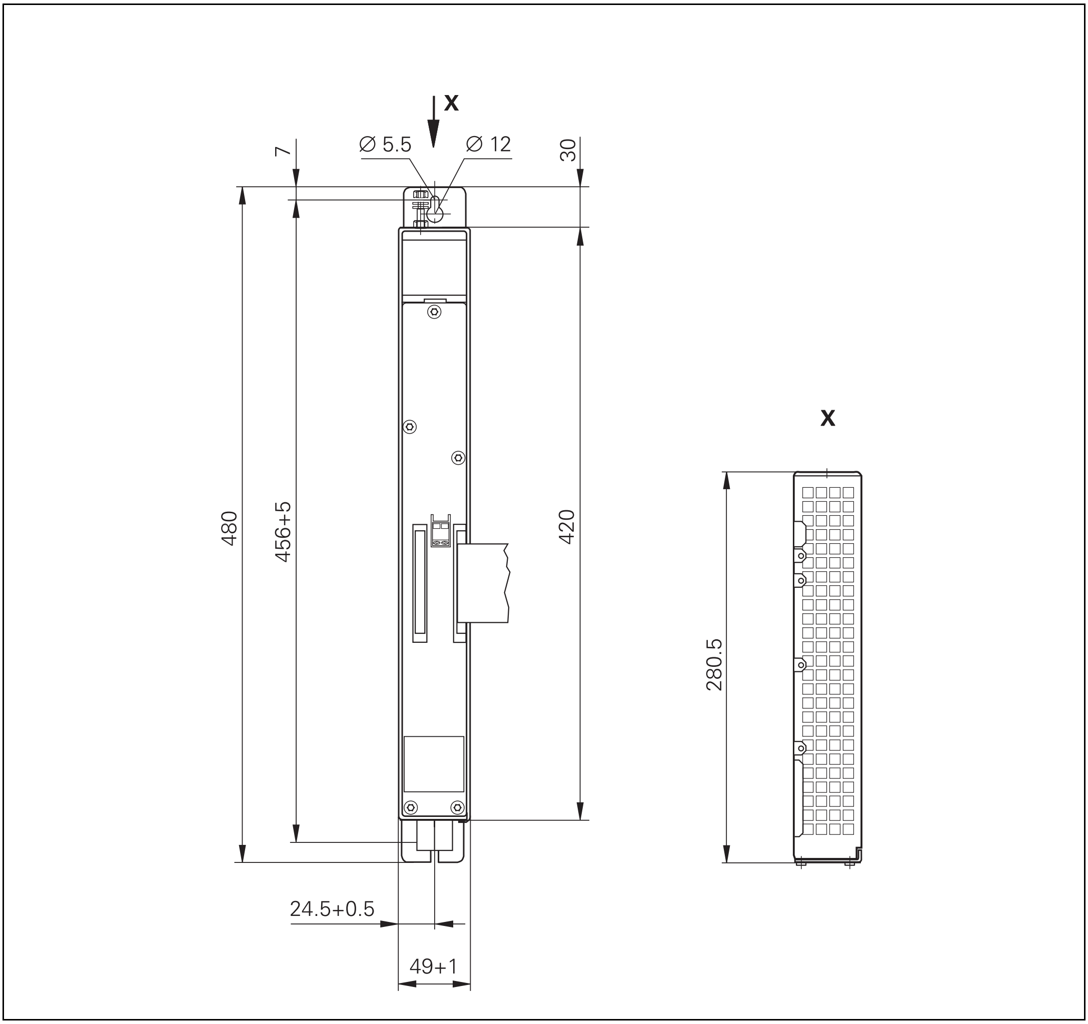
3.27.1 MC 422/5 Position Encoder Inputs and CC 422 with 6 Control Loops



3.27.2 MC 422/10 Position Encoder Inputs and CC 422 with 10 Control Loops

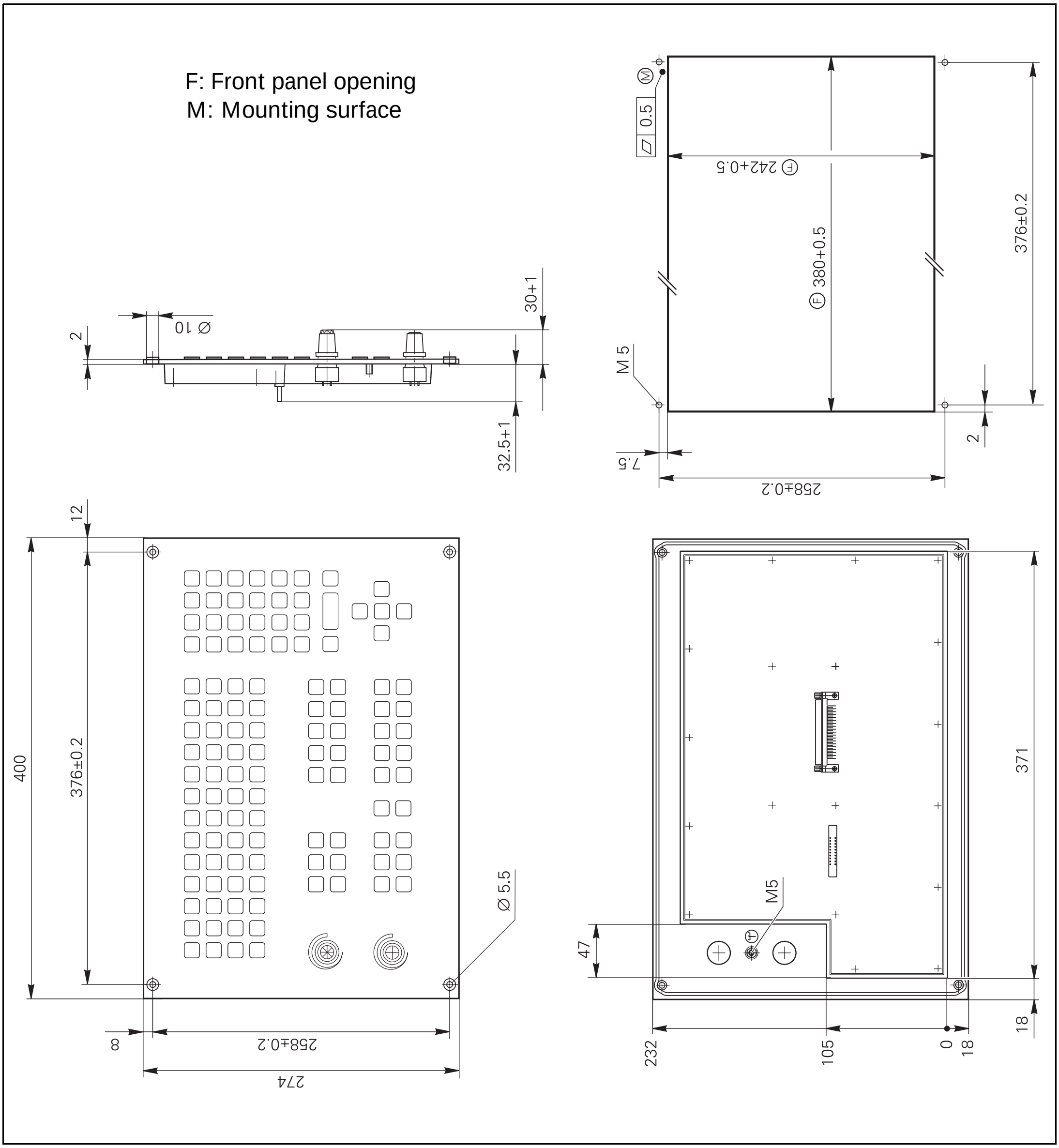


3.27.3 UV 105



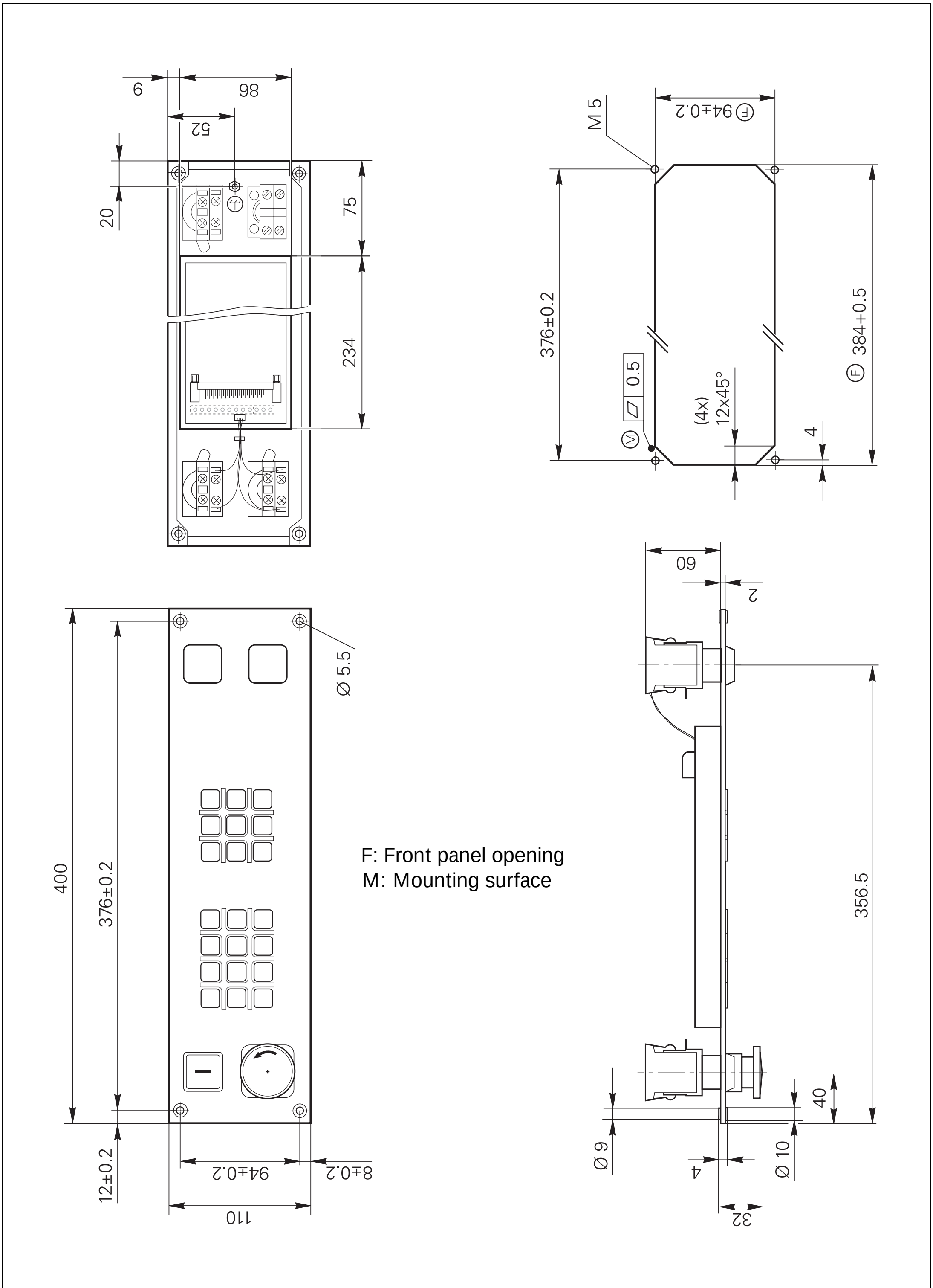
3.27.4 TE 420

Weight: 2.4 kg



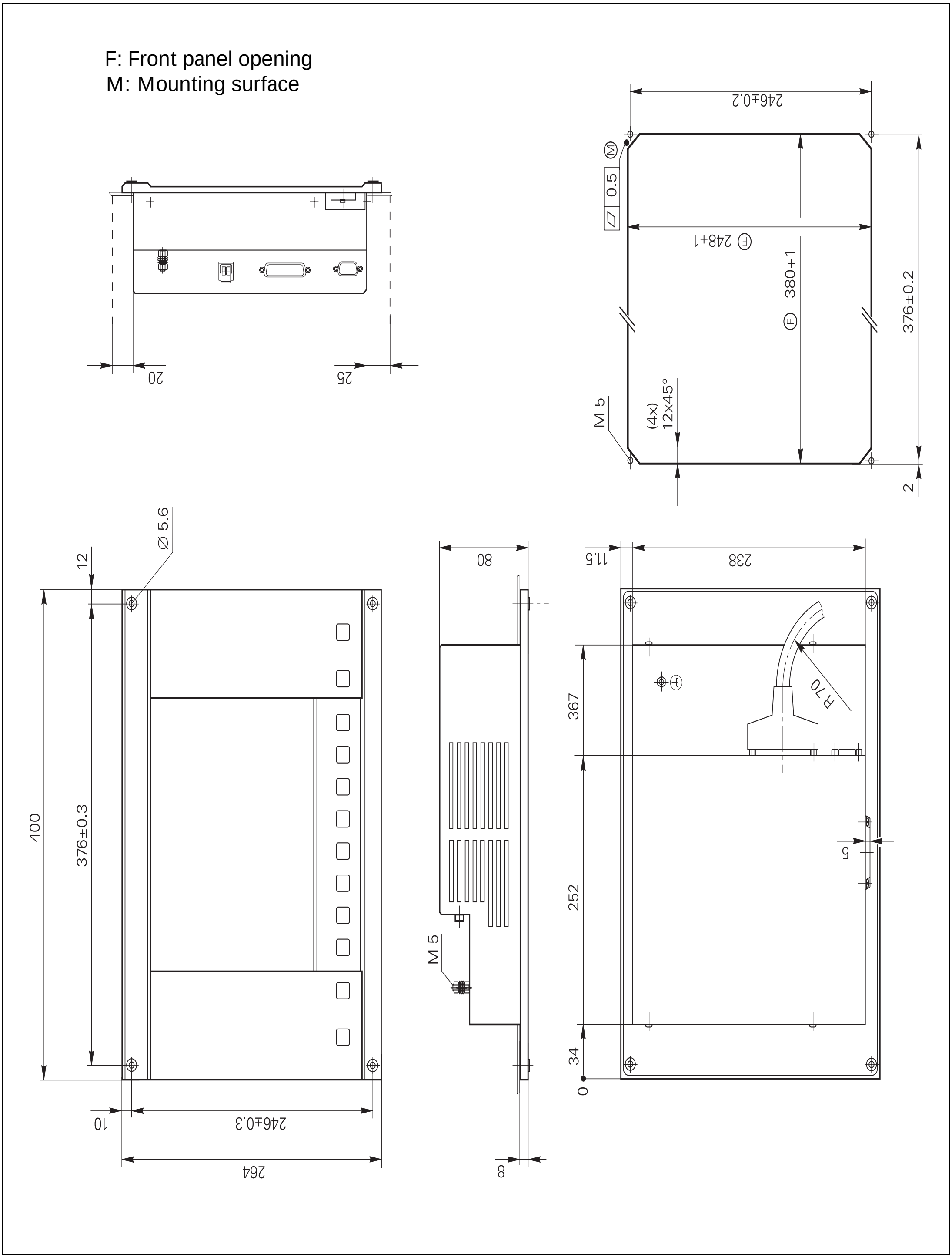
3.27.5 MB 420

Weight: 0.9 kg



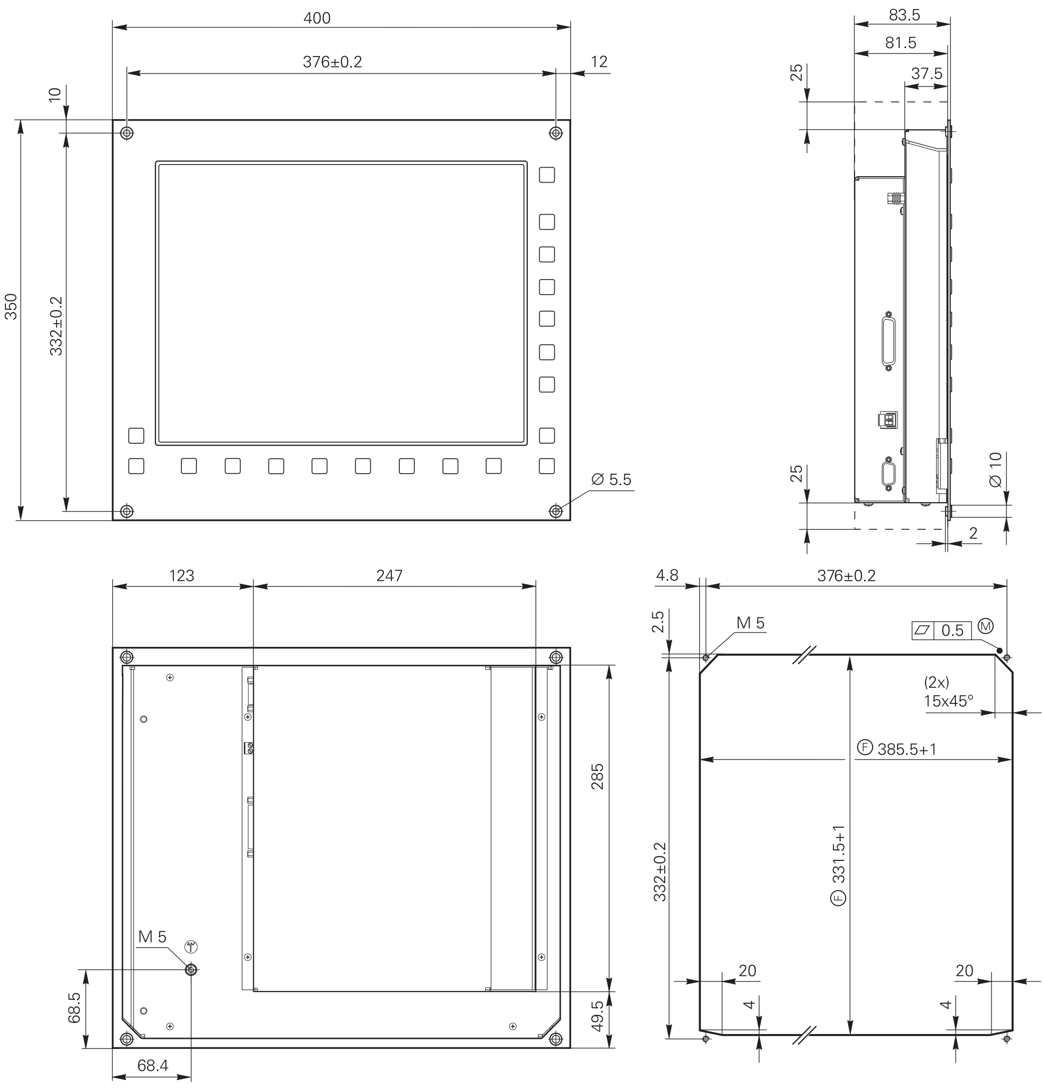
3.27.6 BF 120

Weight: 3 kg



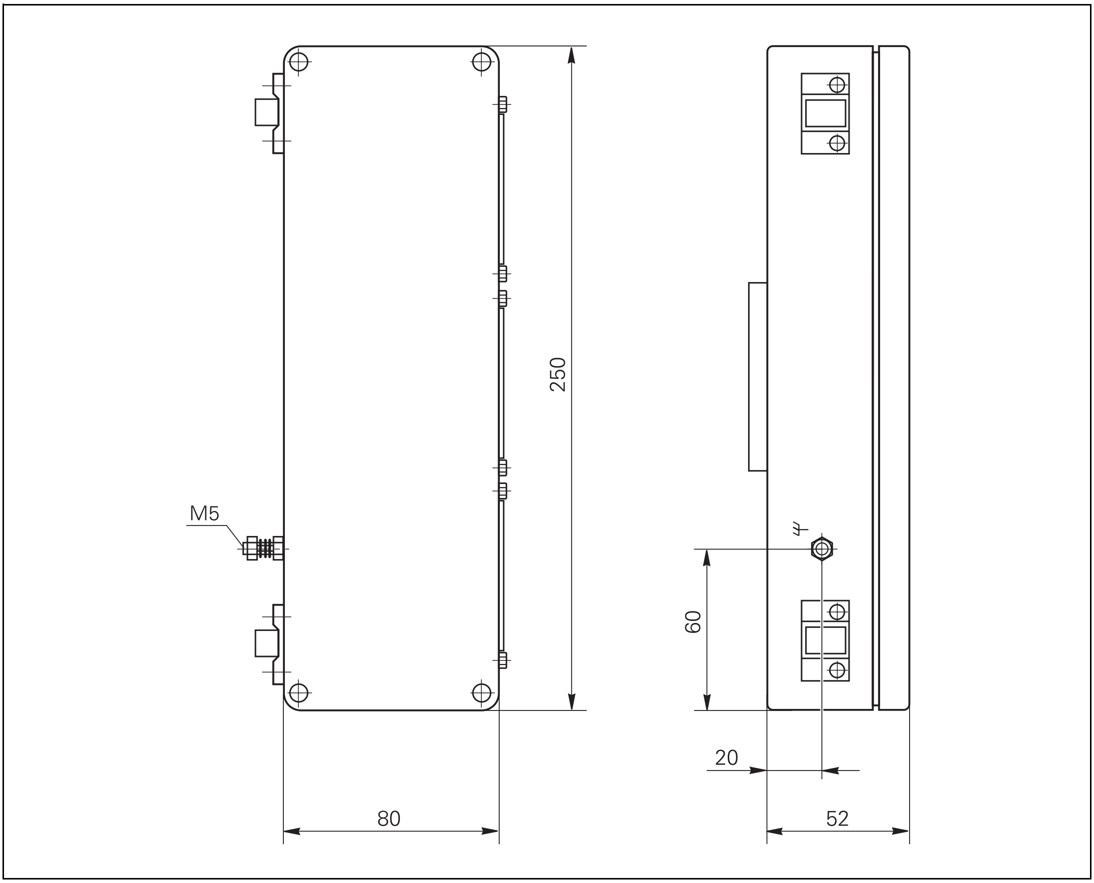
3.27.7 BF 150

Weight: 3 kg



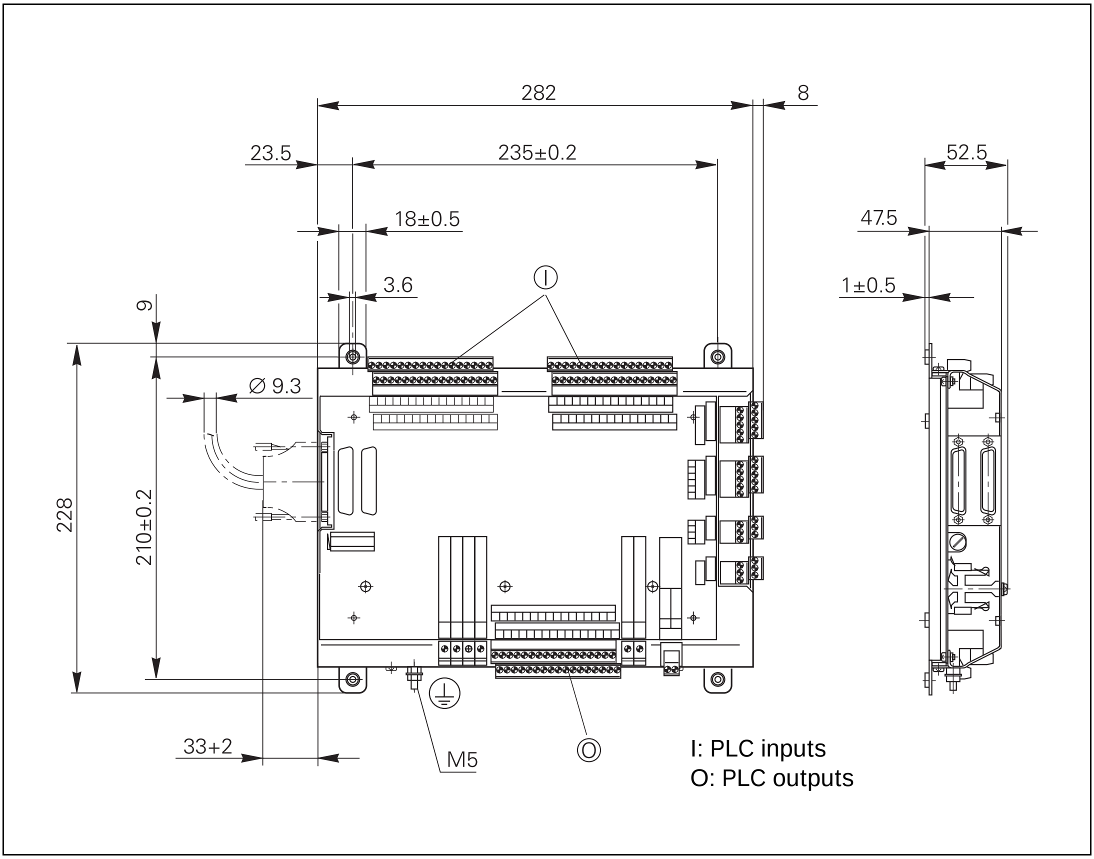
F: Front panel opening
M: Mounting surface

3.27.8 BTS 120/BTS 150



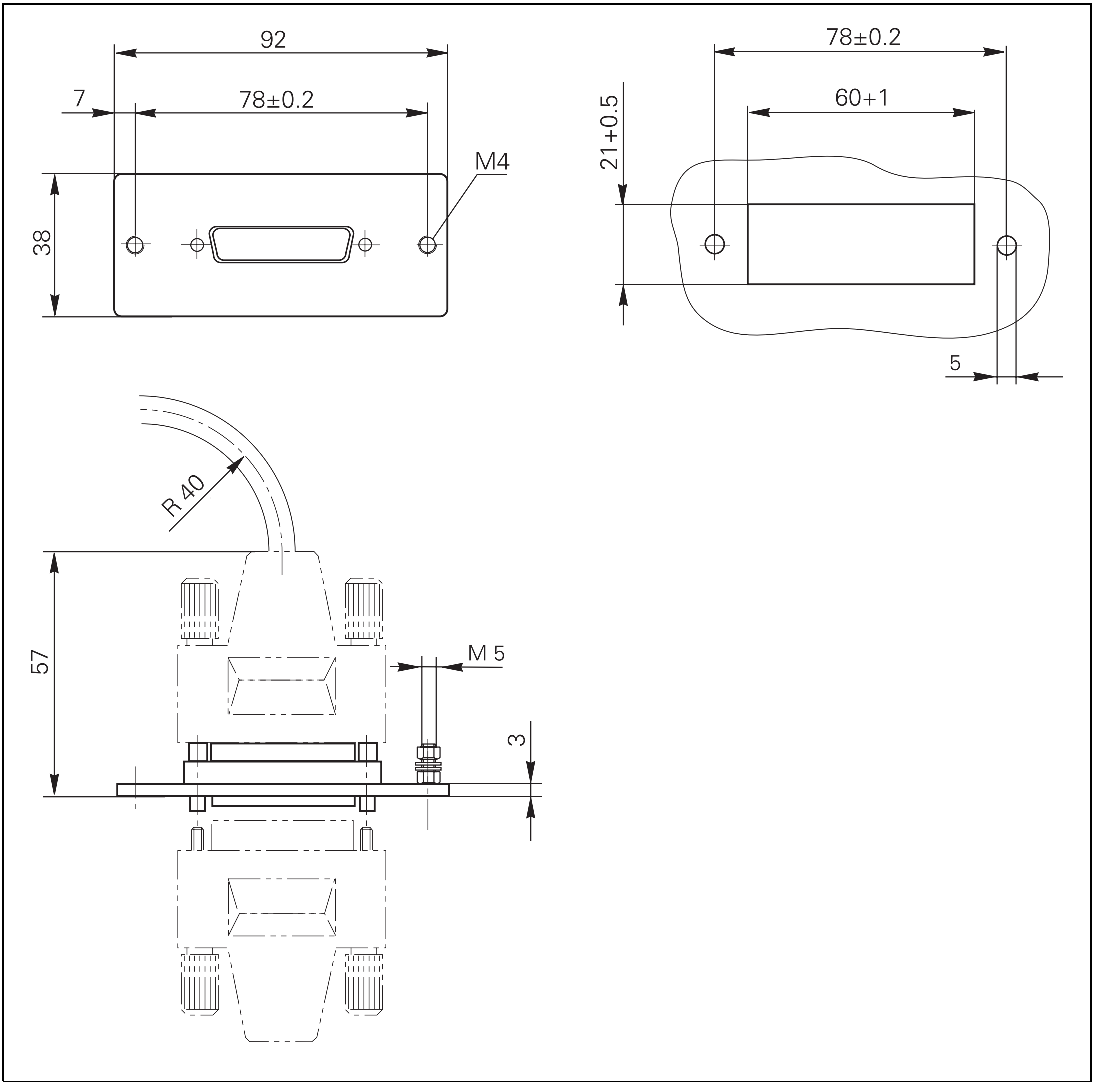
3.27.9 PL 4xx B

Weight: 1.5 kg



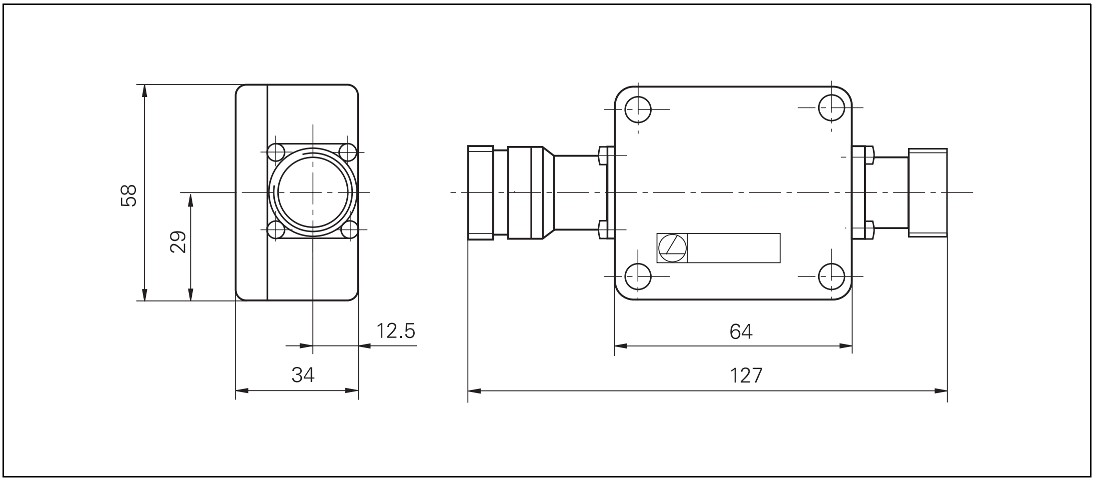
3.27.10 Adapter Block for the Data Interface

RS-232-C/V.24 adapter block and
RS-422/V.11 adapter block



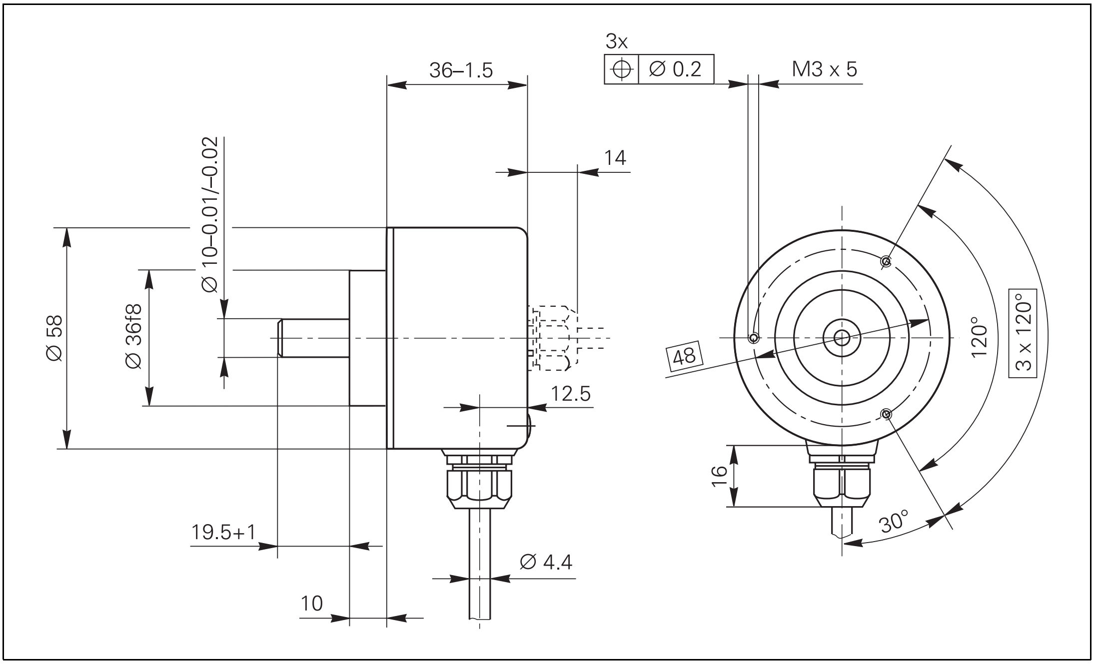
3.27.11 Voltage Controller

Voltage controller for encoders with EnDat interface

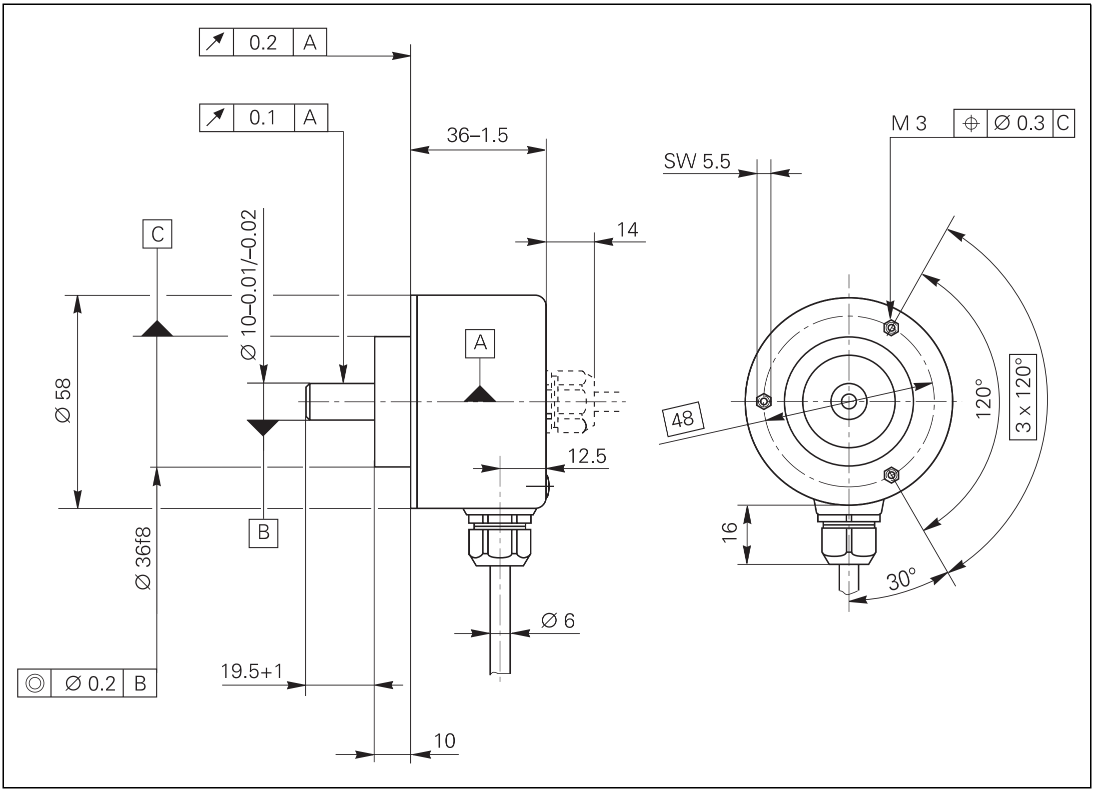


3.27.12 Handwheels

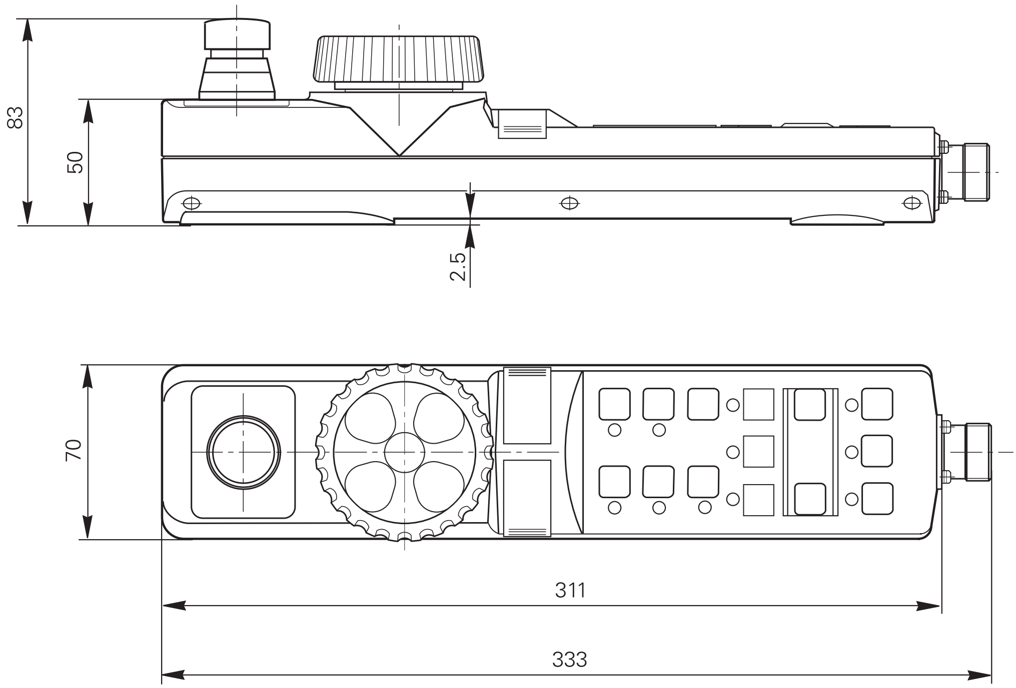
HR 130 Weight: approx. 0.7 kg



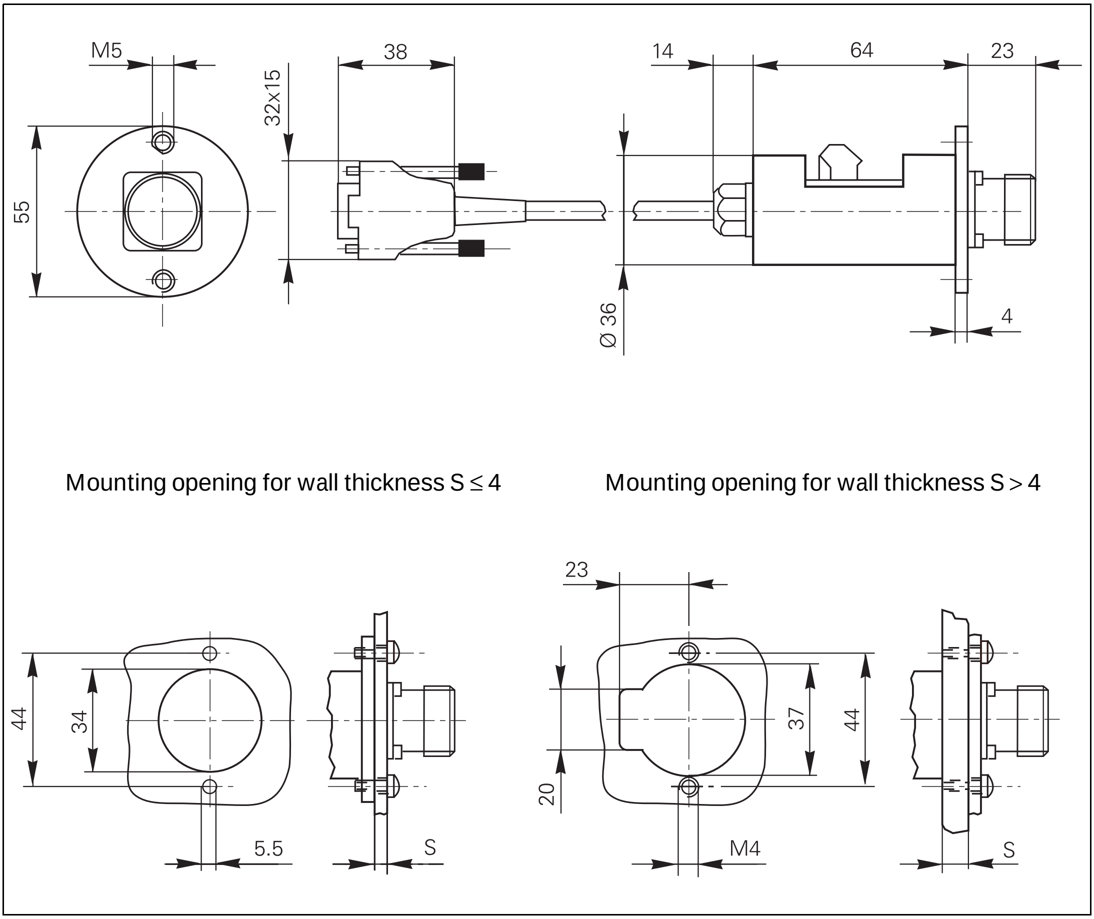
HR 150 Weight: approx. 0.7 kg



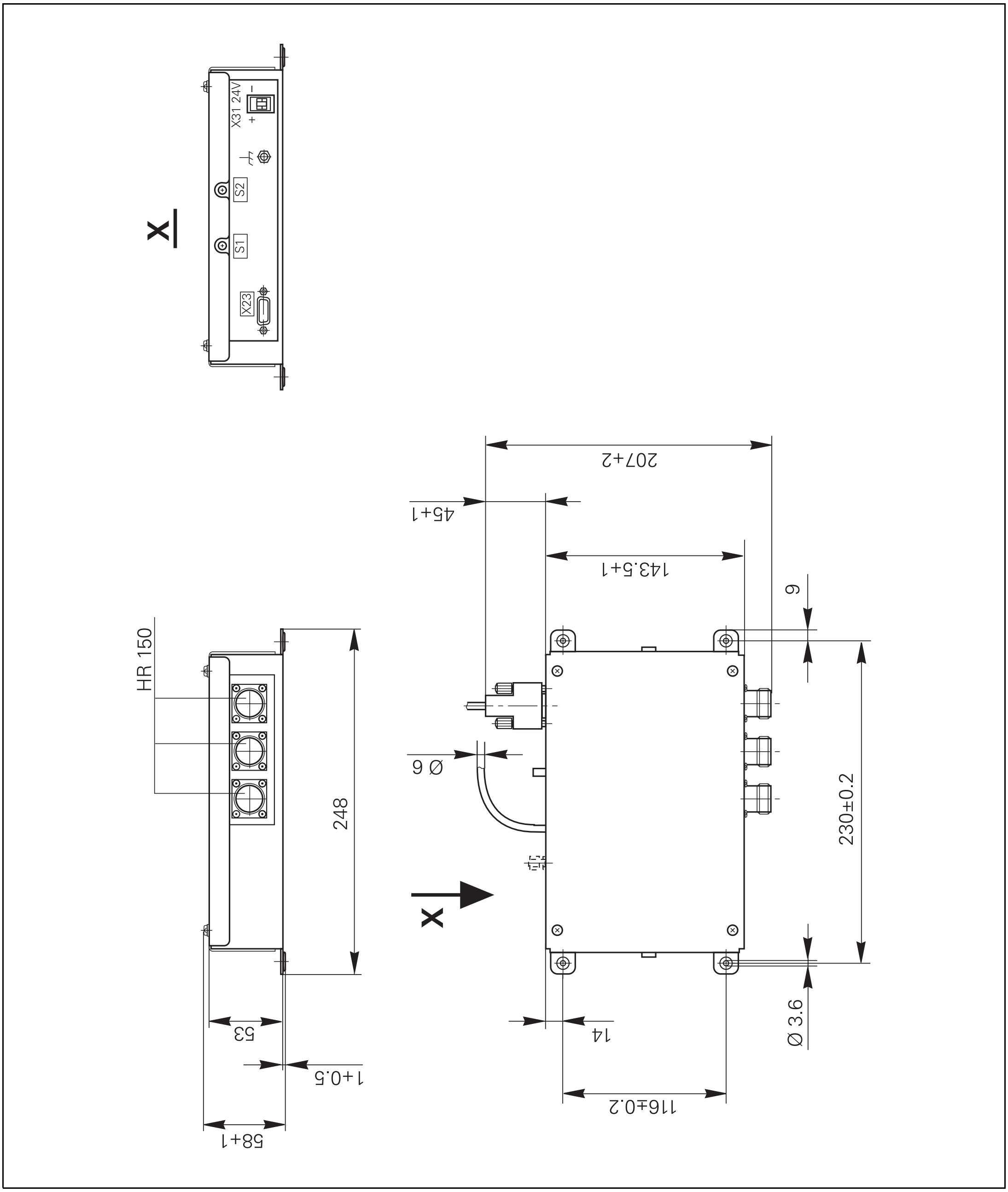
HR 410



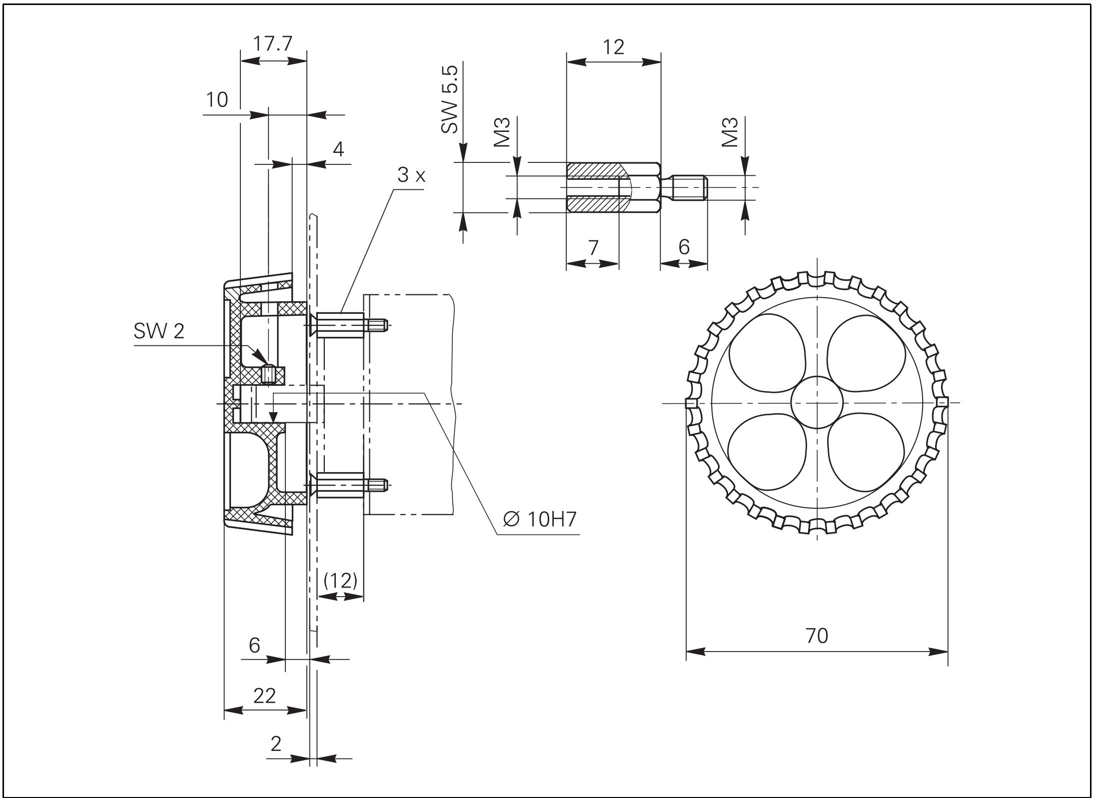
Adapter cables



HRA 110 Weight: approx. 1.5 kg

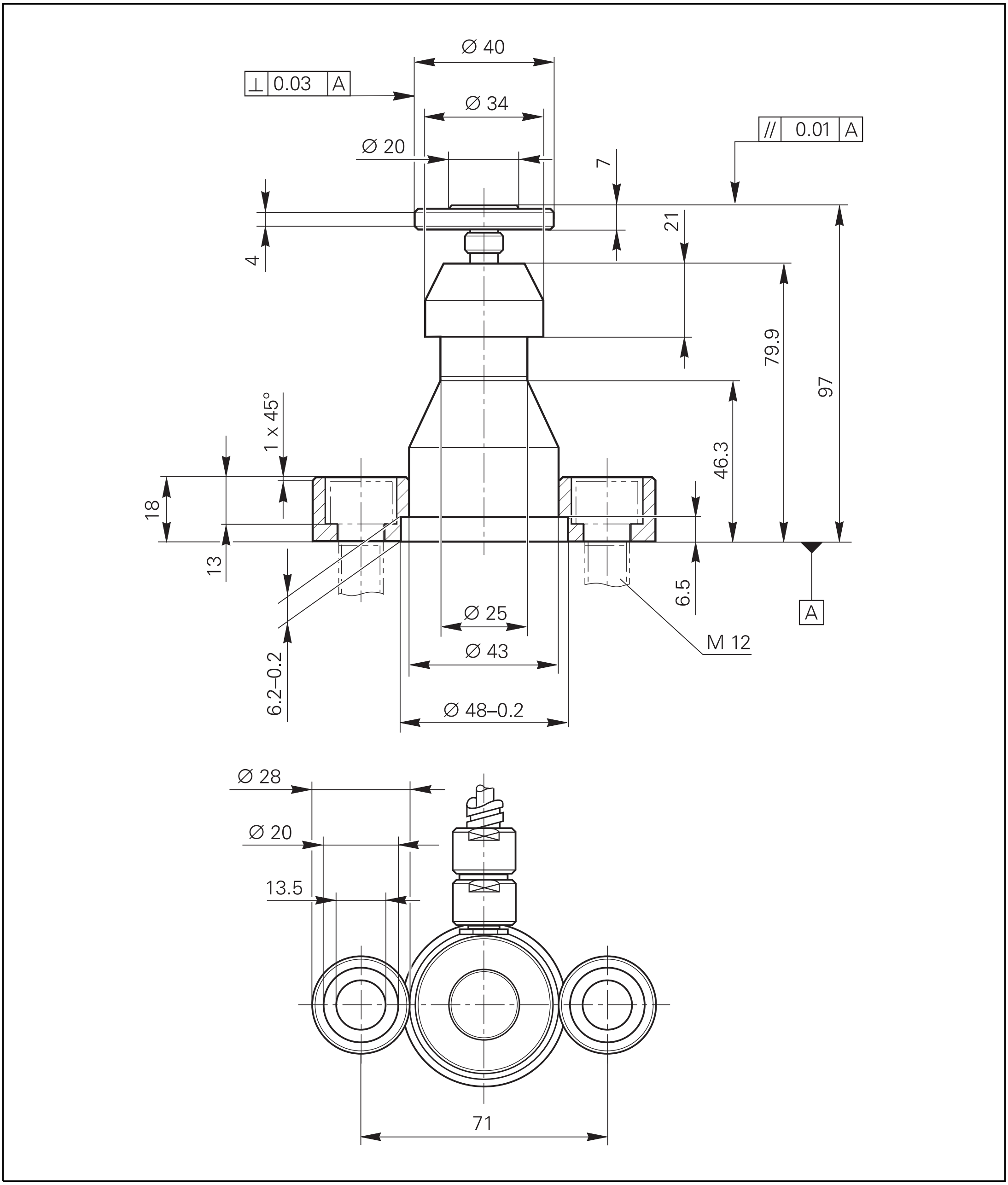


Control knob for
HR 130 and HR 150

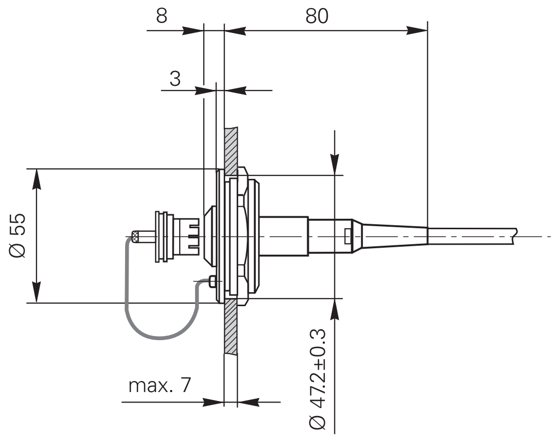


3.27.13 Touch probe systems

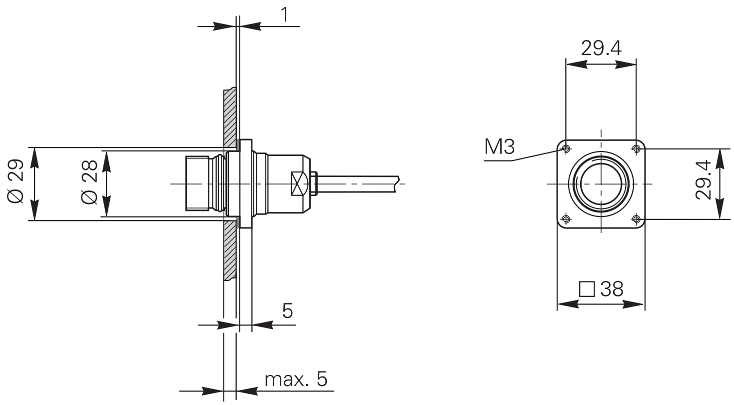
TT 130



Adapter cable for TT and TS

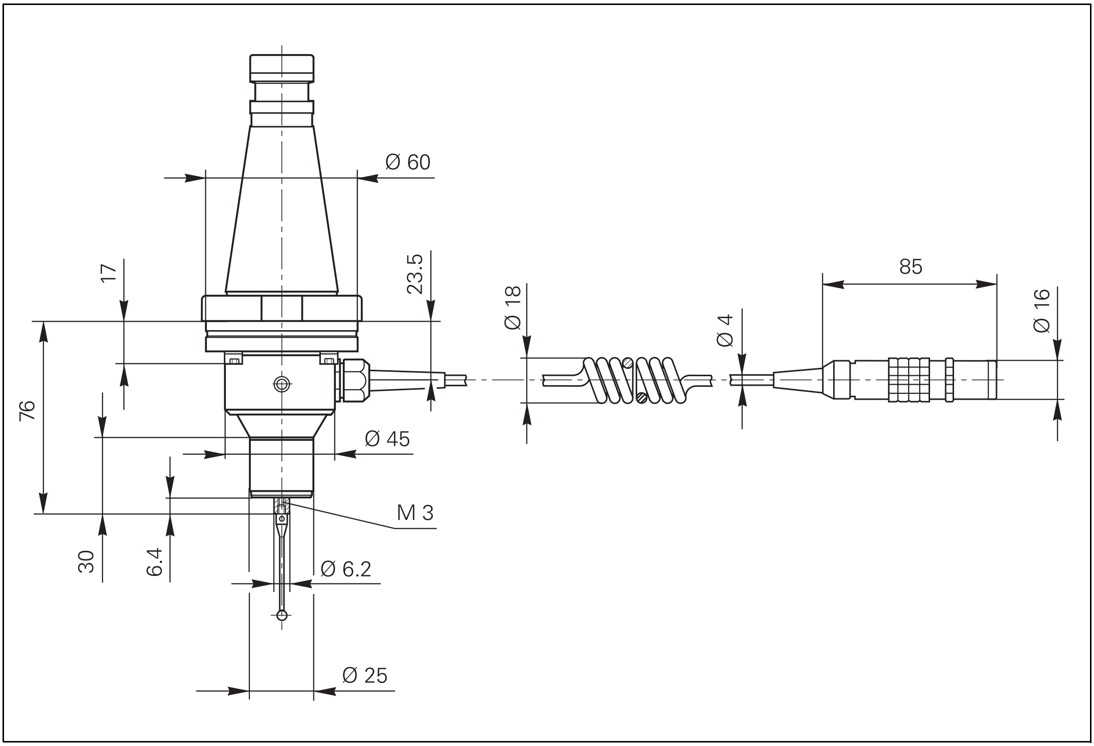


Mounting coupling for quick connection

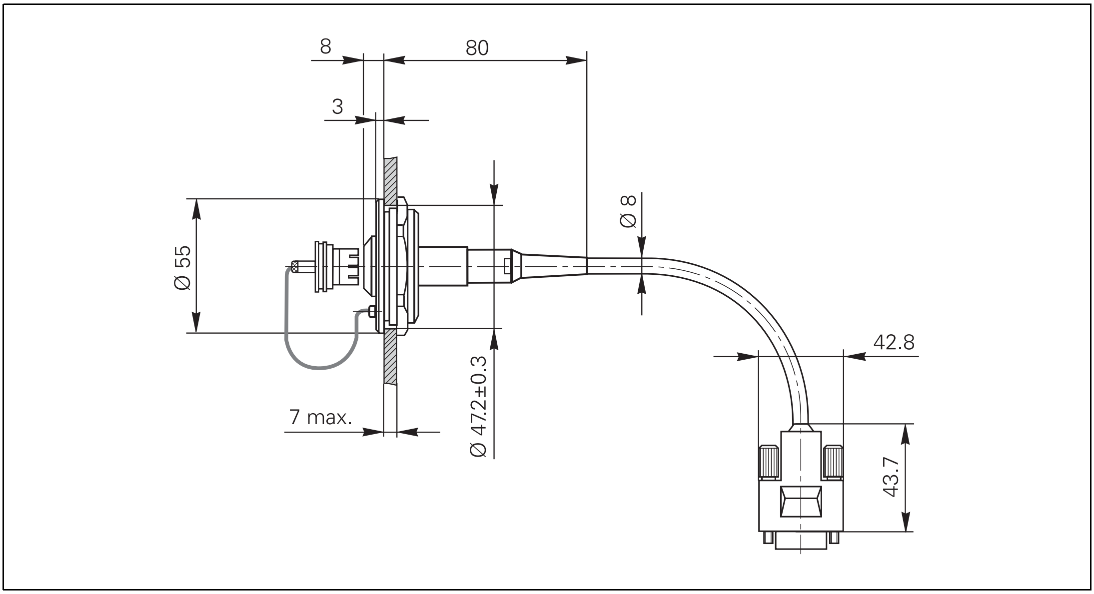


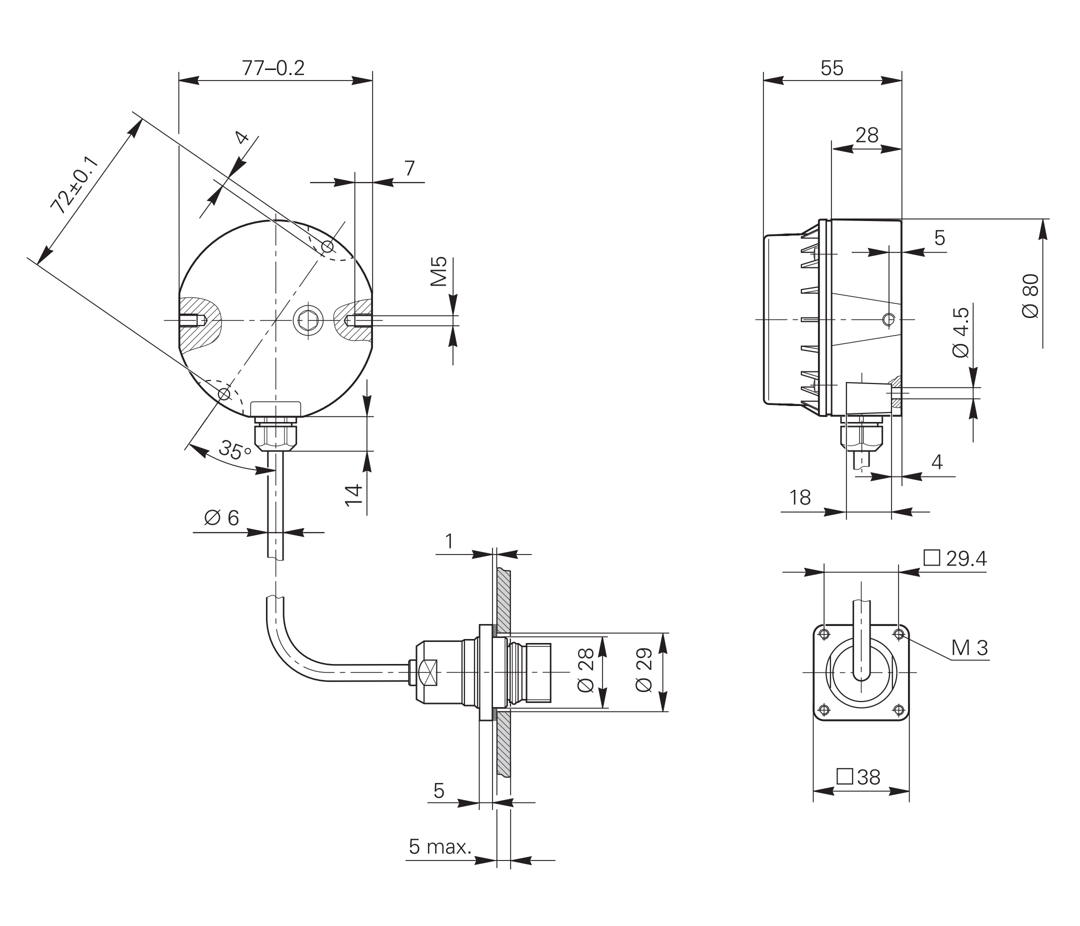
Mounting coupling for HEIDENHAIN standard connector

TS 220

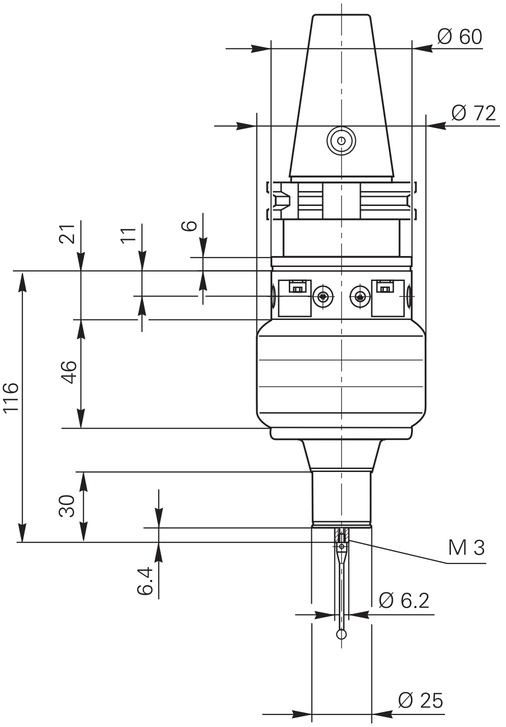


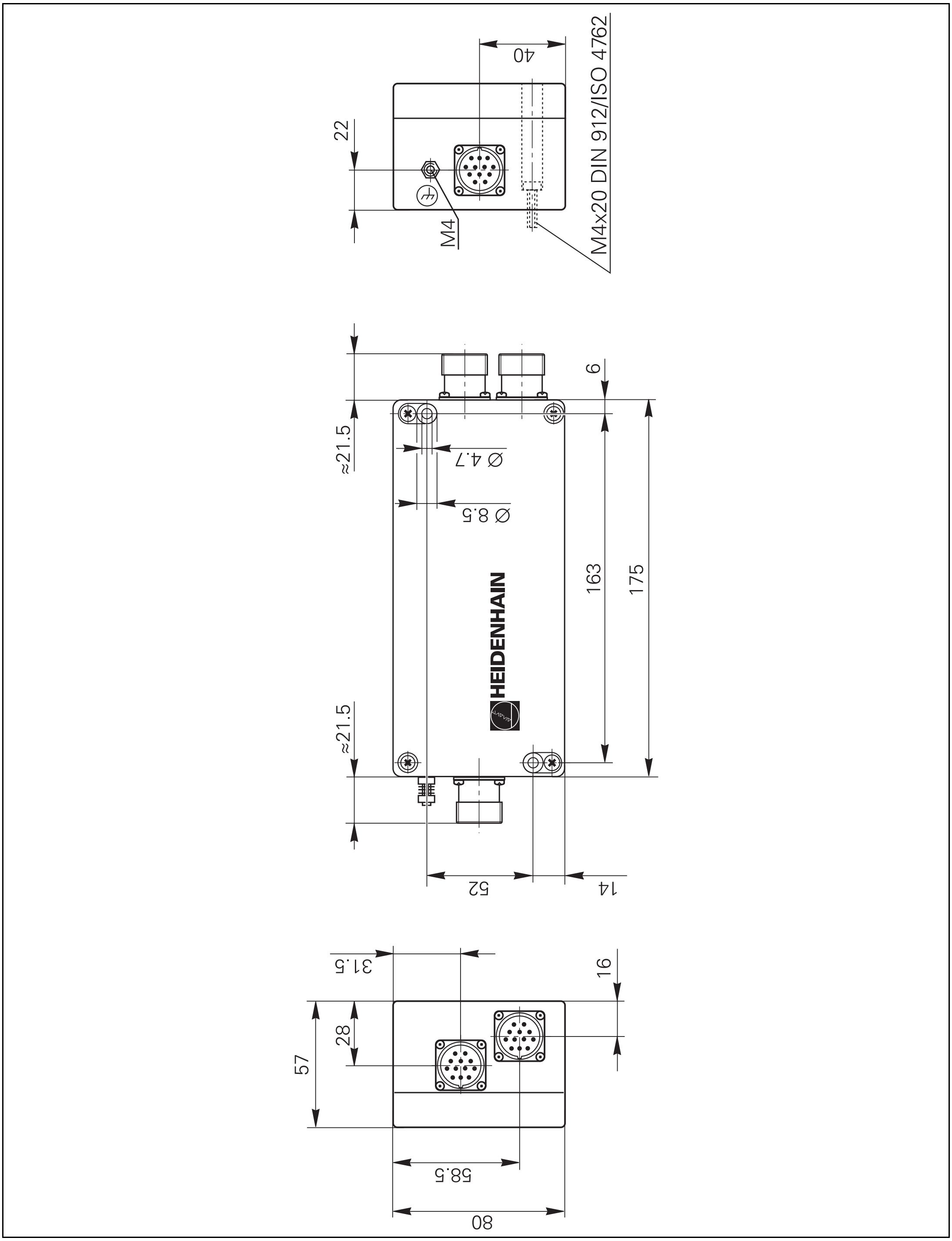
Adapter cable for TS 120/TS 220




77–0.2
72±0.1
4
7
M5
35°
14
Ø 6
1
Ø 28
Ø 29
5
5 max.
55
28
5
Ø 80
Ø 4.5
4
18
□ 29.4
M 3
□38

TS 632



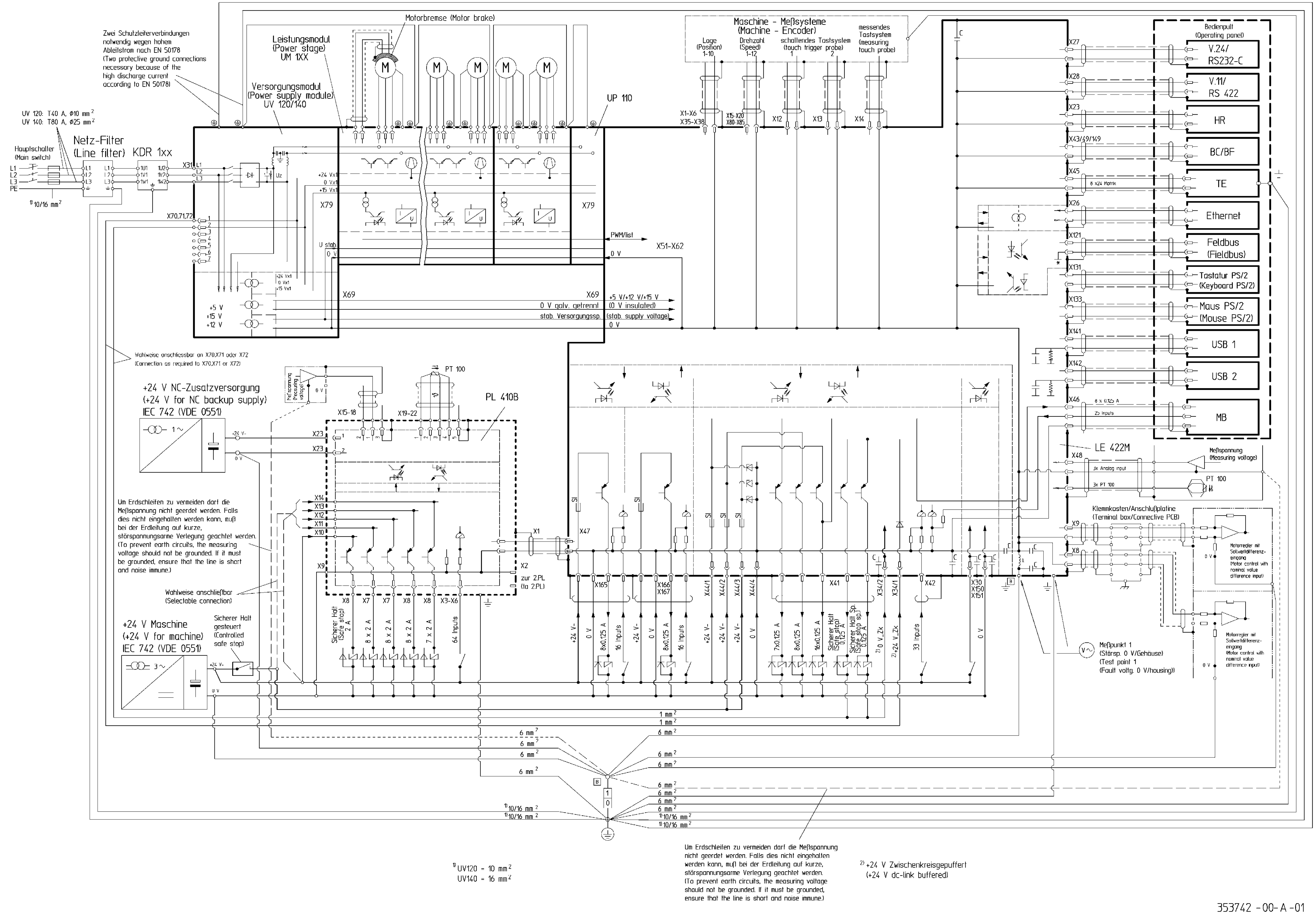

40
22
M4
M4x20 DIN 912/ISO 4762
6
≈21.5
Ø 4.7
Ø 8.5
HEIDENHAIN
163
175
≈21.5
52
14
31.5
16
28
57
58.5
80

3.28 Grounding Diagrams

3.28.1 Grounding Diagram for iTNC 530 with Modular Non-Regenerative HEIDENHAIN Inverter System

In preparation

3.28.2 Grounding Diagram for iTNC 530 with Modular Regenerative HEIDENHAIN Inverter System



In preparation

In preparation

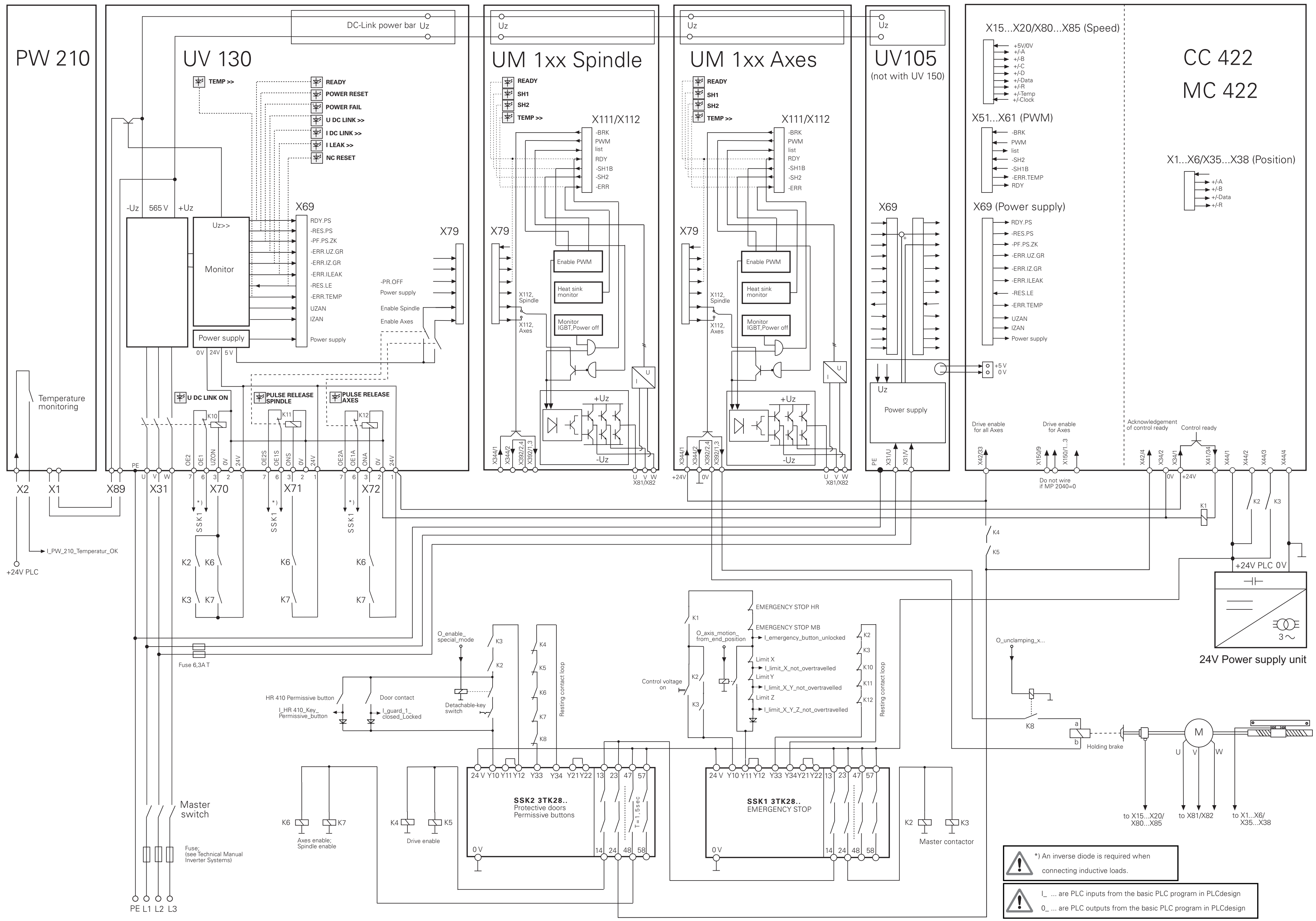
In preparation

In preparation

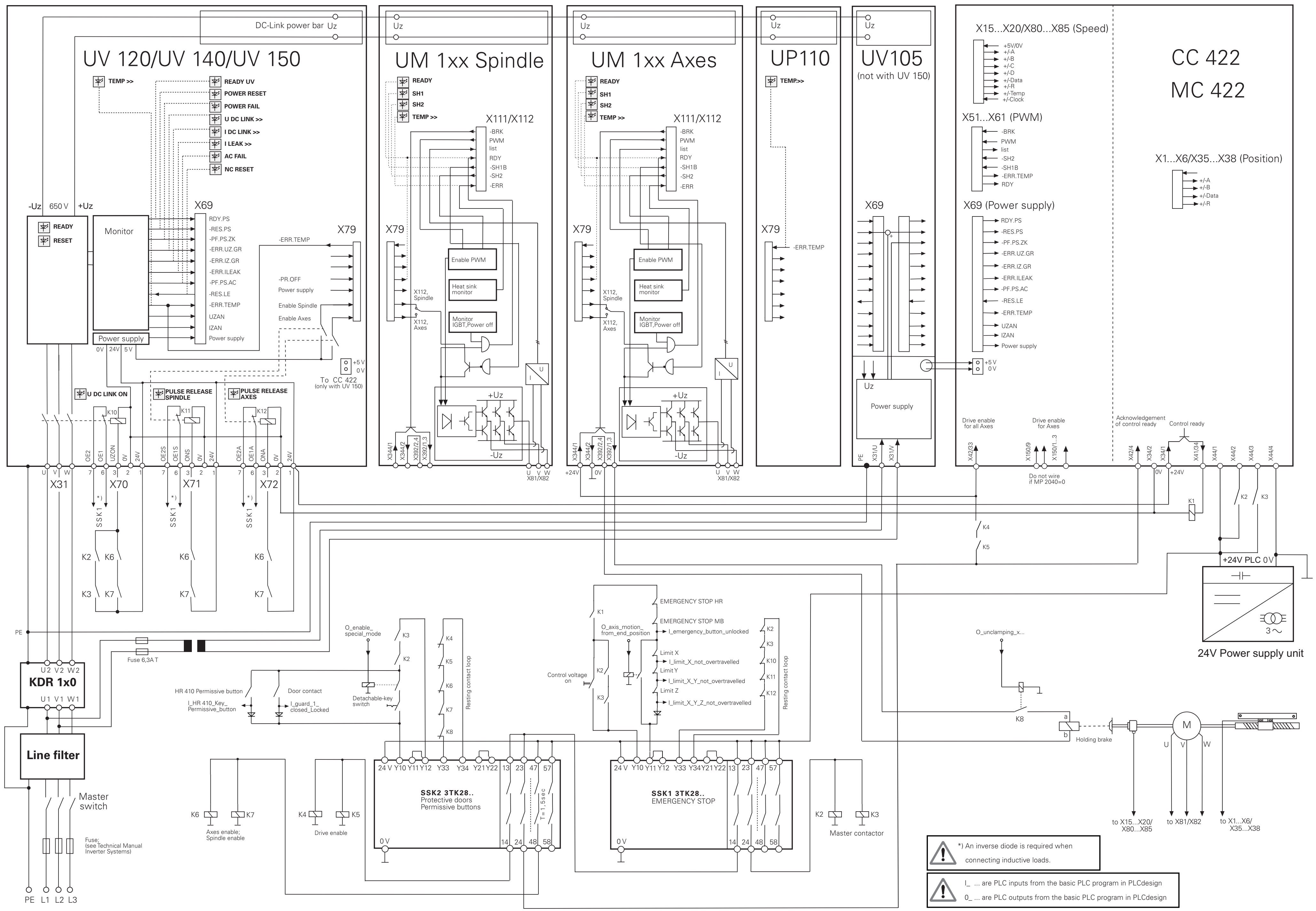
In preparation

3.29 Basic Circuit Diagrams

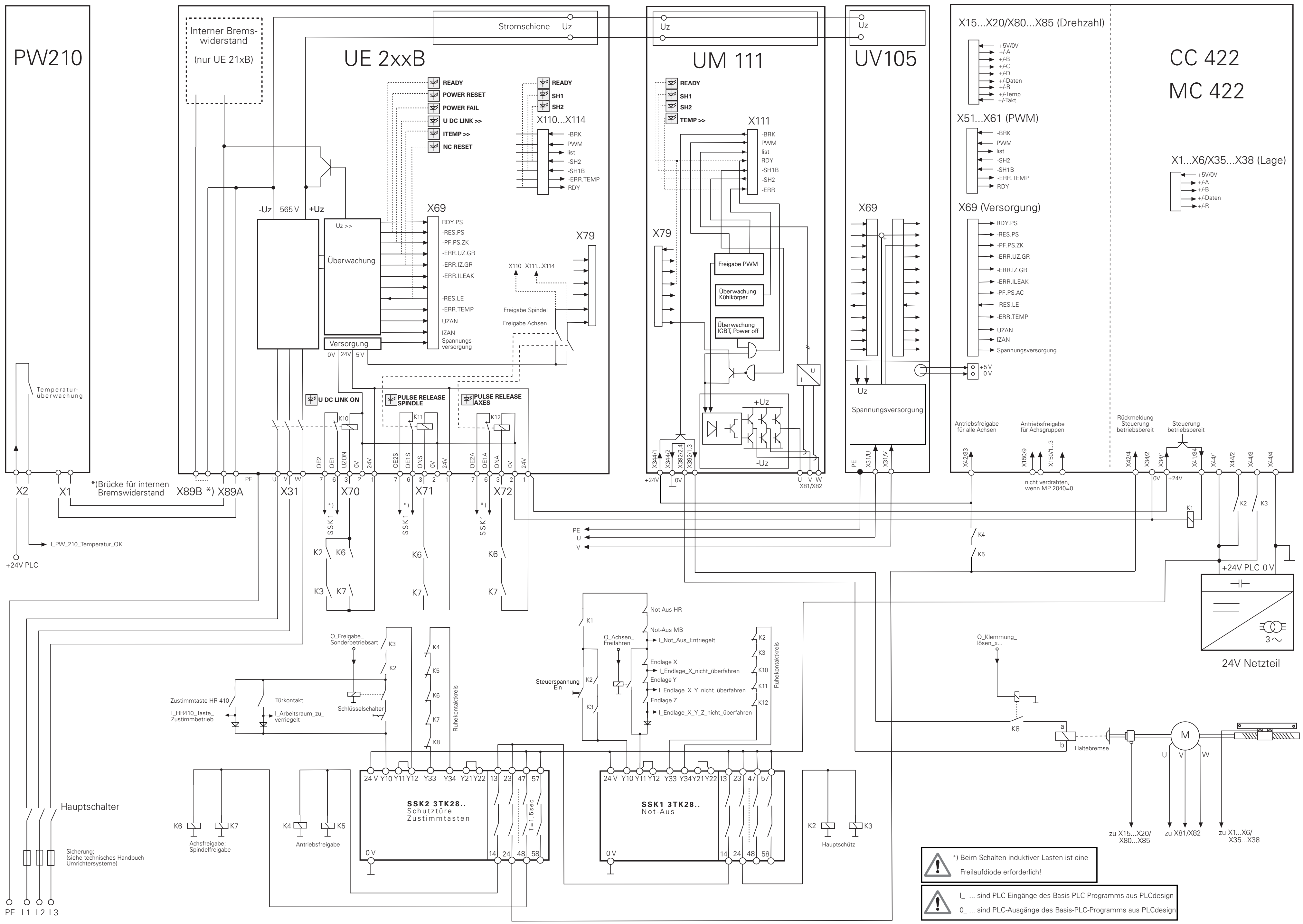
3.29.1 Basic Circuit Diagram for iTNC 530 with Modular Non-Regenerative HEIDENHAIN Inverter System



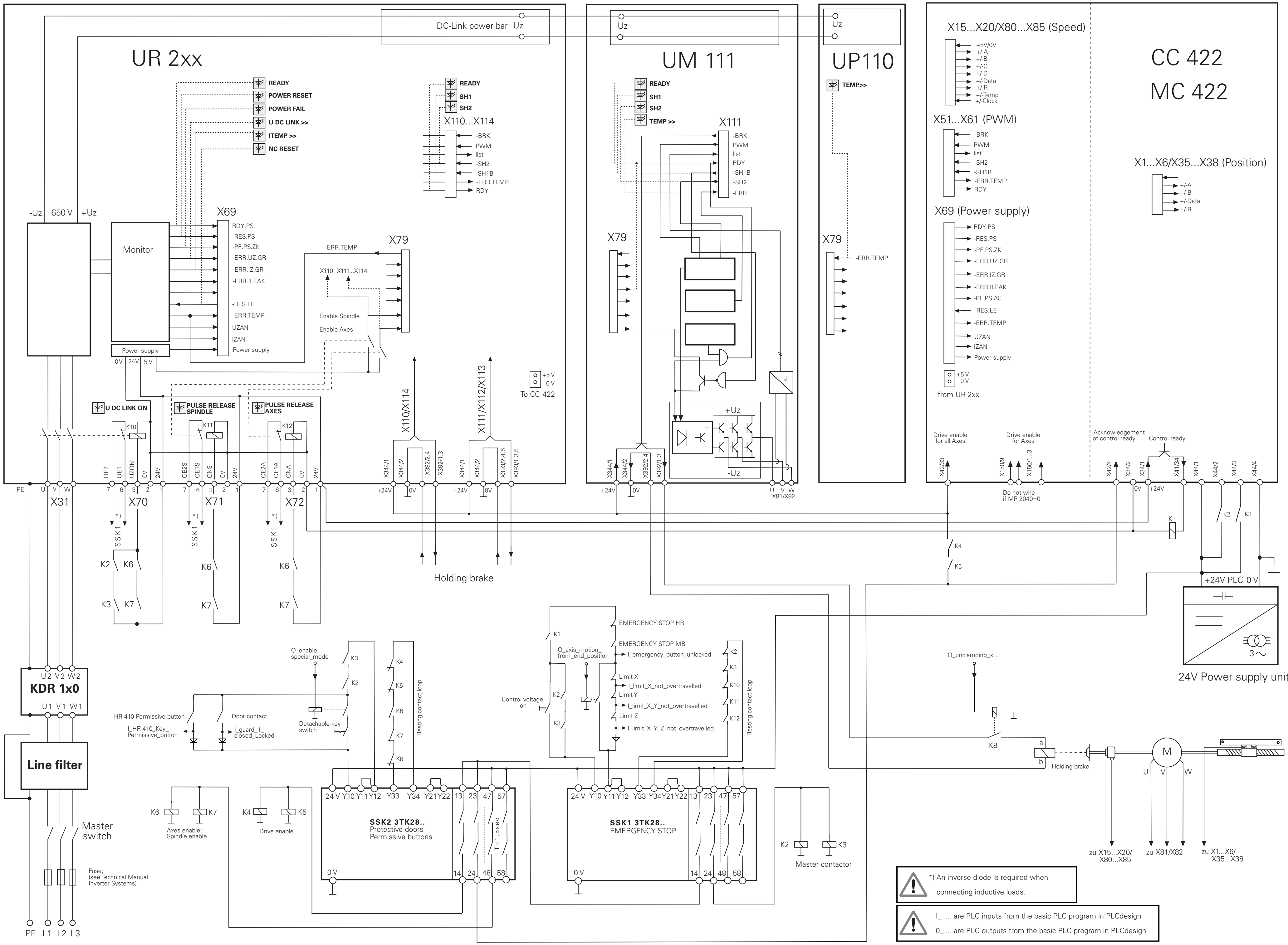
3.29.2 Basic Circuit Diagram for iTNC 530 with Modular Regenerative HEIDENHAIN Inverter System



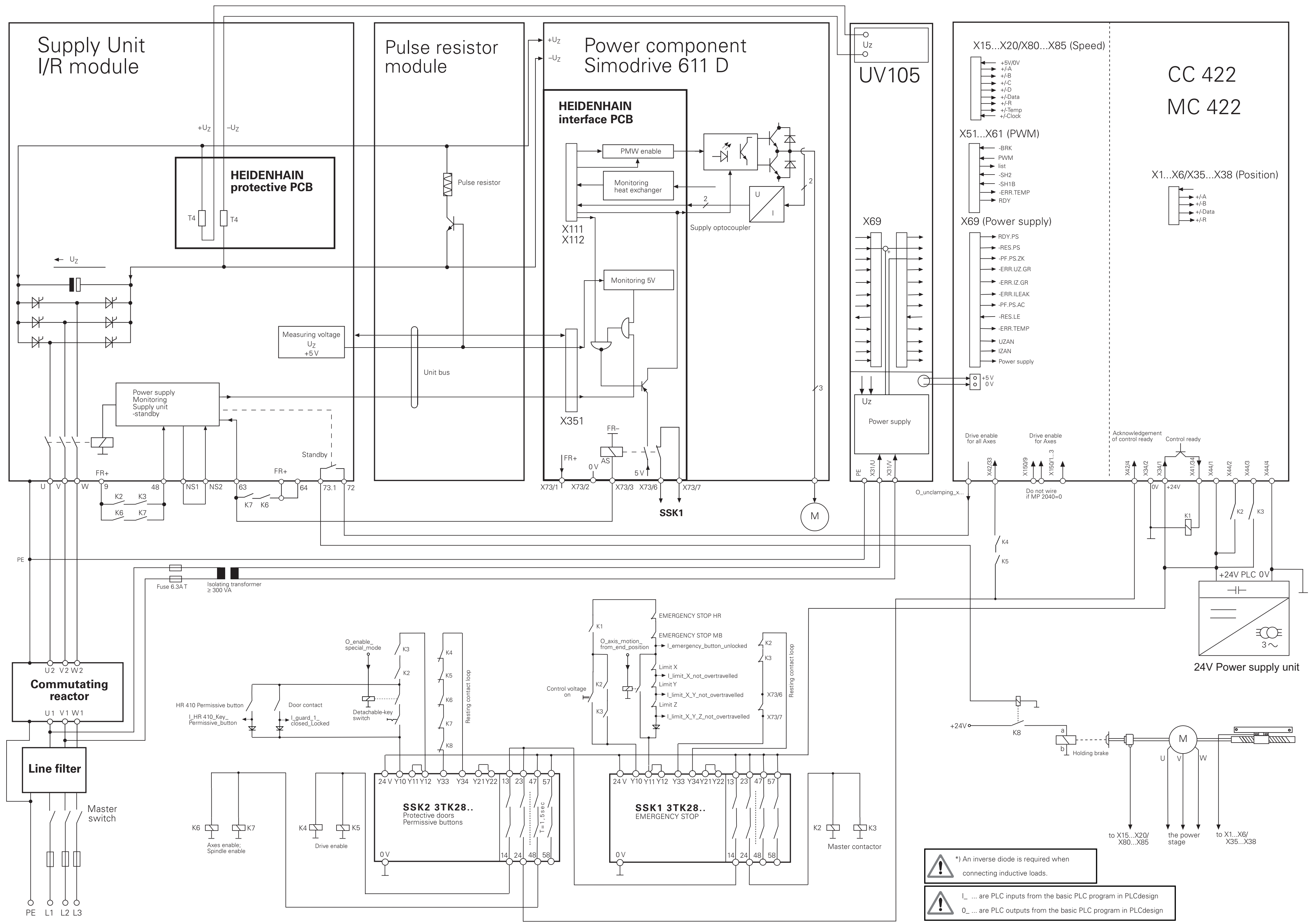
3.29.3 Basic Circuit Diagram for iTNC 530 with UE 2xxB Non-Regenerative HEIDENHAIN Compact Inverter



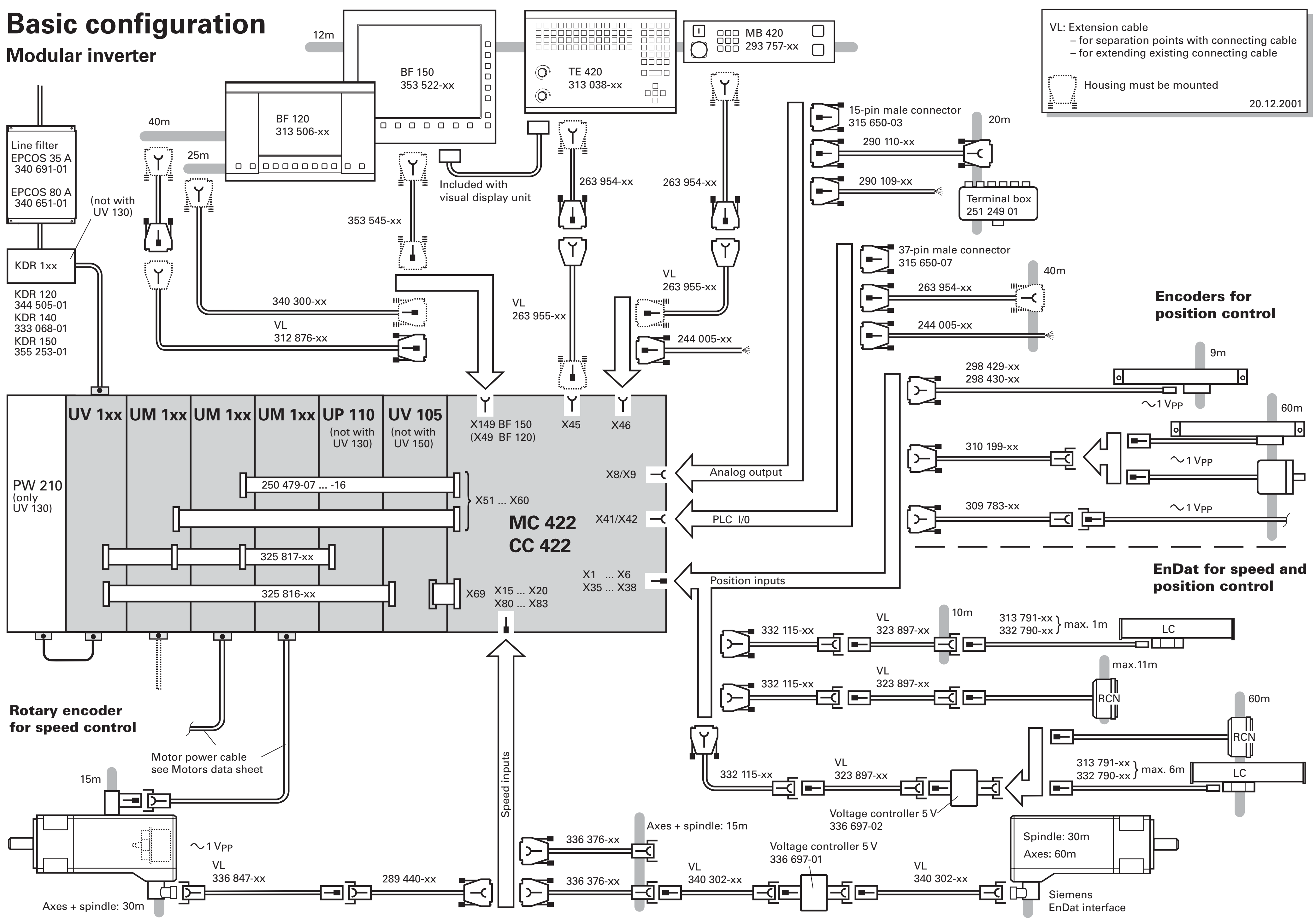
3.29.4 Basic Circuit Diagram for iTNC 530 with UR 2xxB Regenerative HEIDENHAIN Compact Inverter

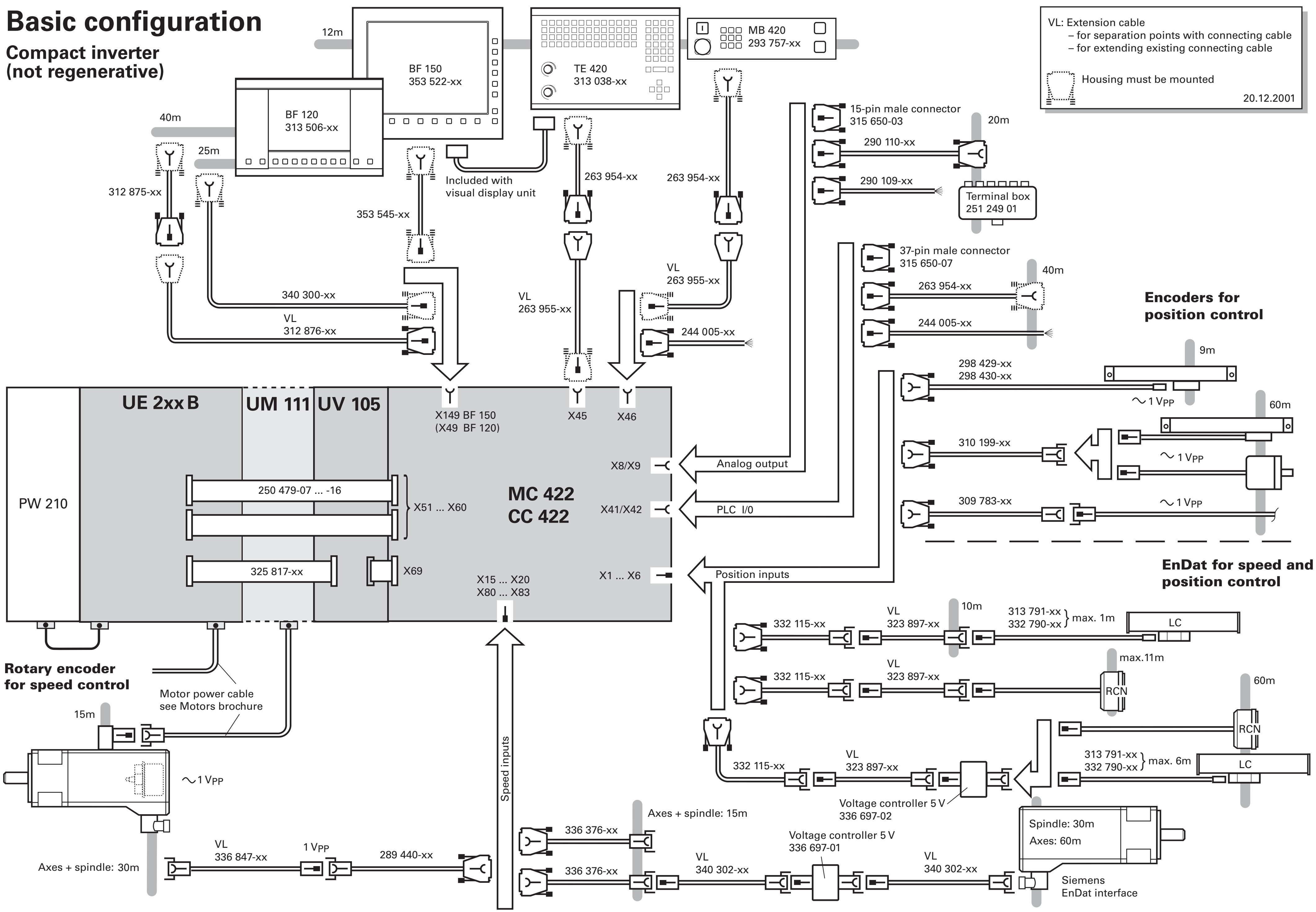


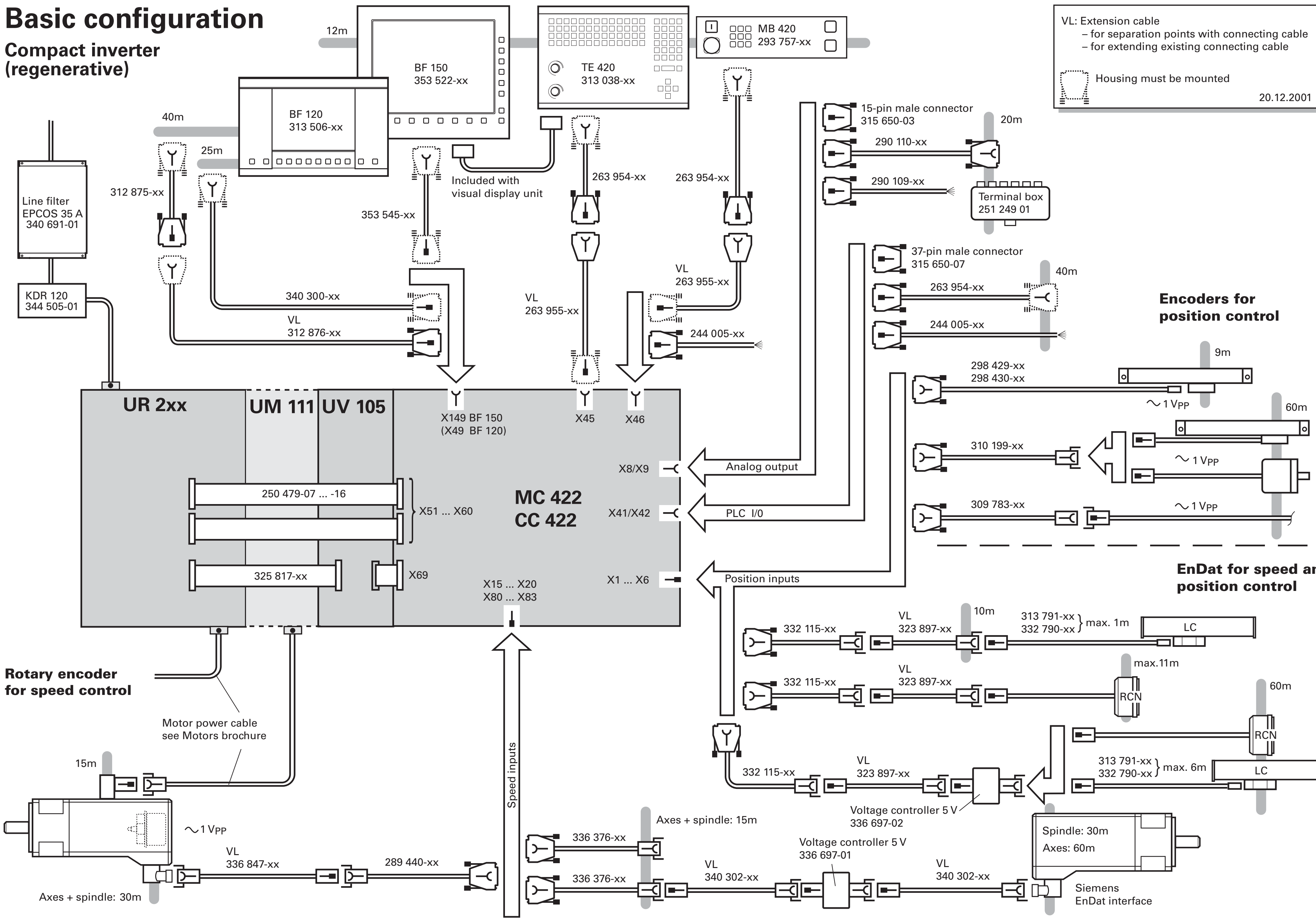
3.29.5 Basic Circuit Diagram for iTNC 530 with SIMODRIVE Inverter System



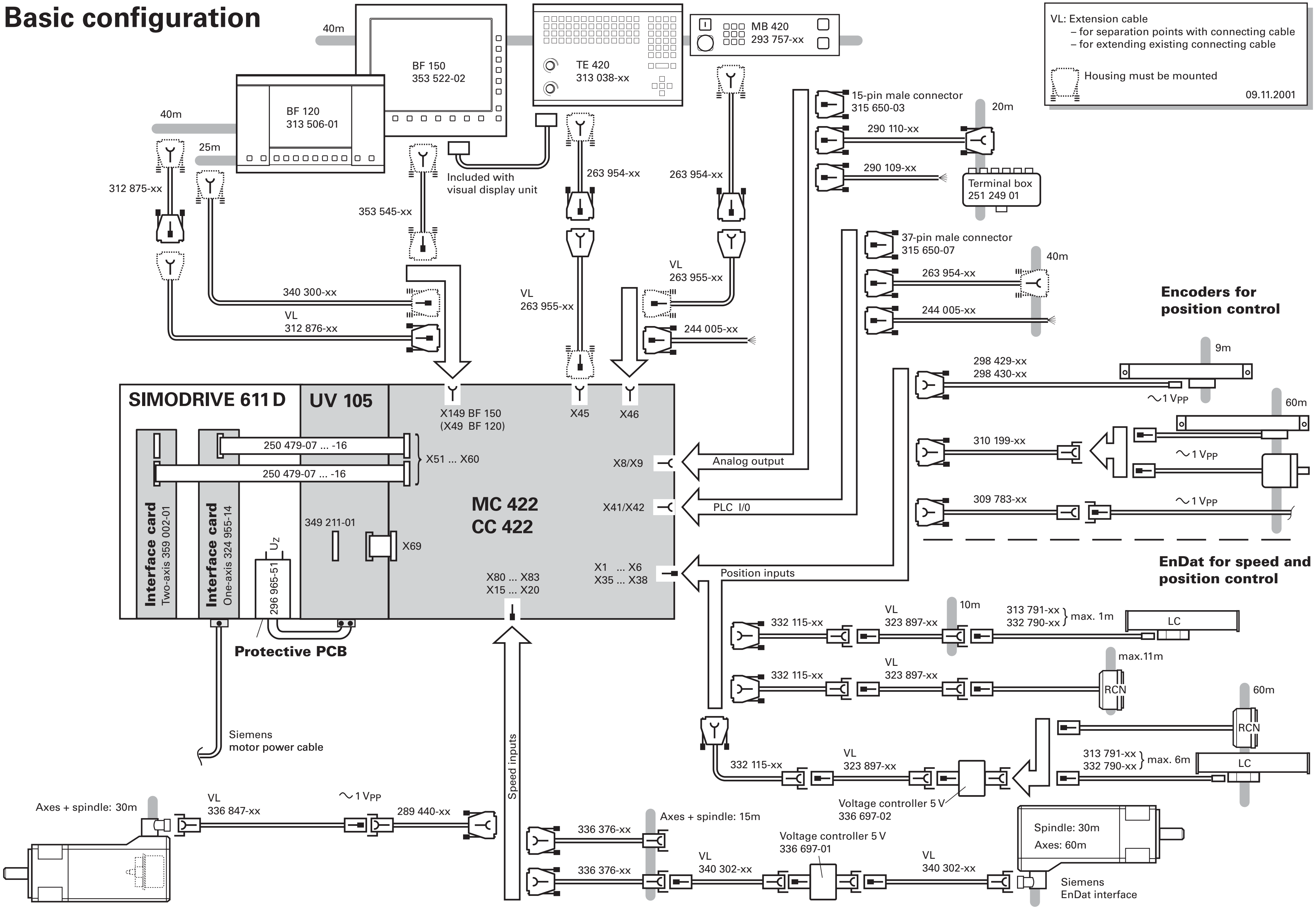
3.30.1 Cable Overview for iTNC 530 with Modular HEIDENHAIN Inverter System – Basic Configuration



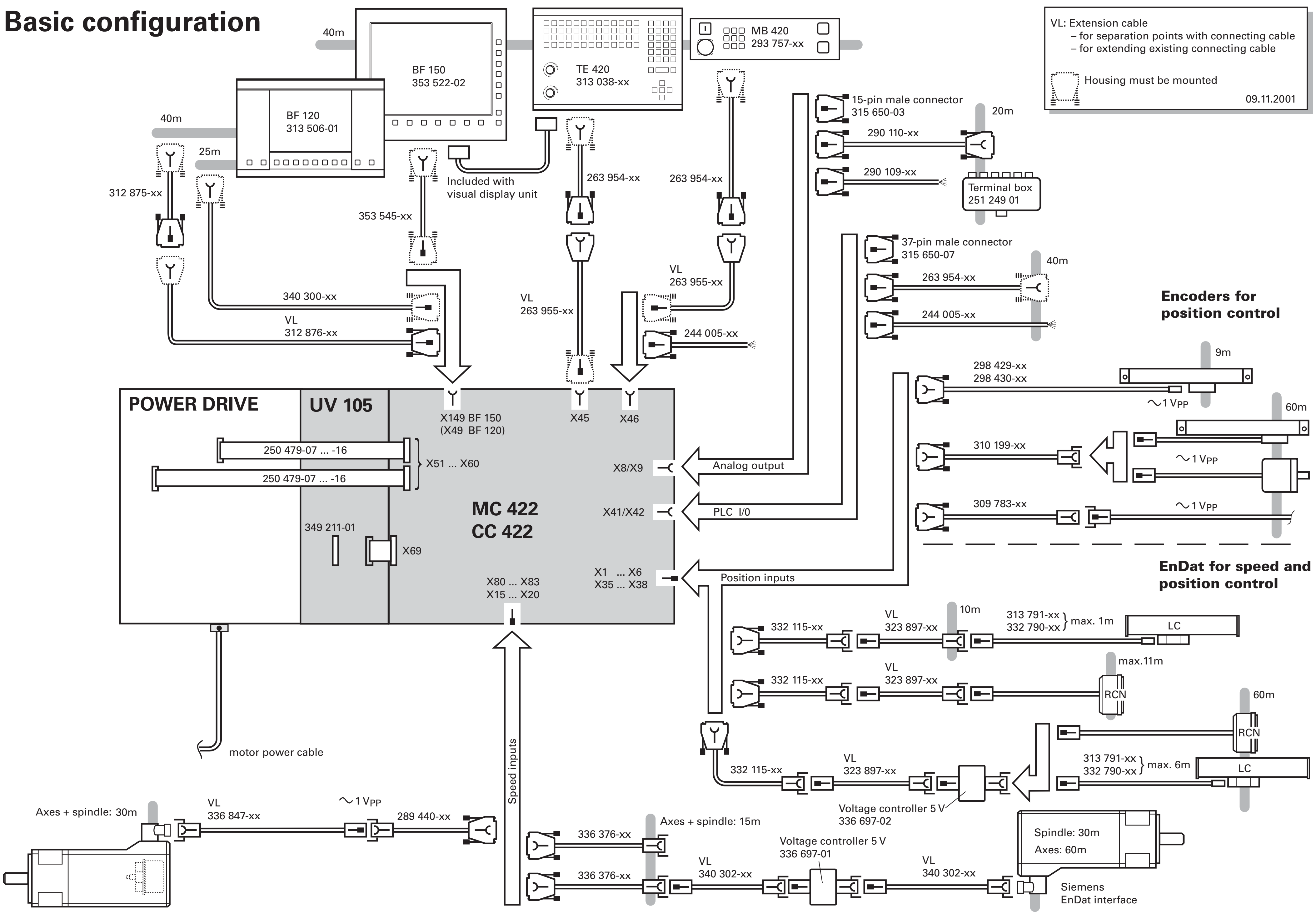

Basic configuration
Compact inverter
(not regenerative)
VL: Extension cable
– for separation points with connecting cable
– for extending existing connecting cable
Housing must be mounted
20.12.2001
BF 150
353 522-xx
BF 120
313 506-xx
TE 420
313 038-xx
MB 420
293 757-xx
12m
40m
25m
312 875-xx
353 545-xx
Included with
visual display unit
263 954-xx
263 954-xx
340 300-xx
VL
312 876-xx
VL
263 955-xx
VL
263 955-xx
244 005-xx
15-pin male connector
315 650-03
290 110-xx
290 109-xx
20m
Terminal box
251 249 01
37-pin male connector
315 650-07
263 954-xx
244 005-xx
40m
Encoders for
position control
298 429-xx
298 430-xx
9m
1 VPP
60m
310 199-xx
1 VPP
309 783-xx
1 VPP
UE 2xx B
UM 111
UV 105
PW 210
MC 422
CC 422
X149 BF 150
(X49 BF 120)
X45
X46
X8/X9
Analog output
X41/X42
PLC I/0
X1 ... X6
Position inputs
250 479-07 ... -16
X51 ... X60
325 817-xx
X69
X15 ... X20
X80 ... X83
EnDat for speed and
position control
332 115-xx
VL
323 897-xx
10m
313 791-xx
332 790-xx
max. 1m
LC
332 115-xx
VL
323 897-xx
max.11m
RCN
60m
RCN
332 115-xx
VL
323 897-xx
313 791-xx
332 790-xx
max. 6m
LC
Voltage controller 5 V
336 697-02
Rotary encoder
for speed control
Motor power cable
see Motors brochure
15m
1 VPP
Speed inputs
Axes + spindle: 30m
VL
336 847-xx
1 VPP
289 440-xx
336 376-xx
336 376-xx
Axes + spindle: 15m
Voltage controller 5 V
336 697-01
VL
340 302-xx
VL
340 302-xx
Spindle: 30m
Axes: 60m
Siemens
EnDat interface


Basic configuration
Compact inverter (regenerative)
VL: Extension cable
– for separation points with connecting cable
– for extending existing connecting cable
Housing must be mounted
20.12.2001
Line filter EPCOS 35 A 340 691-01
KDR 120 344 505-01
BF 120 313 506-xx
BF 150 353 522-xx
TE 420 313 038-xx
MB 420 293 757-xx
12m
40m
25m
312 875-xx
353 545-xx
Included with visual display unit
263 954-xx
263 954-xx
340 300-xx
VL 312 876-xx
VL 263 955-xx
VL 263 955-xx
244 005-xx
15-pin male connector 315 650-03
20m
290 110-xx
290 109-xx
Terminal box 251 249 01
37-pin male connector 315 650-07
40m
263 954-xx
244 005-xx
Encoders for position control
9m
298 429-xx
298 430-xx
1 Vpp
60m
310 199-xx
1 Vpp
309 783-xx
1 Vpp
UR 2xx
UM 111
UV 105
X149 BF 150
(X49 BF 120)
X45
X46
X8/X9
Analog output
250 479-07 ... -16
X51 ... X60
MC 422
CC 422
X41/X42
PLC I/0
325 817-xx
X69
X15 ... X20
X80 ... X83
X1 ... X6
Position inputs
EnDat for speed and position control
10m
VL
332 115-xx
323 897-xx
313 791-xx
332 790-xx
max. 1m
LC
max.11m
332 115-xx
VL 323 897-xx
RCN
60m
RCN
332 115-xx
VL 323 897-xx
313 791-xx
332 790-xx
max. 6m
LC
Voltage controller 5 V 336 697-02
Rotary encoder for speed control
Motor power cable see Motors brochure
15m
1 Vpp
VL 336 847-xx
289 440-xx
Axes + spindle: 30m
Speed inputs
336 376-xx
336 376-xx
Axes + spindle: 15m
VL 340 302-xx
Voltage controller 5 V 336 697-01
VL 340 302-xx
Spindle: 30m
Axes: 60m
Siemens EnDat interface

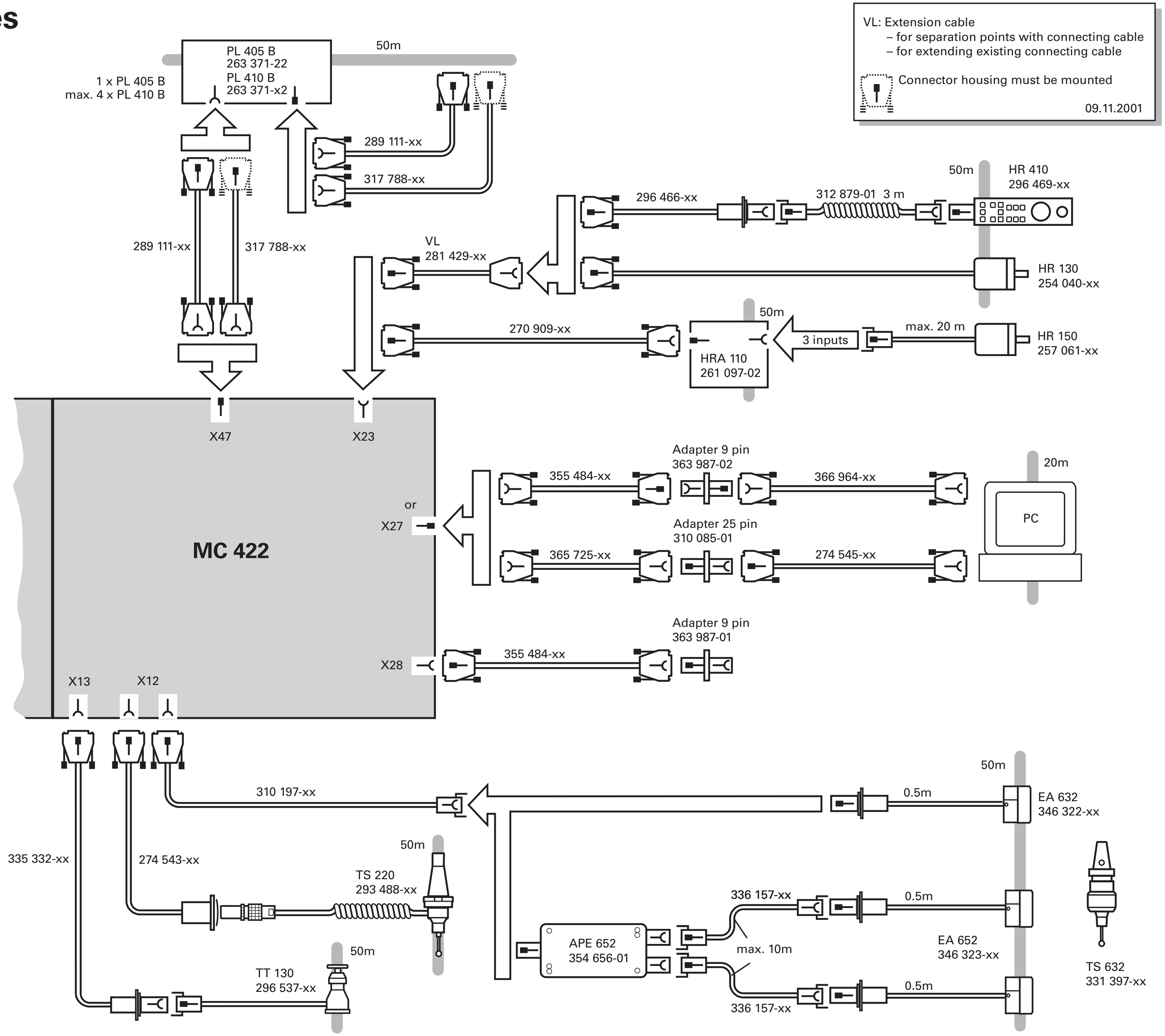
Basic configuration



Basic configuration



Accessories



4 Machine parameters

4 Machine parameters

4.1 What is a Machine Parameter?

A contouring control must have access to specific data (e.g., traverse distances, acceleration) before it can execute its programmed instructions. You define these data in machine parameters.

This list of machine parameters is divided into groups according to topic.

Machine parameters	Topics
10 to 999	Encoders and machines
1000 to 1399	Positioning
1400 to 1699	Operation with Velocity Feedforward Control
1700 to 1999	Operation with Following Error (Servo Lag)
2000 to 2999	Integrated Speed and Current Control
3000 to 3999	Spindle
4000 to 4999	Integral PLC
5000 to 5999	Data Interface
6000 to 6199	3-D touch probe
6500 to 6599	Tool measurement with triggering touch probe
7100 to 7199	Tapping
7200 to 7349	Programming and display
7350 to 7399	Colors
7400 to 7599	Machining and Program Run
7600 to 7699	Hardware

If there is more than one input value for a single function (e.g., a separate input for each axis), the parameter number is extended by indices. Index zero is always axis 1, index one is axis 2, etc.

Example:

MP1010.0-8	Rapid traverse
MP1010.0	Rapid traverse for axis 1
MP1010.1	Rapid traverse for axis 2
MP1010.2	Rapid traverse for axis 3
MP1010.3	Rapid traverse for axis 4
MP1010.4	Rapid traverse for axis 5
MP1010.5	Rapid traverse for axis 6
MP1010.6	Rapid traverse for axis 7
MP1010.7	Rapid traverse for axis 8
MP1010.8	Rapid traverse for axis 9

Enter into OEM.SYS, using the code word **AXISNUMBER =**, the number of axes being used, so that only the necessary index parameters are displayed.

With other machine parameters you can activate specific functions. In this case, the parameters serve as on/off switches for these functions. These parameters are bit-encoded. Each bit is assigned either to an axis or a function.

4.2 Input and Output of Machine Parameters

If the machine parameters have not yet been entered in a HEIDENHAIN contouring control (e.g., before commissioning), the iTNC presents the list of machine parameters after the memory test:

- Enter the values for the machine parameters either by hand on the keyboard or download them through the data interface.

4.2.1 Input Format

You can enter the input values either in decimal, binary (%) or hexadecimal ($) format.

- Enter a number for each machine parameter.

The value represents, for example, the acceleration in mm/s^2 or the analog voltage in V. You can add a comment to your entry be preceding it with a semicolon “;”. Binary input (%) is the best format for machine parameters that activate individual functions bit-encoded.

Example: Disabling soft keys for file types with MP7224.0

Bit 0	HEIDENHAIN programs	.H
Bit 1	ISO programs	.I
Bit 2	Tool tables	.T
Bit 3	Datum tables	.D
Bit 4	Pallet tables	.P
Bit 5	Text files	.A
Bit 6	HELP files	.HLP
Bit 7	Point tables	.PNT

The soft keys for datum tables and text files are to be disabled:

0: Do not disable
1: Disable

Input value for MP7224.0 =	Binary	%00101000
	Hexadecimal	$28
	Decimal	40 (32+8)

Special case: Entering a formula

Only for MP2020.x (linear distance of one motor revolution) and for MP7530.x (type of dimension for transformation).

You can enter a formula instead of a fixed value. When entering the formula, you must pay attention to the case of the letters (whether they are small or capital). Functions are written small, variables are written in capitals.

Functions:

+	Addition	sin	Sine
–	Subtraction	cos	Cosine
·	Multiplication	tan	Tangent
/	Division	asin	Arc sine
log	Logarithm	acos	Arc cosine
log10	Logarithm to the base of 10	atan	Arc tangent
exp	Exponent	sqrt	Square root
()	Expressions in parentheses are solved	sqr	Square

Variable:

REF	Current position of the axis relative to the machine datum (resolution 0.0001 mm or °)

4.2.2 Activating the Machine Parameter List

After you have entered all the values for the machine parameters:

- Exit the machine parameter list by pressing the END key.

Missing or incorrect entries result in error messages from the control that prompt you to correct your entry. The following errors are displayed:

Input error	Meaning
0	No MP number found
1	Invalid MP number
2	No separator (:) found
3	Input value incorrect
4	MP doubly defined
6	MP cannot be stored

If the control does not recognize any errors, it automatically exits the machine parameter editor and is ready for operation.

If you do not make any entries in the machine parameter list during initial commissioning and exit the editor with the END key, the iTNC generates a standard machine parameter list (MP NAME). In this list the iTNC is defined as a programming station with the HEIDENHAIN standard colors. In all other machine parameters a default value is entered.

You can enter more than one machine parameter list in the iTNC:

- Select the lists with the PGM MGT key and the SELECT soft key. The last selected machine parameter list becomes active when you exit the machine parameter editor.

4.2.3 Changing the Input Values

A machine parameter list can be changed either with the machine parameter editor or directly through the PLC. The "List of Machine Parameters" includes the following symbols:

Symbol	Change by / Reaction
CN123	The MP is also accessible through the code number 123.
PLC	The MP can be changed via the PLC; it can also be changed in a running NC program during a strobe output.
RUN	The MP can also be changed while an NC program is running.
RESET	Changing the MP results in a reset.
REF	The axis must be moved over the reference mark again.

Manual input

- Call the machine parameter editor through the MOD function "code number":
  - By entering the code number **95148**, you gain access to the complete list of machine parameters.
  - By entering the code number **123**, you gain access to a subset of machine parameters. This subset can be changed by the user (see User's Manual). Machine parameters that can be accessed through the code number 123 are indicated in the list with the symbol CN123.
- To exit the machine parameter editor, press the END key.

User parameters

You can access some machine parameters without first entering a code number.

- In MP7330.x, define up to 16 machine parameters and define the associated dialog in MP7340.x. The dialog is shown whenever the USER PARAMETERS soft key is pressed.
- Select the MOD function USER PARAMETER.

Protecting the machine parameter list

To protect the current machine parameter list from being edited through the code number 95148:

- In the OEM.SYS file, define a new code number in the entry `MPPASSWORD =` for editing the machine parameter list. Then it is **no longer possible** to edit through the code number 95148.

To protect individual machine parameters against editing:

- In the `MPLOCKFILE =` entry in the OEM.SYS file, enter the path of a machine-parameter subfile. Then it is only possible to edit those machine parameters that have no value assigned in this file. If there is a difference between the current MP value and the MP value in this subfile, the control displays an error message and a window offering the value from the subfile for your acceptance.

Changing the input values via PLC

You can also change the machine parameters through the PLC. The following modules are available for this purpose

- Module 9031 Overwrite machine parameter
- Module 9032 Read machine parameter
- Module 9310 Read the machine parameter from the run-time memory
- Module 9033 Select machine parameter file
- Module 9034 Load machine parameter subfile

The machine parameters that you can change with Module 9031 or Module 9034 are indicated with PLC in the overview.

Module 9031 Overwrite machine parameters

With this module you can overwrite the value of the given machine parameter with a new value. The input value must be a natural number with the decimal point shifted by the number of possible decimal places.

Example:

Example: MP910.0 = 100.12 [mm] Transfer value: 1001200 (4 decimal places)

The value in the run-time memory is changed. The value from the editable machine parameter file does not change. The old value becomes valid again after the machine parameter file is edited and exited.

For non-indexed machine parameters, zero must be transferred as the index. Once the NC program has started, the module operates only during the output of an M/S/T/Q strobe.

Call only in a submit job.

Call:

```
PS   B/W/D/K  <>MP number>
PS   B/W/D/K  <>MP index>
PS   B/W/D    <>MP value>
CM   9031
PL   B/W/D    <>Error code>
              0: No error
              1: MP does not exist / is not changeable / is not changeable
              during a running program
              2: MP value out of range
              3: Error while saving (fatal error)
              4: Call was not in a submit or spawn job
              5: Call during running program without strobe
```

Error detection:

Marker	Value	Meaning
M4203	0	MP was overwritten
	1	MP could not be overwritten

Module 9032 Read machine parameters

With this module you can read the value of the given machine parameter from the active machine parameter file. The input value is transferred as a natural number with the decimal point shifted by the number of possible decimal places.

Only the value from the editable machine parameter file is read, not any value modified in the run-time memory by PLC Module 9031.

For non-indexed machine parameters, zero must be transferred as the index.

Call only in a submit job.

Call:

```
PS    B/W/D/K    <>MP number>
PS    B/W/D/K    <>MP index>
CM    9032
PL    B/W/D      <>MP value / Error code>
                 1: MP number does not exist
                 2: No separator (:)
                 3: MP value out of range
                 4: MP not found in file
                 5: No MP file found
                 6: Call was not in a submit or spawn job
                 7: MP is of the “string” type
                 8: No system memory
```

Error detection:

Marker	Value	Meaning
M4203	0	MP was read
	1	MP could not be read from the table

Module 9310 Read the machine parameter from the run-time memory

With this module you can read the value of the given machine parameter from the run-time memory. The input value is transferred as a natural number with the decimal point shifted by the number of possible decimal places.

A value is read from the run-time memory.

For non-indexed machine parameters, zero must be transferred as the index.

Call:

```
PS      B/W/D/K   <>MP number>
PS      B/W/D/K   <>MP index>
CM      9310
PL      B/W/D     <>MP value/error code>
                  1: MP number does not exist
                  6: Call was not in a submit or spawn job
                  7: MP is of the “string” type
                  8: No system memory
```

Error detection:

Marker	Value	Meaning
M4203	0	MP was read
	1	Error code in W1022
W1022	20	Module was not called in a spawn job or submit job

Module 9033 Select machine parameter file

With this module you can select a new machine parameter file. If machine parameter files that set off a reset were changed, the control system will restart.

> **Warning**
>
> The module does not respect any existing safety problems when setting off a control reset (e.g., axes and spindle coasting to a stop).

The file to be selected is checked; a faulty file is not selected. If file selection is successful, there is no return to the calling PLC program.

The file name is transferred in a string that must contain the complete path, name and file extension. Further characters, even space characters, are not permitted.

If the PLC program is created externally, ensure that lower-case letters are not used for the file name!

Once the NC program has started, the module operates only during the output of an M/S/T/Q strobe.

Call only in a submit job.

Call:

```
PS      B/W/D/K     <>String number>
           0 to 15
CM      9033
           Note: If a new file is selected, program execution ends here.
PS      B/W/D       <>Error code>
           0: No error. File was already selected.
           1: String does not contain a valid file name
           2: File not found
           3: File is faulty
           4: Incorrect string number transferred
           5: Call was not in a submit job
           6: Call during running program without strobe
```

Module 9034 Load a machine parameter subfile

With this module you load the contents of the given machine parameter into the main memory. All MPs not listed in this file remain unchanged.

The MP file to be selected is checked. A faulty file is not loaded. If the MP file contains parameters that require a system reset, the file is not loaded.

The file name is transferred in a string that must contain the complete path, name and file extension. Further characters, even space characters, are not permitted.

If the PLC program is created externally, ensure that lower-case letters are not used for the file name!

Once the NC program has started, the module operates only during the output of an M/S/T/Q strobe.

Call only in a submit job.

Call:

PS	B/W/D/K	<>String number> 0 to 3
CM	9034	
PL	B/W/D	<>Error code> 0: No error 1: String does not contain a valid file name, or the name (including the path) is too long. 2: File not found 3: File is faulty / contains reset parameters 4: Incorrect string number was transferred (0 to 3) 5: Call was not in a submit job 6: Call during running program without strobe

4.3 List of Machine Parameters

4.3.1 Encoders and Machines

MP	Function and input	Software version and behavior	Page
MP10	Active axes Format: %xxxxxxxxxxxxxx Input: Bits 0 to 13 correspond to axes 1 to 14 0: Axis not active 1: Axis active		6 – 3
MP20	Monitoring functions for the axes Format: %xxxxxxxxxxxxxx Input: Bits 0 to 13 correspond to axes 1 to 14 0: Monitoring not active 1: Monitoring active	PLC RUN	6 – 10
MP20.0	Absolute position of the distance-coded reference marks		
MP20.1	Amplitude of encoder signals		
MP20.2	Edge separation of encoder signals		
MP21	Monitoring functions for the spindle Format: %xx Input: Bit 0 – Spindle 1 0: Monitoring not active 1: Monitoring active Bit 1 – Spindle 2 0: Monitoring not active 1: Monitoring active	PLC RUN	6 – 10
MP21.0	No function		
MP21.1	Amplitude of encoder signals		
MP21.2	Edge separation of encoder signals		
MP100	Designation of axes Format: XYZABCUVWxyzabcuvw- Input: Characters 1 to 9 correspond to axes 1 to 9	PLC RUN	6 – 3, 6 – 26
MP100.0	Traverse range 1		
MP100.1	Traverse range 2		
MP100.2	Traverse range 3		
MP110.x	Assignment of position encoder inputs to the axes Input: 0: No position encoder input 1 to 6: Position encoder inputs X1 to X6 35 to 38: Position encoder inputs X35 to X38	RESET	6 – 13
MP111	Position encoder input for the spindle/spindles Input: 0: No position encoder input 1 to 6: Position encoder inputs X1 to X6 35 to 38: Position encoder inputs X35 to X38	REF	6 – 15, 6 – 180
MP111.0	Position encoder input for the first spindle		
MP111.1	Position encoder input for the second spindle		

MP	Function and input	Software version and behavior	Page
MP112.x	Assignment of speed encoder inputs to the axes Input: 0: No speed encoder input 15 to 20: Speed encoder inputs X15 to X20 80 to 83: Speed encoder inputs X80 to X83	RESET	6 – 13
MP113	Speed encoder for the spindle/spindles Input: 0: No speed encoder input 15 to 20: Speed encoder inputs X15 to X20 80 to 83: Speed encoder inputs X80 to X83	REF	6 – 15, 6 – 182
MP113.0	Speed encoder for the first spindle		
MP113.1	Speed encoder for the second spindle		
MP115.0	Position encoder input 1 V_{PP} or 11 μA_{PP} Format: %xxxxxxxxxxx Input: Bit 0 to bit 5: Position encoder inputs X1 to X6 Bit 6 to bit 9: Position encoder inputs X35 to X38 Bit 10: Nonfunctional 0: 1 V_{PP} 1: 11 μA_{PP}	RESET	6 – 8
MP115.1	Reserved Format: %xxxxxxxxxxx Input: Enter %00000000000		
MP115.2	Input frequency of the position encoder inputs Format: %xxxxxxxxxxx Input: Bit 0 to bit 5: Position encoder inputs X1 to X6 Bit 6 to bit 9: Position encoder inputs X35 to X38 Bit 10: Nonfunctional With 1 V_{PP}: 0: 50 kHz 1: 350 kHz With 11 μA_{PP}: 0: 50 kHz 1: 150 kHz		

MP	Function and input	Software version and behavior	Page
MP120.x	Nominal speed command outputs of the axes Input: 0: No servo-controlled axis 1 to 6: Analog outputs 1 to 6 at terminal X8 7 to 12: Analog outputs 7 to 13 at terminal X9 51 to 60: Digital output X51 to X60	PLC RUN	6 – 13
MP121.0	Nominal speed command output of the first spindle Input: 0: No servo-controlled axis 1 to 6: Analog outputs 1 to 6 at terminal X8 7 to 12: Analog outputs 7 to 13 at terminal X9 51 to 60: Digital output X51 to X60	PLC RUN	6 – 15
MP121.1	Nominal speed command output of the second spindle Input: 0: No servo-controlled axis 1 to 6: Analog outputs 1 to 6 at terminal X8 7 to 12: Analog outputs 7 to 13 at terminal X9 51 to 60: Digital output X51 to X60	PLC RUN	
MP130.x	Y index of the machine parameters MP2xxx.y for the axes Input: 0 to 9	PLC RUN	6 – 13
MP131	Y index of the machine parameters MP2xxx.y for the spindle in operating mode 0 Input: 0 to 9	PLC RUN	6 – 15
MP131.0	Index for the first spindle		
MP131.1	Index for the second spindle		
MP132	Y index of the machine parameters MP2xxx.y for the spindle in operating mode 1 Input: 0 to 9	PLC RUN	6 – 15
MP132.0	Index for the first spindle		
MP132.1	Index for the second spindle		
MP210	Counting direction of position encoder output signals Format: %xxxxxxxxxxxxxx Input: Bits 0 to 13 correspond to axes 1 to 14 0: Positive 1: Negative	RESET	6 – 9

MP	Function and input	Software version and behavior	Page
MP331.x	Distance for the number of signal periods in MP332 Input: 0.0001 to 99.999 999 9 [mm] or [°]	PLC RUN REF	6 – 7
MP332.x	Number of signal periods for the distance in MP331 Input: 1 to 16 777 215	PLC RUN REF	6 – 7
MP334.x	Nominal increment between two fixed reference marks on encoders with distance-coded reference marks Input: 1 to 65 535 0: 1 000	PLC RUN REF	6 – 7
MP340.x	Interpolation factor for external interpolation Input: 0 to 99 0 = 1: No external interpolation	RESET	6 – 7
MP410	Assignment of axis keys IV and V Input: Axis designation XYZABCUVWxyzabcuvw–	PLC RUN	6 – 3
MP410.3	Axis key IV		
MP410.4	Axis key V		
MP420.x	Hirth coupling Input: 0: No Hirth coupling 1: Hirth coupling	PLC RUN	
MP430.x	Prescribed increment for Hirth coupling Input: 0.0000 to 30.0000 [°]	PLC RUN	
MP710.x	Backlash compensation Input: -1.0000 to +1.0000 [mm] or [°]	PLC RUN	6 – 34
MP711.x	Height of peaks during circular movement (only analog) Input: -1.0000 000 to +1.0000 999 [mm] (digital: 0)	PLC RUN	6 – 45
MP712.x	Compensation value per control loop cycle time Input: 0.000 000 to 99.999 999 [mm] (digital: 0)	PLC RUN	6 – 45
MP715.x	Height of peaks during circular movement (only analog) with M105 Input: -1.0000 000 to +1.0000 999 [mm] (digital: 0)	PLC RUN	6 – 45
MP716.x	Compensation value per control loop cycle time with M105 Input: 0.000 000 to 99.999 999 [mm] (digital: 0)	PLC RUN	6 – 45
MP720.x	Linear axis error compensation Input: –1000 to +1.000 [mm/m]	PLC RUN	6 – 36
MP730	Selection of linear/nonlinear axis error compensation Format: %xxxxxxxxxxxxxx Input: Bits 0 to 3 correspond to axes 1 to 14: 0: Linear axis error compensation 1: Nonlinear axis error compensation	PLC RUN	6 – 36, 6 – 41

MP	Function and input	Software version and behavior	Page
MP750.x	Reversal error Input: -1.0000 to +1.0000 [mm] or [°]	PLC RUN	6 – 35
MP752.x	Compensation time for reversal error Input: 0 to 1000 [ms]	PLC RUN	6 – 35
MP810.x	Display mode for rotary axes and PLC auxiliary axes Input: 0.0000 to 99 999.9999 [°] 0: Display +/–99 999.9999 1: Modulo value for display	PLC RUN REF	
MP812	Activate software limit switches for tilting axes with modulo display, M94 and encoders with EnDat interface Format: %xxxxxxxxxxxxxx Input: Bits 0 to 3 correspond to axes 1 to 14: 0: Software limit switch not active 1: Software limit switch active	RESET	
MP850.x	Synchronized axes Input: 0: Master axis 1: Slave axis to axis 1 2: Slave axis to axis 2 3: Slave axis to axis 3 4: Slave axis to axis 4 5: Slave axis to axis 5 6: Slave axis to axis 6 7: Slave axis to axis 7 8: Slave axis to axis 8 9: Slave axis to axis 9	PLC RUN	6 – 86
MP855.x	Synchronization monitoring Input: 0 to 100.0000 [mm] 0: Monitoring not active	PLC RUN	6 – 88
MP860.x	Datum for synchronous control Input: 0: Datum at position after switch-on 1: Datum at reference marks 2: Axis is torque slave axis	PLC RUN	6 – 88, 6 – 93
MP910.x	Positive software limit switches, traverse range 1 (default setting after power on) Input: -99 999.9999 to +99 999 [mm] or [°]	PLC RUN	6 – 23
MP911.x	Positive software limit switches, traverse range 2 Input: -99 999.9999 to +99 999 [mm] or [°]	PLC RUN	6 – 23
MP912.x	Positive software limit switches, traverse range 3 Input: –99 999.9999 to +99 999 [mm] or [°]	PLC RUN	6 – 23
MP920.x	Negative software limit switches, traverse range 1 (default setting after power on) Input: -99 999.9999 to +99 999 [mm] or [°]	PLC RUN	6 – 23

MP	Function and input	Software version and behavior	Page
MP921.x	Negative software limit switches, traverse range 2 Input: -99 999.9999 to +99 999 [mm] or [°]	PLC RUN	6 – 23
MP922.x	Negative software limit switches, traverse range 3 Input: -99 999.9999 to +99 999 [mm] or [°]	PLC RUN	6 – 23
MP950.x	Datum for positioning blocks with M92 for axes 1 to 9 Input: -99 999.9999 to +99 999.9999 [mm] or [°] Values with respect to the machine datum	PLC RUN	
MP951.x	Simulated tool-change position for TOOL CALL during mid-program startup (block scan) Input: -99 999.9999 to +99 999.9999 [mm] or [°]	PLC RUN	
MP960.x	Machine Datum Input: -99 999.9999 to +99 999.999 [mm] or [°] Values with respect to the scale reference point	PLC RUN REF	6 – 101

4.3.2 Positioning

MP	Function and input	Software version and behavior	Page
MP1010.x	Rapid traverse Input: 10 to 300 000 [mm/min]	PLC RUN	6 – 127
MP1020.x	Manual feed Input: 10 to 300 000 [mm/min]	PLC RUN	6 – 127
MP1030.x	Positioning window Input: 0.0001 to 2.0000 [mm]	PLC RUN	6 – 166
MP1040	Analog axes: Polarity of nominal value voltage Digital axes: Algebraic sign of the nominal speed value Format: %xxxxxxxxxxxxxx Input: Bits 0 to 13 correspond to axes 1 to 14 0: Positive 1: Negative		6 – 9
MP1050.x	Analog axes: Analog voltage at rapid traverse Input: 1 000 to 9 000 [V] Digital axes: without function Input: 1	PLC RUN	6 – 127
MP1054.x	Linear distance of one motor revolution Input: Analog axes: without function Digital axes: 0 to 100.000 [mm] or [°]		6 – 165
MP1060.x	Acceleration Input: 0.001 to 100.000 [m/s or 1000°/s^2]	PLC RUN	6 – 117
MP1070	Radial acceleration Input: 0.001 to 100.000 [m/s or 1000°/s^2]	PLC RUN	6 – 158
MP1080.x	Analog axes: Integral factor for offset adjustment Input: Enter 0 to 65 535 Digital axes: nonfunctional Input: 0	PLC RUN	6 – 157
MP1086.x	Maximum permissible jerk during single-axis movements at rapid traverse for the operating modes Program Run Full Sequence, Program Run Single Block, and Positioning with Manual Data Input. Input: 0: Function inactive 0.1 to 1000.0 [m/s or 1000°/s]	PLC RUN	
MP1087.x	Max. permissible axis-specific jerk for Manual mode Input: 0.1 to 1000.0 [m/s or 1000°/s]	PLC RUN	6 – 117
MP1089.x	Max. permissible axis-specific jerk for Pass Over Reference Point mode Input: 0.1 to 1000.0 [m/s or 1000°/s]	PLC RUN	6 – 117

MP	Function and input	Software version and behavior	Page
MP1090	Maximum permissible jerk on the tool path Input: 0.1 to 1000.0 [m/s or 1000°/s]	PLC RUN	6 – 117
MP1090.0	With machining feed rate		
MP1090.1	Beginning with feed rate from MP1092		
MP1092	Feed rate threshold from which MP1090.1 becomes effective Input: 10 to 300 000 [mm/min]	PLC RUN	6 – 117
MP1094	HSC filter Input: 0: HSC filter inactive 0.1 to 166.0: Cutoff frequency for HSC filter	280 474-07	6 – 117
MP1095	Nominal position value filter Input: 0: Single filter 1: Double filter	PLC RUN	6 – 117
MP1095.0	In the Program Run, Full Sequence; Program Run, Single Block; and Positioning With Manual Data Input operating modes		
MP1095.1	In the Manual, Handwheel, Jog Increment and Pass Over Reference Point operating modes		
MP1096	Tolerance for contour transitions Input: 0: No nominal position value filter 0.001 to 3.000 [mm]	PLC RUN	6 – 117, 6 – 159
MP1097.x	Max. permissible axis-specific jerk (single/HSC filter) Input: 0.1 to 1000.0 [m/s or 1000°/s]	PLC RUN	6 – 117
MP1098.x	Max. permissible axis-specific jerk (double/HSC filter) Input: 0.1 to 1000.0 [m/s or 1000°/s]	PLC RUN	6 – 117
MP1099	Minimum filter order Input: 0 to 20	PLC RUN	6 – 117
MP1099.0	Minimum filter configuration for single filter (MP1095 = 0)		
MP1099.1	Minimum filter configuration for double filter (MP1095 = 1)		
MP1110.x	Standstill monitoring Input: 0.0010 to 30.0000 [mm]	PLC RUN	6 – 166
MP1140.x	Threshold at which the movement monitoring goes into effect. Input: Analog axes: 0.030 to 10.000 [V] Digital axes: 0.030 to 10.000 [1000 min] Recommended: 0.030 [1000 min]	PLC RUN	6 – 165
MP1144.x	Motion monitor for position and speed Input: Analog axes: without function Digital axes: 0 to 99 999.999 [mm] 0: No monitoring	PLC RUN	6 – 165

MP	Function and input	Software version and behavior	Page
MP1150.0 MP1150.1 MP1150.2	Delay time for deleting the nominal velocity value with the erasable error message **EXCESSIVE SERVO LAG IN <AXIS.>** Input: 0 to 65.535 [s] Recommended: 0 Time period for which the monitoring function is to remain off after the fast PLC input defined in MP4130.0 is set. Input: 0 to 65.535 [s] 0: Monitoring functions on Recommended: 0.2 to 0.5 Minimum time period for which the monitoring functions are to remain effective after expiration of the time from MP1150.1. Input: 0 to 65.535 [s]	PLC RUN	6 – 129, 6 – 162; 6 – 164
MP1320	Direction for traversing the reference marks Format: %xxxxxxxxxxxxxx Input: Bits 0 to 13 correspond to axes 1 to 14 0: Positive 1: Negative	PLC RUN	6 – 101
MP1330.x	Velocity for traversing the reference marks Input: 80 to 300 000 [mm/min]	PLC RUN	6 – 101
MP1331.x	Velocity for leaving the reference mark end position for axes 1 to 9 (only for rotary encoders MP1350 = 2) Input: 10 to 300 000 [mm/min]	PLC RUN	6 – 101
MP1340.x	Sequence for traversing the reference marks Input: 0: No evaluation of reference marks 1 to 14: Axes 1 to 14	PLC RUN REF	6 – 101
MP1350.x	Type of reference mark traverse Input: 0: Linear encoder with distance-coded reference marks (old routine) 1: Position encoder with one reference mark 2: Special type (length measurement with ROD) 3: Linear encoder with distance-coded reference marks (new routine) 4: Same as 3 except that two reference marks are evaluated 5: Encoder with EnDat interface 6: Reference pulse over fast PLC input	PLC RUN REF	6 – 101
MP1355	Reference run Format: %xxxxxxxxxxxxxx Input: Bits 0 to 13 correspond to axes 1 to 14 0: Reference run as defined in MP1350.x 1: Reference run over EnDat interface of the speed encoder	PLC RUN REF 340 420-02	6 – 101

MP	Function and input	Software version and behavior	Page
MP1356.x	Difference between speed and position encoder, if MP1355 = 1 Input: -99 999.999 to +99 999.999 [mm] or [°]	PLC RUN REF 340 420-02	6 – 101
MP1360.x	Fast PLC input for reference pulse Input: 0: No fast PLC input for reference pulse 1 to 5: Fast PLC input 1 to 5 (MP4130.x)	PLC RUN REF	6 – 101
MP1391	Velocity feedforward control in the MANUAL and HANDWHEEL operating modes Format: %xxxxxxxxxxxxxx Input: Bits 0 to 13 correspond to axes 1 to 14 0: Operation with following error (lag) 1: Operation with velocity feedforward control	PLC RUN	6 – 47, 6 – 120
MP1392	Velocity feedforward in the POSITIONING WITH MANUAL DATA INPUT, PROGRAM RUN SINGLE BLOCK and PROGRAM RUN FULL SEQUENCE operating modes Format: %xxxxxxxxxxxxxx Input: Bits 0 to 13 correspond to axes 1 to 14 0: Operation with following error (lag) 1: Operation with velocity feedforward control	PLC RUN	6 – 120
MP1396.x	Feedback control with velocity semifeedforward Input: 0.001 to 0.999 1: Velocity feedforward control	PLC RUN	6 – 126

4.3.3 Operation with Velocity Feedforward Control

MP	Function and input	Software version and behavior	Page
MP1410.x	Position monitoring for operation with velocity feedforward control (erasable) Input: 0.0010 to 30.0000 [mm] Recommended: 0.5 mm	PLC RUN	6 – 164
MP1420.x	Position monitoring for operation with velocity feedforward control (EMERGENCY STOP) Input: 0.0010 to 30.0000 [mm] Recommended: 2 mm	PLC RUN	6 – 164
MP1510.x	k_V factor for velocity feedforward control Input: 0.100 to 1 000.000 [(m/min)/mm]	PLC RUN	6 – 124
MP1511.x	Factor for static friction compensation Input: 0 to 16 777 215 [s]	PLC RUN	6 – 47
MP1512.x	Limitation of the amount of the static friction compensation Input: 0 to 16 777 215 [counting steps]	PLC RUN	6 – 47
MP1513.x	Feed-rate limitation for static friction compensation Input: 0 to 300 000 [mm/min]	PLC RUN	6 – 47
MP1515.x	k_V factor for velocity feedforward control effective after M105 Input: 0.100 to 20.000 [(m/min)/mm]	PLC RUN	6 – 124
MP1516.x	k_V factor for velocity semifeedforward control Input: 0.100 to 20.000 [(m/min)/mm]	PLC RUN	6 – 126
MP1521	Transient response during acceleration and deceleration Input: 1 to 255 [ms] 0: Function inactive	PLC RUN	6 – 117

4.3.4 Operation with Following Error (Servo Lag)

MP	Function and input	Software version and behavior	Page
MP1710.x	Position monitoring for operation with following error (erasable) Input: 0.0000 to 300.0000 [mm] Recommended: 1.2 · following error	PLC RUN	6 – 164
MP1720.x	Position monitoring for operation with following error (EMERGENCY STOP) Input: 0.0000 to 300.0000 [mm] Recommended: 1.4 · following error	PLC RUN	6 – 164
MP1810.x	k_V factor for control with following error Input: 0.100 to 20.000 [(m/min)/mm]	PLC RUN	6 – 122
MP1815.x	k_V factor for control with following error effective after M105 Input: 0.100 to 20.000 [(m/min)/mm]	PLC RUN	6 – 122
MP1820.x	Multiplier for the k_V factor Input: 0.001 to 1.00000	PLC RUN	6 – 128
MP1830.x	Characteristic curve kink point Input: 0.000 to 100.000 [%]	PLC RUN	6 – 128

4.3.5 Integrated Speed and Current Control

MP	Function and input	Software version and behavior	Page
MP2040	Groups for drive enabling through X150 Format: %xxxxxxxxx Input: 0: Axis not assigned 1: Axis assigned	PLC RUN	6 – 142
MP2040.0-5	Groups 1 to 6		
MP2040.6-7	Reserved, enter %000000000		
MP2050	Functionality of drive enabling I32 (X42/33) Input: 0: Emergency stop for all axes, Module 9169 not effective 1: Emergency stop for all axes that are not excepted with Module 9169 2: I32 and Module 9169 are without functionality		6 – 142
MP2100.x	Power stage model Input: Name of the selected power module (entered by the iTNC)	RESET	6 – 220
MP2150	Signal for power fail Input: 0: AC fail 1: Power fail and AC fail 2: Neither power fail nor AC fail 3: Power fail		6 – 168
MP2160	Protection against failure of power supply for synchronous motor in field-weakening range Input: 0: Do not protect 1: Protect		6 – 155
MP2170	Waiting time between the switch-on of the drive and the drive's standby signal Input: 0.001 to 4.999 [s] 0: 2 [s]		6 – 142
MP2180.x	PWM frequency Input: 0: f_{PWM} = 5000 Hz (for HEIDENHAIN inverters) 3200 to 4000: f_{PWM} = 3330 Hz 4001 to 4999: f_{PWM} = 4166 Hz 5000 to 6000: f_{PWM} = 5000 Hz 6001 to 8000: f_{PWM} = 6666 Hz 8001 to 9999: f_{PWM} = 8000 Hz 10000: f_{PWM} = 10000 Hz	RESET	6 – 223
MP2190	dc link voltage U_Z Input: 0 to 10 000 [V] HEIDENHAIN inverters: UE 2xx, UE 2xxB, UV 130: 565 V UR 2xx, UV 120, UV 140, UV 150: 650 V		6 – 228

MP	Function and input	Software version and behavior	Page
MP2200.x	Motor model Input: Name of the selected motor (entered by the iTNC)	RESET	6 – 220
MP2220.x	Monitoring functions Format: %xxx Input: Bit 0 – Monitoring the reference mark 0: Monitoring active 1: Monitoring inactive Bit 1 – Monitoring the direction of rotation 0: Monitoring active 1: Monitoring inactive Bit 2 – Monitoring the ERR-IZ signal 0: Monitoring inactive (Non-HEIDENHAIN inverters, UE 2xx) 1: Monitoring active (All HEIDENHAIN inverters except UE 2xx)	PLC RUN	6 – 153; 6 – 182
MP2302.x	Reference value for I^2t monitoring Input: 0 to 1 000.000 [· rated current of motor] 0: I^2t monitoring of feed motors switched off 1: Rated current of motor as reference value		6 – 173
MP2312.x	Reference value for utilization of feed motors for axes 1 to 9 Input: 0 to 1 000.000 [· rated current of motor] 0 or 1: Reference value is rated current of motor		6 – 174
MP2390.x	Max. braking performance in an emergency stop Input: 0.1 to 3 000.000 [kW] 0: Braking power is not limited		6 – 150
MP2392.x	Power limit Input: 0: No power limit 0.1 to 3 000.000 [kW]		6 – 153
MP2394.x	Maximum braking power during a power fail Input: 0.1 to 3 000.000 [kW] 0: Braking power is not limited		6 – 150
MP2396.x	Maximum torque Input: 0.1 to 30 000.0 [Nm] 0: Torque is not limited	PLC	6 – 153
MP2420.x	Proportional factor of the current controller Input: 0.00 to 9999.99 [VA]		6 – 147
MP2430.x	Integral factor of the current controller Input: 0.00 to 9999.99 [V/As]		6 – 147
MP2500.x	Proportional factor of the shaft speed controller Input: 0 to 1 000 000.000 [As]	PLC RUN	6 – 134
MP2510.x	Integral factor of the shaft speed controller Input: 0 to 100 000 000 [A]	PLC RUN	6 – 134

MP	Function and input	Software version and behavior	Page
MP2512.x	Limiting the integral factor of the speed controller Input: 0.000 to 30.000 [s] (realistically: 0.1 to 2.0)	PLC RUN	6 – 47, 6 – 137
MP2520.x	Differential factor of the shaft speed controller Input: 0 to 1.0000 [As]	PLC RUN	6 – 135
MP2530.x	PT_2 element of the shaft speed controller (2nd-order delay) Input: 0 to 1.0000 [s]	PLC RUN	6 – 136
MP2540.x	Band-rejection filter damping Input: 0.0 to 18.0 [dB]	PLC RUN	6 – 136
MP2550.x	Band-rejection filter for center frequency Input: 0.0 to 999.9 [Hz]	PLC RUN	6 – 136
MP2560.x	Low-pass filter Input: 0: No low-pass filter 1: 1st-order low-pass filter 2: 2nd-order low-pass filter	PLC RUN	6 – 135
MP2590.x	Braking ramp in an emergency stop Input: 0.1 to 999.9 [rpm/ms] 0: Function inactive	PLC RUN	6 – 149
MP2600.x	Acceleration feedforward Input: 0 to 100.0000 [A/(rev/s)]	PLC	6 – 137
MP2602.x	IPC time constant T_1 Input: 0.0001 to 1.0000 [s] 0: IPC inactive	PLC RUN	6 – 139
MP2604.x	IPC time constant T_2 Input: 0.0001 to 1.0000 [s] 0: IPC inactive	PLC RUN	6 – 139
MP2606.x	Following error in the jerk phase Input: 0.000 to 10 000	PLC RUN	6 – 139
MP2610.x	Friction compensation at low speeds (effective only with velocity feedforward control) Input: 0 to 30.0000 [A] 0: No friction compensation (or axis is analog)	PLC RUN	6 – 48
MP2612.x	Delay of the friction compensation (effective only with velocity feedforward control) Input: 0.0000 to 1.0000 [s] (typically: 0.015 s) 0: No friction compensation (or axis is analog)	PLC RUN	6 – 48
MP2620.x	Friction compensation Input: 0 to 30.0000 [A] 0: No friction compensation (or axis is analog)	PLC RUN	6 – 48
MP2630.x	Holding current Input: -30 000 to +30.000 [A]	PLC RUN	6 – 140
MP2700	Reserved, enter 0		

MP	Function and input	Software version and behavior	Page
MP2900.x	Tensioning torque between master and slave for master-slave torque control (entry for the slave axis) Input: -100.00 to +100.00 [Nm]	PLC	6 – 96
MP2910.x	P factor of the torque controller for master-slave torque control (entry for the slave axis) Input: 0.00 to 999.99 [1/(Nm · min)]	PLC	6 – 96
MP2920.x	Factor for variable torque distribution of the torque-master-slave control (entry for the slave axis) Input: 0.000 to 100.000 1: Master and slave axes have identical motors	PLC	6 – 96
MP2930.x	Speed compensation ratio for master-slave torque control (entry for the slave axis) Input: -100.00 to +100.00 [%]	PLC	6 – 96

4.3.6 Spindle

MP	Function and input	Software version and behavior	Page
MP3010	Output of speed, gear range Input: 0: No output of spindle speed 1: Speed code if the speed changes 2: Speed code at every TOOL CALL 3: Nominal speed value always, G code if the gear range shifts 4: Nominal speed value always, G code at every TOOL CALL 5: Nominal speed value always, no G code 6: Same as 3, but with controlled spindle for orientation 7: Same as 4, but with controlled spindle for orientation 8: Same as 5, but with controlled spindle for orientation	PLC RUN	6 – 179
MP3011	Function of analog output S, if MP3010 < 3 Input: 0: No special function 1: Voltage is proportional to the current contouring feed rate, depending on MP3012 2: Voltage is defined as through Module 9130 3: Voltage is defined through M functions (M200 to M204)		
MP3012	Feed rate from output of an analog voltage of 10 V, MP3011 = 1 Input: 0 to 300 000 [mm/min]		
MP3013.x	Characteristic curve kink points (velocity) for output of the analog voltage with M202 Input: 10 to 300 000 [mm/min]	PLC RUN	
MP3014.x	Characteristic curve kink points (voltage) for output of the analog voltage with M202 Input: 0.000 to 9.999 [V]	PLC RUN	
MP3020	Speed range for S code output Format: xxyyz xx: S code for minimum speed yy: S code for maximum speed z: speed increment Input: 0 to 99 999	PLC RUN	6 – 191

MP	Function and input	Software version and behavior	Page
MP3030	Behavior of the spindle Input: Bit 0 – 0: Axis stop for TOOL CALL S 1: No axis stop for TOOL CALL S Bit 1: Zero spindle speed when switching to another gear range 0: Reduce speed to 0 1: Do not reduce speed to 0	PLC RUN	6 – 187
MP3120	Zero speed permitted Input: 0: S = 0 allowed 1: S = 0 not allowed	PLC RUN	6 – 186
MP3130	Polarity of the nominal spindle speed Input: 0: M03 positive, M04 negative 1: M03 negative, M04 positive 2: M03 and M04 positive 4: M03 and M04 negative	PLC RUN	6 – 185
MP3140	Counting direction of spindle position encoder output signals Input: 0: Positive counting direction with M03 1: Negative counting direction with M03	PLC RUN	6 – 185
MP3142	Line count of the spindle position encoder Input: 100 to 9 999 [lines]	PLC RUN	6 – 180
MP3143	Mounting configuration of the spindle position encoder Input: 0: Position encoder directly on the first spindle 1: Position encoder via transmission (ratio in MP3450.x and MP3451.x); X30 pin 1: reference pulse 2: Position encoder via transmission (ratio in MP3450 and MP3451); X30 pin 1: reference pulse release 3: Same as input value 1, except that the second reference pulse is evaluated.	PLC RUN	6 – 180
MP3210.0-7	Analog nominal spindle voltage at rated speed for the gear ranges 1 to 8 Input: 0 to 100 000 [V] Digital spindle motor revolutions at rated speed for the gear ranges 1 to 8 Input: 0 to 100.000 [1000 rpm]	PLC RUN	6 – 186

MP	Function and input	Software version and behavior	Page
MP3240.1	Analog spindle: Minimum nominal value voltage Input: 0 to 9.999 [V] Digital spindle: Minimum motor speed Input: 0 to 9.999 [1000 rpm]	PLC RUN	6 – 186, 6 – 187
MP3240.2	Analog spindle: Spindle jog voltage for gear shifting (M4009/M4010) Input: 0 to 9.999 [V] Digital spindle: Motor speed for gear shifting (M4009/ M4010) Input: 0 to 9.999 [1000 rpm]		
MP3310	Limitation for spindle speed override Input: 0 to 150 [%]	PLC RUN	6 – 189
MP3310.0	Upper limit		
MP3310.1	Lower limit		
MP3411.0-7	Ramp gradient of the spindle with M03 and M04 for gear ranges 1 to 8 Input: Analog axes: 0 to 1.999 [V/ms] Digital axes: 0 to 1.999 [1000 min/min · ms]	PLC RUN	6 – 184
MP3412	Multiplication factor for MP3411.x Input: 0.000 to 1.999	PLC RUN	6 – 184, 6 – 195, 6 – 200, 6 – 204
MP3412.0	With M05		
MP3412.1	With oriented spindle stop		
MP3412.2	With tapping with floating tap holder		
MP3412.3	With rigid tapping		
MP3415	Overshoot behavior of the spindle with M03, M04 and M05 Input: 0 to 1000 [ms]	PLC RUN	6 – 184, 6 – 195, 6 – 200, 6 – 204
MP3415.0	With M03, M04 and M05		
MP3415.1	For oriented spindle stop		
MP3415.2	With tapping		
MP3415.3	With rigid tapping		
MP3420	Spindle positioning window Input: 0 to 360.0000 [°]	PLC RUN	6 – 195
MP3430	Deviation of the reference mark from the desired position (spindle preset) Input: 0 to 360 [°]	PLC RUN	6 – 195
MP3440.0-7	k_V factor for spindle orientation for gear ranges 1 to 8 Input: 0.1 to 10 [(1000°/ min) /°]	PLC RUN	6 – 195

MP	Function and input	Software version and behavior	Page
MP3450.0-7	Number of spindle position-encoder revolutions for gear ranges 1 to 8 Input: 0 to 65 535 0: No transmission	PLC RUN	6 – 180
MP3451.0-7	Number of spindle revolutions for gear ranges 1 to 8 Input: 0 to 65 535 0: No transmission	PLC RUN	6 – 180
MP3510.0-7	Rated speed for the gear ranges 1 to 8 Input: 0 to 99 999.999 [rpm]	PLC RUN	6 – 186
MP3515.0-7	Maximum spindle speed for gear ranges 1 to 8 Input: 0 to 99 999.999 [rpm]	PLC RUN	6 – 189
MP3520.0 MP3520.1	Speed activation through marker M4011 Input: 0 to 99 999.999 [rpm] Spindle speed for oriented stop Input: 0 to 99 999.999 [rpm]	PLC RUN	6 – 195, 6 – 198

4.3.7 Integral PLC

MP	Function and input	Software version and behavior	Page
MP4000.0-15	Options for the conditional compilation of the PLC program		8 – 11
MP4020	PLC Functions Format: %xxxxxxxxxxxxx Input: Bit 0 to bit 4: Reserved Bit 5: Single or double spindle operation 0: Single-spindle operation 1: Double-spindle operation Bit 6 - Reserved Bit 7 - Transferring the values of the Pt 100 inputs 0: Accept values at a change rate of 1 K/s. 1: Accept results immediately Bit 8 - Behavior after an ext. emergency stop 0: “Approach position” is not automatically activated 1: “Approach position” is automatically activated Bit 9 - Behavior of a simulated key 0: Simulated key is transferred immediately to the NC 1: Simulated key is processed first by an active PLC window before being transferred to the NC Bit 10 - Behavior of a locked key 0: Locked key only works on the active PLC window 1: Locked key works on neither the active PLC window nor on the NC Bit 11 – PLC counter in MP4120.x 0: Input in PLC cycles 1: Input in seconds Bit 12 - Font size in PLC window 0: Automatic adaptation of font size to screen 1: Font size for BF 120	RESET	6 – 129, 6 – 206
MP4030	Assignment of physical to logical PL Input: 0: First logical PL 1: Second logical PL 2: Third logical PL 3: Fourth logical PL	PLC RUN	
MP4030.0	First physical PL		
MP4030.1	Second physical PL		
MP4030.2	Third physical PL		
MP4030.3	Fourth physical PL		
MP4050.0-8	Traverse distance for lubrication of axes 1 to 9 Input: 0 to 99 999.999 [m/s]	PLC RUN	6 – 24

MP	Function and input	Software version and behavior	Page
MP4070	Compensation amount per PLC cycle for lagged-tracking axis error compensation Input: 0.0001 to 0.005 [mm]	PLC RUN	6 – 42
MP4110.0-47	Run time PLC timer T0 to T47 Input: 0 to 1 000 000.000 [s]	PLC RUN	8 – 41
MP4111.96-x	Run time PLC timer T96 to x (defined in OEM.SYS) Input: 0 to 1 000 000.000 [s]	PLC RUN	8 – 41
MP4120.0-47	PLC counter preset value Input: 0 to 1 000 000.000 [s or PLC cycles, depending on MP4020, bit 11]	PLC RUN	8 – 44
MP4130.0 MP4130.1 MP4130.2-5	Number of the high-speed PLC input for switching off the monitoring functions Reserved Numerical designation for fast PLC inputs Input: 0 to 255 [no. of the PLC input]		6 – 162
MP4131.0 MP4131.1 MP4131.2-5	Activation criterion for fast PLC input for switching off the monitoring functions Reserved Activation criterion for fast PLC inputs Input: 0: Activation at low level 1: Activation at high level		6 – 162
MP4210.0-47	Setting a number in the PLC (D768 to D956) Input: -99 999.9999 to +99 999.9999		6 – 198, 8 – 36
MP4220.0-4	Setting a number in the PLC (W960 to W968) Input: 10 to 30 000		8 – 36
MP4230.0-31	Setting a number in the PLC (Module 9032) Input: -99 999.9999 to +99 999.9999		8 – 36
MP4231.0-31	Setting a number in the PLC (Module 9032) Input: -99 999.9999 to +99 999.9999		8 – 36
MP4310.0-6	Setting a number in the PLC (W976 to W988, M4300 to M4411) Input: 10 to 30 000		8 – 36

4.3.8 Configuration of the Data Interface

MP	Function and input	Software version and behavior	Page
MP5000	Disable data interfaces Input: 0: No interface disabled 1: RS-232-C/V.24 interface disabled 2: RS-422/V.11 interface disabled	PLC RUN	
MP5020	Configuration of the data interface Format: %xxxxxxxx Input: Bit 0 – 0: 7 data bits 1: 8 data bits Bit 1 - 0 = Any BCC character 1 = BCC not control character Bit 2 - 0: Transmission stop by RTS not active 1: Active Bit 3 - 0: Transmission stop by DC3 not active 1: Active Bit 4 - 0: Character parity even 1: Odd Bit 5 - 0: Character parity not desired 1: Desired Bit 6 = 0, Bit 7 = 0: 1 stop bit Bit 6 = 1, Bit 7 = 0: 2 stop bits Bit 6 = 0, Bit 7 = 1: 1 stop bit Bit 6 = 1, Bit 7 = 1: 1 stop bit	PLC RUN CN123	
MP5020.0	Operating mode EXT1		
MP5020.1	Operating mode EXT2		
MP5020.2	Operating mode EXT3 (PLC)		
MP5030	Data transfer protocol Input: 0 = Standard data transfer protocol 1 = blockwise transfer 2 = without protocol (only for MP5030.2)	PLC RUN CN123	
MP5030.0	Operating mode EXT1		
MP5030.1	Operating mode EXT2		
MP5030.2	Operating mode EXT3 (PLC)		

MP	Function and input	Software version and behavior	Page
MP5040	Data transfer rate in operating mode EXT3 (data transfer through PLC) Input: 0: 110 bps 1: 150 bps 2: 300 bps 3: 600 bps 4: 1200 bps 5: 2400 bps 6: 4800 bps 7: 9600 bps 8: 19200 bps 9: 38400 bps 10: 57600 bps 11: 115 200 bps	PLC RUN	

4.3.9 3-D touch probe

MP	Function and input	Software version and behavior	Page
MP6010	Selection of the touch probe Input: 0: Touch probe with cable transmission 1: Touch probe with infrared transmission	PLC CN123	
MP6120	Probing feed rate (triggering touch probe) Input: 1 to 3000 [mm/min]	PLC RUN CN123	
MP6130	Maximum measuring range Input: 0.001 to 99 999.9999 [mm]	PLC RUN CN123	
MP6140	Setup clearance over measuring point Input: 0.001 to 99 999.9999 [mm]	PLC RUN CN123	
MP6150	Rapid traverse in probing cycle (triggering touch probe) Input: 10 to 20 000 [mm/min]	PLC RUN CN123	
MP6160	M function for probing from opposite directions Input: -1: Spindle orientation directly by NC 0: Function inactive 1 to 999: Number of the M function for spindle orientation through PLC	PLC RUN CN123	
MP6161	M function for orienting the touch probe before every measuring process Input: -1: Spindle orientation directly by the NC 0: Function inactive 1 to 999: Number of the M function	PLC RUN CN123	
MP6162	Orientation angle Input: 0 to 359.9999 [°]	PLC RUN CN123	
MP6163	Minimum difference between the current spindle angle and MP6162 before executing an oriented spindle stop Input: 0 to 3.0000 [°]	PLC RUN CN123	
MP6165	Orient the probe before approaching with Cycle 0 or 1, or with manual probing Input: 0: Probe is not oriented before each probing 1: Probe is oriented and always deflected in the same direction	PLC RUN CN123	

MP	Function and input	Software version and behavior	Page
MP6170	Number of measurements in a programmed measurement (touch probe block) Input: 1 to 3	PLC RUN CN123	
MP6171	Confidence range for programmed measurement (MP6170 > 1) Input: 0.002 to 0.999 [mm]	PLC RUN CN123	
MP6180	Coordinates of the ring gauge center for Probing Cycle 2 with respect to the machine datum (traverse range 1) Input: 0 to +99 999.9999 [mm]	PLC CN123	
MP6180.0	X coordinate		
MP6180.1	Y coordinate		
MP6180.2	Z coordinate		
MP6181	Coordinates of the ring gauge center for Probing Cycle 2 with respect to the machine datum (traverse range 2) Input: 0 to +99 999.9999 [mm]	PLC CN123	
MP6181.0	X coordinate		
MP6181.1	Y coordinate		
MP6181.2	Z coordinate		
MP6182	Coordinate of the ring gauge center for Probing Cycle 2 with respect to the machine datum (traverse range 3) Input: 0 to +99 999.9999 [mm]	PLC CN123	
MP6182.0	X coordinate		
MP6182.1	Y coordinate		
MP6182.2	Z coordinate		
MP6185	Distance of probing point below ring top surface during calibration Input: +0.001 to +99 999.9999 [mm]	PLC CN123	

4.3.10 Tool measurement with TT

MP	Function and input	Software version and behavior	Page
MP6500	Tool measurement with TT 130 Format: %xxxxxxxxxxxxxxx Input: Bit 0 – Cycles for tool measurement 0: Locked 1: Not locked Bit 1 – 0: Tool radius measurement allowed. Tool length measurement with rotating spindle 1: Tool radius measurement and individual tooth measurement disabled Bit 2 – 0: Tool length measurement with rotating spindle (bit 1=1) 1: Tool length measurement with rotating spindle, only if a tool radius offset (TT:R-OFFS) has been entered in the tool table Bit 3 - 0: Tool measurement with spindle orientation 1: Tool measurement without spindle orientation. Individual tooth measurement not possible. Tool radius measurement possibly faulty. Bit 4 – 0: Automatically determine speed 1: Always use minimum spindle speed Bit 5 - NC stop during **Tool checking** 0: The NC program is not stopped when the breakage tolerance is exceeded 1: If the breakage tolerance is exceeded, the NC program is stopped and the error message **Tool broken** is displayed. Bit 6 - NC stop during **tool measurement** 0: The NC program is not stopped when the breakage tolerance is exceeded 1: If the breakage tolerance is exceeded, the NC program is stopped and the error message **Touch point inaccessible** is displayed.	PLC RUN	

MP	Function and input	Software version and behavior	Page
MP6500	Tool measurement with TT 130 Format: %xxxxxxxxxxxxxxx Input: Bit 7 – Reserved Bit 8 – Probing routine 0: Probe contact is probed from several directions 1: Probe contact is probed from one direction Bit 9 – Automatic measurement of the direction of the probe contact basic rotation (bit 8 = 1) 0: Basic rotation is not measured 1: Basic rotation of the probe element is automatically measured Bit 10 – Probing routine (bit 8 = 1) 0: Pre-positioning to starting point in all three principal axes 1: Pre-positioning to starting point in the tool axis and in the axis of the probing direction (MP6505) (bit 9 = 0) Bit 11 - **Tool checking** and changing in the tool routine 0: After **Tool checking** the tool table is changed 1: After **Tool checking** the tool table is not changed Bit 12 – PLC datum shift 0: Do not include 1: Include Bit 13 - 0: Tool is measured in the tilt position in which the tool touch probe was also calibrated 1: Tool is measured in another tilt position Bit 14 – Tool measurement with number of teeth = 0 0: Tool measurement with rotating spindle 1: Tool measurement with stationary spindle	PLC RUN	
MP6505	Probing direction for tool radius measurement for 3 traverse ranges Input: 0: Positive probing direction of the angle reference axis (0° axis) 1: Positive probing direction in the +90° axis 2: Negative probing direction of the angle reference axis (0° axis) 3: Negative probing direction in the +90° axis	PLC RUN CN123	
MP6505.0	Traverse range 1		
MP6505.1	Traverse range 2		
MP6505.2	Traverse range 3		

MP	Function and input	Software version and behavior	Page
MP6507	Calculation of the probing feed rate Input: 0: Calculation of the probing feed rate with constant tolerance 1: Calculation of the probing feed rate with variable tolerance 2: Constant probing feed rate	PLC RUN CN123	
MP6510 MP6510.0 MP6510.1	Permissible measuring error for tool measurement with rotating tool Input: 0.002 to 0.999 [mm] First measurement error Second measurement error	PLC RUN CN123	
MP6520	Probing feed rate for tool measurement with non-rotating tool Input: 1 to 3000 [mm/min]	PLC RUN CN123	
MP6530 MP6530.0 MP6530.1 MP6530.2	Distance from the tool end to the top of the probe contact during tool radius measurement for 3 traverse ranges Input: 0.001 to 99.9999 [mm] Traverse range 1 Traverse range 2 Traverse range 3	PLC RUN CN123	
MP6531 MP6531.0 MP6531.1 MP6531.2	Diameter or edge length of the TT 130 probe contact for 3 traverse ranges Input: 0.001 to 99.9999 [mm] Traverse range 1 Traverse range 2 Traverse range 3	PLC RUN	
MP6540 MP6540.0 MP6540.1	Safety zone around the probe contact of the TT 130 for pre-positioning Input: 0.001 to 99 999.9999 [mm] Safety clearance in tool axis direction Safety clearance in the plane perpendicular to the tool axis	PLC RUN CN123	
MP6550	Rapid traverse in probing cycle for TT 130 Input: 10 to 20 000 [mm/min]	PLC RUN CN123	
MP6560	M function for spindle orientation during individual tooth measurement Input: -1: Spindle orientation directly by NC 0: Function inactive 1 to 999: Number of the M function for spindle orientation by PLC	PLC RUN CN123	

MP	Function and input	Software version and behavior	Page
MP6570	Max. permissible surface cutting speed at the tooth edge Input: 1.0000 to 129.0000 [m/min]	PLC RUN CN123	
MP6572	Maximum permissible speed during tool measurement Input: 1 to 1000 [rpm] 0: 1000 [rpm]	PLC RUN CN123	
MP6580.0-2	Coordinates of the TT 130 probe contact center with respect to the machine datum (traverse range 1) Input: -99 999.9999 to +99 999.9999 [mm]	PLC RUN CN123	
MP6581.0-2	Coordinates of the TT 130 probe contact center with respect to the machine datum (traverse range 2) Input: -99 999.9999 to +99 999.9999 [mm]	PLC RUN CN123	
MP6582.0-2	Coordinates of the TT 130 probe contact center with respect to the machine datum (traverse range 3) Input: -99 999.9999 to +99 999.9999 [mm]	PLC RUN CN123	
MP6585	Monitoring the position of the rotary and additional linear axes during the tool measurement cycles Format: %xxxxxx Input: 0: Axis is not monitored 1: Axis is monitored Bit 0 – A axis Bit 1 – B axis Bit 2 – C axis Bit 3 – U axis Bit 4 – V axis Bit 5 – W axis	PLC RUN CN123	
MP6586 MP6586.0-5	Ref. coordinate for monitoring the position of the rotary and additional linear axes during the tool measurement cycles Input: -99 999.9999 to +99 999.9999 [mm or °] Axes A to W	PLC RUN CN123	

4.3.11 Tapping

MP	Function and input	Software version and behavior	Page
MP7110.0	Minimum for feed rate override during tapping Input: 0 to 150 [%]	PLC RUN	6 – 200
MP7110.1	Maximum for feed rate override during tapping Input: 0 to 150 [%]		
MP7120.0	Dwell time for reversal of spindle rotational direction Input: 0 to 65.535 [s]	PLC RUN	6 – 200, 6 – 201
MP7120.1	Advanced switching time of the spindle during tapping with coded spindle-speed output Input: 0 to 65.535 [s]		
MP7120.2	Spindle slow-down time after reaching the hole depth Input: 0 to 65.535 [s]		
MP7130	Run-in behavior of the spindle during rigid tapping Input: 0.001 to 10 [°/min]	PLC RUN	6 – 204
MP7150	Positioning window of the tool axis during rigid tapping Input: 0.0001 to 2 [mm]	PLC RUN	6 – 204
MP7160	Spindle response during Cycle 17, 207 and 18 Format: %xxx Input: Bit 0 – Oriented spindle stop with Cycles 17 and 207 0: Oriented spindle stop before execution of the cycle 1: No oriented spindle stop before execution of the cycle Bit 1 – Spindle speed 0: Spindle speed is not limited 1: Spindle speed is limited so that it runs with constant speed approx. 1/3 of the time Bit 2 – Spindle in position feedback control 0: Spindle operated without position feedback control 1: Spindle operated with position feedback control Bit 3 – IPC and acceleration feedforward control 0: Active 1: Not active	PLC RUN CN123	6 – 204

4.3.12 Display and Operation

MP	Function and input	Software version and behavior	Page
MP7210	Programming station Input: 0: Controlling and programming 1: Programming station with PLC active 2: Programming station with PLC inactive	CN123	
MP7212	Power interrupted message Input: 0: Acknowledge the **`Power interrupted`** message with CE key 1: **`Power Interrupted`** message does not appear	PLC RUN CN123	7 – 5
MP7220	Block number increment for ISO programs Input: 0 to 250	PLC RUN CN123	
MP7224.0 MP7224.1	Disabling soft keys for file types Format: %xxxxxxxx Input: 0: Do not disable 1: Disable Bit 0 - HEIDENHAIN programs .H Bit 1 — ISO programs .I Bit 2 – Tool tables .T Bit 3 – Datum tables .D Bit 4 – Pallet tables .P Bit 5 – Text files .A Bit 6 – HELP files .HLP Bit 7 – Point tables .PNT Protecting file types Format: %xxxxxxxx Input: 0: Do not protect 1: Protect Bit 0 - HEIDENHAIN programs .H Bit 1 — ISO programs .I Bit 2 – Tool tables .T Bit 3 – Datum tables .D Bit 4 – Pallet tables .P Bit 5 – Text files .A Bit 6 – HELP files .HLP Bit 7 – Point tables .PNT	PLC RUN CN123	
MP7226.0 MP7226.1	Size of the pallet table Input: 0 to 255 [lines] Size of the datum table Input: 0 to 255 [lines]	PLC RUN CN123	

MP	Function and input	Software version and behavior	Page
MP7229 MP7229.0 MP7229.1	Depiction of the NC program Line number for program testing Input: 100 to 9999 Program length to which FK blocks are allowed Input: 100 to 9999	PLC RUN CN123	
MP7230 MP7230.0 MP7230.1 MP7230.2 MP7230.3	Switching the conversational language Input: 0: English 1: German 2: Czech 3: French 4: Italian 5: Spanish 6: Portuguese 7: Swedish 8: Danish 9: Finnish 10: Dutch 11: Polish 12: Hungarian 13: Reserved 14: Russian NC conversational language, soft keys for OEM cycles PLC conversational language (user parameters) Write PLC error messages Help files	PLC RUN CN123	
MP7235	Time difference to time set in BIOS Input: -23 to +23 [hours]	PLC RUN CN123	

MP	Function and input	Software version and behavior	Page
MP7237 MP7237.0 MP7237.1 MP7237.2	Displaying and resetting the operating times Display PLC operating times Input: Bits 0 to 7 represent PLC operating times 1 to 8 0: Do not display 1: Display Resetting PLC operating times with the code number 857282 Input: Bits 0 to 7 represent PLC operating times 1 to 8 0: Do not reset 1: Reset Resetting NC operating times with the code number 857282 Input: Bit 0 – No function Bit 1 – "Machine on" operating time Bit 2 – "Program run" operating time 0: Do not reset 1: Reset	PLC RUN	
MP7238.0-7	Dialog messages for PLC operating times 1 to 8 Input: 0 to 4095 Dialog no. from the file (OEM.SYS)	PLC RUN	
MP7245	Disabling auxiliary cycles Input: 0: Auxiliary cycles disabled 1: Auxiliary cycles permitted	PLC RUN	
MP7246	Disabling paraxial positioning blocks Input: 0: Paraxial positioning block enabled 1: Paraxial positioning block disabled	PLC RUN	
MP7251	Number of global Q parameters that are transferred from the OEM cycle to the calling program Input: 0 to 100	PLC RUN	
MP7260	Number of tools in the tool table Input: 0 to 30 000	CN123	
MP7261.0-3	Number of pockets in the tool magazine 1 to 4 Input: 0 to 254	CN123	
MP7262	Maximum tool index number for indexed tools Input: 0 to 9	CN123	
MP7263	Hiding/showing the POCKET TABLE soft key Format: %x Input: Bit 0 – 0: POCKET TABLE soft key is shown 1: POCKET TABLE soft key is hidden	CN123	

MP	Function and input	Software version and behavior	Page
MP7266	Elements of the tool table Input: 0: No display 1 to 99: Position in the tool table	CN123	
MP7266.0	16-character alphanumeric tool name (NAME)		
MP7266.1	Tool length (L)		
MP7266.2	Tool radius (R)		
MP7266.3	Tool radius 2 for toroidal cutter (R2)		
MP7266.4	Oversize in tool length (DL)		
MP7266.5	Oversize in tool radius (DR)		
MP7266.6	Oversize for tool radius 2 (DR2)		
MP7266.7	Locked tool? (TL)		
MP7266.8	Replacement tool (RT)		
MP7266.9	Maximum tool age, M4543 (TIME1)		
MP7266.10	Maximum tool age, TOOL CALL (TIME2)		
MP7266.11	Current tool age (CUR.TIME)		
MP7266.12	Comment on the tool (DOC)		
MP7266.13	Number of tool teeth (CUT)		
MP7266.14	Wear tolerance for tool length (LTOL)		
MP7266.15	Wear tolerance for tool radius (RTOL)		
MP7266.16	Cutting direction of the tool (DIRECT)		
MP7266.17	Additional information for PLC, Module 9093 (PLC)		
MP7266.18	Tool offset for tool length (TT:LOFFS)		
MP7266.19	Tool offset for tool radius (TT:ROFFS)		
MP7266.20	Breakage tolerance for tool length (LBREAK)		
MP7266.21	Breakage tolerance for tool radius (RBREAK)		
MP7266.22	Tooth length (LCUTS)		
MP7266.23	Plunge angle (ANGLE)		
MP7266.24	Tool type (TYP)		
MP7266.25	Tool material (TMA)		
MP7266.26	Cutting-data tables (CDT)		
MP7266.27	PLC value (PLC-VAL)		
MP7266.28	Probe center offset in reference axis (CAL-OF1)		
MP7266.29	Probe center offset in minor axis (CAL-OF2)		
MP7266.30	Spindle angle during calibration (CAL-ANG)		
MP7266.31	Tool type for pocket table (PTYP)	340 420-02	

MP	Function and input	Software version and behavior	Page
MP7267	Elements of the pocket table Input: 0: No display 1 to 99: Position in the pocket table	CN123	
MP7267.0	Tool number (T)		
MP7267.1	Special tool (ST)		
MP7267.2	Fixed pocket (F)		
MP7267.3	Locked pocket (L)		
MP7267.4	PLC status (PLC)		
MP7267.5	Tool name (TNAME)		
MP7267.6	Comment on the tool (DOC)		
MP7267.7	Tool type for pocket table (PTYP)	340 420-02	
MP7267.8	Value 1 (P1)		
MP7267.9	Value 2 (P2)		
MP7267.10	Value 3 (P3)		
MP7267.11	Value 4 (P4)		
MP7267.12	Value 5 (P5)		
MP7267.13	Reserve pocket (RSV)		
MP7267.14	Pocket above locked (LOCKED_ABOVE)		
MP7267.15	Pocket below locked (LOCKED_BELOW)		
MP7267.16	Pocket at left locked (LOCKED_LEFT)		
MP7267.17	Pocket at right locked (LOCKED_RIGHT)		
MP7270	Feed rate display in the operating modes MANUAL OPERATION and ELECTRICAL HANDWHEEL Input: 0: Display of feed rate by pressing an axis direction key (axis-specific feed rate from MP1020) 1: Display of axis feed rate also before an axis direction key is pressed (smallest value from MP1020 for all axes)	PLC RUN CN123	
MP7280	Decimal character Input: 0: Decimal comma 1: Decimal period	PLC RUN CN123	
MP7281	Depiction of the NC program Input: 0: All blocks completely 1: Current block completely, others line by line 2: All blocks line by line; complete block when editing	PLC RUN CN123	
MP7285	Tool length offset in the tool-axis position display Input: 0: Tool length is not offset 1: Tool length is offset	PLC RUN CN123	

MP	Function and input	Software version and behavior	Page
MP7289	Position display step for the spindle Input: 0: 0.1° 1: 0,05° 2: 0,01° 3: 0,005° 4: 0,001° 5: 0,0005° 6: 0,0001°	PLC RUN CN123	
MP7290.0-8	Position display step for axes 1 to 9 0: 0.1 mm or 0.1° 1: 0.05 mm or 0.05° 2: 0.01 mm or 0.01° 3: 0.005 mm or 0.005° 4: 0.001 mm or 0.001° 5: 0.0005 mm or 0.0005° 6: 0.0001 mm or 0.0001°	PLC RUN CN123	
MP7291	Display of axes on the screen Format: SXYZABCUVWxyzabcuvw- Input: Characters 1 to 9 from the right represent lines 1 to 9 Character 10 is spindle S which is always output in line 9.	PLC RUN	6 – 3
MP7291.0	Display in traverse range 1		
MP7291.1	Display in traverse range 2		
MP7291.2	Display in traverse range 3		
MP7295	Disabling “datum setting” Format: %xxxxxxxxx Input: Bits 0 to 8 correspond to axes 1 to 9 0: Not disabled 1: Disabled	PLC RUN CN123	
MP7296	“Datum setting” through axis keys Input: 0: Datum can be set by axis keys and soft key 1: Datum can be set only by soft key	PLC RUN CN123	

MP	Function and input	Software version and behavior	Page
MP7300	Erasing the status display and Q parameters Input: 0: Erase the status display, Q parameters and tool data when a program is selected. 1: Erase the status display, Q parameters and tool data if a program is selected and M02, M30, and END PGM occur. 2: Erase the status display and tool data when a program is selected. 3: Erase the status display and tool data when a program is selected and in the event of M02, M30, END PGM. 4: Erase the status display and Q parameters when a program is selected. 5: Erase the status display and Q parameters when a program is selected and in the event of M02, M30, END PGM. 6: Erase the status display when a program is selected and in the event of M02, M30, END PGM. 7: Erase the status display when a program is selected and in the event of M02, M30, END PGM.	PLC RUN CN123	
MP7310	Graphic display mode Format: %xxxxxxxx Input: Bit 0 – Projection in three planes: 0: German-preferred projection 1: US-preferred projection Bit 1 - Rotating the coordinate system in the working plane by 90°: 0: No rotation 1: Rotation by +90° Bit 2 – BLK form after datum shift: 0: Shifted 1: Not shifted Bit 3 – Display of the cursor position: 0: No display 1: Display Bit 4 - Reserved Bit 5 - Graphics during program test 0: 2.5-D 1: 3D Bit 6 - Graphics during program run 0: 2.5-D 1: 3D Bit 7 – Reserved	PLC RUN CN123	7 – 11
MP7315	Tool radius for graphic simulation without TOOL CALL Input: 0.0000 to 99 999.9999 [mm]	PLC RUN CN123	

MP	Function and input	Software version and behavior	Page
MP7316	Penetration depth of the tool Input: 0.0000 to 99 999.9999 [mm]	PLC RUN CN123	
MP7317 MP7317.0 MP7317.1	M function for graphic simulation Beginning of graphic simulation Input: 0 to 88 Interruption of the graphic simulation Input: 0 to 88	PLC RUN CN123	
MP7330.0-15	Specifying the user parameters 1 to 16 Input: 0 to 9999.00 (no. of the user parameter)	PLC RUN	
MP7340.0-15	Dialog messages for user parameters 1 to 16 Input: 0 to 4095 (line number of the PLC dialog message file)	PLC RUN	

4.3.13 Colors

MP	Function and input	Software version and behavior	Page
MP7350	Window frames	PLC RUN	7 – 5
MP7351	Error messages	PLC RUN	7 – 5
MP7352 MP7352.0 MP7352.1 MP7352.2	“Machine” operating mode display Background Text for operating mode Dialog	PLC RUN	7 – 5
MP7353 MP7353.0 MP7353.1 MP7353.2	“Programming” operating mode display Background Text for operating mode Dialog	PLC RUN	7 – 5
MP7354 MP7354.0 MP7354.1 MP7354.2 MP7354.3	“Machine” program text display Background General program text Active block Background of inactive window	PLC RUN	7 – 6
MP7355 MP7355.0 MP7355.1 MP7355.2 MP7355.3	“Programming” program text display Background General program text Active block Background of inactive window	PLC RUN	7 – 6
MP7356 MP7356.0 MP7356.1 MP7356.2	Status window and PLC window Background Axis positions in the status display Status display other than axis positions	PLC RUN	7 – 6
MP7357 MP7357.0 MP7357.1	“Machine” soft-key display Background Symbols	PLC RUN	7 – 6
MP7358 MP7358.0 MP7358.1	“Programming” soft-key display Background Symbols	PLC RUN	7 – 6

MP	Function and input	Software version and behavior	Page
MP7360	Graphics: 3-D view and plan view	PLC	7 – 6
MP7360.0	Background	RUN	
MP7360.1	Top surface		
MP7360.2	3-D: Front face		
MP7360.3	Text display in the graphics window		
MP7360.4	3-D: Lateral face		
MP7360.5	Lowest point of blank form		
MP7360.6	Highest point of blank form (below surface)		
MP7361	Graphics: Projection in three planes	PLC	7 – 6
MP7361.0	Background	RUN	
MP7361.1	Top view		
MP7361.2	Front and side view		
MP7361.3	Axis cross and text in the graphic display		
MP7361.4	Cursor		
MP7362	Additional status display in the graphics window	PLC	7 – 6
MP7362.0	Background of graphic window	RUN	
MP7362.1	Background of status display		
MP7362.2	Status symbols		
MP7362.3	Status values		
MP7363	Programming graphics	PLC	7 – 6
MP7363.0	Background	RUN	
MP7363.1	Resolved contour		
MP7363.2	Subprograms and frame for zooming		
MP7363.3	Alternative solutions		
MP7363.4	Unresolved contour		
MP7364	Color of the help illustrations for cycles	PLC	7 – 7
MP7364.0-6	Colors 1 to 7 of the graphic program used	RUN	
MP7364.7	Line color (color 8 of the graphic program)		
MP7364.8	Color for highlighted graphic elements if defined in the help illustration		
MP7364.9	Background		
MP7365	Oscilloscope	PLC	7 – 7
MP7365.0	Background	RUN	
MP7365.1	Channel 1		
MP7365.2	Channel 2		
MP7365.3	Channel 3		
MP7365.4	Channel 4		
MP7365.5	Selected channel		
MP7365.6	Grid		
MP7365.7	Cursor and text		

MP	Function and input	Software version and behavior	Page
MP7366 MP7366.0 MP7366.1 MP7366.2 MP7366.3 MP7366.4 MP7366.5 MP7366.6-14	Pop-up window (HELP key, pop-up menus etc.) Background Text or foreground Active line Title bar Scroll-bar field Scroll bar Reserved	PLC RUN	7 – 7
MP7367 MP7367.0 MP7367.1 MP7367.2 MP7367.3 MP7367.4 MP7367.5 MP7367.6-14	Large PLC window Background Color 1 Color 2 Color 3 Color 4 Color 5 Colors 6 to 14	PLC RUN	7 – 7
MP7368 MP7368.0 MP7368.1 MP7368.2 MP7368.3	Pocket calculator Background Background of displays and keys Key texts ("os" in "cos") Key symbols	PLC RUN	7 – 7
MP7369 MP7369.0 MP7369.1 MP7369.2 MP7369.3 MP7369.4 MP7369.5 MP7369.6	Directory tree in PGM MGT Text background Text Text background of the active folder Line color of the tree structure Folders Drives Text background of the heading in the browser window	PLC RUN	7 – 7
MP7392	Screen saver Input: 1 to 99 [min] 0: No screen saver	PLC RUN CN123	7 – 7

4.3.14 Machining and Program Run

MP	Function and input	Software version and behavior	Page
MP7410	Scaling cycle in two or three axes Input: 0: Scaling cycle is effective in all three principle axes 1: Scaling cycle is effective only in the working plane	PLC RUN CN123	
MP7411	Tool data in the touch probe block Format: %xx Input: Bit 0 – 0: Use the calibrated data of the touch probe 1: Use the current tool data from the last TOOL CALL Bit 1 – 0: Only one set of touch probe calibration data 1: Manage several blocks of touch probe calibration data in the tool table	PLC RUN CN123	
MP7420	Cycles for milling pockets with combined contours Format: %xxxxx Input: Bit 0 – Milling direction for channel milling: 0: Counterclockwise for pockets, clockwise for islands 1: Clockwise for pockets, counterclockwise for islands Bit 1 — Sequence for rough-out and channel milling: 0: First channel milling, then pocket rough-out 1: First pocket rough-out, then channel milling Bit 2 – Merging of listed contours: 0: Contours are merged only if the tool-center paths intersect 1: Contours are merged if the programmed contours intersect Bit 3 — Rough-out and channel milling to pocket depth or for every infeed 0: Each process uninterrupted to pocket depth 1: Both processes for each pecking depth before proceeding to the next depth Bit 4 – Position after completion of the cycle: 0: Tool moves to the same position as before the cycle was called 1: Tool only moves in the tool axis to the "clearance height"	PLC RUN CN123	
MP7430	Overlap factor for pocket milling Input: 0.001 to 1.414	PLC RUN CN123	

MP	Function and input	Software version and behavior	Page
MP7431	Arc end-point tolerance Input: 0.0001 to 0.016 [mm]	PLC RUN CN123	
MP7440	Output of M functions Format: %xxxxxxx Input: Bit 0 – Program stop with M06 0: Program stop with M06 1: No program stop with M06 Bit 1 – Modal cycle call M89 0: Normal code transfer of M89 at beginning of block 1: Modal cycle call M89 at end of block Bit 2 – Program stop with M functions: 0: Program stop until acknowledgment of the M function 1: No program stop: No waiting for acknowledgment. Bit 3 – Switching of k_V factors with M105/M106: 0: Function is not in effect 1: Function is effective Bit 4 — Reduced feed rate in the tool axis with M103: 0: Function is not in effect 1: Function is effective Bit 5 – Reserved Bit 6 – Automatic activation of M134 0: M134 must be activated in the NC program 1: M134 is automatically activated when an NC program is selected.	PLC RUN CN123	6 – 45, 6 – 122, 6 – 124
MP7441	Error message during cycle call Format: %xxx Input: Bit 0 – 0: Error message **Spindle ?** is not suppressed 1: Error message **Spindle ?** is suppressed Bit 1: Reserved, enter 0 Bit 2 – 0: Error message **Enter depth as negative** is suppressed 1: Error message **Enter depth as negative** is not suppressed	PLC RUN CN123	
MP7442	Number of the M function for spindle orientation in the cycles Input: 1 to 999: Number of the M function 0: No oriented spindle stop –1: Oriented spindle stop by the NC	PLC RUN CN123	6 – 194

MP	Function and input	Software version and behavior	Page
MP7450	Offsetting the tool change position from MP951.x in block scan Format: %xxxxxxxxxxxxxx Input: Bits 0 to 3 correspond to axes 1 to 14: 0: Do not offset 1: Offset	PLC RUN	
MP7451.0-8	Feed rate for returning to the contour for axes 1 to 9 Input: 10 to 300 000 [mm/min]	PLC RUN	
MP7470	Maximum contouring tool feed rate at 100% override Input: 0 to 300 000 [mm/min] 0: No limitation	PLC RUN CN123	
MP7471	Maximum velocity of the principle axes during compensating movements through M128 Input: 0 to 300 000 [mm/min]	PLC RUN CN123	6 – 82
MP7475	Reference for datum table Input: 0: Reference is workpiece datum 1: Reference is machine datum (MP960.x)	PLC RUN CN123	
MP7480 MP7480.0	Output of the tool or pocket number With TOOL CALL block Input: 0: No output 1: Tool number output only when tool number changes 2: Tool number output for every TOOL CALL block 3: Output of the pocket number and tool number only when tool number changes 4: Output of the pocket number and tool number for every TOOL CALL block 5: Output of the pocket number and tool number only when tool number changes. Pocket table is not changed. 6: Output of the pocket number and tool number for every TOOL CALL block. Pocket table is not changed.	PLC RUN	
MP7480.1	With TOOL DEF block Input: 0: No output 1: Tool number output only when tool number changes 2: Tool number output for every TOOL DEF block 3: Output of the pocket number and tool number only when tool number changes 4: Output of the pocket number and tool number for every TOOL DEF block		

MP	Function and input	Software version and behavior	Page
MP7490	Functions for traverse ranges Format: %xxxx Input: Bit 0 – 0: Display one traverse range via MOD 1: Display three traverse ranges via MOD Bit 1 - 0: Each traverse range has its own datum (and 3 memories for the positions of the swivel head) 1: One datum for all traverse ranges Bit 2 – Calibration data: touch probe for workpiece measurement: 0: One set of calibration data for all traverse ranges 1: Every traverse range has its own set of calibration data Bit 3 – Calibration data: touch probe for tool measurement: 0: One set of calibration data for all traverse ranges 1: Every traverse range has its own set of calibration data	PLC RUN	6 – 23
MP7500	Tilting working plane Format: %xxxxxxxxx Input: Bit 0 – “Tilted working plane” 0: Off 1: On Bit 1 – 0: Angles correspond to the position of the tilting axes of the head/table 1: Angles correspond to the spatial angle (the iTNC calculates the position of the tilted axes of the head/table) Bit 2 – 0: The tilting axes are not positioned with Cycle 19 1: The tilting axes are positioned with Cycle 19 Bit 3 – 0: The current tilting-axis position is taken into account with respect to the machine datum 1: The 0° position is assumed for the first rotary axis Bit 4 – 0: Compensate mechanical offset during exchange of the spindle head when calling M128, M114 or “tilted working plane” 1: Compensate mechanical offset during PLC datum shift	PLC RUN	6 – 79

MP	Function and input	Software version and behavior	Page
MP7500	Tilting working plane Format: %xxxxxxxxx Bit 5 – 0: The current tilting-axis position is taken into account with respect to the machine datum 1: The tilting-axis position that was entered with the 3-D ROT soft key applies. Bit 6 – 0: Spatial angle C is realized through a rotation of the coordinate system. 1: Spatial angle C is realized through a rotation of the table. Bit 7 – 0: The current tilting-axis position is taken into account with respect to the machine datum 1: The active tilting-axis position is a) Manual tilting is active, derived from the tilting angles in the 3D ROT window. b) derived from the reference coordinates of the rotary axes if tilting is inactive. Bit 8 – Non-functional	PLC RUN	
MP7502	Functionality of M144/M145 Input: %xxx Bit 0 - 0: M144/M145 not active 1: M144/M145 active Bit 1 – M144/M145 in the automatic modes 0: M144/M145 active 1: M144 is activated automatically at the start of an NC program. It can only be deactivated with M145 during an NC program. Bit 2 – M144/M145 in the manual modes 0: M144/M145 not active 1: M144/M145 active	PLC RUN	6 – 83
MP7510	Transformed axis Format: %xxxxxx Input: 0: End of the transformation sequence Bit 0 corresponds to axis X Bit 1 corresponds to axis Y Bit 2 corresponds to axis Z Bit 3 corresponds to axis A Bit 4 corresponds to axis B Bit 5 corresponds to axis C	PLC RUN	6 – 80
MP7510.0-14	Transformation 1 to transformation 15		

MP	Function and input	Software version and behavior	Page
MP7520	Additional code for transformation Format: %xx Input: Bit 0 – Tilting axis 0: Swivel head 1: Tilting table Bit 1 – Type of dimension in MP7530 0: Incremental dimension for swivel head 1: Absolute with respect to the machine datum for tilting table	PLC RUN	6 – 80
MP7520.0-14	Transformation 1 to transformation 15		
MP7530	Type of dimension for transformation Input: -99 999.9999 to +99 999.9999 0: Free tilting axis	PLC RUN	6 – 80
MP7530.0-14	Transformation 1 to transformation 15		
MP7550	Home position of the tilting element Input: -99 999.9999 to +99 999.9999	PLC RUN	6 – 80
MP7550.0	A Axis		
MP7550.1	B Axis		
MP7550.2	C Axis		

4.3.15 Hardware

MP	Function and input	Software version and behavior	Page
MP7600.0	Position controller cycle time = MP7600.0 · 0.6 ms Input: 1 to 20 Proposed input value: 3 (= 1.8 ms)	RESET	6 – 120
MP7600.1	PLC cycle time = position controller cycle time · MP7600.1 Input: 1 to 20 Proposed input value: 7 (= 12.5 ms)		6 – 120, 8 – 2
MP7620	Feed-rate override and spindle speed override Format: %xxxxxxx Input: Bit 0 - Feed-rate override if rapid traverse key is pressed in **Program Run** mode. 0: Override not effective 1: Override effective Bit 1 – Non-functional Bit 2 - Feed-rate override if rapid traverse key and machine direction button are pressed in **Manual mode.** 0: Override not effective 1: Override effective Bit 3 – Feed rate override and spindle speed override in 1% increments or according to a nonlinear characteristic curve 0: 1% steps 1: Nonlinear characteristic curve Bit 4 – Non-functional Bit 5 – Reserved Bit 6 – Feed-rate smoothing 0: Not active 1: Active	PLC RUN	6 – 118, 6 – 189
MP7640	Handwheel Input: 0: No handwheel 1: Reserved 2: HR 130 3: Reserved 4: Reserved 5: Up to three HR 150 via HRA 110 6: HR 410 7 to 10: Reserved	PLC RUN	
MP7641	Entry of the interpolation factor Input: 0: Through iTNC keyboard 1: Through PLC Module 9036	PLC RUN	

MP	Function and input	Software version and behavior	Page
MP7645	Initializing parameter for handwheel	PLC	
MP7645.0	Layout of the handwheel keypad for HR 410 Input: 0: Evaluation of the keys by NC, including LEDs 1: Evaluation of the keys by PLC	RUN	
MP7645.0	Assignment of a third handwheel via axis selector switch S2, when MP7645.2 = 0 Input: 0: Switch position 1 (at the left stop) 3rd handwheel axis Z Switch position 2 3rd handwheel axis IV Switch position 3 3rd handwheel axis V 1: Switch position 1 3rd handwheel axis X Switch position 2 3rd handwheel axis Y Switch position 3 3rd handwheel axis Z Switch position 4 3rd handwheel axis IV Switch position 5 3rd handwheel axis V 2: Switch position 3 3rd handwheel axis Z Switch position 4 3rd handwheel axis IV Switch position 5 3rd handwheel axis V		
MP7645.1	Fixed assignment of third handwheel if MP7645.2 = 1 Input: 4: Axis Z 8: Axis IV (MP410.3) 16: Axis V (MP410.4)		
MP7645.2	Assignment of a third handwheel via axis selector switch or MP7645.1 Input: 0: Assignment by axis selection switch according to MP7645.0 1: Assignment by MP7645.1		
MP7645.3-7	No function		
MP7650	Counting direction for handwheel Format: %xxxxxxxxx Input: 0: Negative counting direction 1: Positive counting direction	PLC RUN	
MP7660	Threshold sensitivity for electronic handwheel Input: 0 to 65 535 [increments]	PLC RUN	

MP	Function and input	Software version and behavior	Page
MP7670	Interpolation factor for handwheel Input: 0 to 10	PLC RUN	
MP7670.0	Interpolation factor for low speed		
MP7670.1	Interpolation factor for medium speed (only HR 410)		
MP7670.2	Interpolation factor for high speed (only HR 410)		
MP7671	Handwheel feed rate in the Handwheel operating mode with HR 410 Input: 0 to 1000 [% of MP1020]	PLC RUN	
MP7671.0	Low speed		
MP7671.1	Medium speed (only HR 410)		
MP7671.2	High speed (only HR 410)		
MP7680	Machine parameter with multiple function Format: %xxxxxxxxxxxxxx Input: Bit 0 – Memory function for axis-direction keys with M4562: 0: Not saved 1: Saved if M4562 is set Bit 1 – Returning to the contour 0: Not active 1: Active Bit 2 – Block scan 0: Not active 1: Active Bit 3 – Interruption of block scan for STOP or M06: 0: Interruption 1: No interruption Bit 4 — Inclusion of programmed dwell time during the block scan: 0: Include the dwell time 1: Do not include the dwell time Bit 5 – Start of calculation for block scan 0: Start from block with cursor 1: Start from beginning of program Bit 6 – Tool length in blocks with normal vectors: 0: Without R2 from tool table (south pole) 1: With R2 from tool table (center of sphere) Bit 7 – Inserting a defined rounding arc or spline: 0: Defined rounding arcs are always inserted 1: Defined rounding arcs are always inserted if the acceleration from MP1060.x or MP1070 was exceeded.	PLC RUN	6 – 159, 6 – 160

MP	Function and input	Software version and behavior	Page
MP7680	Machine parameter with multiple function Bit 8 – Insertion of rounding arc or cubic spline 0: Rounding arc is inserted. 1: A cubic spline is inserted instead of a rounding arc. Bit 9 – Constant jerk on spline (bit 8 = 1) 0: No constant jerk 1: Constant jerk Bit 10 – Cutter-radius-compensated outside corners 0: Insertion of a circular arc 1: Insertion of a spline curve Bit 11 - Behavior of M116 0: Rotary axis is parallel to linear axis 1: Any position of rotary axis to linear axis Bit 12 – Behavior of Cycle 28 0: Standard behavior 1: The slot wall is approached and departed tangentially; at the beginning and end of the slot a rounding arc with a diameter equal to the slot width is cut Bit 13 - Behavior during program interruption with axis movement 0: Automatic activation of **APPROACH POSITION** 1: Do not activate **APPROACH POSITION**	PLC RUN	
MP7681	M/S/T/Q transfer to the PLC during block scan Format: %xxxx Input: Bit 0 – 0: Transfer M functions to the PLC during block scan. 1: Collect M functions and transfer them to the PLC after block scan. Bit 1 – 0: Transfer T code to the PLC during block scan. 1: Transfer last T code to the PLC after block scan. Bit 2 – 0: Transfer S or G code to the PLC during block scan. 1: Transfer S or G code to the PLC after block scan. Bit 3 – 0: Transfer FN19 outputs to the PLC during block scan. 1: Transfer last FN19 outputs to the PLC after block scan.	PLC RUN	

MP	Function and input	Software version and behavior	Page
MP7682	Machine parameter with multiple function Format: %xxxxx Input: Bit 0 – Incremental block after TOOL CALL 0: with length compensation 1: without length compensation Bit 1 – Reference value for calculating the preset during datum setting 0: Actual value is calculated 1: Nominal value is calculated Bit 2 – Traverse path of rotary axes with modulo display 0: Positioning without passing over zero 1: Positioning on the shortest path Bit 3 - Reserved, enter 0 Bit 4 - Tolerance of rotary axes with M128 0: With consideration of head dimensions 1: Without consideration of head dimensions	PLC RUN	6 – 80, 6 – 118
MP7683	Executing pallet tables and NC programs Format: %xxxxx Input: Bit 0 - Nonfunctional Bit 1 - **Program Run, Full Sequence** mode 0: During the start, a complete NC program is run. 1: At the start all NC programs are executed up to next pallet. Bit 2 - **Program Run, Full Sequence** mode 0: As defined in bit 1 1: All NC programs and pallets up to the end of the table are executed . Bit 3 – When the end of the table is reached, the process begins again with the first line. 0: Function is not in effect 1: Function is effective (bit 2 = 1) Bit 4 – Editing the active pallet table 0: Active pallet table cannot be edited. 1: In the **Program Run, Full Sequence** and **Program Run, Single Block** modes, the current pallet table can be edited. Bit 5 – AUTOSTART soft key 0: Do not display soft key 1: Display soft key Bit 6 – Display of pallet table and NC program 0: Both simultaneously in a split screen 1: Pallet table or NC program individually Bit 7 - AUTOSTART function 0: AUTOSTART function by NC 1: AUTOSTART function by PLC	PLC RUN	

MP	Function and input	Software version and behavior	Page
MP7684	Nominal position value filter and path control with M128 Format: %xxxxxxx Input: Bit 0 - Nominal position value filter 0: Include acceleration 1: Do not include the acceleration Bit 1 - Nominal position value filter 0: Include the jerk 1: Do not include the jerk Bit 2 - Nominal position value filter 0: Include the tolerance 1: Do not include the tolerance Bit 2 - Nominal position value filter 0: Include the radial acceleration 1: Do not include the radial acceleration Bit 4 - Nominal position value filter 0: Include curvature changes 1: Do not include curvature changes Bit 5 - Feed-rate reduction at corners with M128 0: Include only maximum compensatory path 1: Do not include compensatory paths Bit 5 - Feed-rate reduction at corners with M128 0: Include compensatory paths depending on the entry in bit 5 1: Include all compensatory paths	PLC RUN	
MP7690	MEMORY TEST during switch-on Format: %xxx Input: 1: No MEMORY TEST during switch-on 0: MEMORY TEST during switch-on Bit 0 – Test the RAM Bit 1 — Test the EPROM Bit 2 – Test the hard disk		

4.3.16 Second Spindle

MP	Function and input	Software version and behavior	Page
MP13010 to MP13520	Machine parameter block for the second spindle Input: Function and input range are identical with MP3010 to MP3520.		6 – 206

5 Modules, Markers and Words

5 Modules, Markers and Words

5.1 Overview of Modules

Module	Function	SW Vers.	Page
9000/ 9001	Copy in the marker or word range		
9002	Reading all inputs of a PLC input/output unit		
9003	Reading in analog inputs		
9004	Edges of PLC inputs		
9005	Update all outputs of a PLC input/output unit		
9006	Set and start PLC timer		8 – 42
9007	Diagnostic information of the PL		
9008	Reading specific inputs of a PLC input/ output unit		
9009	Update certain outputs of a PLC input/ output unit		
9010/ 9011/ 9012	Read in the word range		
9019	Size of the processing stack		
9020/ 9021/ 9022	Write in the word range		
9031	Overwrite machine parameters		4 – 7
9032	Read machine parameters		4 – 8, 8 – 36
9033	Select machine parameter file		4 – 10
9034	Load a machine parameter subfile		4 – 11
9035	Reading status information		6 – 19
9036	Writing status information		6 – 41
9038	Reading general axis information		6 – 17
9040	Reading of axis coordinates (format 0.001 mm)		
9041	Reading of axis coordinates (format 0.0001 mm)		
9042	Reading the spindle coordinates (format 0.001°)		6 – 181

Module	Function	SW Vers.	Page
9044	Reading the spindle coordinates (format 0.0001°)		6 – 181
9050	Conversion of binary numbers → ASCII		
9051	Conversion of binary numbers → ASCII		
9052	Conversion of ASCII → Binary		
9053	Conversion from binary ASCII → hexadecimal		
9054	Conversion from ASCII → hexadecimal binary		
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9060	Status of M functions		
9061	Status of non-modal M functions		
9066	Status of HEIDENHAIN inverter		6 – 175
9070	Copy a number from a string		
9071	Find the string length		
9080	Clearing the small PLC window		
9081	Interrogating the status of the small PLC window		
9082	Showing a string in the small PLC window		
9083	Showing a moving-bar diagram in the small PLC window		
9085	Display PLC error messages		
9086	Erase PLC error messages		
9087	Status of PLC error message		
9088	Displaying the M functions		
9089	Control in operation		
9090	Selection of a line in the pallet table		
9091	Finding the line number of a tool in the tool table		
9092	Searching for an entry in the tables selected for execution (.T/.D/.TCH)		
9093	Read data from tables selected for program (.T/.D/.TCH)		
9094	Writing data into a tool and datum table		
9095	Select active line in configuration file		6 – 41
9096	Deletion of a line in the tool table		
9097	Selecting the geometry description		6 – 64
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Module	Function	SW Vers.	Page
9100	Assign data interface		
9101	Release data interface		
9102	Status of data interface		
9103	Transmit string through data interface		
9104	Receive string through data interface		
9105	Transmit binary data through data interface		
9106	Receive binary data through data interface		
9107	Read from receiving buffer		
9110	Transmit a message via LSV2		
9111	Receive a message via LSV2		
9112	Transmit ASCII characters via data interface		
9113	Receive ASCII characters via data interface		
9120	Starting a PLC axis		6 – 27
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Module	Function	SW Vers.	Page
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9165	Sampling the current motor temperature		6 – 170
9166	Momentary utilization of the drive motor		6 – 174
9167	Supply voltage monitoring		6 – 169
9168	Interrogating the commissioning status		6 – 230
9169	Axes for which I32 does not switch off the drives		6 – 144
9171	Oriented spindle stop		6 – 196
9175	Spindle switchover		6 – 207
9180	Simulation of NC keys		
9181	Disable individual NC keys		
9182	Re-enabling individual NC keys		
9183	Disabling groups of NC keys		
9184	Re-enabling groups of NC keys		
9186	Call a soft-key function		
9187	Status of a soft-key function call		
9189	Shutting down the control		7 – 4
9190	Starting the operating times		
9191	Stopping the operating times		
9192	Reading the operating times		
9193	Setting the operating times		
9194	Alarm when operating time exceeded		
9195	System time		
9196	Finding the PLC cycle time		8 – 2
9197	Start cycle timer		8 – 42
9200	Display/delete PLC soft-key row		7 – 14
9201	Display/delete PLC soft key		7 – 15
9202	Select/deselect PLC soft keys and PLC windows		7 – 15
9203	Activate PLC soft-key resource file		7 – 19
9204	Update the PLC soft keys		7 – 20
9205	Define the setup parameters for the PLC soft keys		7 – 21
9206	Change setting of the PLC soft keys		7 – 22
9207	Replace PLC soft keys		7 – 23
9208	Status information of PLC soft-key structure		7 – 24
9210	Opening or erasing screen mask for the PLC window		
9211	Status of the large PLC window		

Module	Function	SW Vers.	Page
9215	Activating a PLC pop-up window		
9220	Renewed traversing of the reference marks		6 – 103
9221	Starting a PLC positioning movement		6 – 32
9222	Status request of PLC positioning movement		6 – 32
9223	Free rotation		
9225	Compensation value for the reference mark		6 – 98
9230	Datum shift		
9231	Compensation of thermal expansion		6 – 43
9240	Opening a file		
9241	Closing a file		
9242	Positioning in a file		
9243	Reading from a file line by line		
9244	Writing to a file line by line		
9245	Reading a field out of a table		
9246	Writing to a field in a table		
9247	Searching for a condition in a table		
9250	Starting the PLC editor for tables		
9251	Ending the PLC editor for tables		
9252	Positioning the cursor in the PLC editor		
9255	Reading a field out of a table		
9256	Writing to a field in a table		
9260	Receiving and waiting for events		
9261	Sending events		
9262	Context change between spawn processes		
9263	Interrupting a spawn process for a defined time		
9270	Reading a code word		8 – 17
9271	Writing a code word		8 – 17
9275	Writing ASCII data into the log		7 – 29
9276	Writing operand contents into the log		7 – 30
9279	Control reset		7 – 4
9280	Start the NC macro (Run pallet entry)		
9281	Selection of a line in the pallet table		
9290	Selecting a file		
9291	Calling an NC macro		8 – 19
9300	Locking/releasing the pocket table		
9301	Find the number of an entry in the pocket table		
9302	Search for a free pocket in the tool magazine		
9305	Tool exchange in the pocket table		
9306	Exchange tools between tool magazines		
9310	Read the machine parameter from the run-time memory		4 – 9
9320	Status of the NC program end		

5.2 Overview of Markers and Words

	Marker	Description	Set	Reset	SW Vers.	Page
M	1900 - 1999	Decoded M function if M4571 is set	NC	NC		
M	4000	Spindle in position	NC	NC		6 – 196
M	4001	Nominal speed command signal of the spindle not in the ramp	NC	NC		6 – 185
M	4002	Nominal speed value = 0	NC	NC		6 – 185
M	4003	Nominal speed value output analog or digital (MP3010 = 3 to 8)	NC	NC		6 – 183
M	4004	Impermissible speed was programmed	NC	NC		6 – 186
M	4005	Status display and nominal speed value output for M03	PLC	PLC		6 – 185
M	4006	Status display and nominal speed value output for M04	PLC	PLC		6 – 185
M	4007	Status display M05 and spindle stop	PLC	PLC		6 – 185
M	4008	Disable speed output for spindle	PLC	PLC		6 – 186
M	4009	Counterclockwise spindle rotation (for gear change)	PLC	PLC		6 – 188
M	4010	Clockwise spindle rotation (for gear change)	PLC	PLC		6 – 188
M	4011	Activate rotational speed MP3520.0 and direction of rotation from M4013	PLC	PLC		6 – 198
M	4012	Opening the spindle control loop	PLC	PLC		6 – 196
M	4013	Direction for spindle orientation from a standstill (M03 = 0; M04 = 1)	PLC	PLC		6 – 198
M	4014	Reverse the direction of spindle rotation	PLC	PLC		6 – 185
M	4015	Renewed evaluation of the spindle reference mark	PLC	NC		6 – 196
M	4016	Cycle 13 is executed	NC	PLC		6 – 198
M	4017	Spindle moving in feedback control	NC	NC		6 – 196
M	4018	Reference mark for spindle not yet traversed	NC	NC		6 – 196
M	4019	Reversing the counting direction of the position encoder on the spindle	PLC	PLC		6 – 185
M	4030	Cycle 2 or Cycle 17 active	NC	NC		6 – 200, 6 – 204
M	4031	Cycle 17 or Cycle 18 active	NC	NC		6 – 204

	Marker	Description	Set	Reset	SW Vers.	Page
M	4040	Status display M07, M08, and M09 highlighted	PLC	PLC		
M	4041	Status display M07, M08, M09, MK	PLC	PLC		
M	4042	Status display M07, M08, M09, MK	PLC	PLC		
M	4050	Touch probe not ready, ready signal is missing	NC	NC		
M	4051	Stylus deflected before start of probing cycle	NC	NC		
M	4052	Stylus is deflected, probing process is completed	NC	PLC		
M	4053	Probing process has been ended or canceled	NC	NC		
M	4054	Battery voltage too low (battery warning at touch probe connection); evaluated only during the probing process	NC	NC		
M	4055	Enable the probing process	NC	PLC		
M	4056	NC stop in all operating modes if stylus is deflected	PLC	PLC		
M	4060	Cycle for tool measurement started	NC	NC		
M	4061	0: Measure the tool 1: Check the tool	NC	NC		
M	4062	0: Wear tolerance not exceeded 1: Wear tolerance exceeded	NC	NC/ PLC		
M	4063	0: Breakage tolerance not exceeded 1: Breakage tolerance exceeded	NC	NC/ PLC		
M	4065	Workpiece dimensions are OK	NC	PLC		
M	4066	Workpiece must be reworked	NC	PLC		
M	4067	Workpiece is scrap	NC	PLC		
M	4070	Strobe signal for gear code	NC	NC		6 – 188
M	4071	Strobe signal for S code	NC	NC		6 – 191
M	4072	Strobe signal for M functions	NC	NC		
M	4073	Strobe signal T code (P code) with TOOL CALL	NC	NC		
M	4074	Strobe signal T code (P code) with TOOL DEF	NC	NC		
M	4075	Transfer active with FN19	NC	NC		8 – 21
M	4090	Acknowledgment of ”gear change completed”	PLC	PLC		6 – 188
M	4091	Acknowledgment of S code	PLC	PLC		6 – 191
M	4092	Acknowledgment of M functions	PLC	PLC		
M	4093	Acknowledgment of T code (P code) with TOOL CALL	PLC	PLC		
M	4094	Acknowledgment of T code (P code) with TOOL DEF	PLC	PLC		
M	4095	Acknowledgment of transfer with FN19	PLC	PLC		8 – 21

	Marker	Description	Set	Reset	SW Vers.	Page
M	4120 - 4128	PLC positioning axis 1 to 9 active	NC/ PLC	NC/ PLC		6 – 33
M	4130	Activation of spindle orientation, or spindle orientation has been started with Module 9171	NC/ PLC	NC		6 – 198
M	4131	Activation of Q-parameter transfer to the NC; data from D258, Q number from W516	PLC	NC		8 – 22
M	4132	Activate datum shift from D528 to D544, or call Module 9230	PLC	NC		
M	4133	Starting and stopping the free rotation function	PLC	NC		
M	4134	Activation of a gear range and speed through the PLC	PLC	NC		6 – 188
M	4135	Strobe marker for selecting the traverse range	PLC	NC		6 – 20
M	4150	Operating mode: Manual operation	NC	NC		
M	4151	Operating mode: Electronic handwheel	NC	NC		
M	4152	Operating mode: Positioning with manual data input	NC	NC		
M	4153	Operating mode: Program run, single block	NC	NC		
M	4154	Operating mode: Program run, full sequence	NC	NC		
M	4155	Operating mode: Traversing the reference marks	NC	NC		
M	4156	MANUAL TRAVERSE soft key pressed	NC	NC		
M	4157	Returning to the contour (MOVE TO POSITION) is active	NC	NC		
M	4158	Block scan active	NC	NC		
M	4159	PLC editor: END key or soft key pressed	NC	NC/ PLC		
M	4160	Pallet table selected	NC	NC		
M	4161	M/S/T/Q transfer after block scan	NC	NC		
M	4170	END PGM, M02 or M30 was executed	NC	NC		
M	4172	1st PLC scan after power on	NC	NC		
M	4173	1st PLC scan after interruption of the PLC program	NC	NC		
M	4174	1st PLC scan after editing the MPs (MP edit was exited and the MPs were altered)	NC	NC		
M	4175	Program interruption, control-in-operation symbol blinks	NC	NC		
M	4176	Control is in operation, control-in-operation symbol is on or is blinking	NC	NC		
M	4177	Erasable error message is displayed	NC	NC		6 – 176
M	4178	Error message EMERGENCY STOP is displayed	NC	NC		6 – 176
M	4179	Control is shut down	NC	NC		7 – 4
M	4180	Rapid traverse programmed (FMAX)	NC	NC		

	Marker	Description	Set	Reset	SW Vers.	Page
M	4181	NC program selected	NC	PLC		
M	4182	AUTOSTART active	NC	NC		
M	4183	Time from AUTOSTART expired	NC	NC		
M	4200	Overflow during multiplication	NC	PLC		
M	4201	Division by 0	NC	PLC		
M	4202	Incorrectly executed modulo	NC	PLC		
M	4203	Error status for PLC module	NC	NC/ PLC		
M	4204	Reserved for errors that the PLC programmer would like to catch	NC	NC		
M	4220	Error from PET table with F stop active	NC	NC		
M	4221	Error from PET table with NC stop active	NC	NC		
M	4222	Error from PET table with EM. STOP active	NC	NC		
M	4230	NC start via LSV2	NC	NC		
M	4231	NC stop via LSV2	NC	NC		
M	4300 to 4315	Value from MP4310.0	NC	NC		8 – 35
M	4316 to 4331	Value from MP4310.1	NC	NC		8 – 35
M	4332 to 4347	Value from MP4310.2	NC	NC		8 – 35
M	4348 to 4363	Value from MP4310.3	NC	NC		8 – 35
M	4364 to 4379	Value from MP4310.4	NC	NC		8 – 35
M	4380 to 4395	Value from MP4310.5	NC	NC		8 – 35
M	4396 to M4411	Value from MP4310.6	NC	NC		8 – 35
M	4520	Additional T code (P code) follows with TOOL CALL	NC	NC		
M	4521	Tool number zero programmed	NC	NC		
M	4522	Tool with pocket number programmed is in effect with MP7480.0 = 3 or 4 and TOOL CALL	NC	NC		
M	4523	Tool without pocket number programmed is in effect with MP7480.0 = 3 or 4 and TOOL CALL	NC	NC		

	Marker	Description	Set	Reset	SW Vers.	Page
M	4524	Special tool called, TOOL CALL	NC	NC		
M	4525	TOOL CALL after expiration of tool life	NC	NC		
M	4526 - 4534	Axis 1 to Axis 9 is the tool axis	NC	NC		6 – 18
M	4538	Geometry of the tool from W264	PLC	NC		
M	4540	Sequence of tool number or pocket number transfer (M4520 = 1)	PLC	PLC		
M	4541	Special tool in original pocket in spite of variable pocket coding	PLC	PLC		
M	4542	Do not update pocket number in the pocket table	PLC	PLC		
M	4543	Tool life 1 expired (TIME1 in the tool table)	NC	NC/ PLC		
M	4546	Tool life 2 expired (TIME2 in the tool table)	NC	NC/ PLC		
M	4547	T and G strobes with TOOL CALL	NC	NC		6 – 188
M	4560	NC stop (0: Stop)	PLC	PLC		
M	4561	Rapid traverse	PLC	PLC		
M	4562	Memory function for axis direction keys (MP7680 Bit 0 = 1)	PLC	PLC		
M	4563	Feed-rate enable for all axes	PLC	PLC		6 – 130
M	4564	NC start	PLC	PLC		
M	4570	Unit of measure for transfer with FN19	NC	NC		8 – 21
M	4571	Activation of decoded M-code transfer in M1900 to M1999	PLC	PLC		
M	4572	Enabling the incremental jog positioning	PLC	PLC		
M	4574	Select the traverse range (with M4575)	PLC	PLC		6 – 20
M	4575	Select the traverse range (with M4574)	PLC	PLC		6 – 20
M	4576	Locking the handwheel	PLC	PLC		
M	4577	Disabled key was pressed	NC	PLC		
M	4579	INCREMENT OFF/ON soft key	NC	NC		
M	4580	Suppress EMERGENCY STOP, open all position control loops, NC stop	PLC	PLC		6 – 129, 6 – 176
M	4581	Open all position control loops, NC stop, activate “Approach position”	PLC	PLC		6 – 129
M	4586	Enable AUTOSTART	PLC	NC/ PLC		
M	4587	Feed rate limit exceeded F MAX	PLC	PLC		6 – 127

	Marker	Description	Set	Reset	SW Vers.	Page
M	4590	Status fast PLC input from MP4130.2	NC	PLC		
M	4591	Status fast PLC input from MP4130.3	NC	PLC		
M	4592	Status fast PLC input from MP4130.4	NC	PLC		
M	4593	Status fast PLC input from MP4130.5	NC	PLC		

	Marker	Description	Set	Reset	SW Vers.	Page
W	256	Gear code	NC/ PLC	NC/ PLC		6 – 188
W	258	S code	NC	NC		6 – 191
W	260	Code for M functions	NC	NC		
W	262	Tool pocket number	NC	NC		
W	264	Tool number	NC	NC		
W	266	Index number of a programmed indexed tool	NC	NC		
W	268	Tool magazine number	NC	NC		
W	270	Line number in help file	NC	NC		
W	272	Mode of operation	NC	NC		6 – 102
W	274	Code of the depressed key	NC	NC		
D	276	Code of the code number last entered via MOD	NC	NC		
D	280	1. integer value from FN19	NC	NC		8 – 21
D	284	2. integer value from FN19	NC	NC		8 – 21
W	302	Number of the horizontal PLC soft key that was pressed	NC	NC		7 – 13
W	304	Number of the vertical PLC soft key that was pressed	NC	NC		7 – 19
W	320	Nominal speed value [rpm]	NC	NC		6 – 183
W	322	Actual speed value [rpm]	NC	NC		6 – 183
D	356	Programmed speed [0.001 rpm]	NC	NC		6 – 183, 6 – 188
D	360	Programmed feed rate	NC	NC		6 – 127
D	364	Nominal speed value [rpm]	NC	NC		6 – 183
D	368	Actual speed value [rpm]	NC	NC		6 – 183
D	388	Current tool feed rate [mm/min]	NC	NC		6 – 127
W	480-484	Analog input at X48 [0.1 V]	NC	NC		
W	486 - 490	Temperature input at X48 [0.5 °C]	NC	NC		6 – 42
W	492	Percentage for spindle override (NC to PLC)	NC	NC		6 – 189
W	494	Percentage for feed rate override (NC to PLC)	NC	NC		
W	516	Q No. 0-7 for numerical data transfer PLC to NC	PLC	PLC		8 – 22
B	518	Defining the free rotation function	PLC	PLC		
B	519	Traverse direction for free rotation	PLC	PLC		
W	522	Enabling the high-speed PLC inputs	PLC	PLC		6 – 162
W	524	Monitoring functions if drive is released for axis group 1	PLC	PLC		6 – 142
D	528	Double word with multiple function, here data for transfer from PLC to NC	PLC	PLC		8 – 22

	Marker	Description	Set	Reset	SW Vers.	Page
D	528-544	Target position for PLC positioning	PLC	PLC		6 – 33
D	528	Datum shift for axis 1	PLC	PLC		
D	532	Datum shift for axis 2	PLC	PLC		
D	536	Datum shift for axis 3	PLC	PLC		
D	540	Datum shift for axis 4	PLC	PLC		
D	544	Datum shift for axis 5	PLC	PLC		
W	560 - 568	Feed rate for PLC positioning	PLC	PLC		6 – 33
W	576 - 584	Lag-tracking axis error compensation	PLC	PLC		6 – 42
D	592	Nominal position for spindle orientation	PLC	PLC		6 – 198
D	596	Max. feed rate from PLC [mm/min]	NC/ PLC	PLC		6 – 127
D	604	Maximum possible spindle speed	PLC	NC/ PLC		6 – 183
W	754	% function for feed-rate override for free rotation	PLC	PLC		
D	756	Programmed rotational speed or rotational speed of the PLC [0.001 rpm]	NC/ PLC	NC/ PLC		6 – 188
D	760	Offset in tilting axes touch probe center offset [1/10 000°]	PLC	PLC		
W	764	Percentage for spindle override (PLC to NC)	NC/ PLC	NC/ PLC		6 – 189
W	766	Percentage for feed rate override (PLC to NC)	NC/ PLC	NC/ PLC		
D	768 - 956	Values from MP4210.0 to MP4210.47	NC	NC		8 – 34
W	960 - 968	Value from MP4220.0 to MP4220.4	NC	NC		8 – 35
W	976 - 988	Value from MP4310.3 to MP4310.6	NC	NC		8 – 35
W	1008	S code for minimum speed	NC	NC		6 – 191
W	1018	Number of files opened by the PLC	NC	NC		
W	1020	Number of open files	NC	NC		
W	1022	Error status of the module last called	NC	NC		
W	1024	Axis release	NC	NC		6 – 129
W	1026	Axes in position	NC	NC		6 – 166
W	1028	Axes in motion	NC	NC		6 – 167
W	1030	Current direction of traverse	NC	NC		6 – 9
W	1032	Reference marks not yet traversed	NC	NC		6 – 102
W	1034	Positive software limit switch was traversed	NC	NC		6 – 23
W	1036	Negative software limit switch was traversed	NC	NC		6 – 23
W	1038	Preparing opening of the position control loop	PLC	PLC		6 – 130
W	1040	Axis-specific opening of the position control loop	PLC	PLC		6 – 130
W	1042	Deactivation of monitoring functions	PLC	PLC		6 – 161

	Marker	Description	Set	Reset	SW Vers.	Page
W	1044	Actual-to-nominal value transfer	PLC	PLC		6 – 131
W	1046	Manual traverse in positive direction	PLC	PLC		
W	1048	Manual traverse in negative direction	PLC	PLC		
W	1050	Incremental jog positioning in positive direction	PLC	PLC		
W	1052	Incremental jog positioning in negative direction	PLC	PLC		
W	1054	Reference end position	PLC	PLC		6 – 102
W	1056	Lubrication pulse: Value in MP4060 exceeded	NC	NC		6 – 24
W	1058	Resetting the accumulated distance	PLC	PLC		6 – 24
W	1060	Axis-specific feed-rate enable	PLC	PLC		6 – 130
W	1062	Lock the handwheel for specific axes	PLC	PLC		

6 Configuring Axes and Spindle

6 Configuring Axes and Spindle

6.1 Control Loops

6.1.1 Selecting the Axes

With MP10 you define which machine axes are to be operable.
The bits may be changed during the run-time without a control reset.
However, the bits to be changed must have been set before the control was switched on.
Changing bits that had not been set leads to a control reset.

MP10	**Active axes**
Format:	%xxxxxxxxxxxxxx
Input:	Bits 0 to 13 correspond to axes 1 to 14 0: Axis not active 1: Axis active

Screen display

You can define how the axes are shown on the screen

- In MP100.x, assign a designation to each logical axis.
- Define in MP7291.x the screen line in which the axis is to be displayed.

Rules for the display:

- NC axes are designated with uppercase letters.
- PLC axes are designated with lowercase letters.
- Axes that are not present are given a hyphen "-".

MP100	**Designation of axes**
Format:	XYZABCUVWxyzabcuvw-
Input:	Characters 1 to 9 from the right represent axes 1 to 9
MP100.0	Designation of axes for traverse range 1
MP100.1	Designation of axes for traverse range 2
MP100.2	Designation of axes for traverse range 3

MP7291	**Display of axes on the screen**
Format:	SXYZABCUVWxyzabcuvw-
Input:	Characters 1 to 9 from the right represent lines 1 to 9 Character 10 is the spindle "S", which is always output in line 9.
MP7291.0	Display in traverse range 1
MP7291.1	Display in traverse range 2
MP7291.2	Display in traverse range 3

Assignment of axis keys IV and V

On the keyboard unit and the HR 410 handwheel, you can assign the axis keys IV and V as desired.

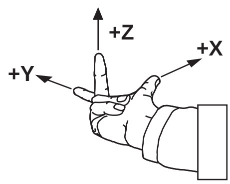
MP410	**Assignment of axis keys IV and V**
Input:	Axis designation XYZABCUVWxyzabcuvw-
MP410.3	Axis key IV
MP410.4	Axis key V

6.1.2 Axis Designation

Principal axes X, Y, Z

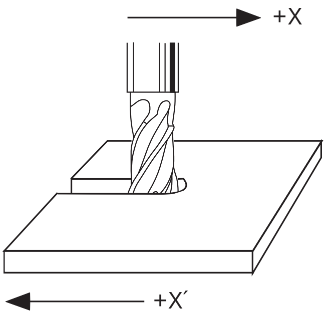
The coordinate axes and their directions of motion are defined in the international standard ISO 841 .

An easy way to remember this system is to use the “right-hand rule”:



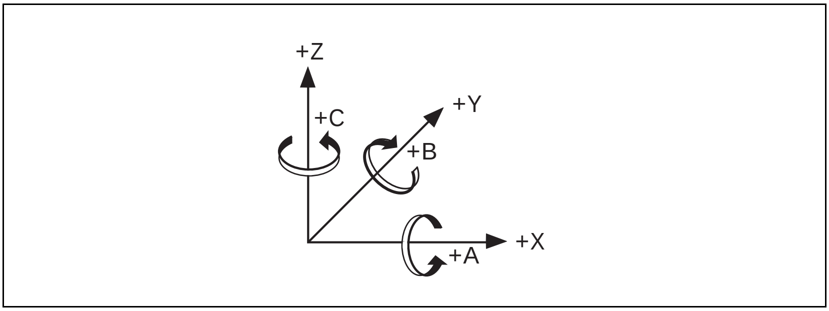
Algebraic signs of the axes

When the programmer writes an NC program, he always assumes that the tool (not the workpiece) is in motion. If the machine moves its workpiece-holding element (table) in a particular axis instead of the tool, then the direction of actual motion is opposite to the direction of axis motion. In this case the direction of motion is designated with the same algebraic sign as the axis direction, but with an apostrophe: +X´, +Y´ and +Z´:



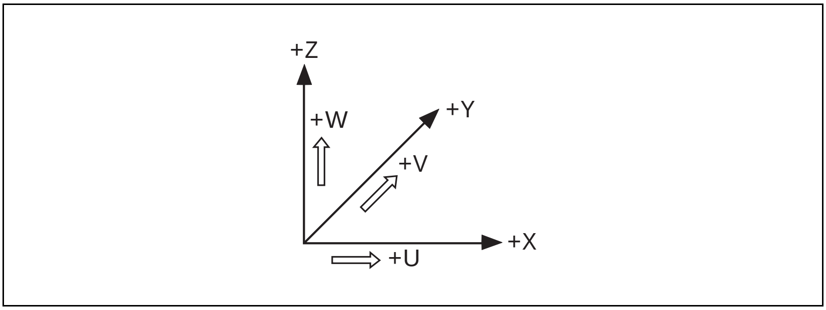
Rotary axes A, B, C

The directions of the rotary axes A, B and C follow the “right-fist rule.” The fingers of the closed right hand point in the proper rotational direction of an axis when the thumb points in the direction of the associated linear axis:



Secondary linear axes

The secondary linear axes U, V and W are parallel to the principal axes X, Y and Z.



6.1.3 Encoders

Position encoders report positions and movements of the machine to the control. The iTNC 530 operates with incremental and absolute encoders with EnDat interface.

Signal period

For any given distance the position encoder outputs a fixed number of signal periods. The signal is subdivided by 1024.

To calculate the signal period, the control requires the following data:

- In MP331.x, enter for each axis the length required for the number of signal periods given in MP332.x.
- In MP332.x, enter for each axis the number of signal periods for the length given in MP331.x.

From these data the iTNC calculates the quotient:

$$\text{Signal period} = \frac{\text{MP331.x}}{\text{MP332.x}}$$

Note

Digital axes:
If no position encoder (MP110.x = 0) is connected, the data of the speed encoder must be entered in MP331.x and MP332.x. This also applies to speed encoders with an EnDat interface, since the incremental track of the speed encoder is used for position feedback control.

HEIDENHAIN offers incremental linear encoders with **distance-coded reference marks.** The nominal increment between two fixed reference marks depends on the encoder being used:

- In MP334.x, enter for each axis the nominal increments between two fixed reference marks.

If the number of grating periods between the reference end position and the first reference mark exceeds the value from MP334.x, the error message **`Ref mark <axis>: incorrect spacing`** appears. This monitoring is turned off with MP334.x = 0.

Example:
LS 486C:
Incremental linear encoder with distance-coded reference marks, grating period 20 µm (= one signal period covers 0.02 mm), nominal increment between reference marks is 20 mm.

MP331.x = 0.02
MP332.x = 1

$$\text{MP334.x} = \frac{20\text{ mm}}{0.02\text{ mm}} = 1000 \text{ (or 0)}$$

MP331.x **Distance for the number of signal periods in MP332**
Input: 0.0001 to 99 999.9999 [mm] or [°]

MP332.x **Number of signal periods for the distance in MP331**
Input: 1 to 16 777 215

MP334.x **Nominal increment between two fixed reference marks on encoders with distance-coded reference marks**
Input: 1 to 65 535
0: 1 000

External interpolation

If you connect encoders with TTL signals and an external interpolation unit through the TTL/1 V_{PP} adapter to the control:

- In MP340.x, enter the interpolation factor of the external interpolation unit.

MP340.x **Interpolation factor for external interpolation**
Input: 0 to 99
0 = 1: No external interpolation

Encoder signals

Position encoders with 1-V_{PP} or 11- μA_{PP} signals can be connected to the MC 422.

- With MP115.0, you set the 1-V_{PP} or 11-μA_{PP} signal.
- With MP115.2, you set the maximum input frequency.

Note

The incremental track data must be entered for the corresponding position encoder inputs for encoders with EnDat interfaces.

MP115.0	**Position encoder input 1 V_{PP} or 11 μA_{PP}**
Format:	%xxxxxxxxxxx
Input:	Bit 0 to bit 5: Position encoder inputs X1 to X6 Bit 6 to bit 9: Position encoder inputs X35 to X38 Bit 10: Nonfunctional 0: 1 V_{PP} 1: 11 μA_{PP}
MP115.1	**Reserved**
Format:	%xxxxxxxxxxx
Input:	Enter %00000000000
MP115.2	**Input frequency of the position encoder inputs**
Format:	%xxxxxxxxxxx
Input:	Bit 0 to bit 5: Position encoder inputs X1 to X6 Bit 6 to bit 9: Position encoder inputs X35 to X38 Bit 10: Nonfunctional For 1 V_{PP}: 0: 50 kHz 1: 350 kHz For 11 μA_{PP}: 0: 50 kHz 1: 150 kHz

Direction of traverse

With MP210 and MP1040 you define the direction of traverse of the axes. The counting direction depends on the position in which the encoders are mounted. Configuration errors in these parameters provoke the error message **`MOVEMENT MONITORING ERROR IN <AXIS.>`** Through W1030 the NC informs the PLC of the direction in which the axes traverse.

If the speed encoder is also used for position measurement, MP210 must be set for the speed encoder. Configuration errors in these parameters provoke the error message **`standstill monitoring <in axis>.`**

MP210	**Counting direction of position encoder output signals**
Format:	%xxxxxxxxxxxxxx
Input:	Bits 0 to 13 correspond to axes 1 to 14 0: Positive 1: Negative
MP1040	**Analog axes: Polarity of nominal value voltage** **Digital axes: Algebraic sign of the nominal speed value**
Format:	%xxxxxxxxxxxxxx
Input:	Bits 0 to 13 correspond to axes 1 to 14 0: Positive 1: Negative

		Set	Reset
W1030	**Current direction of traverse** Bits 0 to 8 correspond to axes 1 to 9 0: Positive traverse direction 1: Negative traverse direction	NC	NC

Note

The counting direction of the speed encoder signals is defined in the motor table (DIR column). If the error message **`C3B0 Motor <AXIS> does not rotate`** appears, you must change this entry.

Encoder monitoring

HEIDENHAIN contouring controls monitor the signal transmission from the encoders. With machine parameters MP20.x and MP21.x, you activate the monitoring function for the position encoders. The following criteria are checked:

Criterion	Error message
Absolute position with distance-coded reference marks	`Encoder <AXIS> DEFECTIVE`
Amplitude of encoder signals	`Encoder AMPLITUDE TOO LOW <AXIS>`
Edge separation of encoder signals	`Encoder <AXIS>: FREQUENCY TOO HIGH`

MP20 **Monitoring functions for the axes**

Format: %xxxxxxxxxxxxxx
Input: Bits 0 to 13 correspond to axes 1 to 14
0: Monitoring not active
1: Monitoring active
MP20.0 Absolute position of distance-coded reference marks
MP20.1 Amplitude of encoder signals
MP20.2 Edge separation of encoder signals

MP21 **Monitoring functions for the spindle**

Format: %xx
Input: Bit 0 – Spindle 1
0: Monitoring not active
1: Monitoring active
Bit 1 – Spindle 2
0: Monitoring not active
1: Monitoring active
MP21.0 Has no function
Input: 0
MP21.1 Amplitude of encoder signals
MP21.2 Edge separation of encoder signals

Note

Please note:

- For digital axes the speed encoders are always monitored.
- For more information on error messages from speed encoders, see "Error Messages" section.

Monitoring for encoders with EnDat interface:

In the event of a disturbance, the error message **`EnDat defective <error codes> <axis>`** will appear.

The error code is shown in hexadecimal notation. The error codes may also appear combined, in which case they add themselves together.

There are two possible types of errors:

- The encoder reports an error.
- Access to the encoder via the EnDat interface is faulty.

Codes of errors reported by the encoder:

Error code	Meaning
0x00000001	Light source defective
0x00000002	Signal amplitude too small
0x00000004	Incorrect position value
0x00000008	Overvoltage
0x00000010	Undervoltage
0x00000020	Overcurrent
0x00000040	Replace battery
0x00000080	Reserved
0x00000100	Reserved
0x00000200	Reserved
0x00000400	Reserved
0x00000800	Reserved
0x00001000	Reserved
0x00002000	Reserved
0x00004000	Reserved
0x00008000	Reserved

Error codes if the access to the encoder via the EnDat interface is faulty:

Error code	Meaning
0x80010000	Delete the alarm bit
0x80020000	Read the alarm status
0x80040000	Read the number of pulses
0x80080000	Read the number of signal periods
0x80100000	Read the number of differentiable revolutions
0x80200000	Read the measuring steps
0x80400000	Read the series number
0x80800000	Read the type of encoder
0x81000000	Read the position value
0x82000000	Reserved
0x84000000	Reserved
0x88000000	Read the checksum
0x90000000	Alarm bit remains set
0xA0000000	Timeout while waiting for data - signal “high”
0xC0000000	Timeout while waiting for data - signal “low”
0x80000000	Error during access to EnDat interface

Speed encoder

The iTNC 530 uses the **Type of encoder** entry in the "motor.mot" motor table. If an encoder with Z1 track is entered in the motor table, the message **C310 Z1 track error** appears in the event of an error. If an encoder with EnDat interface is entered in the motor table, the control attempts to communicate with the encoder. If this fails, the error message **C3F0 EnDat not found <axis>** appears.

Warning

If you use the HEIDENHAIN standard motor table motor.mot and motors with EnDat encoders, you might have to change the entry for the motor in the SYS column (type of encoder) of the motor table or enter a new motor.

- SYS = 1: Incremental rotary encoder with Z1 track
- SYS = 2: Absolute speed encoder with EnDat interface

6.1.4 Assignment for Axes

With the following machine parameters you assign the position and speed encoder inputs, the speed command output and the machine parameter block of the current and speed controller to the individual logic axes:

- In MP110.x you enter the number of the position encoder input.
- In MP112.x you enter the number of the speed encoder input.
- In MP120.x you enter the number of the speed command output (analog or digital).
- In MP130.x you enter index number y of machine parameter block MP2xxx.y of the current and speed controller.

Note

Depending on the maximum spindle speed, it might no longer be possible to use all PWM outputs, See "Maximum spindle speed" on page 6 – 14.

If MP120.x = 0, then the axis will only be displayed.

Digital axes: If MP110.x = 0, then the speed encoder (with or without EnDat interface) is also used for position control.

Note

For axes 7 to 10, only speed encoder inputs X80 to X83 and speed command outputs X57 to X60 can be used.

MP110.x **Assignment of position encoder inputs to the axes**
Input: 0: No position encoder input
1 to 6: Position encoder inputs X1 to X6
35 to 38: Position encoder inputs X35 to X38

MP112.x **Assignment of speed encoder inputs to the axes**
Input: 0: No speed encoder input
15 to 20: Speed encoder inputs X15 to X20
80 to 83: Speed encoder inputs X80 to X83

MP120.x **Nominal speed command outputs of the axes**
Input: 0: No servo-controlled axis
1 to 6: Analog speed command outputs 1 to 6 (X8)
7 to 12: Analog speed command outputs 7 to 12 (X9)
51 to 60: Digital speed command outputs X51 to X60

MP130.x **Y index of the machine parameters MP2xxx.y for the axes**
Input: 0 to 9

6.1.5 Assignment for Spindles

With the following machine parameters you assign the position and speed encoder inputs, the speed command output and the machine parameter block of the current and speed controller to the spindle/spindles:

- In MP110.x you enter the number of the position encoder input.
- In MP112.x you enter the number of the speed encoder input.
- In MP120.x you enter the number of the speed command output.
- In MP130.x you enter index number y of machine parameter block MP2xxx.y of the current and speed controller.

First spindle			Second spindle		
Position	**Rotational speed**	**Nominal value**	**Position**	**Rotational speed**	**Nominal value**
X1 to X6, X35 to X38	X15 to X20, X80 to X83	Digital: X51 to X56, X57 to X60	X1 to X6, X35 to X38	X15 to X20, X80 to X83	Digital: X51 to X56, X57 to X60
X1 to X6, X35 to X38	X15 to X20, X80 to X83	Digital: X51 to X56, X57 to X60	X1 to X6, X35 to X38	–	Analog: 1 to 12
X1 to X6, X35 to X38	–	Analog: 1 to 12	X1 to X6, X35 to X38	–	Analog: 1 to 12

Maximum spindle speed

The individual PWM outputs are assigned to different controller groups:

- Controller group 1: X51, X53, X54
- Controller group 2: X52, X55, X56
- Controller group 3: X57, X59, X60
- Controller group 4: X58

If all PWM outputs of a controller group are used, the maximum spindle speed is

$$\frac{60\,000\text{ rpm}}{\text{No. of pole pairs}}\ .$$

If only the first PWM output of a controller group is used, the maximum spindle speed is

$$\frac{80\,000\text{ rpm}}{\text{No. of pole pairs}}\ .$$

The unused PWM outputs must not be entered in MP120.x or. MP121.x. Otherwise, the DSP error message **`C440 PWM frequency <Axis>`** will appear.

The PWM frequency can be set separately for each of the controller groups, See "PWM Frequency" on page 6 – 223.

MP111	**Position encoder input for the spindle/spindles**
Input:	0: No position encoder input 1 to 6: Position encoder inputs X1 to X6 35 to 38: Position encoder inputs X35 to X38
MP111.0	Position encoder input for the first spindle
MP111.1	Position encoder input for the second spindle
MP113	**Speed encoder for the spindle/spindles**
Input:	0: No speed encoder input 15 to 20: Speed encoder inputs X15 to X20 80 to 83: Speed encoder inputs X80 to X83
MP113.0	Speed encoder for the first spindle
MP113.1	Speed encoder for the second spindle
MP121	**Nominal speed command output of the spindle/spindles**
Input:	0: No servo-controlled spindle 1 to 6: Analog speed command outputs 1 to 6 (X8) 7 to 12: Analog speed command outputs 7 to 12 (X9) 51 to 60: Digital speed command outputs X51 to X60
MP121.0	Nominal speed command output of the first spindle
MP121.1	Nominal speed command output of the second spindle
MP131	**Y index of the machine parameters MP2xxx.y for the spindle in operating mode 0**
Input:	0 to 9
MP131.0	Y index of first spindle
MP131.1	Y index of second spindle
MP132	**Y index of the machine parameters MP2xxx.y for the spindle in operating mode 1**
Input:	0 to 9
MP132.0	Y index of first spindle
MP132.1	Y index of second spindle

6.1.6 Reading Axis Information

Module 9038 Reading general axis information

With Module 9038 you can interrogate the general status information of the axes. You can ask for the status of a specific axis or of all axes at once. Bit 0 to Bit 8 correspond to axes 1 to 9. Bit 15 corresponds to the spindle. If status information is read for only one axis, only bit 0 is changed. The following table shows the meanings of the return codes:

Status information	Meaning
0	0: Axis (spindle) not active (MP10 or MP3010 or no encoder) 1: Axis (spindle) active
1	Depending on the current traverse range: 0: NC axis or not active 1: PLC axis
2	0: No servo-controlled axis (spindle), only display or not active 1: Servo-controlled axis (spindle)
3	Maximum temperature of the motor [°C]
4	0: No Hirth axis 1: Hirth axis (MP420)
5	Hirth grid [1/10 µm] (MP430)
6	Modulo value (MP810)
7	0: Linear axis or not active 1: Rotary axis in at least one of the traverse ranges
8	0: Analog axis (spindle) or not active 1: Digital axis (spindle)

Call:

```
PS    B/W/D/K   <>Axis>
                Axis specific: 0 to 8 represent axes 1 to 9,
                15 represents the spindle
                Bit-coded output for all axes: –1
PS    B/W/D/K   <>Status information>
                See table above
CM    9038
PL    B/W/D     <>Information>
```

Error detection:

Marker	Value	Meaning
M4203	0	Information was read
	1	Error code in W1022
W1022	1	Status information not available on this iTNC
	2	Axis does not exist

Current tool axis

You can define the current tool axis in two ways in the NC block:

- In the HEIDENHAIN conversational dialog with TOOL CALL
- In ISO programming with G17 to G20

In the PLC you can interrogate the current tool axis via marker:

		Set	Reset
M4526	**Axis 1 is tool axis**	NC	NC
M4527	**Axis 2 is tool axis**	NC	NC
M4528	**Axis 3 is tool axis**	NC	NC
M4529	**Axis 4 is tool axis**	NC	NC
M4530	**Axis 5 is tool axis**	NC	NC
M4531	**Axis 6 is tool axis**	NC	NC
M4532	**Axis 7 is tool axis**	NC	NC
M4533	**Axis 8 is tool axis**	NC	NC
M4534	**Axis 9 is tool axis**	NC	NC

6.1.7 Traverse Ranges

You can divide the working range of the machine into three traverse ranges, e.g. one for each workpiece. Each traverse range is limited by a software limit switch.

For the software limit switch of a traverse range:

- The datum is the machine datum (MP960.x).
- Software limit switches for tilting axes must be activated with MP812 when MP810.x ≠ 0
- The traverse range can be limited further through the MOD function.
- If a software limit switch is activated, the error message **LIMIT SWITCH <AXIS>** appears.
- Software limit switches can be overwritten with **FN17:SYSWRITE,** e.g. for automatic tool change. This function is effective only until the next GOTO command (GOTO key or FN9 to FN12) or the end of the program.

Determining range of traverse

- You can determine the current range of traverse with Module 9035

Module 9035 Reading status information

Call:

```
PS    B/W/D/K   <>27>
CM    9035
PL    B/W/D     <>Range of traverse>
                 0 to 2: Traverse ranges 1 to 3
```

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	1	Status information invalid
	20	Call was not in a submit or spawn job

Selecting the traverse range

You can switch the range of traverse in two ways:

- Select the traverse range with Module 9151 or 9152. With Module 9152 you can change the axis display at the same time.

or

- Select the traverse range with M4574 and M4575 according to the table below.
- In all operating modes you must activate the traverse range with strobe marker M4135.

You may only use the traverse range switching function via M4574 and M4575 during an M/S/T/Q strobe in all operating modes (except for **Manual Operation** and **El. Handwheel**).

M4574	M4575	Traverse range/Datum
0	0	Range 1
1	0	Range 2
0	1	Range 3

		Set	Reset
M4574	**Select the traverse range (with M4575)**	PLC	PLC
M4575	**Select the traverse range (with M4574)**	PLC	PLC
M4135	**Strobe marker for selecting the traverse range**	PLC	NC

Module 9151 Select traverse range and axis designation

With Module 9151 you can select the traverse range and the axis designation in one step. The axis designations in MP100.x are overwritten and cannot be activated until the module has received the axis designation –1, a traverse range has been activated with M4135, MP100.x is edited, or the control has been reset.
When the module is called it sets M4135. After switchover the NC resets M4135.

Call:
PS B/W/D/K/S<>String with axis designation>
Format: XYZABCUVWxyzabcuvw
Characters 1 to 9 correspond to axes 1 to 9
With –1 the axis designations from M100.x are valid
PS B/W/D/K <>Traverse range>
0 to 2: Range of traverse
–1: Do not change range of traverse
CM 9151

Error detection:

Marker	Value	Meaning
M4203	0	Traverse range/axis designation switched over
	1	Error code in W1022
W1022	2	Invalid value for traverse range
	3	For the axis assignment, neither a string nor –1 was transferred
	21	The module was called during a running part program or without an M/S/T/Q strobe

Module 9152 Selecting traverse range, axis display and axis designation

With Module 9152 you can select the traverse range, the axis designation, and the axis display. The axis designations in MP100.x and the axis display in MP7291 are overwritten and cannot be activated until the module has received –1 for the axis designation and axis display, a traverse range has been activated with M4135, MP100.x or MP7291 have been edited, or the control has been reset.

When the module is called it sets M4135. After switchover the NC resets M4135.

Call:

PS B/W/D/K/S<>String with IV and V key configuration>

Format: AB

The first character represents the IV key, the second character represents the V key

With –1 the key configuration from MP410 is valid

PS B/W/D/K/S<>String with axis display>

Format: SWVUCBAZYXwvucbazyx

Characters 1 to 9 (from the right) represent lines 1 to 9

Character 10 = S always in line 10

With –1 the axis display from MP7291 is valid

PS B/W/D/K/S<>String with axis designation>

Format: XYZABCUVWxyzabcuvw

Characters 1 to 9 correspond to axes 1 to 9

With –1 the axis designations from M100.x are valid

PS B/W/D/K <>Traverse range>

0 to 2: Range of traverse

–1: Do not change range of traverse

CM 9152

Error detection:

Marker	Value	Meaning
M4203	0	Traverse range, axis designation and axis display are switched
	1	Error code in W1022
W1022	2	Invalid value for traverse range, or string for axis configuration, axis display or key configuration is too long
	3	For the axis assignment, axis display or key configuration, neither a string nor –1 was transferred
	21	The module was called during a running part program or without an M/S/T/Q strobe

Setting the software limit switches

With the following machine parameters, you can set the software limit switches for the various ranges of traverse. The position values are with respect to the machine datum. Ranges of traverse 2 and 3 do not become effective until they are activated by M4574, M4575 and M4135 or with Module 9151 or 9152.

Note

The values for MP910.x, MP911.x, MP912.x, MP920.x, MP921.x and MP922.x can be transferred with the actual-position-capture key.

MP910.x **Positive software limit switches, traverse range 1 (default setting after power on)**
Input: -99 999.9999 to +99 999 [mm] or [°]

MP911.x **Positive software limit switches, traverse range 2**
Input: -99 999.9999 to +99 999 [mm] or [°]

MP912.x **Positive software limit switches, traverse range 3**
Input: -99 999.9999 to +99 999 [mm] or [°]

MP920.x **Negative software limit switches, traverse range 1 (default setting after power on)**
Input: -99 999.9999 to +99 999 [mm] or [°]

MP921.x **Negative software limit switches, traverse range 2**
Input: -99 999.9999 to +99 999 [mm] or [°]

MP922.x **Negative software limit switches, traverse range 3**
Input: -99 999.9999 to +99 999 [mm] or [°]

MP7490 **Functions for traverse ranges**
Format: %xxxx
Input: Bit 0 = 0: Display one traverse range via MOD
Bit 0 = 1: Display three traverse ranges via MOD
Bit 1 = 0: Each traverse range has its own datum
(and 3 memories for the positions of the swivel head)
Bit 1 = 1: One datum for all traverse ranges

The NC reports the activation of limit switches in words W1034 and W1036 to the PLC:

		Set	Reset
W1034	**Positive software limit switch was traversed** Bits 0 to 8 represent axes 1 to 9	NC	NC
W1036	**Negative software limit switch was traversed** Bits 0 to 8 represent axes 1 to 9	NC	NC

6.1.8 Lubrication Pulse

You can define the traverse distance for each axis after which the PLC commands lubrication:

- In MP4050.x you define the traverse distance at which the lubrication pulse is to be output. The NC reports in W1056 when the entered distance in an axis has been exceeded.
- With W1058 you reset the distance counter to 0 after lubrication.

MP4050.0-8 Traverse distance for lubrication of axes 1 to 9
Input: 0 to 99 999.999 [m] or [1000°]

		Set	Reset
W1056	**Lubrication pulse: Value in MP4060 exceeded** Bits 0 to 8 represent axes 1 to 9	NC	NC
W1058	**Resetting the accumulated distance** Bits 0 to 8 represent axes 1 to 9	PLC	PLC

6.2 PLC axes

You can assign the controlled axes individually to the PLC.

Remember that:

- PLC axes can be operated with following error (also called lag) or with velocity feedforward control. The axis-specific jerk (MP1097.x and MP1098.x) is accounted for.
- You can start more than one axis simultaneously. However, the axes are not interpolated with each other.
- PLC axes are positioned by the shortest path if you enter a modulo value in MP810.x.

With MP100.x you define for every traverse range which axes the PLC controls and which the NC controls. Uppercase letters represent NC axes, and lowercase letters represent PLC axes. To indicate axes that are not present, mark them with a hyphen "-".

MP100	**Designation of axes**
Format:	XYZABCUVWxyzabcuvw-
Input:	Bits 0 to 8 correspond to axes 1 to 9
MP100.0	Traverse range 1
MP100.1	Traverse range 2
MP100.2	Traverse range 3

Module 9120 Starting a PLC axis

This module starts positioning a PLC axis regardless of other processes in the control.

Conditions:

- Status changes through a PLC positioning command are not detected until the next PLC scan.
- The axis must be activated in MP10 and identified in MP100 as a PLC axis.
- Traverse over the software limit switches is not checked.
- The axis must be stationary before positioning. Interrupt a running positioning movement with Module 9121.
- The feed-rate override is disabled. To change the feed rate, use module 9124.
- If no reference mark has been traversed, the positioning process builds on the counter value as it was upon switch-on.

Call:

PS	B/W/D/K	<>Axis>
		0 to 8 correspond to axes 1 to 9
PS	B/W/D/K	<>Target position>
		Input unit: [0.0001 mm]
PS	B/W/D/K	<>Feed rate>
		Input unit: [mm/min]
PS	B/W/D/K	<>Mode>
		Bit 0: Type of target position input
		0: Absolute, i.e. relative to the machine datum
		1: Incremental
CM	9120	
PL	B/W/D	<>Error code>
		0: No error. Positioning was started.
		1: Axis does not exist
		2: Not a PLC axis
		3: Axis is already being positioned
		4: Absolute position is outside of modulo range
		5: Programmed axis not in closed loop
		6: Feed rate not permitted

Module 9121 Stopping a PLC axis

Stops a running PLC positioning process in an axis.

Condition:

- Status changes through a PLC positioning command are not detected until the next PLC scan.

Call:

PS	B/W/D/K	<>Axis>
		0 to 8 correspond to axes 1 to 9
CM	9121	
PL	B/W/D	<>Error code>
		0: Positioning is canceled
		1: Axis does not exist
		2: Not a PLC axis
		3: Axis was already stationary

Module 9122 Status of PLC axis

Request for PLC positioning status.

Condition:

- Status changes through the PLC positioning command are not detected until the next PLC scan.

Call:

PS	B/W/D/K	<>Axis> 0 to 8 correspond to axes 1 to 9
CM	9122	
PL	B/W/D	<>status> Bit 0 – A PLC axis? 0: NC axis or not active 1: PLC axis Bit 1 – Reference mark 0: Reference mark not yet traversed 1: Reference mark traversed Bit 2 – Positioning 0: Inactive 1: Active Bit 3 – Direction of motion 0: Positive 1: Negative Bit 4 – Positioning error 0: No positioning errors occurred 1: Positioning error Bit 5 – Close-loop or open-loop axis 0: Close-loop axis was programmed 1: Axis programmed which was switched to open-loop in Module 9155 Bit 6 – Target position reached? 0: Target position not yet reached 1: Target position reached

Module 9123 Traversing the reference marks of PLC axes

Traverse the reference marks as for NC axes.

- You can use the same procedure to traverse a reference mark for PLC axes as for NC axes. Use Module 9123 only if no conventional procedure is possible.
- Module 9123 moves the axis in the given direction until the reference mark has been traversed. The axis stops next to the reference mark, offset by the braking path.

Call:

PS	B/W/D/K	<>Axis>
		0 to 8 correspond to axes 1 to 9
PS	B/W/D/K	<>Feed rate>
		Input unit: [mm/min]
PS	B/W/D/K	<>Mode>
		Bit 0: Direction of traverse
		0: Positive
		1: Negative
CM	9123	
PL	B/W/D	<>Error code>
		0: No error. Positioning was started.
		1: Axis does not exist
		2: Not a PLC axis
		3: Axis is already being positioned
		5: Programmed axis not in closed loop
		6: Feed rate not permitted

Module 9124 Feed rate override for PLC axis

Enters the feed rate override for one PLC axis.

Conditions:

- After interruption of a PLC program, the override value is set to 100%.
- When a positioning is started, the last defined override value is in effect.
- The override value can also be changed during a positioning movement.

Call:

PS	B/W/D/K	<>Axis>
		0 to 8 correspond to axes 1 to 9
PS	B/W/D/K	<>Override>
		Input unit: 0 to 10 000, corresponds to 0 to 100% in 0.01% steps.
CM	9124	
PL	B/W/D	<>Error code>
		0: No error, override value was set
		1: Axis does not exist
		2: Not a PLC axis
		3: Override value incorrect

Module 9125 Stop PLC axis at next Hirth grid position

Stop an already started PLC-positioning of an axis at the next Hirth grid position.

Call:

PS	B/W/D/K	<>Axis> 0 to 8 correspond to axes 1 to 9
CM	9125	
PL	B/W/D	<>Error code> 0: Positioning is canceled 1: Axis does not exist 2: Not a PLC axis 3: Axis was already stationary 4: Axis is not a Hirth axis (MP420.x)

6.3 PLC Positioning

You can position the axes directly through the PLC. PLC positioning of the main spindle See page 6 – 179.

Prerequisites

The following constraints apply to a PLC positioning command:

- It is possible in the Manual and Handwheel modes only while there is no positioning movement.
- Possible in the other modes of operation only with an M/S/T/Q strobe or if no part program is started.
- If the NC is positioning an axis, you can position additional axes only if they have already been defined as PLC axes. See "PLC axes" on page 6 – 26.

Programming

You start a PLC positioning movement with Module 9221, and you can interrogate the status with Module 9222. After Module 9221 has been called, markers M4120 to M4128 are set (depending on MP4020 bit 2). If you reset these markers, positioning is canceled. This is necessary if you would like to change a parameter, for example the feed rate, during positioning.

The following conditions apply to a PLC positioning command:

- If more than one axis is moved simultaneously, then the axes will be interpolated.
- If you start another axis during a PLC positioning movement,
  - then the first positioning command will be canceled and
  - the resulting positioning movement will be executed in all axes.
- Tool compensation is not included. Before a PLC positioning command you must end any tool compensation.
- A PLC positioning movement is not displayed in the test graphic.

The NC cancels a PLC positioning movement under the following conditions:

- If in the Manual or Handwheel modes there is an NC STOP
- If in the automatic operating modes there is an NC STOP and “internal stop”
- An EMERGENCY STOP
- An error message that results in a STOP
- A reset of the Markers M4120 to M4128 (depending on MP4020 bit 2)

Module 9221 Starting a PLC positioning movement

Starts a PLC positioning movement in one axis.

Call:

PS	B/W/D/K	<>Axis>
		0 to 8 correspond to axes 1 to 9
PS	B/W/D/K	<>Target position>
		Input unit: 0.0001 mm
PS	B/W/D/K	<>Feed rate>
		Input unit: mm/min
PS	B/W/D/K	<>Mode>
		Bit 0 – Definition of the target position
		0: Absolute, i.e. relative to the machine datum
		1: Incremental
		Bit 1 – Software limit switch
		0: Inactive
		1: Active
CM	9221	
PL	B/W/D	<>Error code>
		0: Positioning is started
		1: Axis is not in a closed loop or is an auxiliary axis
		2: Inadmissible values for the feed rate
		3: Axis has not traversed the reference mark
		4: No M/S/T/Q strobe during started part program
		5: Programmed axis not in closed loop

Module 9222 Status request of PLC positioning movement

With this module you can interrogate the status of a PLC positioning movement.

Call:

PS	B/W/DK	<>axis>
		0 to 8 correspond to axes 1 to 9
CM	9222	
PL	B/W/D	<>status>
		0: No PLC positioning was started
		1: Target position reached
		2: PLC positioning was started
		3: Due to cancellation, target position not attained
		4: Target position is outside of traverse range
		5: Positioning not possible (e.g. due to “free rotation”)

PLC positioning through markers and words

To ensure compatibility, a PLC positioning command is permissible for axes 1 to 9 with M4120 to M4128, D528 to D544 and W560 to W568.

Warning

Software limit switches are ignored!

Programming:

- Enter the target position in the double words D528 to D544 in the unit [0.0001 mm].
- Enter the feed rate in words W560 to W568 [mm/min].
- To start the PLC positioning movement: Set markers M4120 to M4124 for the desired axis.

		Set	Reset
D528-544	**Target position for PLC positioning**	PLC	PLC
W560-568	**Feed rate for PLC positioning**	PLC	PLC
M4120	**PLC positioning axis 1 active**	NC/PLC	NC/PLC
M4121	**PLC positioning axis 2 active**	NC/PLC	NC/PLC
M4122	**PLC positioning axis 3 active**	NC/PLC	NC/PLC
M4123	**PLC positioning axis 4 active**	NC/PLC	NC/PLC
M4124	**PLC positioning axis 5 active**	NC/PLC	NC/PLC
M4125	**PLC positioning axis 6 active**	NC/PLC	NC/PLC
M4126	**PLC positioning axis 7 active**	NC/PLC	NC/PLC
M4127	**PLC positioning axis 8 active**	NC/PLC	NC/PLC
M4128	**PLC positioning axis 9 active**	NC/PLC	NC/PLC

6.4 Axis Error Compensation

The iTNC can compensate the following mechanical axis errors:

- Backlash
- Linear axis errors
- Nonlinear axis errors
- Thermal expansion
- Reversal spikes during circular movements
- Stiction

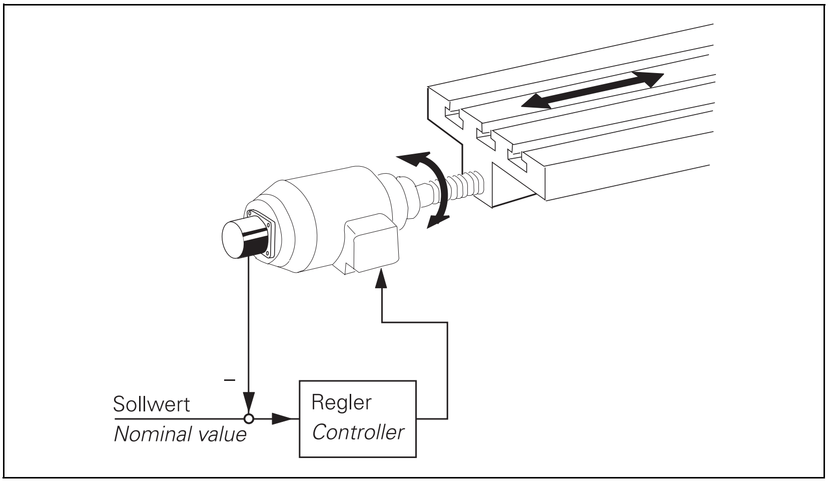
Per axis you can activate either the linear or the nonlinear axis error compensation. All other types of compensation are nonexclusive.

6.4.1 Backlash Compensation

Cause outside of the control loop

During a reversal in axis direction, there is often a little play between the rotary encoder and table. This play is referred to as backlash.

Positive backlash: The rotary encoder reading is ahead of the table. The table traverse is too short. Negative backlash: The rotary encoder reading is behind the table. The table traverse is too long.



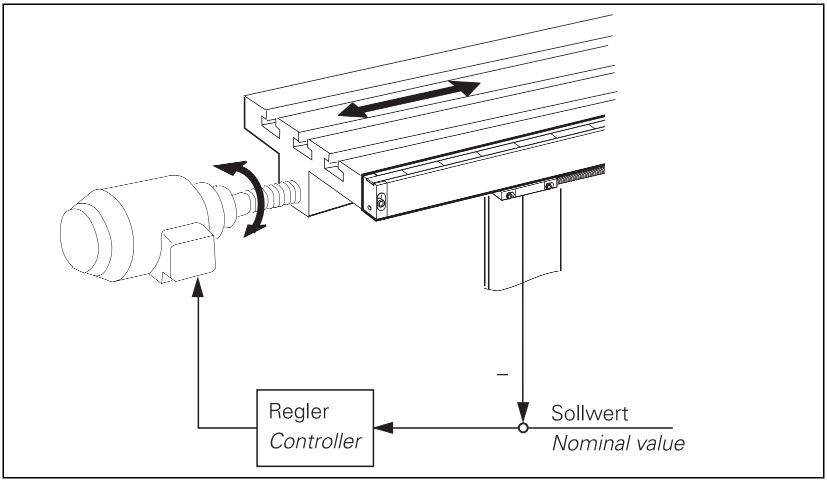
Compensation:

- In MP710, enter the value that the iTNC should add to or subtract from the encoder signal after a reversal in direction.

MP710.x	**Backlash compensation**
Input:	-1.0000 to +1.0000 [mm] or [°]

Cause within the control loop

If axis movement is measured with a linear encoder, the iTNC can compensate the play between the motor and the table. At the same time, the reversal spikes during circular movements are compensated: machine parameters MP711 to MP716 for "Compensation of reversal spikes" are **not** necessary.



Compensation:

- In MP750.x, enter the reversal error in mm.
- In MP752.x, enter the time in which the distance to be compensated should be traversed.

MP750.x	**Backlash in axes 1 to 9**
Input:	-1.0000 to +1.0000 [mm] or [°]
MP752.x	**Compensation time for reversal error**
Input:	0 to 1000 [ms]

Example:

MP750.x: 0.03 mm
MP752.x: 15 ms

For every change in direction, a nominal speed command signal is output for 15 ms, which corresponds to a feed rate of 120 mm/min:

$$\frac{0.03\text{ mm}}{15\text{ ms}} = 120\text{ mm/min}$$

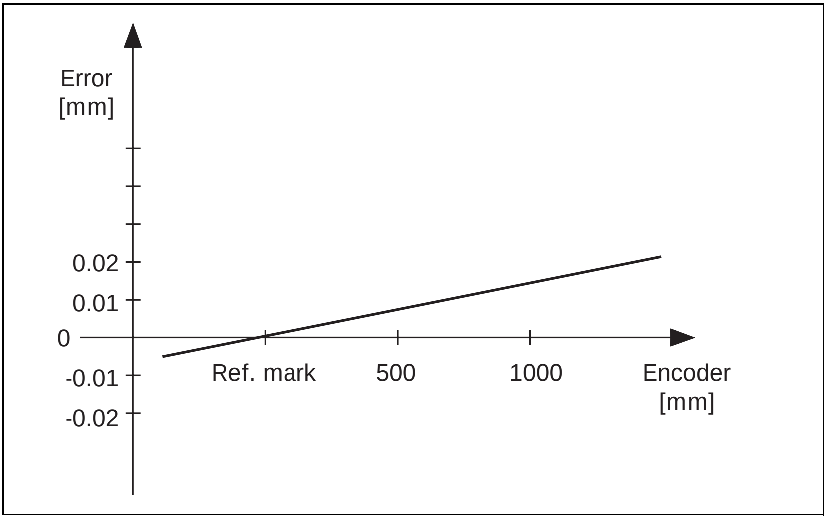
6.4.2 Linear Axis Error Compensation

Note

Linear axis error compensation is not available for rotary axes!

For every linear axis you can compensate a linear axis error.

Positive linear axis error: The table moves too far.
Negative linear axis error: The table moves short.



Compensation:

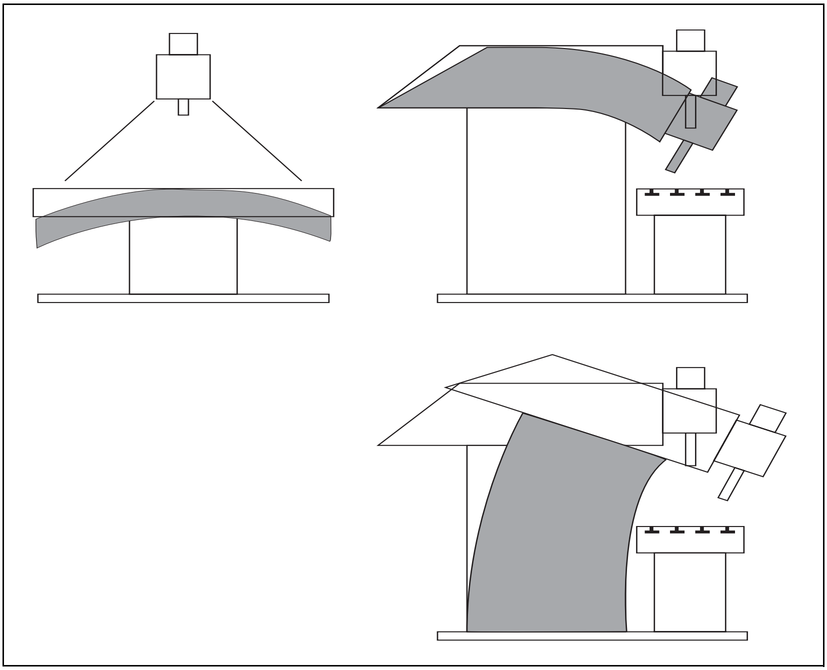
- In MP720, enter the axis error in [mm/m].
- With MP730, activate the linear axis error compensation.

MP720.x	**Linear axis error compensation**
Input:	–1.000 to +1.000 [mm/m]

MP730	**Selection of linear/nonlinear axis error compensation**
Format:	%xxxxxxxxxxxxxx
Input:	Bits 0 to 13 correspond to axes 1 to 14 0: Linear axis error compensation 1: Nonlinear axis error compensation

6.4.3 Nonlinear Axis Error Compensation

Errors in machine geometry (e.g. an error in one axis caused by the sagging of another axis) or external influences (e.g. temperature) can cause nonlinear axis errors. These graphics show typical nonlinear axis errors:

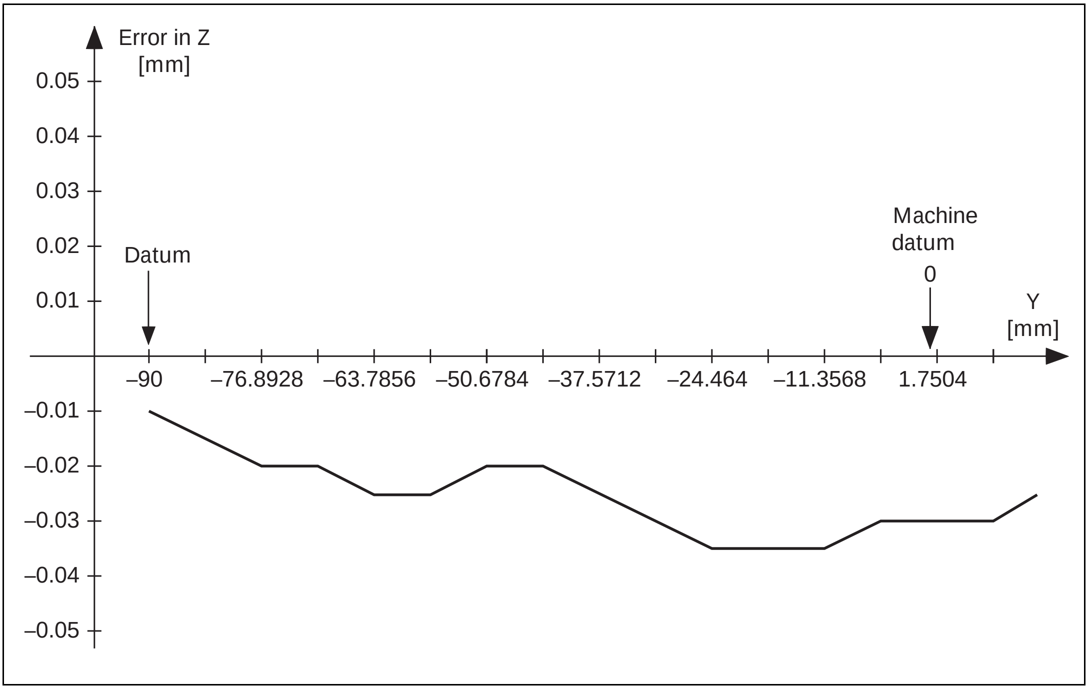


The best way to measure nonlinear axis error is with a comparator measuring system such as the HEIDENHAIN VM 101.

Note

The iTNC can compensate screw-pitch error and axis sag simultaneously.

The following graphic shows the trace of an axis sag error as a function of Y (Z = f(Y)):



Inputting the error trace

To enter the error trace in the iTNC:

- Ascertain the error trace with a comparator measuring system.
- To create a compensation-value table: Press the MOD key and enter the code number 807667; for each axis that is to be compensated for, use the program manager to create a compensation-value table with the name *.COM.
- Using soft keys (e.g. 1 OFF/ON), activate columns in the compensation value table only for the axes whose positions affect the error of the compensated axis.
- Begin your entry with the soft key HEAD LINE: Enter the datum for the compensation values as a distance from the machine datum (MP960.x).
- Enter a value for the spacing of the compensation points as a power to the base of 2. The maximum input value is 23.
  Example: The input value 16 represents 2^{16} = 65536 = 6.5536 mm
- Exit the header by pressing END.
- With the soft key APPEND N LINES, enter the number of compensation points:
  - Maximum of 256 compensation points per column
  - Maximum of 10 columns in all active compensation value tables
  - Total maximum of 1280 compensation points
- To enter compensation values: Enter only the break points of the error trace. The iTNC interpolates linearly between the kink points.

Example

The following dependencies apply for axes 2 = Y and 3 = Z:

- Ballscrew pitch error in Z and Y: Z = F(Z) and Y = F(Y)
- Axis sag in Z depending on Y
- Traverse range: Z = 800 mm, Y = 500 mm
- Datum point of compensation values: Z = –200 mm, Y = –90 mm
- Desired spacing of compensation points: 7 mm

Calculations:

Input values for the spacing of the compensation points:
possible powers of 2^{16} = 6.5536 mm

Number of compensation points:

$$\frac{500\ \text{mm}}{6.5536\ \text{mm}} = 77 \text{ compensation points in Y}$$

$$\frac{800\ \text{mm}}{6.5536\ \text{mm}} = 123 \text{ compensation points in Z}$$

Entries:

Manual operation

Compensation value table
Compensation value?

File: AXIS-Y.COM DATUM: -90 DIST: 16

NR		2=F()	3=F()
0	-90	+0	-0.01
1	-83.4464		
2	-76.8928	-0.005	-0.02
3	-70.3392		-0.02
4	-63.7856		-0.025
5	-57.232		-0.025
6	-50.6784		-0.02
7	-44.1248		-0.02
8	-37.5712		
9	-31.0176	-0.01	
10	-24.464		-0.035
11	-17.9104		
12	-11.3568		-0.035

BEGIN ⇧	END ⇩	PAGE ⇧	PAGE ⇩	INSERT LINE	DELETE LINE	NEXT LINE	HEAD LINE

Y axis:
Ballscrew pitch error in column 2 = F(), sag error in column 3 = F()

Manual operation

Compensation value table
Compensation value?

File: AXIS-Z.COM DATUM: -200 DIST: 16

NR		3=F()
0	-200	+0
1	-193.4464	
2	-186.8928	
3	-180.3392	
4	-173.7856	
5	-167.232	+0.005
6	-160.6784	
7	-154.1248	+0.006
8	-147.5712	+0.007
9	-141.0176	
10	-134.464	
11	-127.9104	+0.001
12	-121.3568	

BEGIN ⇧	END ⇩	PAGE ⇧	PAGE ⇩	INSERT LINE	DELETE LINE	NEXT LINE	HEAD LINE

Z axis:
Ballscrew pitch error in column 3 = F()

Activate error compensation

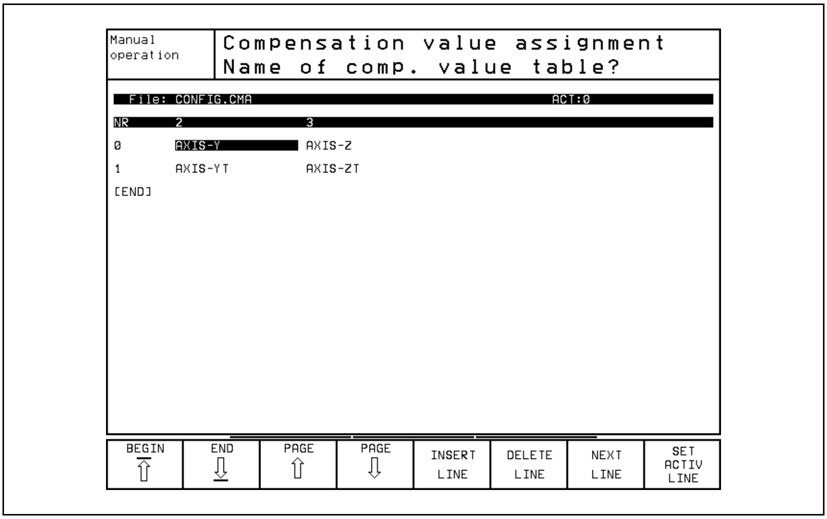
The appropriate machine parameter must be set for nonlinear axis error compensation, and the compensation value table must be registered in a configuration file:

- With MP730, activate for each axis the nonlinear axis error compensation.
- To create a configuration file: Press the MOD key and enter the code number 807667; with the program manager, create a configuration file with a .CMA extension.
- Use soft keys (e.g. 1 OFF/ON) to activate columns for the axes for which you have created compensation value tables.
- Enter the compensation value table: You can assign more than one compensation value table to each axis, however, only one table can be active. Enter the file names of the compensation value tables in the respective lines. You can select the active line either with the soft key SET ACTIV LINE or with Module 9095. With Module 9035 you can interrogate the active line.
- Enter the complete name of the configuration file with the .CMA extension in the system file OEM.SYS with the command TABCMA=.

Example

Entry in the configuration file for axes 2 = Y and 3 = Z:

Compensation-value table valid for 20° = AXIS-Y.COM and AXIS -Z.COM
Compensation-value table valid for 35° = AXIS -YT.COM and AXIS -ZT.COM



MP730 Selection of linear/nonlinear axis error compensation

Format: %xxxxxxxxxxxxxx

Input: Bits 0 to 13 correspond to axes 1 to 14
0: Linear axis error compensation
1: Nonlinear axis error compensation

Module 9095 Select active line in configuration file

Call:

```
PS      B/W/D/K   <>active line>
CM      9095
PL      B/W/D     <>Error code>
                  0: No error
                  1: Entered line does not exist
                  2: Compensation value table does not exist
                  3: Compensation value table > 256 entries
                  4: Maximum total number of compensation points
                     exceeded
                  5: Too many compensation value tables
                  6: CMA file does not exist.
                  7: Call was not from a submit job
                  8: Call during running program without strobe.
                  10: CMA file is protected.
```

Module 9035 Reading status information

Call:

```
PS      B/W/D/K   <>19>
                  Active line in the configuration file (*.CMA)
                  –1:  No .CMA file active
CM      9035
PL      B/W/D     <>active line number>
                   0: Line number
                  –1:  No CMA file active.
```

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	1	Status information invalid
	20	Call was not in a submit or spawn job

A rotary axis is a special case

For a rotary axis, only the compensation values for the entries between 0° and +360° are effective, relative to the machine datum. Therefore, the datum for the nonlinear compensation must lie within the 0° to +360° range. To compensate a full circle, set the compensation value datum on the machine datum.

Example: Rotary axis from –180° to +180°

Rotary axis:	0	...	+180	...	–179	...	–1	...	0
Corresponding angle for compensation values:	0	...	+180	...	+181	...	+359	...	0

6.4.4 Compensation of Thermal Expansion

To compensate thermal expansion, exact measurements of machine thermal behavior as a function of temperature (e.g., the center of axis expansion, the amount of the expansion) are necessary.

The temperatures measured by the Pt100 thermistors are saved in the PLC words W486 to W490. Since the thermal expansion of the axes is largely proportional to the temperature, you can directly determine the amount of expansion by multiplying the temperature value by a certain factor.

Compensation:

- Transfer the distance to be compensated to module 9231. At the same time, “lag tracking” becomes active. This means that the actual position is offset by a certain value per PLC cycle until the complete value is compensated.
- In MP4070, enter the value for the offset per PLC cycle.

For gantry axes, the compensation value must be transferred separately for each axis.

Heat compensation when using tilting axes is defined through machine parameters or the kinematics table. See “Temperature Compensation with Tilting Axes” on page 6 – 72

The actual value display does not change during the compensation. As an alternative, for axes 1 to 5 you can enter the value to be corrected in W576 to W584.

MP4070 **Compensation amount per PLC cycle for lagged-tracking axis error compensation**
Input: 0.0001 to 0.005 [mm]

		Set	Reset
W486 - 490	**Temperature input at X48 [0.5 °C]** Inputs 1 to 3	NC	NC
W576 - 584	**Lag-tracking axis error compensation** For axes 1 to 5 Input: –32 768 to +32 767 [1/10 µm]	PLC	PLC

Module 9231 Compensation of thermal expansion

With Module 9231, thermal expansion can be compensated by transferring the axis number and a compensation value.

Call:

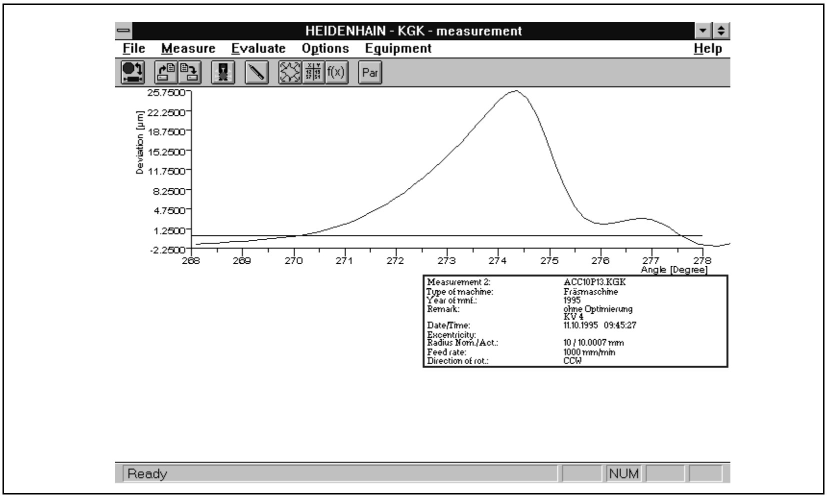
PS	B/W/D/K	<>Axis>
		Axes 0 to 8
PS	B/W/D/K	<>Compensation value>
		Range: – up to +30000 [1/10µ]
CM	9231	

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	1	Invalid axis number
	2	Invalid compensation value
	24	The module was called in a spawn job or submit job

6.4.5 Compensation of Reversal Spikes during Circular Traverse

The static friction in the axis bearings during circular movement can lead to reversal spikes at the quadrant transitions. With the HEIDENHAIN KGM grid encoder and the ACCOM evaluation software you can measure the size and duration of the spikes.



Calculation

Duration of the reversal spike:

$$t_{SpD}[s] = \frac{\text{Peak width } [°] \cdot 2(\pi \cdot \text{radius [mm]} \cdot 60)}{360\ [°] \cdot \text{Feed rate [mm/min]}}$$

The spike width is [°] displayed in the diagram. The feed rate [mm/min] is the programmed tool path feed rate.

Compensation per control loop cycle time:

$$\text{Comp. [mm =]} \frac{\text{Reversal peaks [µm]} \cdot \text{control loop cycle time} \cdot [s] \cdot 10^{-3}}{0.5 \cdot t_{SpD}[s]}$$

The compensation value is entered in MP712.x.

Compensation

Digital axes:

Compensate friction in the range of the speed controller (MP2610 to MP2620). Do not compensate with MP711 to MP716. See "Compensation of Sliding Friction (Only for Digital Axes)" on page 6 – 48.

Analog axes:

If you have compensated the **backlash** with MP750, there should be no more reversal spikes. If there are, compensate them with MP711 to MP716.

Compensation:

- In MP711.x, enter the height of the spike.
- In MP712.x, enter the amount of the reversal spike that is to be compensated per control loop cycle (see "Calculation" above).

MP711.x **Height of peaks during circular movement (only analog)**
Input: -1.0000 000 to +1.0000 999 [mm] (digital: 0)

MP712.x **Compensation value per control loop cycle time**
Input: 0.000 000 to 99.999 999 [mm] (digital: 0)

If the compensation has no effect, it may be because the machine's dynamic performance is too weak. You can selectively increase the contour accuracy with a higher k_V factor. With the M function M105 you can switch to a second set of k_V factors: In this way a second set of machine parameters becomes active for reversal spike compensation (MP715.x and MP716.x). M106 resets M105.

- Enable the M functions M105/M106 with MP7440, bit 3.
- In MP715.x, enter the height of the spike.
- In MP716.x, enter the amount of the reversal spike that is to be compensated per control loop cycle (see "Calculation" above)

MP7440 **Output of M functions**
Format: %xxxxx
Input: Bit 3 – switching the k_V factors with M105/M106
0: Function is not in effect
1: Function is effective

MP715.x **Height of peaks during circular movement (only analog) with M105**
Input: -1.0000 000 to +1.0000 999 [mm] (digital: 0)

MP716.x **Compensation value per control loop cycle time with M105**
Input: 0.000 000 to 99.999 999 [mm] (digital: 0)

6.4.6 Compensation of Static Friction

On guideways with high static friction (stick-slip friction), a following error can occur at low feed rates during operation with velocity feedforward control. This error can be compensated by the iTNC. You can measure following error by using, for example, the integrated oscilloscope of the iTNC.

Compensation of static friction works only under velocity feedforward control. If it is also to work in manual operating modes, you must activate velocity feedforward control in each axis with MP1391.x for manual operation.

Calculations

For compensation of static friction, an additive nominal velocity is output whose value F_{zus} is calculated from the factor for static friction compensation:

$$F_{zus} = \frac{\Delta s_a}{t_R} \cdot k_v \cdot MP1511$$

F_{zus} = additional feed rate [m/min]
Δs_a = following error difference after one control loop cycle [mm]
t_R = control loop cycle time [µs]
k_v = control loop gain [(m/min)/mm]
MP1511.x = factor for static friction compensation [µs]

This additive nominal value is limited with MP1512.x. If this limit is too high, the machine vibrates at a standstill:

$$MP1512.x = \frac{s_{agrenz} \cdot 256}{TP}$$

MP1512.x = limitation of the amount of the static friction compensation [counting steps]
s_{agrenz} = limit value for Δs_a [µm]
TP = grating period of the encoder [µm]

Compensation

The compensation must be effective only at low feed rates, otherwise the nominal value increase will cause vibration at high velocity:

- In MP1511.x, enter a factor for static friction compensation (approximate value: 5000 to 10 000).
- In MP1512.x, enter a limit for the amount of the static friction compensation (approx. value: < 50).
- In MP1513.x, limit the maximum feed rate up to which the static friction compensation remains in effect.

MP1511.x **Factor for static friction compensation**
Input: 0 to 16 777 215 [µs]

MP1512.x **Limitation of the amount of the static friction compensation**
Input: 0 to 16 777 215 [counting steps]

MP1513.x **Feed-rate limitation for static friction compensation**
Input: 0 to 300 000 [mm/min]

MP1391 **Velocity feedforward control in the MANUAL and HANDWHEEL operating modes**
Format: %xxxxxxxxxxxxxx
Input: Bits 0 to 13 correspond to axes 1 to 14
0: Operation with following error (lag)
1: Operation with velocity feedforward control

Digital axes: Limit to the integral factor

In machines with very high static friction, a position deviation at standstill can lead to the accumulation of a very high integral factor. This can lead to a jump in the position value when the axis "tears loose." In such cases you can limit the integral-action component of the speed controller with MP2512.x.

MP2512.x **Limiting the integral factor of the speed controller**
Input: 0.000 to 30.000 [s] (realistically: 0.1 to 2.0)

6.4.7 Compensation of Sliding Friction (Only for Digital Axes)

Sliding friction is compensated within the range of the speed controller:

- With the integrated oscilloscope of the iTNC, define the nominal current value (I NOMINAL) at a very low speed of approx. 10 rpm.
- Enter the value for current in MP2610.x. At every change in direction, this amount is fed forward to the speed controller to compensate the sliding friction at low speeds.
- Measure the nominal value for current (I NOMINAL) at rated speed and enter it in MP2620.x. Depending on the speed nominal value, a certain current is fed forward to the speed controller and causes a sliding friction that depends on the speed.

When the traverse direction is reversed at high feed rates, the sliding friction might be overcompensated. In a circular interpolation test, such overcompensation appears in the form of reversal spikes that jut inward. With MP2612.x you can prevent overcompensation by delaying the compensation.

MP2610.x **Friction compensation at low speed for axes 1 to 9 (effective only with velocity feedforward control)**

Input: 0 to 30.0000 [A]
0: No friction compensation (or axis is analog)

MP2612.x **Delay of friction compensation for axes 1 to 9 (effective only with velocity feedforward control)**

Input: 0.0000 to 1.0000 [s] (typically: 0.015 s)
0: No friction compensation (or axis is analog)

MP2620.x **Friction compensation at rated speed for axes 1 to 9**

Input: 0 to 30.0000 [A]
0: No friction compensation (or axis is analog)

6.5 Tilting Axes

Swivel heads and tilting tables are often used on milling machines to machine workpieces from several sides.

The NC programs are written with a CAD system or directly at the iTNC using the **Tilt working plane** function. The user programs the part program in the X/Y plane and the iTNC interpolates the proper axes. All path functions, cycles, “datum setting” and “probing” can be applied in the transformed working plane.

6.5.1 Determining the Mechanical Offset

As an example, we will show how to determine the mechanical offset of a 45° double swivel head and of a forked swivel head.

Note

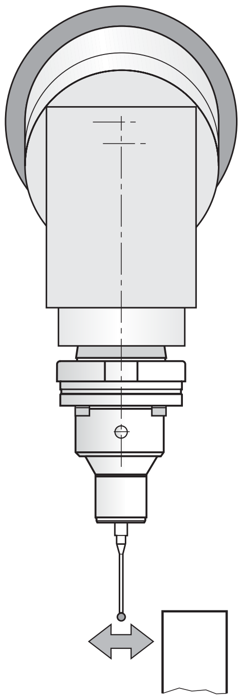
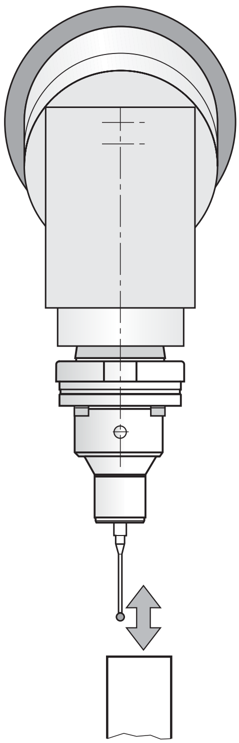
The 3-D ROT function must be inactive during the entire measuring process.

Double swivel head 45°

In this example, the mechanical offset of a double swivel head is determined by using a 3-D touch probe.

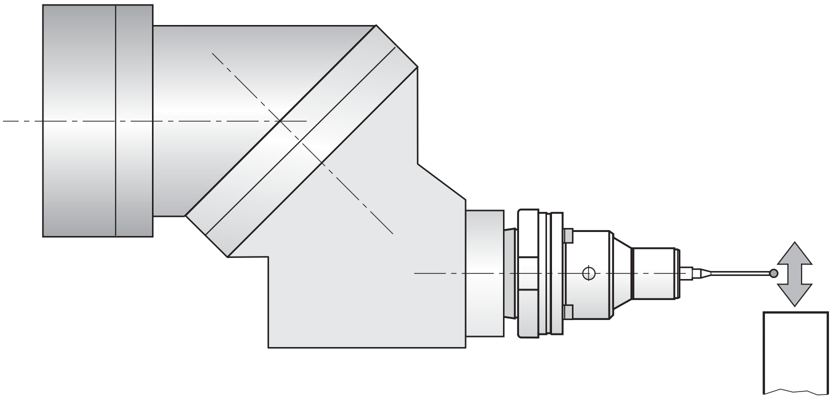
Input values for the machine parameters:

- MP7500 = %xxxx101
- MP7510.0 = %000100 ; Shift in Z axis
- MP7510.1 = %000001 ; Shift in X axis
- MP7510.2 = %001000 ; Rotate about A axis
- MP7510.3 = %000100 ; Shift in Z axis
- MP7510.4 = %100000 ; Free tilting axis C
- MP7510.5 = %001000 ; Rotate about A axis
- MP7510.6 = %000001 ; Shift in X axis
- MP7510.7 = %010000 ; Free tilting axis B
- MP7510.8 = %000000 ; End transformation

Step 1a ■ Move tilting axes B and C to 0° position ■ Probe surface X1 ■ Set X = 0	
Step 1b ■ Probe surface Z ■ Set Z = 0	

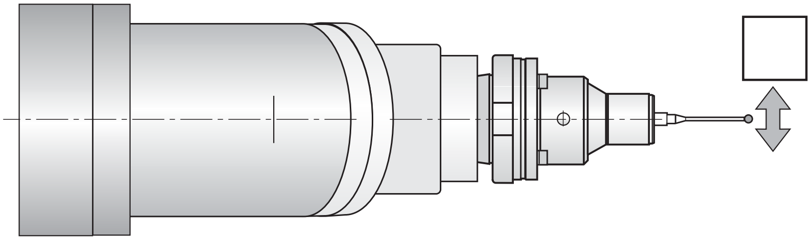
Step 2

- Position C = 180
- Probe surface Z
- MP7530.0 = determined value – probe length + ball radius



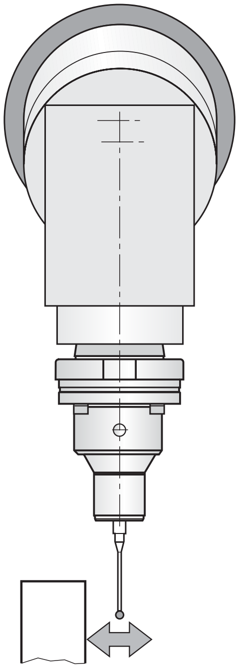
Step 3

- Probe surface X1
- MP7530.1 = -0.5 * determined value



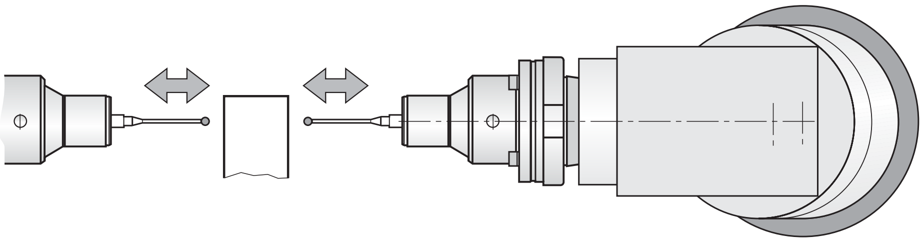
Step 4a

- Position C = 0
- Probe surface X2
- L = determined value



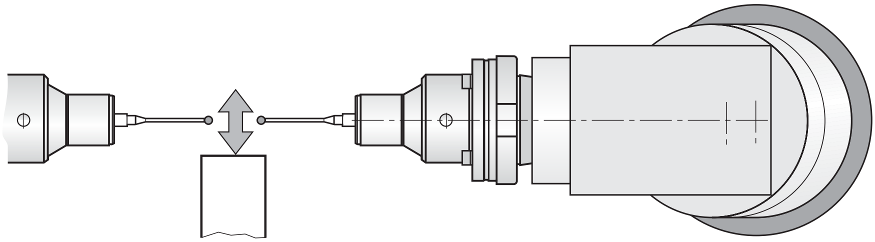
Step 4b

- Position B = –90
- Probe surface X1
- ΔX1 = determined value
- Position B = +90
- Probe surface X2
- ΔX2 = determined value
- MP7530.3 = {[0.5 * (ΔX2 – ΔX1 – L – 2*(probe length) + 2*(ball radius))] – MP7530.0} / cos 45°



Step 4c

- Position B = –90
- Probe surface Z
- Set Z = 0
- Position B = +90
- Probe surface Z
- MP7530.6 = –0.5 * determined value – MP7530.1

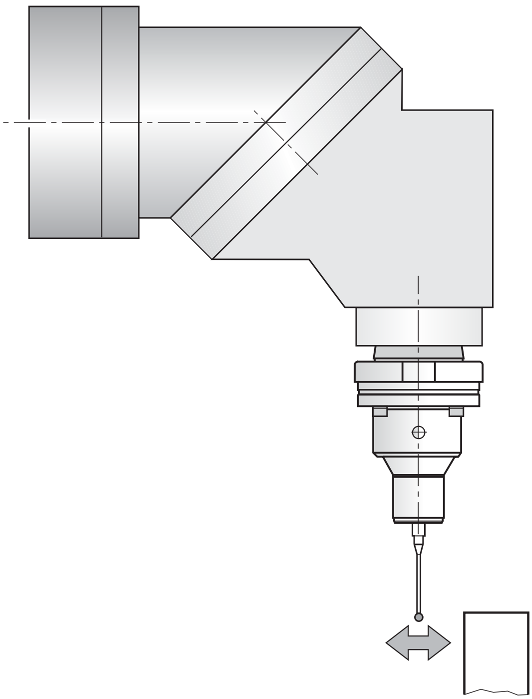


Step 5

- Probe surfaces X1, X2, Y2 and Z in a tilted working plane with the tilting angles B = –90, B = +90 and C = 180 (with MP7500 = %xxxxx0x)
- If there are differences between the individual tilting angles, the offsets from MP7530.0 and MP7530.3 should be determined with a different process (steps 6 to 8), and the averages from both processes should be entered in MP7530.0 and MP7530.3.

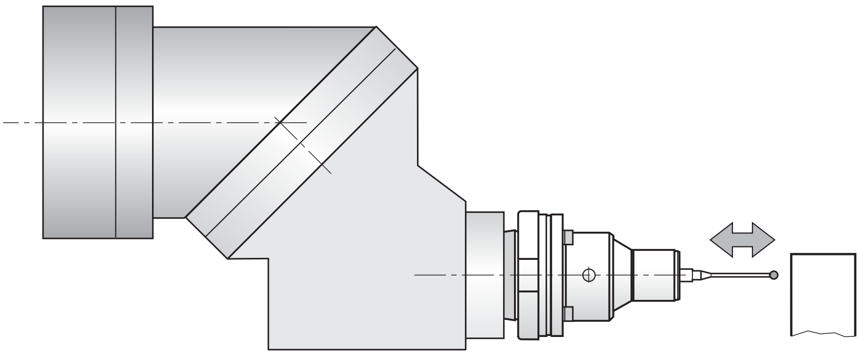
Step 6

- Probe surface Y2
- Set Y = 0



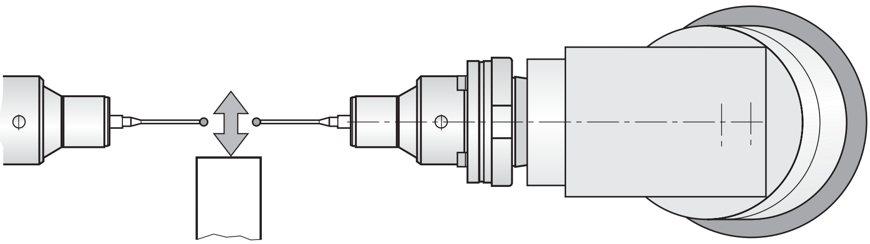
Step 7

- Position C = 180
- Probe surface Y2
- ΔY2 = determined value
- Z1 = ΔY2 – probe length + ball radius
- If there is a difference between MP7530.0 and Z1, then MP7530.0 = 0.5 * (MP7530.0 + Z)



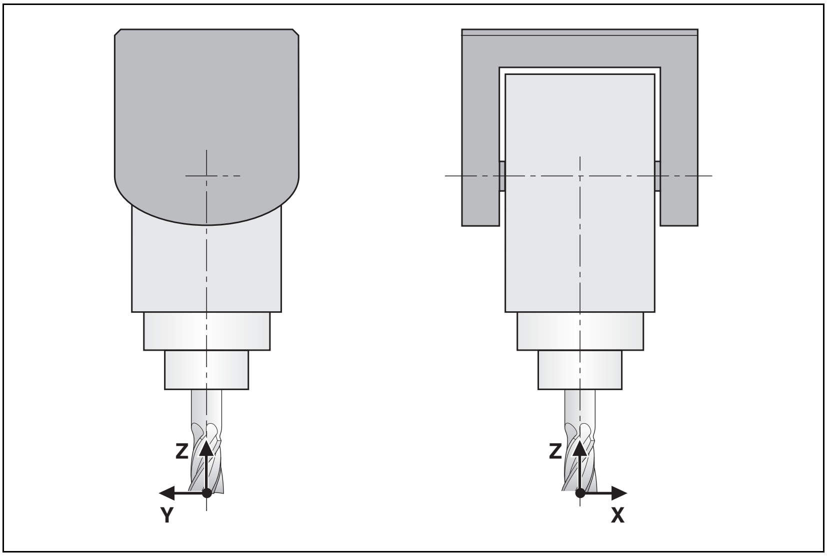
Step 8

- Position C = 0
- Position B = –90
- Probe surface Z
- ΔZ = determined value
- Position B = +90
- Probe surface Z
- Z = {[–0.5 * (ΔZ + determined value) – probe length + ball radius] – Z1} / cos 45°
  (Z1 see step 7)
- If there is a difference between MP7530.3 and Z, then MP7530.3 = 0.5 * (MP7530.3 + Z)



Forked swivel head

In this example, the mechanical offset of a forked swivel head is determined with a dial indicator and a cylinder with a known diameter.



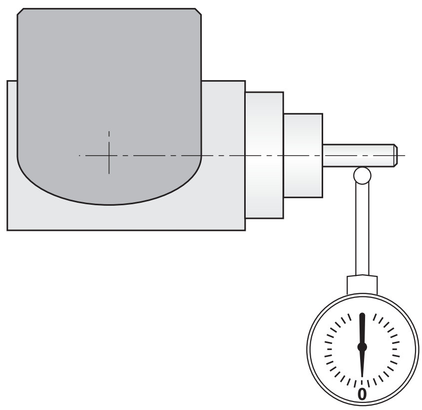
Temporary input values for the machine parameters:

- MP7500 = %xxxx101
- MP7510.0 = %000100 ; Shift in Z axis
- MP7510.1 = %000010 ; Shift in Y axis
- MP7510.2 = %001000 ; Free tilting axis A
- MP7510.3 = %000001 ; Shift in X axis
- MP7510.4 = %000010 ; Shift in Y axis
- MP7510.5 = %100000 ; Free tilting axis C
- MP7510.6 = %000000 ; End transformation

Step 1a

Determining the Y offset:

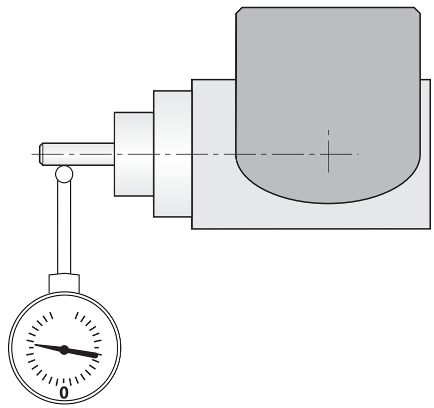
- Position A = –90
- Set dial indicator to 0



Step 1b

Determining the Y offset:

- Position A = +90
- Offset = 0.5 * determined value
- If the determined value > 0, then MP7530.1 = **–** offset
- If the determined value < 0, then MP7530.1 = **–** offset



Step 1c

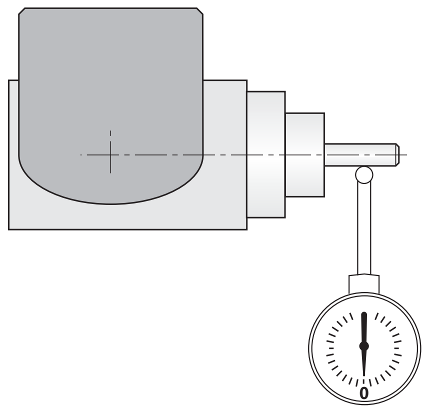
Checking the settings:

- Activate 3-D ROT
- Position A = +90
- Set dial indicator to 0
- Datum setting
- Position A = –90
- Probe same position again
- Display and dial indicator must read 0

Step 2a

Determining the Z offset:

- Position A = –90
- Set dial indicator to 0

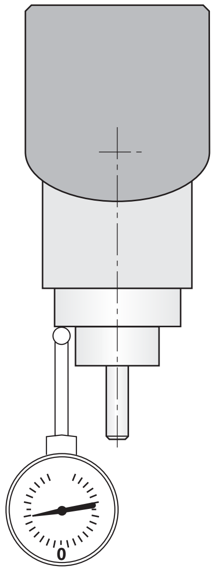


<table>
<tr><td>

Step 2b

Determining the Z offset:

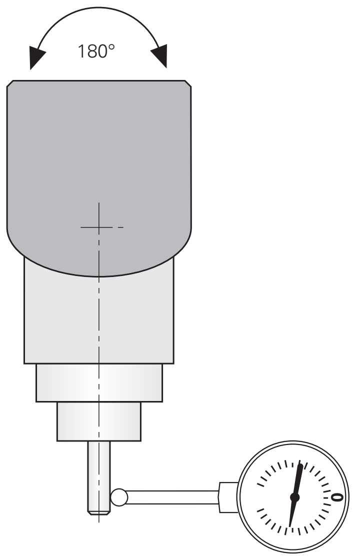
- Position A = 0
- Place dial indicator against the spindle nose
- **MP7530.0** = determined value – cylinder radius

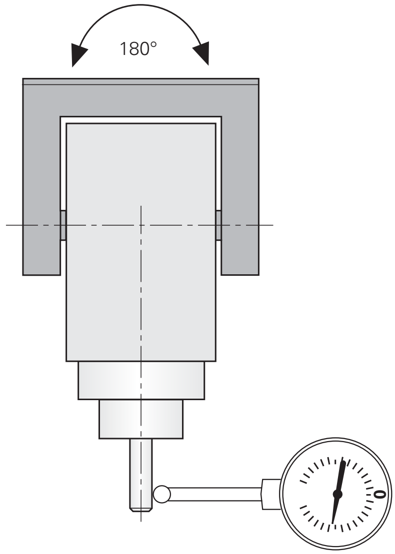
</td><td>
</td></tr>
<tr><td>

Step 3

Determining the Y offset:

- Position A = 0
- Position C = 0 and set C = 0
- Position C = 180
- Read Y offset from the dial indicator
- **MP7530.4** = (0.5 * (determined value)) – MP7530.1

</td><td>
</td></tr>
</table>

Step 4 Determining the X offset: ■ Position C = –90 and set C = 0 ■ Position C = 180 ■ Read X offset from the dial indicator ■ MP7530.3 = 0.5 * determined value	

6.5.2 Describing the Mechanical Offset

Describing the Mechanical Offset

Determine the mechanical offset of the axes in the home position. For swivel heads, the starting point is the tool datum; for tilting tables, the starting point is the center of rotation of the first axis (as seen from the workpiece):

- Only for tilting tables: Define the center of rotation of the first tilting axis with respect to the machine datum.
- Determine in sequence the linear or rotary offset to the next tilting axis until you reach a point that is not separated from the machine frame by any free tilting axis.
- In MP7510.x, enter the sequence of the transformed axes, in MP7520.x the type of axis and dimensional data, and in MP7530.x enter the value of the offset. See the examples on the following pages.
- In MP7550.x, enter the home position of the tilting device in the machine coordinate system.

If a rotation has been entered, it must be canceled again in an additional transformation.

Compensation of mechanical offset when exchanging the spindle head:

- With MP7500 bit 4 = 0, the mechanical offset is only compensated when M128, M114 or "tilted working plane" is called.
- With MP7500 bit 4 = 1 you must compensate the mechanical offset by means of a PLC datum shift. This allows the mechanical offset to be compensated during all tilting axis movements, and not just when M128, M114 or "tilted working plane" is called. You can also use functions M144 or M145; See page 6 – 83.

Describing the mechanical offset with tables

In order to manage several descriptions of the mechanical offset, e.g. when swivel heads are changed, the descriptions can be saved in tables. A description is activated either by the PLC or the NC.

Two types of tables are required:

Assignment table
Each row corresponds to one description (row 0 = description no. 1, etc.). The first column contains the line number. For each description (= row), the value of MP7500 for the description is entered in column two. Keep in mind that the value must be entered as a decimal number. The file name with its complete path is entered in the third column.

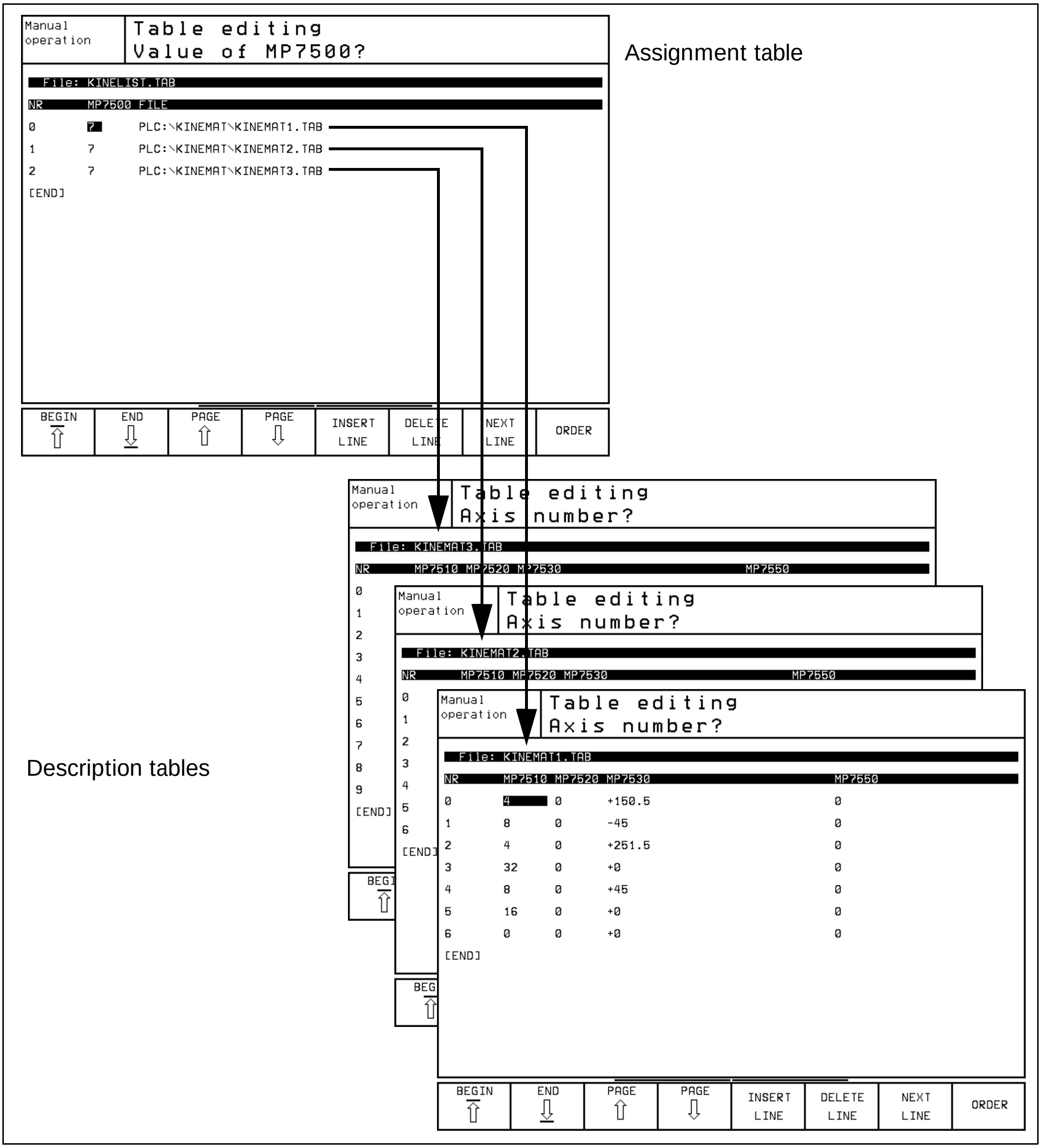
Description tables
The description table contains the contents of machine parameters MP7510.x, MP7520.x, MP7530.x and MP7550.x. The index x corresponds to the line number.
Of course the MP7530 column may also contain formulas, such as temperature compensation with M128, etc. See page 6 – 73. A formula for a permanently effective temperature compensation may be entered in the TEMPCOMP column. See page 6 – 73.

Working with the description of the mechanical offset in tables:

- Switch to the **`Programming and Editing`** operating mode, press the MOD key and enter the code number 807667.
- Choose the file PLC:\OEM.SYS from within program management.
- Enter the code word **`KINEMATIC=`** , followed by the file name with its complete path from the assignment table.
  (e.g., **`KINEMATIC= PLC:\KINEMAT\KINELIST.TAB`**)
- Leave OEM.SYS by pressing the END key.
- To create an assignment table: In program management, switch to the desired directory and enter the name of the assignment table, including the extension .TAB.
- Choose the table format with the MP7500, FILE, MPFILE fields.
- Enter the value from MP7500.x in the table for each description, and the path to the corresponding description table.
- To create a description table: In program management, switch to the desired directory and enter the name of the description table, including the extension .TAB.
- Choose the table format with the MP7510, MP7520, MP7530, MP7550, TEMPCOMP fields.
- Enter the values of machine parameters MP7510.x, MP7520.x, MP7530.x and MP7550.x in the table.
- Activate the description table by transferring the row numbers from the assignment table
  - from the PLC with Module 9097
  - from the NC with FN17: SYSWRITE ID290 NR1
- You can ascertain the active description table in two ways:
  - With the PLC you can use Module 9098 to ascertain the name of the description table or the line number in the assignment table.
  - With the NC you can use FN18: SYSREAD ID290 NR1 to ascertain the line number in the assignment table.

Note

The active description table is indicated with the status “M” in program management.



Example:

This example shows an assignment table for three description tables. The double swivel head 45° from example 2 was entered in the description table.

Assignment table KINEMATIC.TAB

NR	MP7500	FILE	MPFILE
0	7	PLC:\KINEMAT1.TAB	
1	7	PLC:\KINEMAT2.TAB	
2	7	PLC:\KINEMAT3.TAB	
[END]			

Description table KINEMAT1.TAB

NR	MP7510	MP7520	MP7530	TEMPCOMP	MP7550
0	4	0	+150,5		
1	8	0	-45		
2	4	0	+251,5		
3	32	0	0		
4	8	0	+45		
5	16	0	0		
6	0	0	0		
[END]					

Compensation of offset of adapter spindle

It may happen that the current adapter spindle in the swivel head has a phase-angle error. This can be compensated as follows:

- Open the corresponding description table.
- Press the EDIT FORMAT soft key.
- Move the cursor to the END line and insert a new line by pressing the INSERT LINE soft key.
- Enter RAX_OFFS as **Field name**, C for **Field type**, 31 for **Field width**, 4 for the number of **decimal places** and a dialog text for the desired dialog languages, e.g. **OFFSET of angular axes?**
- Press the **END** key.

The new column RAX-OFFS has been added to the description table. In the first three lines of these columns, you can enter the phase-angle error of the adapter spindle.

- Line 0 corresponds to axis A
- Line 1 corresponds to axis B
- Line 2 corresponds to axis C

As soon as the description table has been activated, the phase-angle error is compensated.

Module 9097 Selecting the geometry description

A geometry description from an assignment table can be chosen with Module 9097. The module can be called in a running NC program only in connection with a strobe. The module must be called in a submit job or spawn job, and cannot be cancelled with the CAN command.

Call:

PS	B/W/D/K	<>Line number in the assignment table>
PS	B/W/D/K	<>Mode, reserved> Transferred value must be 0
CM	9097	
PL	B/W/D	<>Error condition> 0 = Geometry description was selected 1 = Invalid mode 2 = Line was not found in the assignment table 3 = Assignment table is not defined 4 = Description table does not exist 5 = Description table is incomplete 6 = Module was not called in a spawn job or submit job 7 = Call during running NC program without strobe 8 = No **KINEMATIC=** entry in the OEM.SYS file

Error detection:

Marker	Value	Meaning
M4203	0	Geometry description was selected
	1	Error code in W1022
W1022	2	Invalid mode; or line was not found in the assignment table; or description table was not defined, does not exist or is incomplete; or there is no KINEMATIC= entry in the OEM.SYS file.
	9	Error in the MPFILE column
	10	Error in the MP7500 column
	11	Error in the machine parameter subfile
	20	Module was not called in a spawn job or submit job
	21	Call was made during a running NC program without a strobe

Module 9098 Finding the active geometry description

Module 9098 can find the name of the active description table and/or line number in the assignment table.

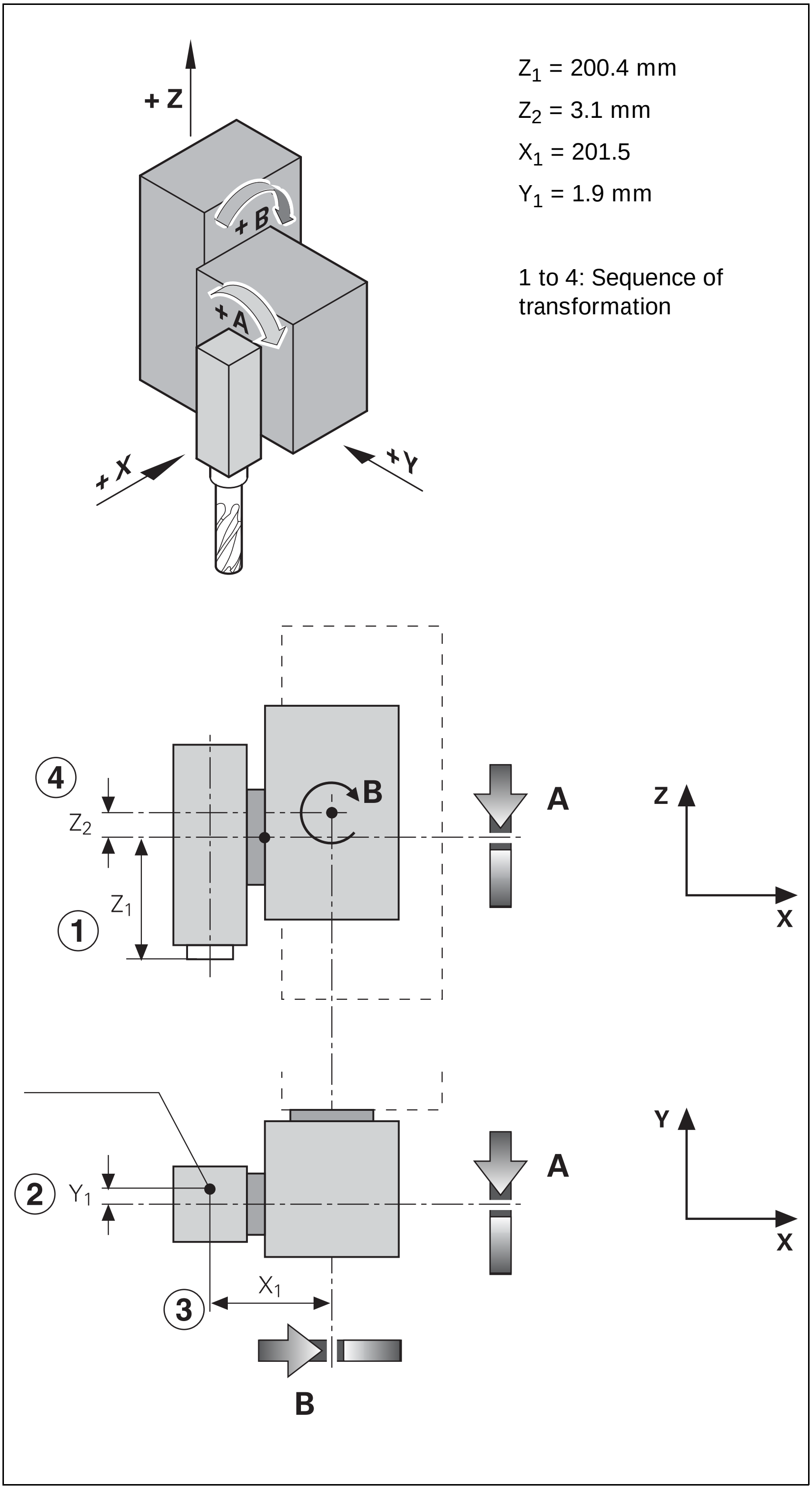
Call:

PS B/W/D/K <>String number for table name>
0 to 7: String number (line number is also found)
–1: Find only line number, no name
CM 9098
PL B/W/D <>Line number in the assignment table>
–1: Line number not found

Error detection:

Marker	Value	Meaning
M4203	0	Name and/or line number was found
	1	Error code in W1022
W1022	2	Incorrect parameter for string number
	20	Module was not called in a submit job or spawn job

**Example 1:
Rectangular double
swivel head**

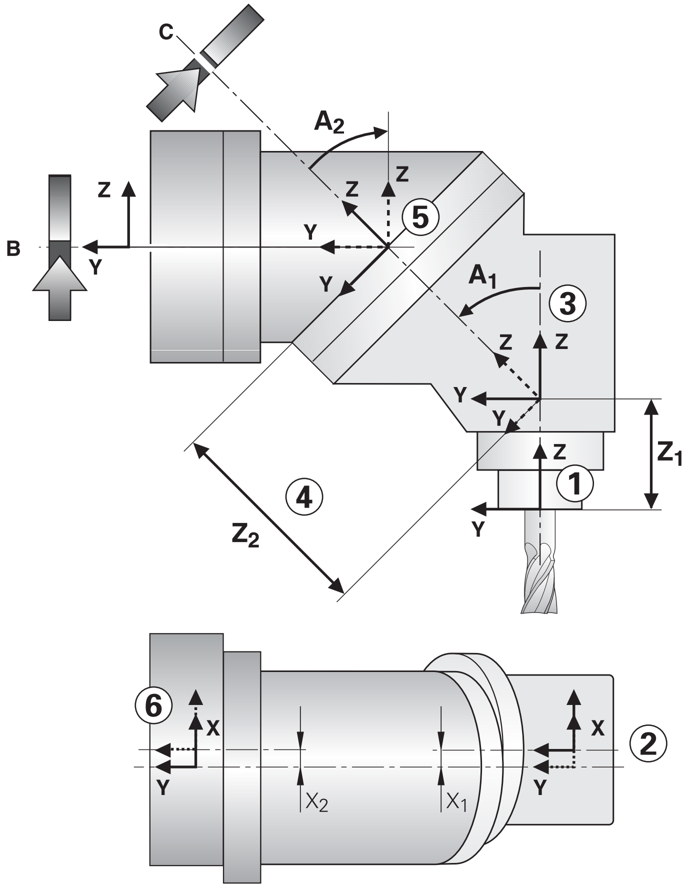


```
MP 7510.0    : %000100    ;Shift in Z axis (Z1)
MP 7510.1    : %000010    ;Shift in Y axis (Y1)
MP 7510.2    : %001000    ;Free tilting axis A
MP 7510.3    : %000001    ;Shift in X axis (X1)
MP 7510.4    : %000100    ;Shift in Z axis (Z2)
MP 7510.5    : %010000    ;Free tilting axis B
MP 7510.6    : %000000    ;End of the transformation chain

MP 7520.0    : %00        ;Incremental dimensions, swivel head
MP 7520.1    : %00        ;Incremental dimensions, swivel head
MP 7520.2    : %00        ;Incremental dimensions, swivel head
MP 7520.3    : %00        ;Incremental dimensions, swivel head
MP 7520.4    : %00        ;Incremental dimensions, swivel head
MP 7520.5    : %00        ;Incremental dimensions, swivel head

MP 7530.0    : +200.4     ;Dimension Z1
MP 7530.1    : -1.9       ;Dimension Y1
MP 7530.2    : +0         ;Variable dimension (free tilting axis A)
MP 7530.3    : +201.5     ;Dimension X1
MP 7530.4    : +3.1       ;Dimension Z2
MP 7530.5    : +0         ;Variable dimension (free tilting axis B)
```

Example 2: Double swivel head 45°



Z_1 = 150.5 mm

Z_2 = 251.5 mm

A_1 = 45°

A_2 = 45°

X_1 = 1.2 mm

X_2 = 0.8 mm

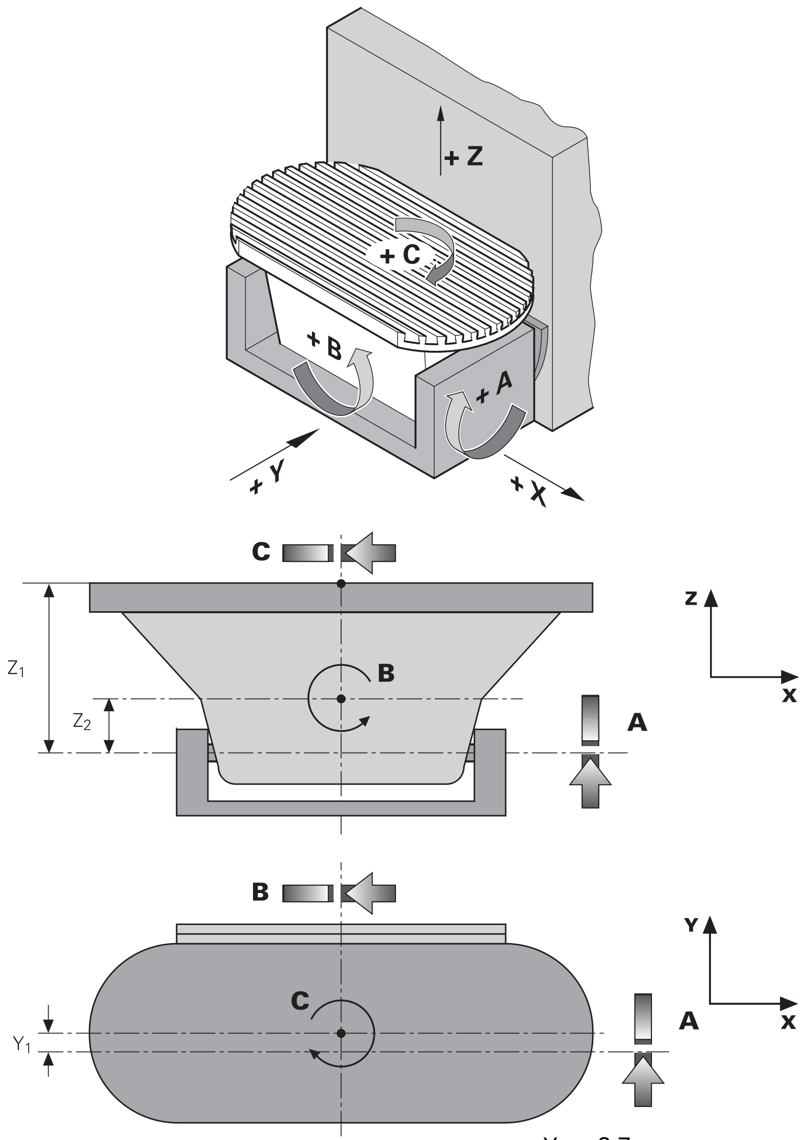
1 to 6: Sequence of transformation

```
MP 7510.0  : %000100  ;Shift in Z axis (Z1)
MP 7510.1  : %000001  ;Shift in X axis (X1)
MP 7510.2  : %001000  ;Rotate the coordinate system about axis A (A1)
MP 7510.3  : %000100  ;Shift in Z axis (Z2)
MP 7510.4  : %100000  ;Free tilting axis C
MP 7510.5  : %001000  ;Rotate the coordinate system about axis A (A1)
MP 7510.6  : %000001  ;Shift in X axis (X2)
MP 7510.7  : %010000  ;Free tilting axis B
MP 7510.8  : %000000  ;End of the transformation chain

MP 7520.0  : %00      ;Incremental dimensions, swivel head
MP 7520.1  : %00      ;Incremental dimensions, swivel head
MP 7520.2  : %00      ;Incremental dimensions, swivel head
MP 7520.3  : %00      ;Incremental dimensions, swivel head
MP 7520.4  : %00      ;Incremental dimensions, swivel head
MP 7520.5  : %00      ;Incremental dimensions, swivel head
MP 7520.6  : %00      ;Incremental dimensions, swivel head
MP 7520.7  : %00      ;Incremental dimensions, swivel head

MP 7530.0  : +150.5   ;Dimension Z1
MP 7530.1  : -1.2     ;Dimension X1
MP 7530.2  : -45      ;Dimension A1
MP 7530.3  : +251.5   ;Dimension Z2
MP 7530.4  : +0       ;Variable dimension (free tilting axis C)
MP 7530.5  : +45      ;Dimension A1
MP 7530.6  : +0.8     ;Dimension X2
MP 7530.7  : +0       ;Variable dimension (free tilting axis B)
```

Example 3:
Universal table
(pitch, tilt, rotation)



$Y_1 = 2.7$ mm

$Z_1 = 331.3$ mm
$Z_2 = 125.9$ mm

Coordinates (with respect to machine datum) of the center of rotation of table C when all tilting axes are in their home position:

$X_R = 420.0$ mm
$Y_R = 151.2$ mm
$Z_R = –395.4$ mm

```
MP 7510.0  : %000001   ;X coordinate of the center of rotation of axis C
MP 7510.1  : %000010   ;Y coordinate of the center of rotation of axis C
MP 7510.2  : %000100   ;Z coordinate of the center of rotation of axis C
MP 7510.3  : %100000   ;Free tilting axis C
MP 7510.4  : %000010   ;Shift in Y axis (Y1)
MP 7510.5  : %000100   ;Shift in Z axis (Z1)
MP 7510.6  : %001000   ;Free tilting axis A
MP 7510.7  : %000100   ;Shift in Z axis (Z2)
MP 7510.8  : %010000   ;Free tilting axis B
MP 7510.9  : %000000   ;End of the transformation chain

MP 7520.0  : %11       ;Absolute dimension, tilting table
MP 7520.1  : %11       ;Absolute dimension, tilting table
MP 7520.2  : %11       ;Absolute dimension, tilting table
MP 7520.3  : %01       ;Tilting table
MP 7520.4  : %01       ;Tilting table
MP 7520.5  : %01       ;Tilting table
MP 7520.6  : %01       ;Tilting table
MP 7520.7  : %01       ;Tilting table
MP 7520.8  : %01       ;Tilting table

MP 7530.0  : +420      ;Dimension XR
MP 7530.1  : +151.2    ;Dimension YR
MP 7530.2  : -395.4    ;Dimension ZR
MP 7530.3  : +0        ;Variable dimension (free tilting axis C)
MP 7530.4  : -2.7      ;Dimension Y1
MP 7530.5  : –331.3    ;Dimension Z1
MP 7530.6  : +0        ;Variable dimension (free tilting axis A)
MP 7530.7  : +125.9    ;Dimension Z2
MP 7530.8  : +0        ;Variable dimension (free tilting axis B)
```

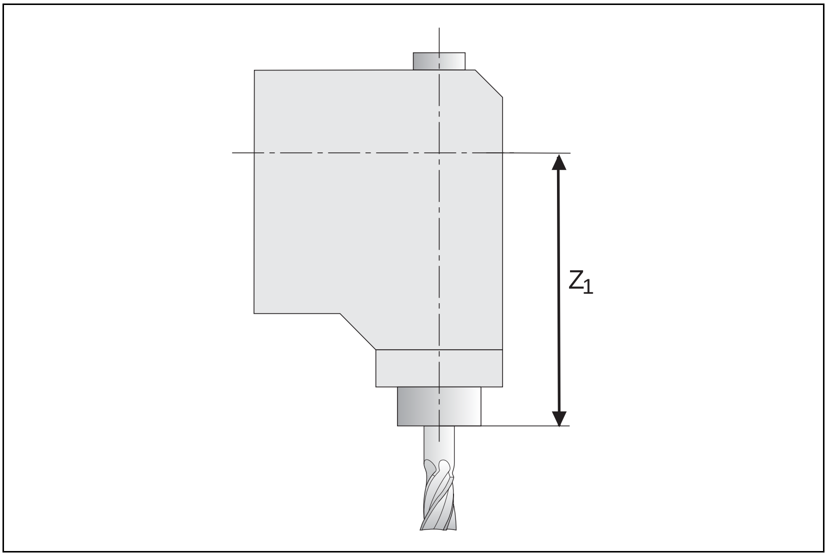
6.5.3 Temperature Compensation with Tilting Axes

A change in temperature always causes a change in length. For tilting axes, thermal growth of the spindle head must be compensated in the X, Y and/or Z axes.
There are two possibilities for temperature compensation:

- Temperature compensation with a "tilted working plane"
  - by entering a formula in MP7530.x
  - by entering a formula in the **MP7530** column of the description table
- Permanently effective temperature compensation
  - by entering a formula in the **TEMPCOMP** column of the description table

In most cases, the formula to be used will be the formula for calculating a change in length: $\Delta l = l \cdot \Delta T \cdot \alpha$
Δl: change in length
l: Length
ΔT: change in temperature
α: coefficient of expansion (steel: $11.5 \cdot 10^{-6}$ 1/K)

Example:



Z_1 = 300 mm (at 20 °C)
$\alpha_{steel} = 11.5 \cdot 10^{-6}$ 1/K (coefficient of expansion of steel)
W486: Temperature measured by a Pt100 thermistor

MP7530.x or TEMPCOMP = 300 + 300 * 11.5e–6 * (W486 – 20)
better: MP7530.x or TEMPCOMP = 300 + 3.45e–3 * (W486 – 20)

If the front part of the spindle gets warmer by 40 K, it results in a spindle length growth of

$$\Delta l = 300 \text{ mm} \cdot 40 \text{ K} \cdot 11.5 \cdot 10^{-6} \frac{1}{\text{K}} = 0.138 \text{ mm}$$

Constraints on the entry of a formula

- Maximum length of a formula: 31 characters
- Maximum of 16 variables per formula
- Mathematical operations in lowercase letters, variables in uppercase letters
- The following operations are permitted in a formula:
  - Addition +
  - Subtraction –
  - Multiplication *
  - Division /
  - Logarithm to the base of 10log10
  - Exponent ^
  - Parentheses ( )
  - Sine sin
  - Cosine cos
  - Tangent tan
  - Arc sine asin
  - Arc cosine acos
  - Arc tangent atan
  - Square root sqrt

An erroneous syntax of the formula is not recognized until the NC program is started. The error message **`MP75xx not defined`** appears.

Temperature compensation

If the "tilted working plane" function is active, the position of the tilting element is calculated for each positioning movement.
The variables are monitored every second, and if there are any changes, MP7530.x is recalculated.

Note

Remember that the changes are compensated with a certain delay. Positioning blocks that have already been calculated can no longer be considered.

Permanent temperature compensation

The permanent temperature compensation with the formula from the **`TEMPCOMP`** column is only effective if the description table is active. The algebraic sign of the compensation must match that of the axis error compensation in Words W576 to W584.
The variables are monitored every second and changes are reported to the position controller. The position controller uses the formula in the **`TEMPCOMP`** column and the current angle of the rotary axes to calculate the compensation values.
With Module 9040 or 9041, transfer value 8, the value of the temperature compensation can be determined.
The formula is only entered for the transformations where compensation is to occur.

Example of a description table with permanent temperature compensation for a 45° double swivel head:

NR	MP7510	MP7520	MP7530	TEMPCOMP	MP7550
0	4	0	+150,5	+150.5+1.73e–3*(W486-20)	0
1	1	0	–1,2		0
2	8	0	–45		0
3	4	0	+251,5		0
4	32	0	0		0
5	8	0	+45		0
6	1	0	+0,8		0
7	16	0	0		0
8	0	0	0		0
[END]					

6.5.4 Changing the Milling Heads

In order to change the milling heads, some new machine parameter values must be defined along with the new tilting axis geometry. For this purpose a machine parameter subfile can be entered in the **MPFILE** column. The machine parameter subfile contains the new axis configuration, the new axis motors, the assignments of the PWM outputs and the encoder inputs, etc. In this machine parameter subfile there must be no machine parameters that provoke a control reset:

- In the standard machine parameter file, the bits in MP10 need to be set to 1 for all possible axes.
- Switch off drives for the affected axes.
- Choose a row in the assignment table in which a machine parameter subfile is activated which sets the bits in MP10 to 0 for the affected axes. If the encoder of a **digital** axis needs to be disconnected, then the appropriate bit must also be set in MP20.x bit x = 0. In addition, MP2200.x = “ ” must be set.

Note

Encoders with EnDat interface must not be disconnected and reconnected during operation, since the absolute value is only read when the control is started up.

- Change the milling head.
- Choose a row in the assignment table which contains a machine parameter subfile for the new axes to set the bits in MP10 to 1 for the new axes. If an encoder on a digital axis was disconnected and reconnected, then MP20.x and MP2200.x must be correctly entered again.
- Switch on drive for the new axis/axes.
- After the drive has been switched on, the affected motors should make at least one revolution.

6.5.5 “Tilt Working Plane” Feature

The user defines the position of the working plane in Cycle 19, “Tilted Working Plane.” Then the iTNC performs a coordinate transformation.

With the 3D ROT soft key you can activate the tilted working plane separately for the MANUAL and PROGRAM RUN operating modes.

With MP7500 you can define the function of the tilted working plane cycle. With **FN18: SYSREAD ID290 NR2** you can request the values of the individual bits from MP7500.

Assignment of input values (Cycle 19)

With MP7500 bit 1 you define whether the input applies to the position of the tilted axes (bit 1 = 0) or the position of the working plane (bit 1 = 1).

If the input value applies to the position of the working plane, the iTNC calculates the position of the tilting axes and saves the coordinates in Q parameters:

- Q120: Coordinate of the A axis
- Q121: Coordinate of the B axis
- Q122: Coordinate of the C axis

With **FN17:SYSWRITE ID990 NR5 IDX5** you can determine if a principle axis is shown on top of another principle axis in an untilted coordinate system due to a tilt motion.

Automatic positioning

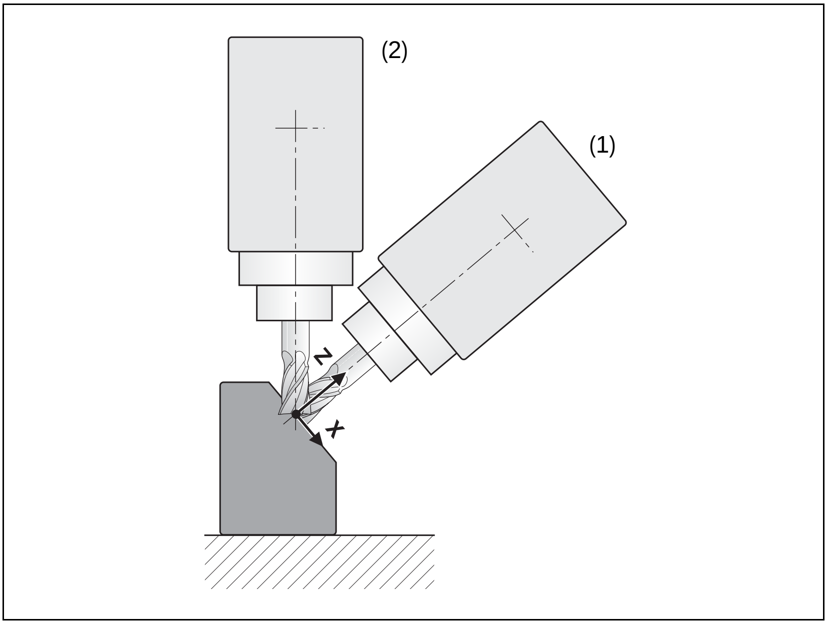
After the coordinate transformation, the Z axis remains parallel to the tool axis, perpendicular to the X/Y plane. With MP7500 bit 2 you define whether the “tilted working plane” function automatically positions the tilting axes (bit 2 = 1). In this case the user can enter the feed rate and setup clearance in the cycle.

The iTNC then moves automatically to the setup clearance and interpolates the swivel and principle axes so that the tool point remains in the same position in the tilted coordinate system.

Datums

Servo-controlled axes:

During “datum setting” for X, Y and Z, the datum is recalculated back to the home position of the tilting element when “tilted working plane” is **active** (1). So when “tilted working plane” is **inactive** and the tilting element is in its home position, the tool is positioned at the datum set while “tilted working plane” was **active.** This requires that bit 7 equal 1.



Behavior during "datum setting" can also be influenced over MP7500 bit 3, bit 5 and bit 7:

MP7500 bit 3 = 0
During "datum setting" in X, Y, and Z, the iTNC saves the reference coordinates of the tilting element needed for calculating the offset when "tilted working plane" is **active.**

MP7500 bit 3 = 1
Datum = 0 is assumed only for the first rotary table axis (only this axis can align a workpiece). For all other axes, “datum setting” in X, Y, and Z is possible with “tilted working plane” **active.**

MP7500 bit 5 = 0
see MP7500 bit 3 = 0

MP7500 bit 5 = 1
It can happen with titling elements with Hirth couplings that by locking the Hirth coupling, the actual value of the encoder will no longer exactly agree with the mechanical position of the tilting element. If this happens, the nominal values should be used to calculate the various datums (MP7682 bit 1).
If problems continue to occur, MP7500 bit 5 should be set to 1. The tilting angles entered in 3-D ROT are used to calculate the datums for X, Y and Z.

MP7500 bit 7 = 0
see MP7500 bit 3 = 0

MP7500 bit 7 = 1 (recommended)
During “datum setting” for X, Y and Z, the tilting angles entered in 3-D ROT are used to calculate the datum if “tilted working plane” is **active.**
During “datum setting” for X, Y and Z, the reference points of the tilting axes are used to calculate the datum if “tilted working plane” is **inactive.** This allows a workpiece to be aligned, a datum to be set, “tilt working plane” to be activated, and a new datum to be set in the “tilted working plane.”

With MP7682 bit 1 you define whether the nominal or the actual values are used to calculate the presets during “datum setting” (is valid for MP7500 bit 3, bit 5, bit 7, bit 8).

No servo-controlled axes:

The user must enter the current positions of the tilting axes by using the 3-D ROT soft key.

Note

In the combination of coordinate transformation cycles, note the sequence of activation and deactivation.

Spatial angle C ≠ 0

On machines with C tables and tool axis Z, the spatial angle C ≠ 0 (with A = 0 and B = 0) can be realized through a rotation of the coordinate system or a rotation of the table:

- With MP7500 bit 6 = 0, the spatial angle C is realized through a rotation of the coordinate system.
  With MP7500 bit 6 = 1, the spatial angle C is realized through a rotation of the table. At the same time, the angle is saved in Q122. This makes it possible, for example, to machine a workpiece by always using the same axis for paraxial linear blocks in the X/Y plane.

Conditions and constraints

Conditions:

- The display position in the status window is referenced to the tilted coordinate system.
- In the combination of coordinate transformation cycles the sequence of activation must agree with the sequence of deactivation.
- The tool radius compensation in the working plane and the tool length compensation parallel to the tool axis is active.
- For machining with tilting tables, the coordinate system remains parallel to the machine coordinate system.

Constraints:

- PLC positioning movements are always parallel to an axis of the machine coordinate system (Cycle 19 has no influence)
- A datum shift via PLC also works with the “tilted working plane” function.
- The axis designations for the tilting axes are limited to A, B, C. Each designation can be used only once.
- With an active Cycle 19 "tilted working plane", it is not possible to position with M91 or M92.

If the position of the working plane is entered, only the following swivel axes (with tool axis Z) are permissible:

- Double swivel head 45°: Axis sequence A fixed; B or C variable; A fixed; B or C variable
- Rectangular double swivel head: Axis sequence A or B variable; C variable
- Rotary or tilting table: Axis sequence C variable; A or B variable
- Swivel head and rotary table: Axis sequence A or B variable; C variable
- Swivel head 45°: Axis sequence C variable; A fixed; B variable; A fixed
- Rectangular double swivel head: Axis sequence A variable; B variable
- Universal swivel head: Axis sequence A fixed; B –90°; A variable; B +90°; A fixed; C variable
- Swivel head and rotary table: axis sequence B variable, A variable

With tool axis Y:

- Rotary or tilting table: Axis sequence B variable; A variable
- Double swivel head 45° and rotary table: Axis sequence A fixed; C variable; A fixed; B variable
- Rotary or tilting table: Axis sequence A or C variable; A or C variable

With tool axis X:

- Universal swivel head: Axis sequence B fixed; A variable; B fixed; C variable

MP7500 **“Tilted working plane”**

Format: %xxxxxxxxx

Input: Bit 0 – Switch-on “tilted working plane” function
0: Off
1: On
Bit 1 –
0: Angles correspond to the position of the tilting axes of the head/table
1: Angles correspond to the spatial angle (the iTNC calculates the position of the tilted axes of the head/table)
Bit 2 –
0: The tilting axes are not positioned with Cycle 19
1: The tilting axes are positioned with Cycle 19
Bit 3 –
0: The current tilting-axis position is taken into account with respect to the machine datum
1: The 0° position is assumed for the first tilting axis
Bit 4 –
0: Compensate mechanical offset during exchange of the spindle head when calling M128, M114 or “tilted working plane”
1: Compensate mechanical offset during PLC datum shift
Bit 5 –
0: The current tilting-axis position is taken into account with respect to the machine datum
1: The tilting-axis position that was entered with the 3-D ROT soft key applies.
Bit 6 –
0: Spatial angle C is realized through a rotation of the coordinate system.
1: Spatial angle C is realized through a rotation of the table.
Bit 7 –
0: The current tilting-axis position is taken into account with respect to the machine datum
1: The active tilting-axis position is
a) derived from the tilting angles in the 3-D ROT window if manual tilting is active.
b) derived from the reference coordinates of the rotary axes if tilting is inactive.
Bit 8 – Non-functional

MP7510	**Transformed axis**
Format:	%xxxxxx
Input:	0: End of the transformation sequence Bit 0 corresponds to axis X Bit 1 corresponds to axis Y Bit 2 corresponds to axis Z Bit 3 corresponds to axis A Bit 4 corresponds to axis B Bit 5 corresponds to axis C
MP7510.0–14	Transformation 1 to transformation 15

MP7520	**Additional code for transformation**
Format:	%xx
Input:	Bit 0 – Tilting axis 0: Swivel head 1: Tilting table Bit 1 – Type of dimension in MP7530 0: Incremental dimension for swivel head 1: Absolute with respect to the machine datum for tilting table
MP7520.0–14	Transformation 1 to transformation 15

MP7530	**Type of dimension for transformation**
Input:	-99 999.9999 to +99 999.9999 0: Free tilting axis
MP7530.0–14	Transformation 1 to transformation 15

Note

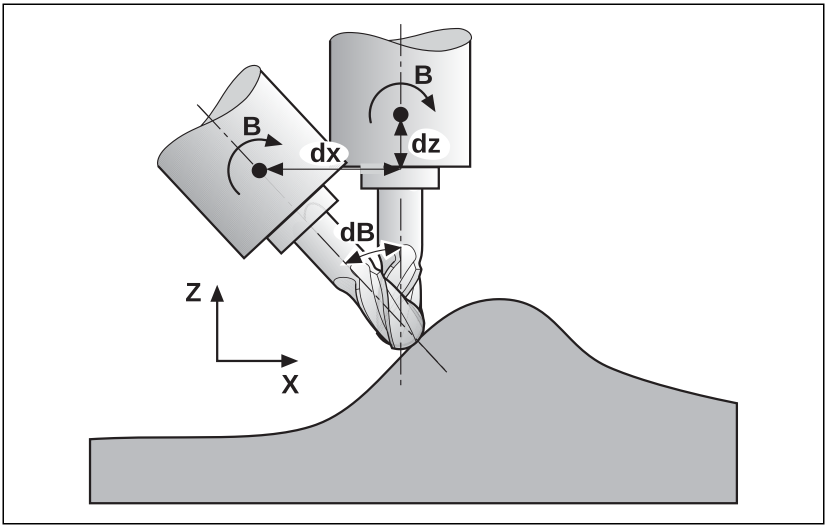
MP7530 cannot be overwritten with Module 9031 (overwrite machine parameters), since the MP contains a string, but the module transfers an integer value.

MP7550	**Home position of the tilting element**
Input:	-99 999.9999 to +99 999.9999
MP7550.0	A axis
MP7550.1	B axis
MP7550.2	C axis

MP7682	**Machine parameter with multiple function**
Format:	%xxx
Input:	Bit 1 – Reference value for calculating the preset during “datum setting” 0: Actual value is calculated 1: Nominal value is calculated

6.5.6 Automatic Compensation of Offset for Tilting Axes

Unlike the “tilted working plane,” here the coordinate system is not tilted. With M114 or M128, the iTNC compensates the offset of the tool that results from tilting the axes. The tool tip is always located on the programmed nominal- coordinates.



The TNC can perform a 3-D length compensation; the radius compensation must be performed by the CAD system or the postprocessor. If the iTNC compensates the tool length, then the programmed feed rate refers to the tool point. Otherwise it refers to the tool datum.

Miscellaneous function M114

Automatic compensation with M114:

- Linear and rotational movements are superimposed. The resulting contour deviations depend on the length of the linear interpolation.
- When the table is rotated, the coordinate system is rotated against the machine coordinate system. The iTNC **does not take this into account.**
- M114 can be used with non-controlled tilting axes or PLC tilting axes. In this case, the current tilting angle and the tilting axis are entered in the NC block behind M114.

Miscellaneous function M128

Automatic compensation with M128:

- Linear and rotational movements are superimposed. The resulting contour deviations are compensated.
- When the table is rotated, the coordinate system is rotated against the machine coordinate system. The iTNC **takes this into account.**
- M128 remains in effect even after a change in operating modes. This means that the axis can be moved with the compensated machine geometry in Manual mode with the axis direction keys, or in the Handwheel mode.
- With the miscellaneous function M118, the handwheel positioning movements can be superimposed on the program run movements. The iTNC automatically performs the compensating movements in the principal axes.

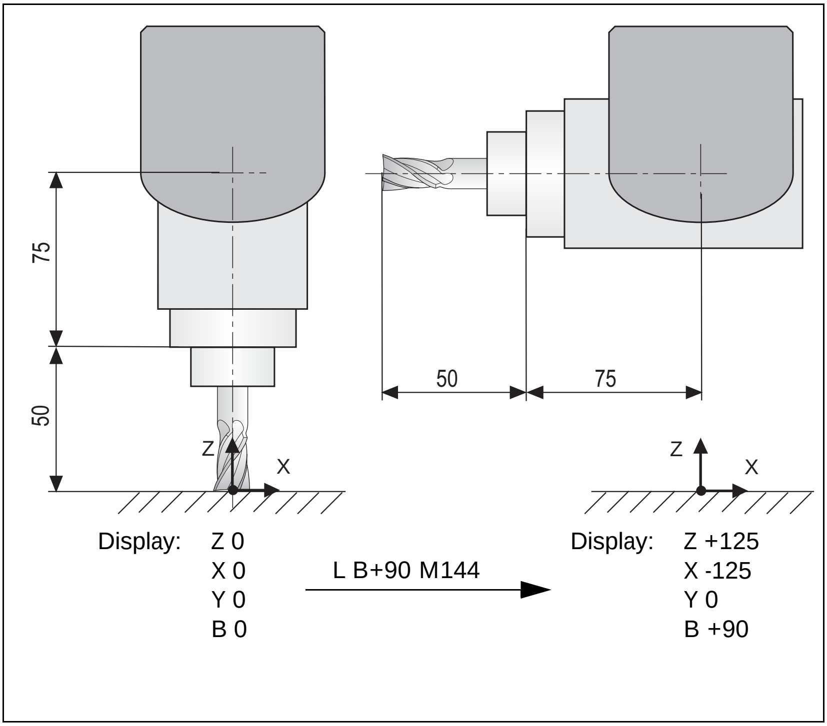
When M128 is used, the principal axes make compensating movements:

- In MP7471, define the maximum velocity of the principal axes during compensating movements.

MP7471	**Maximum velocity of the principal axes during compensating movements through M128**
Input:	0 to 300 000 [mm/min]

Miscellaneous function M144/ M145

With M144 the movement of a tilted axis is recorded in the display. There is no need for the axes to traverse a compensatory path. M144 is deactivated with M145.



FN18: SYSREAD ID310 NR144 can determine if M144 is active or inactive.

MP7502	**Functionality of M144/M145**
Input:	%xxx Bit 0 0: M144/M145 not active 1: M144/M145 active Bit 1 – M144/M145 in the automatic modes 0: M144/M145 active 1: M144 is activated automatically at the start of an NC program. It can only be deactivated with M145 during an NC program. Bit2 – M144/M145 in the manual modes 0: M144/M145 not active 1: M144/M145 active

6.5.7 Cylindrical Surface

Cycles 27 and 28, "Cylinder Surface," enable the user to machine a contour on a cylindrical surface (see the User's Manual).

Prerequisites:

- In MP7510 to MP7530, the center of rotation of a rotary axis must be defined (see example 3). MP7500 is not needed if only one rotary axis is present.
- If a PLC datum compensation is used, the same home position must apply in the description of the machine geometry in MP7510.x to MP7530.x as in the datum shift.
- After a change in MP7510.x or MP7530.x, the datum must be reset.

6.6 Synchronized Axes

6.6.1 Gantry Axes

In gantry axes, tandem tables, etc., two servo-controlled axes are coupled so that they can move only simultaneously. The main axis is referred to as the master, and the tracking axis as the slave. From a maximum of nine controlled axes, four times two axes can be controlled synchronously.

The function is effective during control both with following error and with velocity feedforward.

Activating synchronized axes:

▶ Assign a slave axis to a master axis.

MP850.x	**Synchronized axes**
Input:	0: Master axis 1: Slave axis to axis 1 2: Slave axis to axis 2 3: Slave axis to axis 3 4: Slave axis to axis 4 5: Slave axis to axis 5 6: Slave axis to axis 6 7: Slave axis to axis 7 8: Slave axis to axis 8 9: Slave axis to axis 9

Example

Axis 4 is slave to axis 1:

- MP850.0 = 0
- MP850.1 = 0
- MP850.2 = 0
- MP850.3 = 1
- MP850.4 = 0
- MP850.5 = 0
- MP850.6 = 0
- MP850.7 = 0
- MP850.8 = 0

Master-slave position deviation

The iTNC monitors the synchronism of the coupled axes. If the master and slave axes deviate from each other by the difference of the following errors, the iTNC displays the slave axis with the message **EXCESSIVE SERVO LAG IN <AXIS>**. The LAG display shows the current difference in position.

▶ In MP855.x of the slave axis, enter the maximum permissible difference in positions between the master and slave.

If you cause an offset in the axes through an emergency stop, they will be synchronized after the emergency stop.

Datum at position after switch-on (MP860.x = 0)

Entry for the slave axis

With MP860.x you can select whether the position after switch-on should be used as a synchronization reference. Master and slave axes must be at identical positions. If the defined datums are to be reproduced, then only the master needs to be moved over the reference mark.

Monitoring of synchronized axes begins immediately upon switch-on.

Datum at reference marks (MP860.x = 1)

Entry for the slave axis

With MP860.x you can select whether the position should be ascertained by traversing the reference marks. After crossing over the reference mark, the master and slave axes are positioned to the same value. The default setting can be corrected with MP960.x (machine datum). In order for MP960.x to be set, the axes must traverse the reference marks with MP860.x = 0, so that no compensation movements are made. An offset in the axes is corrected after both reference marks are traversed. Reference mark traverse is ended as soon as a reference mark is traversed in both axes. The monitoring function is not active until after the compensation movement. The monitoring function is not active before the reference marks are traversed.

Conditions:

- The same type of reference mark traverse must be set for both the master and slave axes (MP1350.x).
- The velocity with which an offset (after traversing a reference mark or emergency stop) is compensated for is defined in MP1330.x for the slave axis.
- In the sequence for traversing the reference marks (MP1340.x), the master axis must be defined before the slave axis.
- The compensation movement can **not** be stopped with an NC stop (only with an emergency stop).
- The compensation movement is **not** considered in the following words:
  - W1026 (Axes in position)
  - W1028 (Axes in motion)
- If the master axis has traversed the reference mark at the time of an NC stop or an emergency stop, but the slave axis has not yet crossed it, then the slave axis can only be moved across it by using the axis-direction keys.
- Using a linear encoder: it is sufficient if the master axis has one reference end position.
- Using the speed encoder for linear measurement: One reference end position is enough, but the NC needs a reference end position signal for both axes (W1054).

Conventions

For synchronized axes:

- The slave axis cannot be moved separately.
- The nominal value display of the slave axis shows the nominal value of the master axis.
- The PLC program must ensure that the master axis does not move until the slave axis is ready (clamping, feed-rate enable).
- For the slave axis, the bits for traverse direction in W1030 and axis in motion in W1028 are **not** set.
- One axis cannot be both master and slave.
- Linear and nonlinear axis error compensation as well as temperature compensation must be entered separately for each axis.
- The values for rapid traverse, acceleration, jerk, software limit switches, feed rate for reference mark traverse, and manual feed rate are also taken over from the input values of the master axis for the slave axis.
- When operating with following error, the k_v factors for master and slave must be the same.
- The axes must be either both analog or both digital.
- Master and slave axes can be linear or rotary axes

- For gantry axes, one position encoder is sufficient.
- The nonlinear axis-error compensation can be used separately for master and slave axes.
- For the nonlinear axis-error compensation, master and slave axes may be dependent on each other.

MP855.x **Synchronization monitoring**
Input: 0 to 100.0000 [mm]
0: Monitoring not active

MP860.x **Datum for synchronous control**
Input: 0: Datum at position after switch-on
1: Datum at reference marks

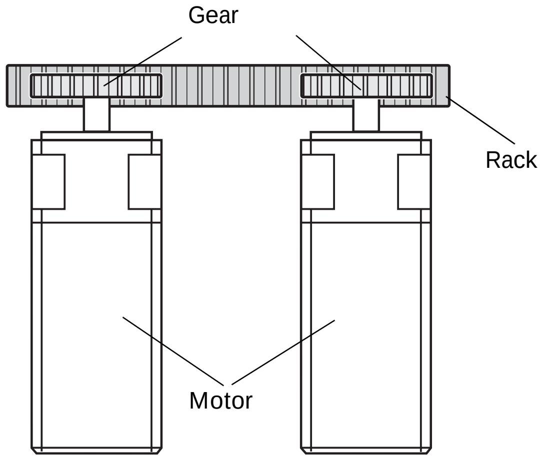
6.6.2 Master-Slave Torque Control

In master-slave torque control, two motors (master and slave) are mechanically coupled. Because of the coupling, only one position encoder is required. The motor to which the position encoder is assigned is the master.

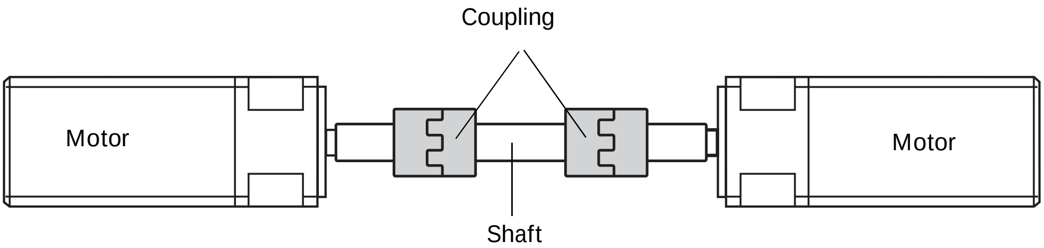
From a maximum of nine controlled axes, four times two axes can be controlled in the torque-master-slave-control, whereby you must keep in mind that the master and slave axis are on the same speed controller PCB.
First speed controller PCB: X15 to X20
Second speed controller PCB: X80 to X83

In principle there are two applications:

- Minimization of mechanical play through mutual tensioning
- Distribution of torque with a rigid coupling

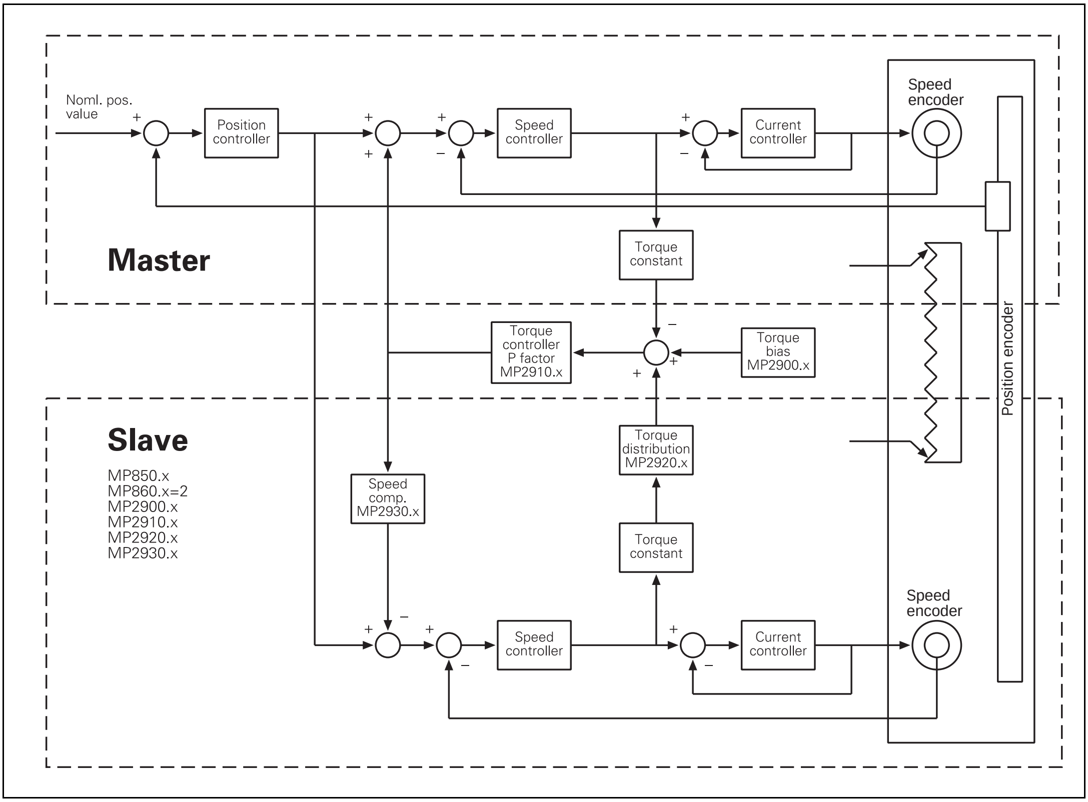


Minimization of mechanical play through mutual tensioning



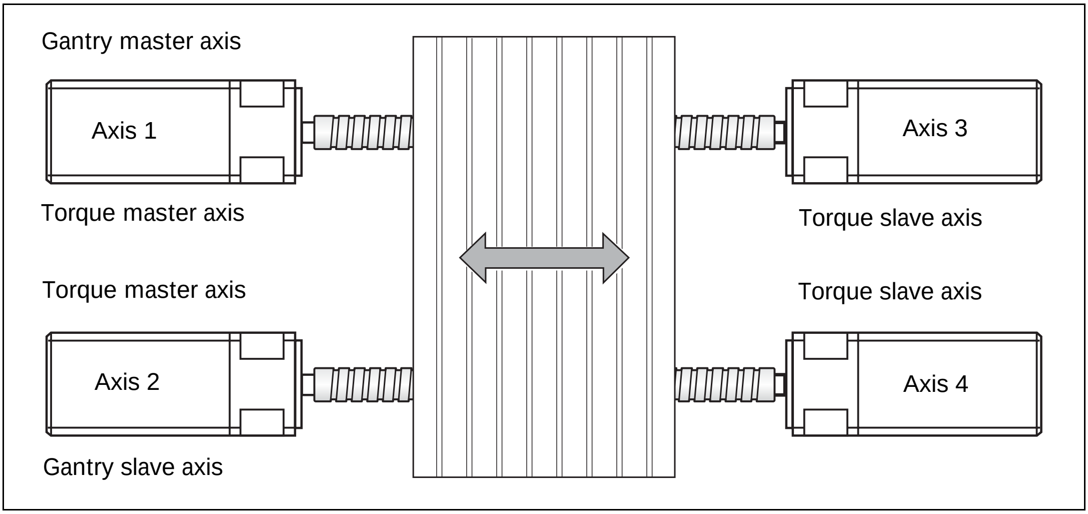
Distribution of torque with a rigid coupling

Method of function Position control is deactivated in the slave axis. The nominal velocity of the master axis is at the same time the nominal velocity of the slave axis. The speed controllers of both axes remain independent. The manipulated variables coming from the speed controllers, i.e. the nominal torque current values, are weighted with the torque constants of the motors and compared with each other. In addition, a tensioning torque (MP2900.x) can be introduced at this comparison point. To permit a distribution of drive torque, the nominal torque of the slave axis can be multiplied with a weighting factor (MP2920.x). The result at the comparison point is fed to a torque balancing controller that amplifies it proportionally (MP2910.x). The manipulated variable of the balancing controller is a speed compensation value that is added to the current speed value.



Gantry axes in master-slave torque control

It is possible to run gantry axes in master-slave torque control. The gantry master and gantry slave axes are at the same time torque master axes and have one torque slave axis each.



Example for the MP entries:

MP850.0 = 0
Axis 1 is master axis

MP850.1 = 1
Axis 2 is slave to axis 1

MP850.2 = 1
Axis 3 is slave to axis 1

MP850.3 = 2
Axis 4 is slave to axis 2

MP860.0 = 0 or 1
Axis 1: Datum for synchronous control

MP860.1 = 0 or 1
Axis 2: Datum for synchronous control

MP860.2 = 2
Axis 3 is torque slave axis

MP860.3 = 2
Axis 4 is torque slave axis

Activation of master-slave torque control

- Activate the master and slave axes with MP10.
- In MP110.x, define the position encoder for the master.
- Enter MP110.x = 0 for the slave.
- In MP850.x, define the master axis as the main axis and the slave axis as the tracking axis.
- Activate the master-slave torque control by entering MP860.x = 2 for the slave axis.

MP860.x	**Datum for synchronous control**
Input:	2: Axis is torque slave axis

Setting the master-slave torque control for minimizing mechanical play

- For the master and slave axes you must select in MP1040 the same or the opposite direction of rotation, depending on the application (MP210 has no effect on the slave).
- Adjust the current controller for the master and slave axes. See "Commissioning" on page 6 – 218
- Enter the following temporary values in the machine parameters for the slave axis:
  MP2900.x = approx. 20% to 25% of the rated torque of the motor
  MP2910.x = 3
  MP2930.x = 0
- In MP2920.x, enter the ratio of the mass moment of inertia of the master to the mass moment of inertia of the slave. For identical motors, therefore, the value to be entered is 1.
- If you use a position encoder, in MP2930.x enter 100 for the slave axis; if you do not use a position encoder, enter the value 0.
- Enter MP2510.x (I factor of speed controller) = 50 or, if you have one, an empirical value for your motor.
- Adjust the P and I factor of the speed controller for the master and slave axes at the same time See "Commissioning" on page 6 – 218. It is not permissible to commission the master and slave axes separately, since the motors must be tensioned during commissioning.
- If you do not reach the desired rise time (approx. 10 ms), you can increase the P factor with the aid of a filter. Here the band-rejection filter is preferable to the low-pass filter.
- To find the center frequency for the band-rejection filter, slowly increase the P factor to the oscillation limit and find the frequency with the integrated oscilloscope.

Note

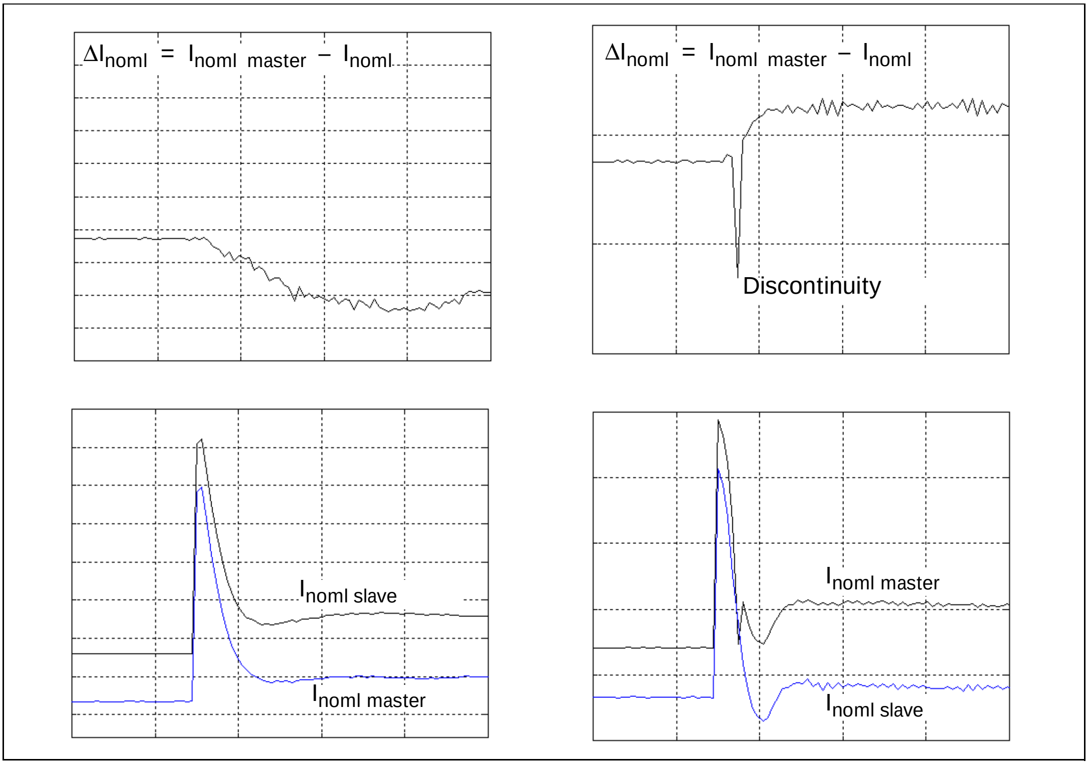
For low-frequency oscillations (< approx. 200 Hz) you should not use a filter, because it may have a negative influence on the dynamics of the control.
For the mid-range frequency (approx. 200 Hz to approx. 400 Hz) ensure that you do not excite any low-frequency oscillation.
The higher the frequency of the oscillation (> approx. 400 Hz), the less negative will be the influence of high damping on the dynamics.

Note

For identical motors, the factors of the speed controller should be identical to ensure identical dynamic behavior.

Test the tensioning torque:

- With the integrated oscilloscope, record the nominal current (I nominal) of the master and the slave axes at standstill.
- Send a step to the speed controller and, with the integral oscilloscope, record the nominal current of the master and slave axes.
- If there is an discontinuity in the course of the nominal current, increase the tensioning torque for the slave axis in MP2900.x.



Note

The lower the ratio of the total mass moment of inertia (transmission, machine table, etc.) to the motor mass moment of inertia, the smaller is the required tensioning torque (MP2900.x).

Test the P factor of the torque controller:

- With the integrated oscilloscope, record the actual speed value V (N ACTL).
- Increase the P factor in MP2910.x for the slave axis up to the oscillation limit.
- Enter in MP2910.x for the slave axis 50% of the resulting value.

Setting the master-slave torque control for torque distribution in a rigid design

- For the master and slave axes you must select in MP1040 the same or the opposite direction of rotation, depending on the application (MP210 has no effect on the slave).
- Adjust the current controller for the master and slave axes See "Commissioning" on page 6 – 218.
- Enter the following temporary values in the machine parameters for the slave axis:
  MP2900.x = 0
  MP2910.x = 3
  MP2930.x = 0
- In MP2920.x, enter the ratio of the mass moment of inertia of the master to the mass moment of inertia of the slave. For identical motors, therefore, the value to be entered is 1.
- If you use a position encoder, in MP2930.x enter 100 for the slave axis; if you do not use a position encoder, enter the value 0.
- Enter MP2510.x (I factor of speed controller) = 50 or, if you have one, an empirical value for your motor.
- Deactivate the slave axis in MP10.
- For the master axis, adjust the P and I factor of the speed controller See "Commissioning" on page 6 – 218.
- If you do not reach the desired rise time (approx. 10 ms), you can increase the P factor with the aid of a filter. Here the band-rejection filter is preferable to the low-pass filter.
- To find the center frequency for the band-rejection filter, slowly increase the P factor to the oscillation limit and find the frequency with the integrated oscilloscope.

Note

For low-frequency oscillations (< approx. 200 Hz) you should not use a filter, because it may have a negative influence on the dynamics of the control. For the mid-range frequency (approx. 200 Hz to approx. 400 Hz) ensure that you do not excite any low-frequency oscillation. The higher the frequency of the oscillation (> approx. 400 Hz), the less negative will be the influence of high damping on the dynamics.

- Deactivate the master axis in MP10.
- Set MP850.x and MP860.x to 0 for the slave axis.
- Set the speed controller and the filter parameters for the slave axis in the same manner as for the master axis.

Note

For identical motors, the factors of the speed controller should be identical to ensure identical dynamic behavior.

Test the P factor of the torque controller:

- In MP10 reactivate the master and slave axes.
- With the integrated oscilloscope, record the actual speed value V (N ACTL).
- Increase the P factor in MP2910.x for the slave axis up to the oscillation limit.
- Enter in MP2910.x for the slave axis 50% of the resulting value.

MP2900.x Tensioning torque between master and slave for master-slave torque control (entry for the slave axis)

Input: -100.00 to +100.00 [Nm]

MP2910.x P factor of the torque controller for master-slave torque control (entry for the slave axis)

Input: 0.00 to 999.99 [1/(Nm · min)]

MP2920.x Factor for variable torque distribution for master-slave torque control (entry for the slave axis)

Input: 0.000 to 100 000
1: Master and slave axes have identical motors

MP2930.x Speed compensation ratio for master-slave torque control (entry for the slave axis)

Input: -100.00 to +100.00 [%]

6.7 Reference Marks

6.7.1 Definition

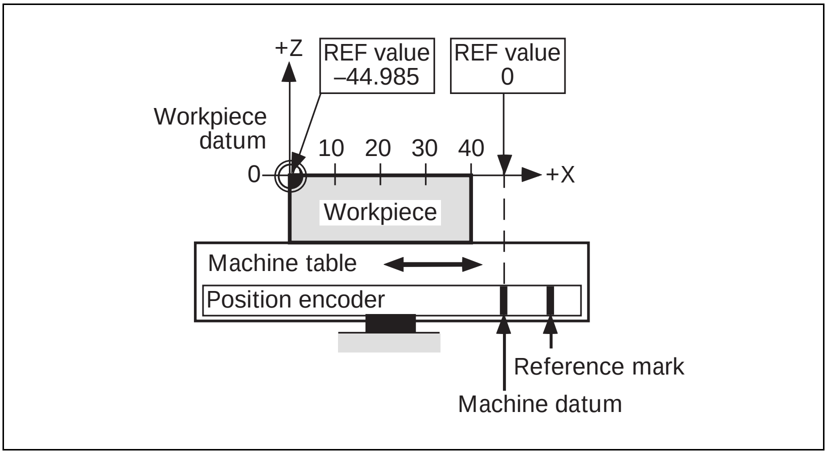
The position value (coordinates) of an axis position is defined with respect to a freely selectable datum. When the axes are moved, the ACTUAL position is calculated incrementally. If there is an interruption in power, the reference between the axis position and the position value is lost.

Reference marks

HEIDENHAIN linear encoders are designed with one or more reference marks. The reference marks identify an axis position at a known distance from the machine datum. The position of the freely selectable datum is defined with respect to the machine datum.

The datum and the actual position can be reproduced as soon as the reference marks are traversed.

HEIDENHAIN recommends position encoders with distance-coded reference marks. With distance-coded reference marks, the position value can be reestablished after traverse of a short distance over any two reference marks.



6.7.2 Traversing the reference marks

The reference marks must be traversed after any interruption in power:

▶ Press the machine START button: The reference marks are automatically traversed. The sequence of axes is predetermined.

or:

▶ Press the machine axis-direction button. The user determines the sequence of the axes.

After the reference marks have been traversed:

- The software limit switches are activated.
- The most recently saved datum and machine datum are reproduced.
- PLC positioning and positioning with M91 and M92 become possible.
- The counter is set to zero for axes in an open loop.

Distance between the scale reference point and the machine datum

For distance-coded reference marks, the machine datum is defined with respect to the scale reference point, which is at the first reference mark after the beginning of the measuring length. On angle encoders, the scale reference point is marked:

- In MP960.x, enter the distance between the scale reference point and the machine datum.

For position encoders without distance-coded reference marks but with more than one reference mark, the distance between the reference mark to be traversed and the scale reference point must also be entered:

- With Module 9225, enter the distance between the reference mark to be traversed and the scale reference point.

Module 9225 Compensation value for the reference mark

With Module 9225 you define the distance between the reference mark to be traversed and the scale reference point for the NC and PLC axes.

Call:

PS	B/W/D/K	<>Axis> 0 to 8: Axes 1 to 9 15: Spindle
PS	B/W/D/K	<>Compensation value in 0.1 µm> 0: Reference mark to be traversed = scale reference point
CM	9225	
PL	B/W/D	<>Error code> 1: Axis does not exist

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Axis does not exist

Assigning a reference value

In some cases a new reference mark may have to be assigned to an axis, e.g. if an axis is mechanically fixed and the encoder is moved. Since due to the mechanical fixing the position of the axis cannot be changed, you can assign it a new reference value:

- Enter the new reference value in Module 9147.

Module 9147 Assigning the reference value to an axis

If a new reference value is assigned to an axis, the corresponding bit is reset in W1032.

Call:

PS	B/W/D/K	<>Axis number<> 0 to 8: Axes 1 to 9
PS	B/W/D/K	<>New reference value in 0.1 µm>
CM	9147	

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	2	Invalid axis number
	21	Missing strobe in M4176 = 1
	24	Module was called in a spawn job or submit job

Defining the process of traversing the reference marks

In machine parameters, you define the process of traversing the reference marks:

- In MP1320.x and MP1330.x (for rotary encoders also in MP1331.x) you define the direction and velocity for traversing the reference marks.
- In MP1340.x you define the sequence of axes for traversing the reference marks.
- With MP1350.x you select the type of reference marks.

External reference pulse

If it is not possible to use the reference mark of the encoder, for example due to an unsuitable transmission ratio between the motor and rotary axis, then you can use an external reference pulse:

- In MP4130.x, define the fast PLC input for the external reference pulse
- For the corresponding axis in MP1360.x, enter the number of the fast PLC input
- Enter MP1350.x = 6 for the corresponding axis

“Pass Over Reference Point” mode of operation

The NC uses W272 to report the “Pass Over Reference Point” operating mode to the PLC.

If you switch the operating mode before all reference marks are traversed, the PASS OVER REFERENCE soft key prompts you traverse the remaining reference marks. In W1032 the PLC receives the information as to which axes have not yet been referenced.
In W1032, the bits for axes that are not to traverse the reference marks (MP1340.x = 0) are reset.

In the NCMACRO.SYS file, after the code word RESETINIT= you can enter the name (incl. path) of a macro that will be called when the Pass Over Reference Point mode of operation is exited. If the NC macro is terminated once with END PGM or M02, it will no longer be run when the Pass Over Reference Point mode is called and exited.
To synchronize the current machine status and the look-ahead calculation with an NC macro call,

Reference end position

To prevent the axes from violating their traverse limits when traversing the reference marks, each axis requires a trip dog (at the reference end position). The trip dogs must be installed by the machine tool builder at the ends of the traverse range. The switch signals from the trip dogs are sent to free PLC inputs. The PLC program must gate these PLC inputs with W1054 for “reference end position.”

Encoders with EnDat interface

Encoders with EnDat interface can be connected to the position and speed inputs of the MC 422 and CC 422. With these encoders there is no need to traverse the reference marks. The position value is only read when the control is switched on. It cannot be read again.
When connecting a position encoder with an EnDat interface:

- Enter MP1350.x = 5.

When connecting a speed encoder with an EnDat interface:

- The iTNC automatically attempts to communicate with the encoder.

When connecting a speed encoder with an EnDat interface as a position encoder:

- Enter MP1350.x = 5.
- In MP110.x, enter 0 for the axis with EnDat interface of the speed encoder.

If the position encoder has no EnDat interface and the speed encoder does, instead of traversing the reference marks of the position encoder, you can evaluate the absolute position of the speed encoder:

- For the axis in which the absolute position is to be evaluated over the speed encoder, set the corresponding bit in MP1355 to 1
- Run a control reset
- If an incorrect distance between the position and speed encoder is entered in MP1356.x, the message `Set MP1356.x to <value>` appears. Enter this value in MP1356.x.

Note

If use of multiturn encoders with EnDat interfaces results in overruns, the corresponding information is entered in the system file NCDATA.SYS. For a control exchange, this file must be transferred or MP960.x must be readjusted.

MP960.x **Machine Datum**
Input: -99 999.9999 to +99 999.999 [mm] or [°]
Values with respect to the scale reference point

MP1320 **Direction for traversing the reference marks**
Format: %xxxxxxxxxxxxxx
Input: Bits 0 to 13 correspond to axes 1 to 14
0: Positive
1: Negative

MP1330.x **Velocity for traversing the reference marks**
Input: 80 to 300 000 [mm/min]

MP1331.x **Velocity for leaving the reference mark end position for axes 1 to 9 (only for rotary encoders MP1350 = 2)**
Input: 10 to 300 000 [mm/min]

MP1340.x **Sequence for traversing the reference marks**
Input: 0: No evaluation of reference marks
1 to 14: Axes 1 to 14

MP1350.x **Type of reference mark traverse**
Input: 0: Linear encoder with distance-coded reference marks (old routine)
1: Position encoder with one reference mark
2: Special type (length measurement with ROD)
3: Linear encoder with distance-coded reference marks (new routine)
4: Same as 3 except that two reference marks are evaluated
5: Encoder with EnDat interface
6: Reference pulse over fast PLC input

MP1355 **Reference run**
Format: %xxxxxxxxxxxxxx
Input: Bits 0 to 13 correspond to axes 1 to 14
0: Reference run as defined in MP1350.x
1: Reference run over EnDat interface of the speed encoder

MP1356.x Difference between speed and position encoder, if MP1355 = 1
Input: –99 999.999 to +99 999.999 [mm] or [°]

MP1360.x **Fast PLC input for reference pulse**
Input: 0: No fast PLC input for reference pulse
1 to 5: No fast PLC input for reference pulse

		Set	Reset
W272	**Mode of operation** 1: MANUAL OPERATION 2: ELECTRONIC HANDWHEEL 3: POSITIONING WITH MANUAL DATA INPUT 4: PROGRAM RUN, SINGLE BLOCK 5: PROGRAM RUN, FULL SEQUENCE 7: REFERENCE MARK TRAVERSE	NC	NC
W1032	**Reference marks not yet traversed** Bits 0 to 8 correspond to axes 1 to 9	NC	NC
W1054	**Reference end position** Bits 0 to 8 correspond to axes 1 to 9	PLC	PLC

Renewed traversing of the reference marks

Module 9220 Renewed traversing of the reference marks

With this module you start an NC or PLC axis or a servo-controlled spindle to traverse the reference mark. It is possible to repeat the reference mark traverse in an axis that has already been referenced. The module can be called in all operating modes. Software limit switches are not effective. The strobe marker must remain set for the entire duration of the reference-mark traverse.

Axis:

- The sequence of functions (MP1350.x) and the velocity for leaving the reference end position (MP1331.x) are defined by machine parameter.
- The velocity and the direction for traversing the reference marks are either taken from MP1330.x and MP1320.x or they are defined in the module.

> **Note**
>
> The direction of traverse should be defined in the module only in exceptional cases. Since the reference end position is not considered in this case, the limits of the traverse range may be violated.

- If an axis is started for reference point traverse although the reference mark has already been traversed, the corresponding bit is set in W1032 and the reference mark is traversed again. The same constraints apply as for traversing the reference mark the first time.
- An axis cannot be started for reference mark traverse until all axes are in position.

Servo-controlled spindles:

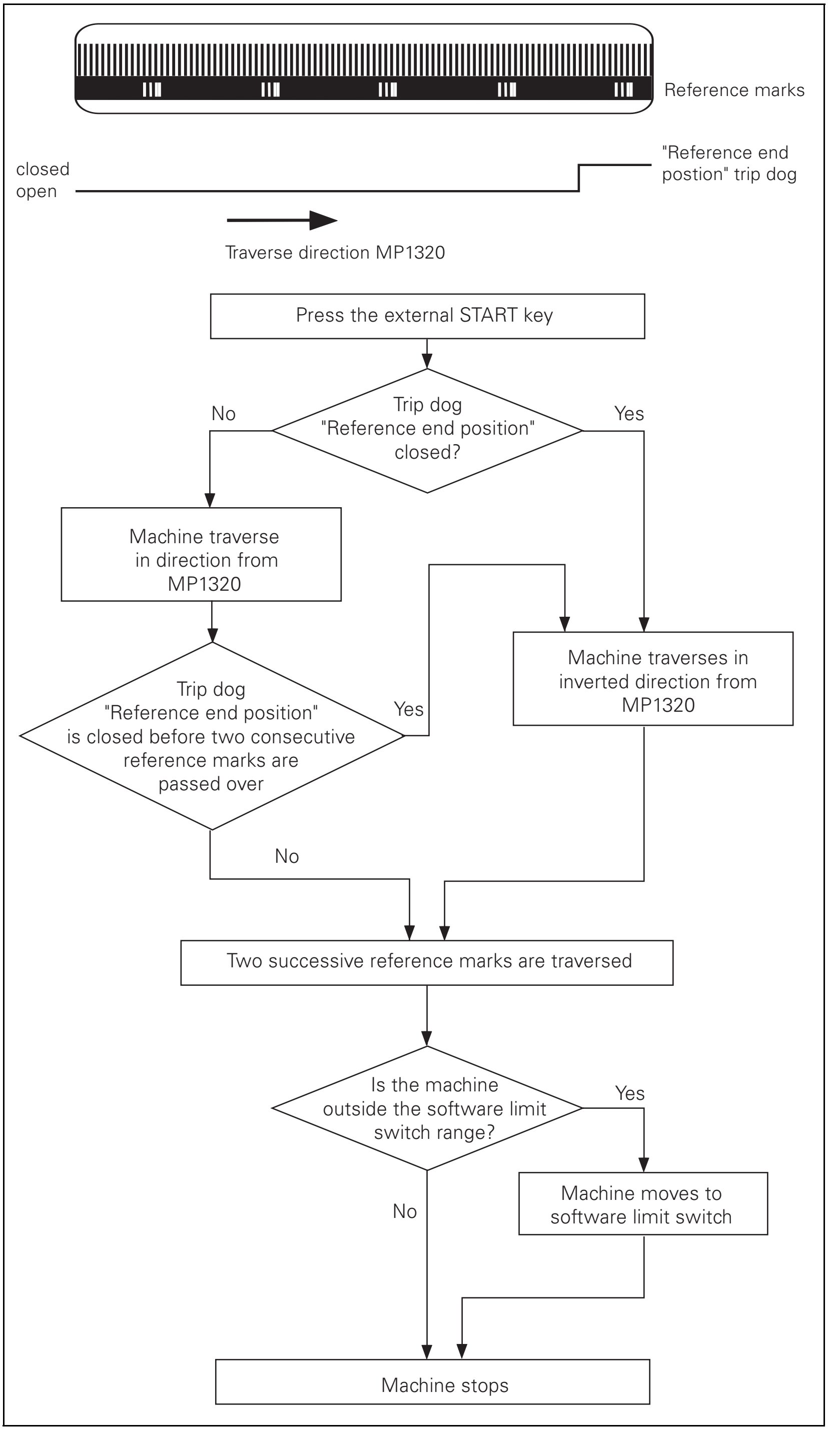
- The speed for traversing the reference mark is defined in the module.
- The spindle must be started from a standstill to traverse the reference mark.
- If the spindle is started for reference mark traverse, marker M4018 is set.

Call:

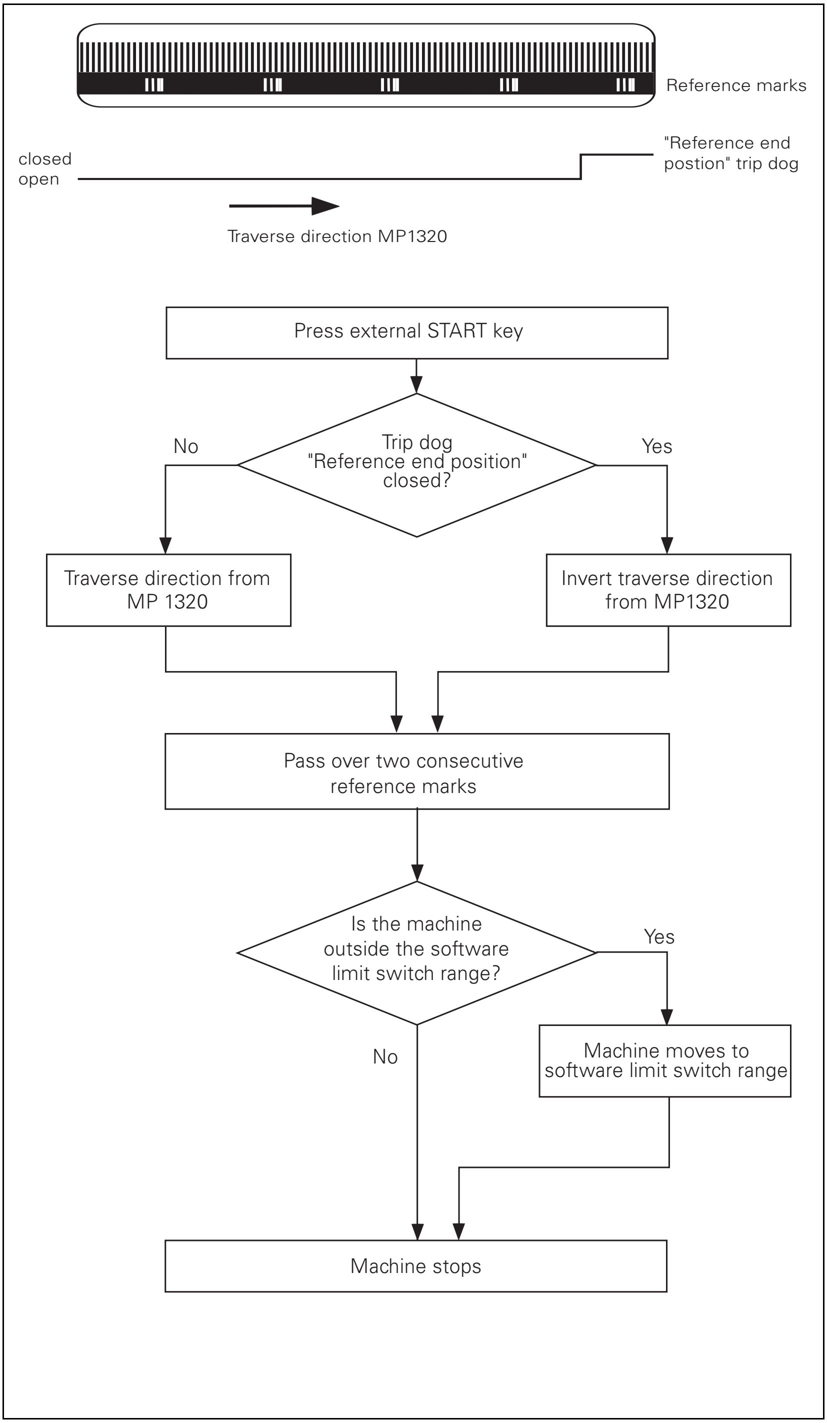
PS	B/W/D/K	<>Axis/spindle> 0 to 8: Axes 1 to 9 15: Spindle
PS	B/W/D/K	<>Feed rate/shaft speed> 0: Feed rate MP1330.x >0: Feed rate in mm/min or shaft speed in 1/1000 rpm
PS	B/W/D/K	<>Direction of traverse> –1: Negative direction 0: Direction from MP1320.x 1: Positive direction
CM	9220	
PL	B/W/D	<>Error code> 0: Reference mark traverse is commanded 1: Axis does not exist or is not a servo-controlled spindle 2: Inadmissible values for the feed rate / direction 4: Reference traverse not possible because reference traverse already started 5: Axis is already being positioned or the spindle is in motion 6: Other axis is already being positioned 8: Programmed axis not in closed loop

Position encoder with distance-coded reference marks

Function when MP1350.x = 3



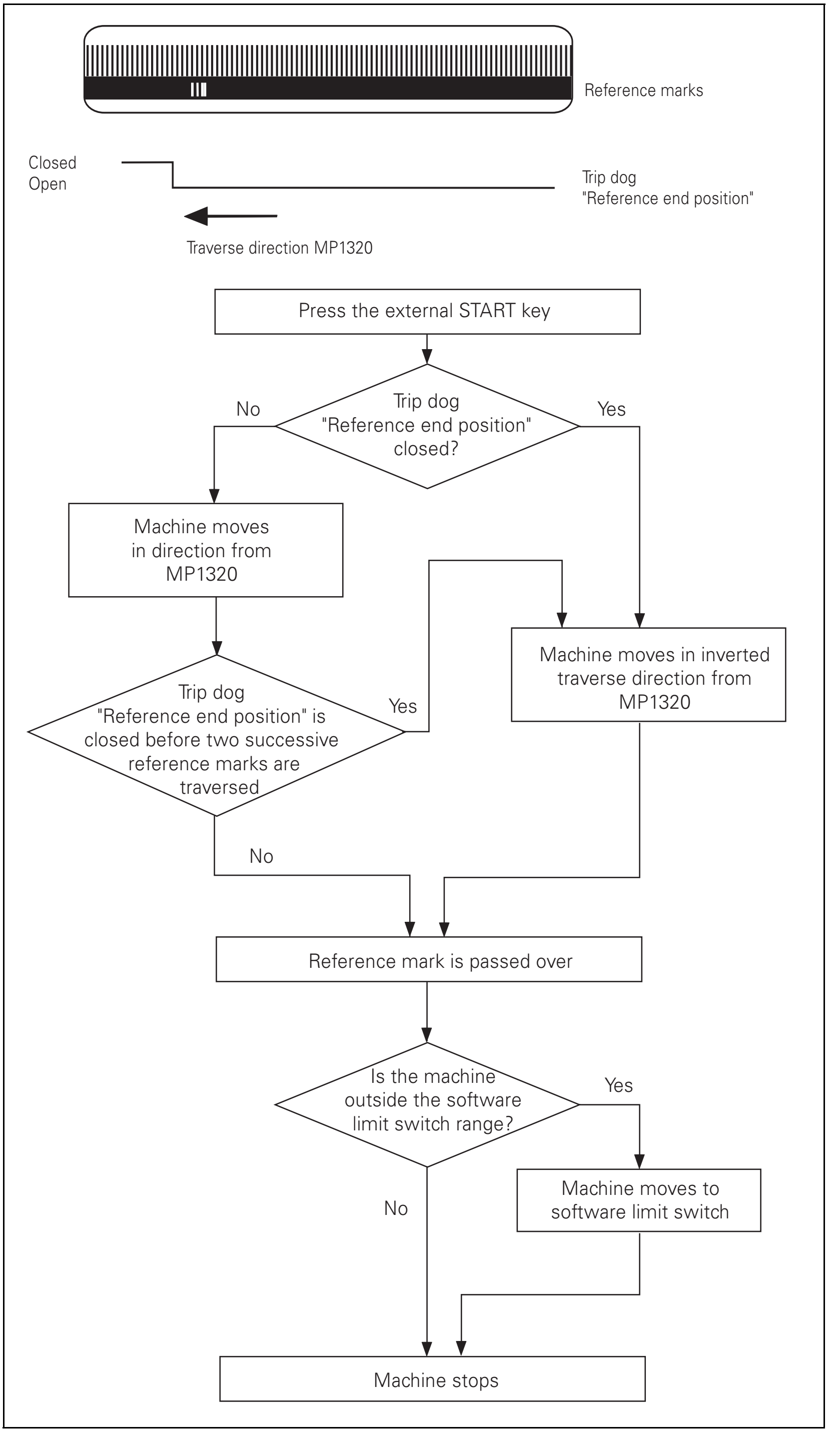
Function when MP1350.x = 0. This setting is used only to ensure compatibility. Do not use for new installations.



If during automatic referencing the trip dog is not closed until it is in the reference end position range, the contouring control will ignore this signal. It is therefore necessary that there be at least two reference marks in the range of the reference end position.

Position encoder with one reference mark

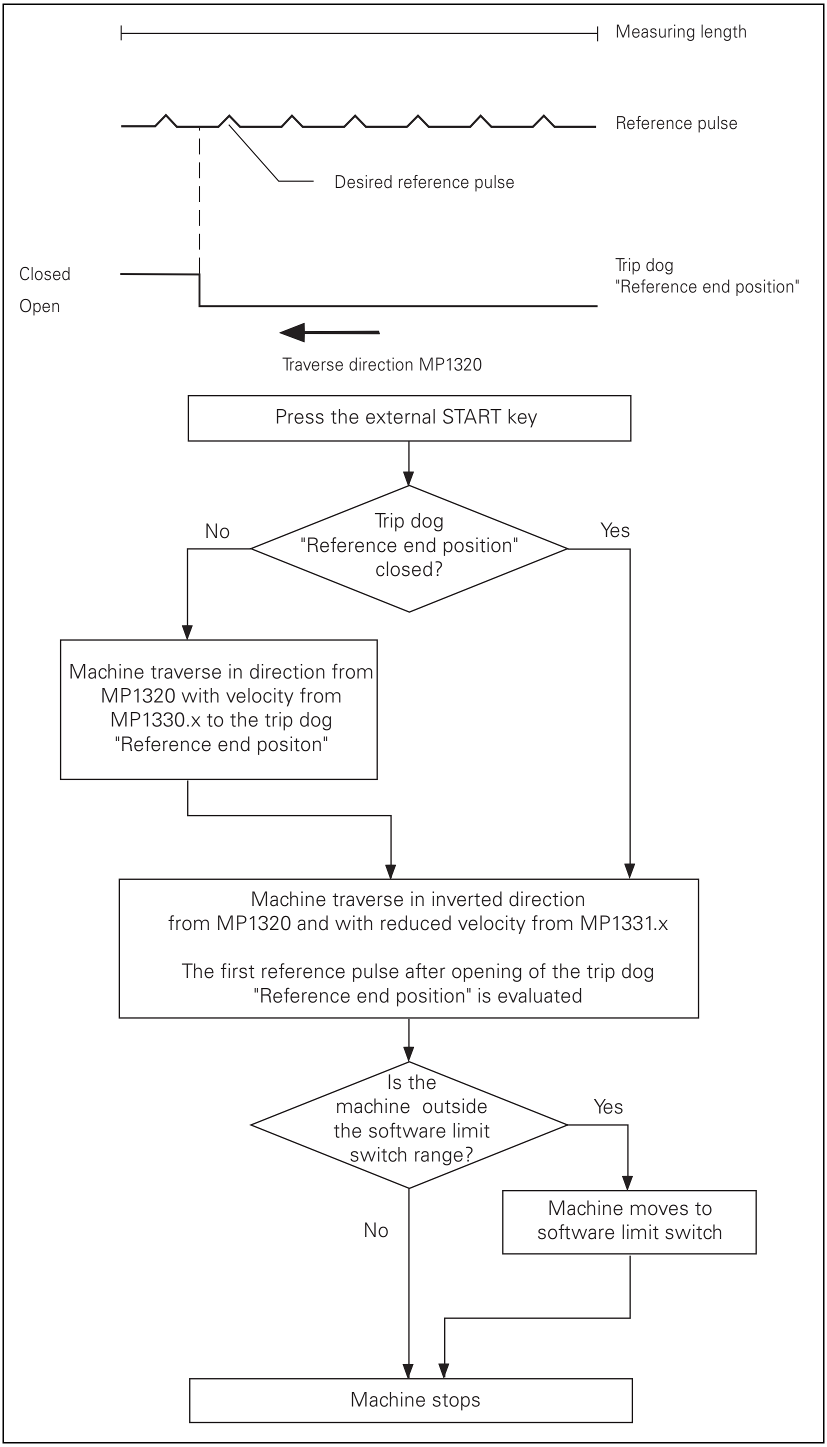
Function when MP1350.x = 1



Linear measurement through rotary encoder

Function when MP1350.x = 2

For linear measurement using a rotary encoder, a reference pulse is produced on each revolution of the encoder. Ensure that during referencing the same reference pulse is always evaluated. This can be realized with the trip dog for reference end position.



6.8 The Control Loop

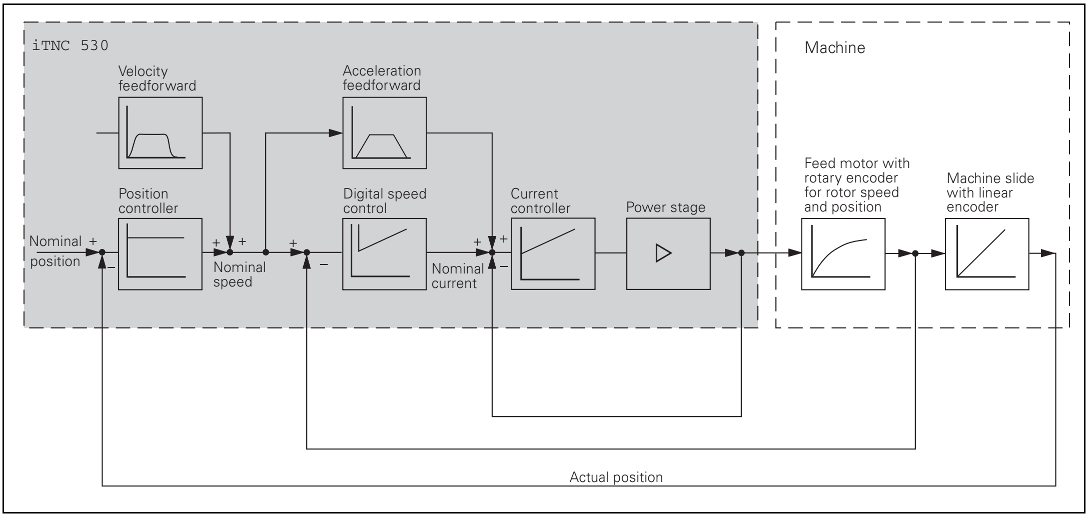
Machine tools normally function on the principle of cascade control. Here the position control loop is prior to the speed and current control loops.

Benefits of cascade control:

- Transparent structure of the individual control loops.
- Disturbances can be compensated through the subsequent controllers. This relieves the prior controller.
- The respective outer control loop protects the inner control loop by limiting the command variable.
- Individual commissioning of each control loop, starting with the innermost loop.

The position, speed, and current controllers, and the power module are integrated in the iTNC. The power module is driven by the CC 422 through PWM signals (PWM = pulse width modulation).

The iTNC 530 controls machines with up to 9 axes and a spindle or up to 8 axes and 2 spindles. Spindle speeds up to 40 000 rpm for motors with two pole pairs are possible.



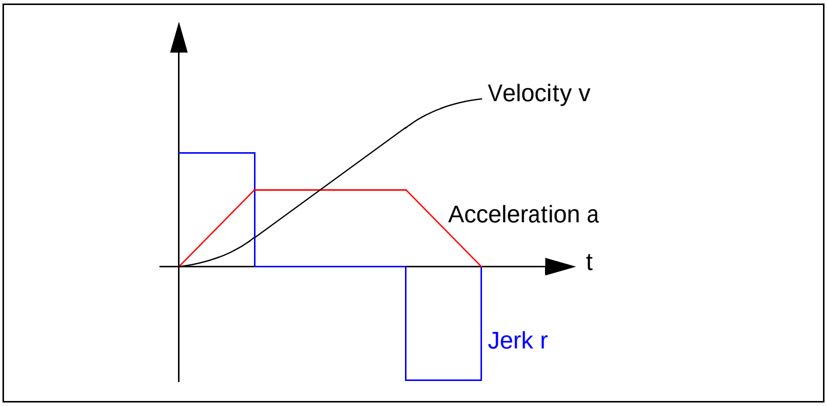
6.8.1 Relation Between Jerk, Acceleration, Velocity and Distance

To ensure proper operation of an axis, the following two conditions must be fulfilled:

- The desired maximum speed v_{max} and maximum jerk r_{max} result in a maximum acceleration a_{max}.
- A minimum distance s_{min} must be traversed in order to attain the maximum speed v_{max}.

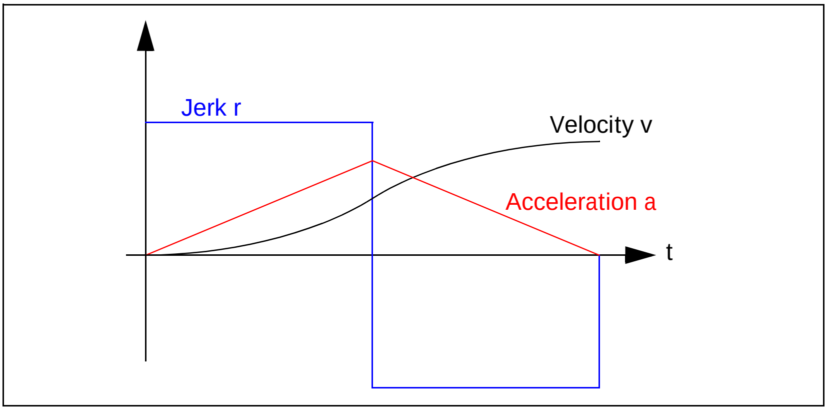
Maximum acceleration

Taking into account the motor and the power module, the machine should be specified in such a way that acceleration during the acceleration phase is as constant as possible. This ensures maximum utilization of the drive current.



The machine, on the other hand, should be designed to fulfill the following dynamic requirements: The jerk should be kept to a minimum and the jerk phase should be maximized in order to prevent the machine from oscillating. The result is no constant acceleration, but a short acceleration peak. If the maximum velocity and the maximum permissible jerk of the machine are preset, the maximum attainable velocity can be determined.

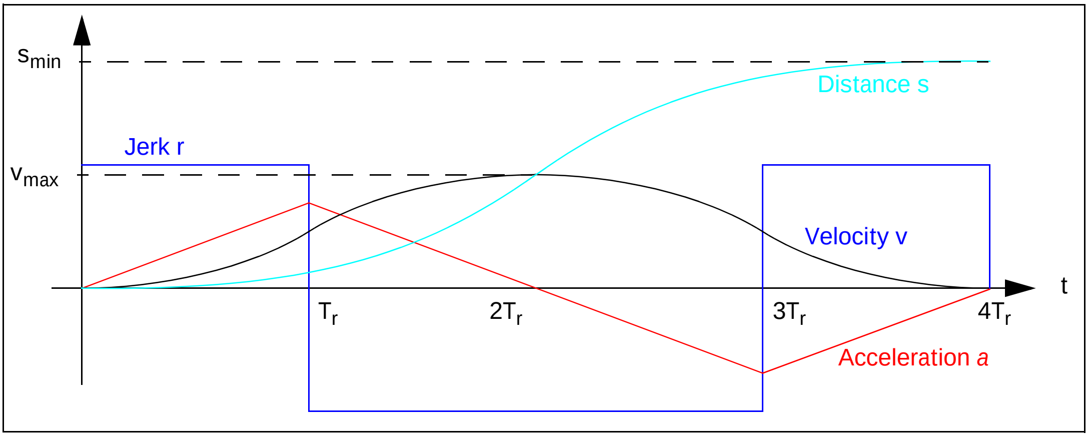
$$a_{max} = \sqrt{v_{max} \cdot r_{max}}$$



Minimum distance

To attain the maximum velocity, a minimum distance s_{min} must be traversed. If the traversed distance is greater than s_{min}, a movement with constant speed is inserted at the time $2T_r$. The minimum distance is:

$$s_{min} = 2 \cdot v_{max} \cdot \sqrt{\frac{v_{max}}{r_{max}}}$$



Example

Rapid traverse v_{max} = 30 000 mm/min (= 0.5 m/s); MP1010.x = 30000
Max. jerk with velocity v > 20 000 mm/min (= 0.33 m/s) r_{max1} = 70 m/s^3;
MP1090.1 = 70, MP1092 = 20000
Max. jerk r_{max2} = 35 m/s^3 during machining; MP1090.0 = 35

Maximum attainable acceleration a_{max1} during rapid traverse:

$$a_{max1} = \sqrt{v_{max} \cdot r_{max1}} = \sqrt{0{,}5\,\frac{m}{s} \cdot 70\,\frac{m}{s^3}} = 5{,}92\,\frac{m}{s^2}$$

Maximum attainable acceleration a_{max2} during machining (v up to 20 000 mm/min):

$$a_{max2} = \sqrt{v_{max} \cdot r_{max2}} = \sqrt{0{,}33\,\frac{m}{s} \cdot 35\,\frac{m}{s^3}} = 3{,}40\,\frac{m}{s^2}$$

Distance s_{min} required to attain rapid-traverse velocity:

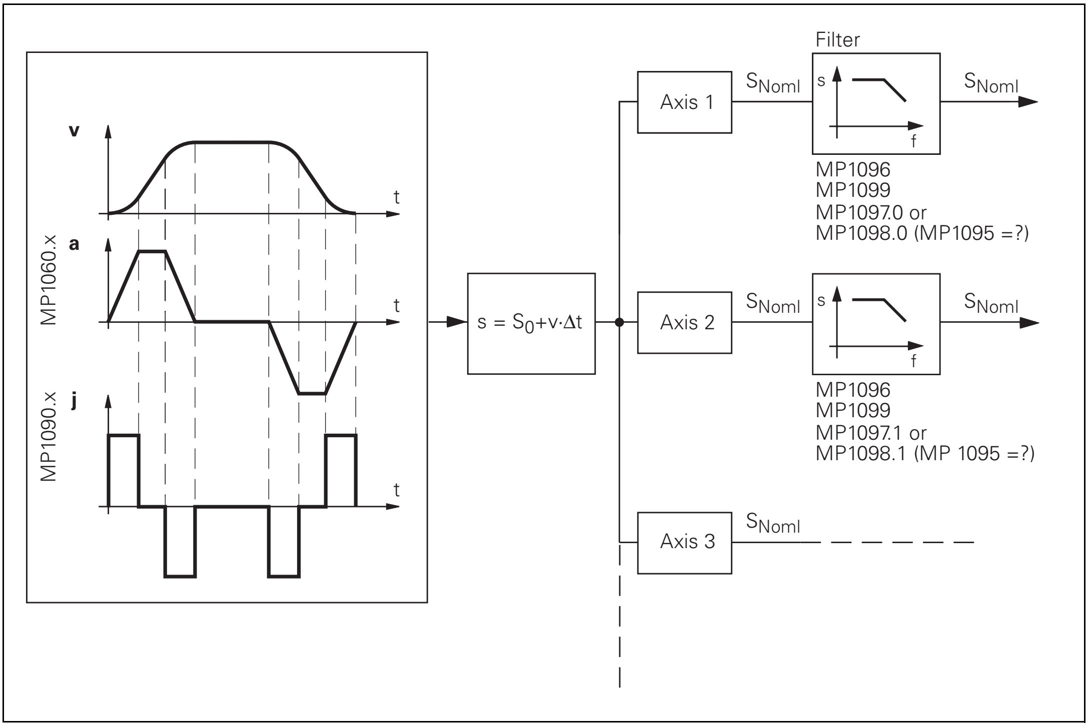
$$s_{min} = 2 \cdot v_{max} \cdot \sqrt{\frac{v_{max}}{r_{max}}} = 2 \cdot 0{,}5\,\frac{m}{s} \cdot \sqrt{\frac{0{,}5\,\frac{m}{s}}{70\,\frac{m}{s^3}}} = 0{,}085\text{ m} = 85\text{ mm}$$

Note

The rectangular jerk curve is rounded through the use of a nominal position value filter (MP1096 ≠ 0). As a result, acceleration is reduced and the minimum distance required for attaining the maximum velocity is increased.

6.8.2 Interpolator

Schematic of the Interpolator:



The interpolator calculates a velocity every 1.8 ms from the programmed feed rate. The value is also dependent on the acceleration curve and the end position.

If more than one axis is moved simultaneously, the smallest acceleration value applies.

You must adjust the velocity feedforward value to the dynamics of the machine:

- With MP1060.x you define the acceleration or the steepness of the velocity curve.
- In MP1090.x, you limit the jerk for the **Program run full sequence** and **Program run single block** modes of operation. The jerk is the rate of change in acceleration. The greater the entered value, the more the system will tend to oscillate.
- Use MP1087.x to limit the axis-specific jerk in **Manual mode.**
- Use MP1089.x to limit the axis-specific jerk in the **Pass Over Reference Point** mode of operation. This is necessary if you want to brake or accelerate faster in this operating mode than in other operating modes.

Please note:

$$\text{Jerk} \geq \frac{a^2}{v}$$

At high feed rates (e.g. rapid traverse) a higher jerk is permitted than at low feed rates:

- Enter the jerk for low feed rates in MP1090.0, and for high feed rates in MP1090.1. MP1090 is the jerk on the tool path. The input value is determined by the weakest axis.
- In MP1092, define a machining feed rate beginning at which MP1090.1 becomes effective.

A nominal position value is acquired every 1.8 ms from the calculated velocity. For linear interpolation:

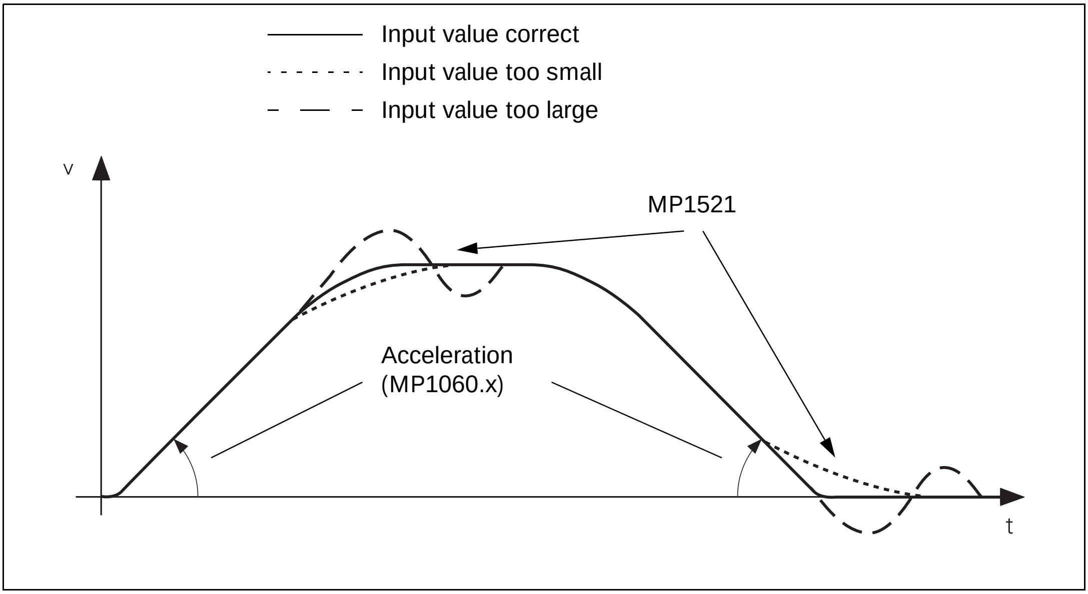
$$s = s_o + v \cdot \Delta t$$

s = nominal position value
s_o = previous nominal position value
v = calculated velocity
Δt = cycle time

The nominal position value is resolved into the individual axis components, depending on which axes have been programmed.

It may happen that the axes at first move past the target position and then oscillate onto it. This overshoot behavior during acceleration and braking can be influenced by a time constant:

- In MP1521, define the time constant for the overshoot behavior.



Nominal position value filter

To attain a high machining velocity, the workpiece contour can be adapted to the machine dynamics by means of a nominal position value filter. Here the iTNC always complies with the tolerance (MP1096, Cycle 32), the axis-specific jerk (MP1097.x, MP1098.x), the acceleration (MP1060.x) and the radial acceleration (MP1070.x).

The iTNC calculates the filter parameters from the permissible axis-specific jerk and the tolerance:

- Enter the permissible axis-specific jerk:
  - For single filter: MP1097.x (at corners)
  - For double filter: MP1098.x (at corners)
  - For HSC filter: MP1098.x (at corners), MP1097.x (at curvature changes, e.g. tangential transition from a line to an arc)
- In MP1096, define a tolerance for contour transitions. This tolerance can be overwritten by the machine user with Cycle 32 "Tolerance."
- Select from the following tables the input values for MP1099.x or MP1094. Note the lowest resonance frequency of your machine axes and the desired damping at this frequency.

Note

The tolerance (MP1096, Cycle 32) always refers to the nominal value, meaning the servo lag also affects the contour accuracy.
For example, if the servo lag S = 5 µm and the tolerance T = 10 µm, then the total deviation is 15 µm.

Single filter (MP1099.0)

Damping [dB]	Frequency to be damped [Hz]										
	10	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
3	10	–	–	–	3	2	2	–	–	–	1
4	12	7	5	4	–	–	–	2	–	–	–
5	13	8	6	–	–	3	–	–	2	–	–
6	14	9	–	5	4	–	–	–	–	2	–
7	15	10	7	–	–	–	3	–	–	–	–
8	16	–	–	6	–	4	–	3	–	–	2
9	17	11	8	–	5	–	–	–	–	–	–
10	18	–	–	–	–	–	–	–	–	–	–
11	19	12	–	–	–	–	4	–	3	–	–
12	–	–	9	7	–	–	–	–	–	–	–

Double filter (MP1099.1)

Damping [dB]	Frequency to be damped [Hz]										
	10	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
3	7	4	3	2	–	–	1	1	–	–	–
4	8	5	–	–	2	–	–	–	1	–	–
5	9	6	4	3	–	2	–	–	–	1	–
6	10	–	–	–	–	–	–	–	–	–	1
7	11	7	5	–	3	–	2	–	–	–	–
8	–	–	–	4	–	–	–	–	–	–	–
9	12	8	–	–	–	–	–	2	–	–	–
10	13	–	6	–	–	3	–	–	–	–	–
11	–	–	–	–	–	–	–	–	2	–	–
12	14	9	–	5	4	–	–	–	–	–	–

HSC filter (MP1094)

Damping [dB]	Frequency to be damped [Hz]										
	10	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
3	12	19	24	29	34	39	44	49	54	59	64
4	10	17	22	27	32	37	42	47	52	57	62
5	6	15	21	26	31	36	41	46	51	56	61
6	1	14	20	25	30	35	39	45	50	55	60
7	–	13	18	23	28	33	38	43	48	54	59
8	–	11	17	23	28	33	38	43	48	53	58
9	–	10	16	22	27	32	37	42	47	52	57
10	–	9	16	21	26	31	36	41	46	51	56
11	–	7	15	20	25	30	35	40	45	50	55
12	–	6	14	19	24	29	34	39	44	49	54

- With MP1095.x you select the single or double filter. The HSC filter is switched on with MP1094.
  MP1095.1 is effective in the Manual, Handwheel, Incremental Jog Positioning and Reference Mark Traverse modes. MP1095.0 and MP1094 are effective in the Program Run, Single Block, Program Run, Full Sequence and MDI modes. If MP1094 is used, MP1095.0 is without effect.
  Example:
  Set the double filter in the Program Run modes for a smooth traverse (MP1095.0 = 1), or set the single filter in the Manual mode for a shorter deceleration path (MP1095.1 = 0).
- Test the three filter settings using a test part made of short line segments.
  - Single filter
  - Double filter
  - HSC filter

Note

If you have selected the best nominal position value filter for your application, please note that your input value can be overwritten by the machine user through Cycle 32. If you have switched off the nominal position value filter (MP1096 = 0), the machine user can also switch it on using Cycle 32.

The nominal position value filters function in all operating modes (even in rapid traverse). For RIGID TAPPING (Cycle 17), the nominal position value filter is automatically switched off.

Machine parameters	Single filter	Double filter	HSC filter
HSC filter MP1094	MP1094 = 0	MP1094 = 0	MP1094 = cutoff frequency
Single/double filter MP1095.x	MP1095.x = 0	MP1095.x = 1	MP1095.0 = nonfunctional MP1095.1 = 0 or 1
Tolerance for contour transitions MP1096	MP1096 = Tolerance (Cycle 32)		
Axis-specific jerk for single filter MP1097.x	MP1097.x = Jerk (at corners)	MP1097.x = nonfunctional	MP1097.x = Jerk (at curvature changes)
Axis-specific jerk for double filter MP1098.x	MP1098.x = nonfunctional	MP1098.x = jerk (at corners)	MP1098.x = jerk (at corners)
Minimum filter configuration MP1099.x	MP1099.0 = Filter order	MP1099.1 = Filter order	MP1099.x = nonfunctional

MP1060.x Acceleration
Input: 0.001 to 100.0 [m/s^2 or $1000°/s^2$]

MP1087.x Max. permissible axis-specific jerk for Manual mode
Input: 0.1 to 1000.0 [m/s^3 or $1000°/s^3$]

MP1089.x Max. permissible axis-specific jerk for Pass Over Reference Point mode
Input: 0.1 to 1000.0 [m/s^3 or $1000°/s^3$]

MP1090 Maximum permissible jerk on the tool path
Input: 0.1 to 1000.0 [m/s^3 or $1000°/s^3$]
MP1090.0 With machining feed rate
MP1090.1 Beginning with feed rate from MP1092

MP1092 Feed rate threshold from which MP1090.1 becomes effective
Input: 10 to 300 000 [mm/min]

MP1094 HSC filter
Input: 0: HSC filter inactive
0.1 to 166.0: Cutoff frequency for HSC filter

MP1095 Nominal position value filter
Input: 0: Single filter
1: Double filter
MP1095.0 In the Program Run, Full Sequence; Program Run, Single Block; and Positioning With Manual Data Input operating modes
MP1095.1 In the Manual, Handwheel, Jog Increment and Pass Over Reference Point operating modes

MP1096 Tolerance for contour transitions
Input: 0: No nominal position value filter
0.001 to 3.000 [mm]: Permissible tolerance at contour transitions

MP1097.x Max. permissible axis-specific jerk (single/HSC filter)
Input: 0.1 to 1000.0 [m/s^3 or $1000°/s^3$]

MP1098.x Max. permissible axis-specific jerk (double/HSC filter)
Input: 0.1 to 1000.0 [m/s^3 or $1000°/s^3$]

MP1099 Minimum filter order
Input: 0 to 20
MP1099.0 Minimum filter configuration for single filter (MP1095 = 0)
MP1099.1 Minimum filter configuration for double filter (MP1095 = 1)

MP1521 Transient response during acceleration and deceleration
Input: 1 to 255 [ms]
0: Function inactive

Feed rate smoothing

Fluctuations in feed rate sometimes occur during execution of NC programs consisting of short straight-line segments. MP7620 bit 6 smoothes the feed-rate. However, it also reduces it somewhat.

MP7620	**Feed-rate override and spindle speed override**
Input:	Bit 6 – Feed-rate smoothing 0: Not active 1: Active

Tolerance consideration with M128

During program run with M128 the head dimensions are also included in the tolerance consideration (MP1096, Cycle 32). This means that the control tries to observe the tolerance, taking the head dimensions into account. As a result, the tolerance is reduced, which leads to a reduction of the feed rate and might cause the rotary axis to jerk.

To switch off the consideration of the head dimensions for rotary axes with M128:

- Enter bit 4 = 1 in MP7682.

MP7682	**Machine parameter with multiple function**
Format:	%xxxxx
Input:	Bit 4 – Tolerance of rotary axes with M128 0: With consideration of head dimensions 1: Without consideration of head dimensions

6.8.3 Position Controller

Position controller cycle time

With MP7600.0 you can set the position controller cycle time:

- In MP7600.0, enter a factor which, when multiplied by 0.6 ms, results in the position controller cycle time.

With the input value MP7600.0 = 3, the iTNC has a minimum position controller cycle time of 1.8 ms. The increase of the position controller cycle time also increases the PLC cycle time. To return to the previous PLC cycle time, enter the corresponding factor in MP7600.1. For entries which lead to a PLC cycle time < 10 ms, the PLC cycle time is limited to 10 ms.

MP7600.0 Position controller cycle time = MP7600.0 · 0.6 ms
Input: 1 to 20
Proposed input value: 3 (= 1.8 ms)

MP7600.1 PLC cycle time = position controller cycle time · MP7600.1
Input: 1 to 20
Proposed input value: 7 (= 12.5 ms)

You can choose between two types of feedback control:

- Feedback control with following error (servo lag)
- Feedback control with velocity feedforward
- Select the type of control in the **Positioning with manual data input**, **Program run, single block** and **Program run, full sequence** operating modes with MP1392.
- Select the type of control in the **Manual** and **Handwheel** modes of operation with MP1391.

Note

The machine must always be adjusted for both types of control.

MP1392 Velocity feedforward in the POSITIONING WITH MANUAL DATA INPUT, PROGRAM RUN SINGLE BLOCK and PROGRAM RUN FULL SEQUENCE operating modes
Format: %xxxxxxxxxxxxxx
Input: Bits 0 to 13 correspond to axes 1 to 14
0: Operation with following error (lag)
1: Operation with velocity feedforward control

Note

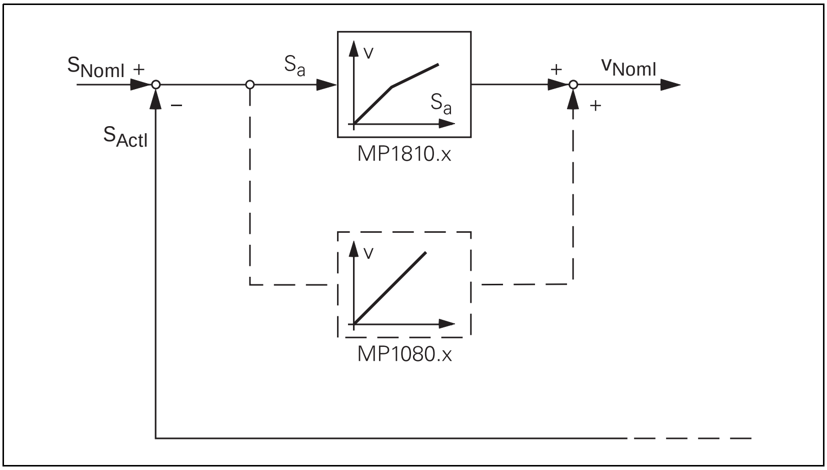
M90 (lag mode: Constant contouring speed at corners) is effective only if operation with following error is selected for all axes (MP1392 = %00000000000000).

MP1391 Velocity feedforward control in the MANUAL and HANDWHEEL operating modes
Format: %xxxxxxxxxxxxxx
Input: Bits 0 to 13 correspond to axes 1 to 14
0: Operation with following error (lag)
1: Operation with velocity feedforward control

Feedback control with following error

Following error (also known as servo lag) is a gap that remains between the nominal position commanded by the NC and the actual position.

Simplified representation:



The nominal position value s_{noml} for a given axis is compared with the actual position value s_{actl} and the resulting difference is the following error s_a:

$s_a = s_{Noml} – s_{Actl}$

s_a = following error
s_{Noml} = nominal position value
s_{Actl} = actual position value

The following error is multiplied by the k_v factor and passed on as nominal velocity value:

$v = k_v \cdot s_a$

v_{noml} = nominal velocity value

Analog axes:
For stationary axes, the integral factor has an additional effect (MP1080.x). It produces an offset adjustment.

Digital axes:
There is no offset. MP1080.x has no function.

k_v factor during control with following error

The control loop gain, the so-called k_v factor, defines the amplification of the position control loop. You must find the optimum k_v factor by trial and error.

If you select too high a k_v factor, the following error is very small. But this can result in oscillations.

If you choose too small a k_v factor, the axis will move to a new position too slowly.

For axes that are interpolated with each other, the k_v factors must be equal to prevent contour deviations.

▶ In MP1810.x define a set of k_v factors for operation with following error.

You can selectively increase the contour accuracy with a higher k_v factor . This k_v factor is activated with the M function M105:

▶ In MP1815.x define a second set of k_v factors and activate them with M105.

M105 also influences compensation of reversal spikes during circular motion. With M106 you can switch back to the original set of k_v factors:

▶ Enable the M functions M105/M106 with MP7440, bit 3.

Interrelation of k_v factor, feed rate, and following error

The following formula shows the interrelation of k_v factor, feed rate, and following error:

$$k_v = \frac{v_e}{s_a} \quad \text{or} \quad s_a = \frac{v_e}{k_v}$$

k_v = loop gain [(m/min)/mm]
v_e = rapid traverse [m/min]
s_a = following error [mm]

MP1810.x **k_v factor for control with following error**
Input: 0.100 to 20.000 [(m/min)/mm]

MP1815.x **k_v factor for control with following error effective after M105**
Input: 0.100 to 20.000 [(m/min)/mm]

MP7440 **Output of M functions**
Format: %xxxxx
Input: Bit 3 – Switching the k_v factors with M105/M106
0: Function is not in effect
1: Function is effective

Feedback control with velocity feedforward

The nominal velocity value consists of an open-loop and a closed-loop component.

With velocity feedforward control, the machine-adjusted nominal velocity value is the open-loop controlled component. The closed-loop velocity component is calculated through the following error. The following error is small.

In most cases, machines are controlled with velocity feedforward, since it makes it possible to machine exact contours even at high speeds.

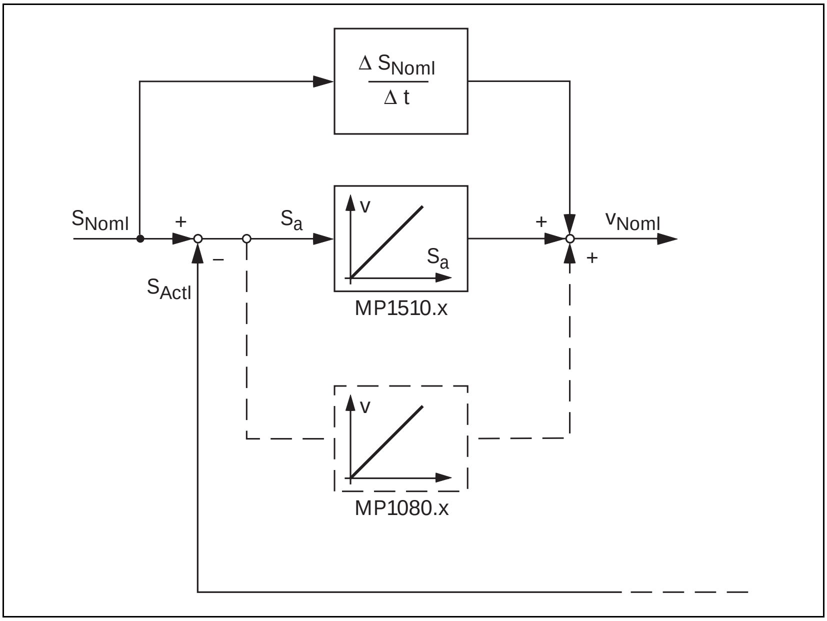
For the **`Positioning with manual data input`**, **`Program run, single block`** and **`Program run, full sequence`** operating modes:

▶ Switch-on the velocity feedforward control with MP1392.

For the MANUAL and HANDWHEEL operating modes:

▶ Switch-on the velocity feedforward control with MP1391.

Block diagram:

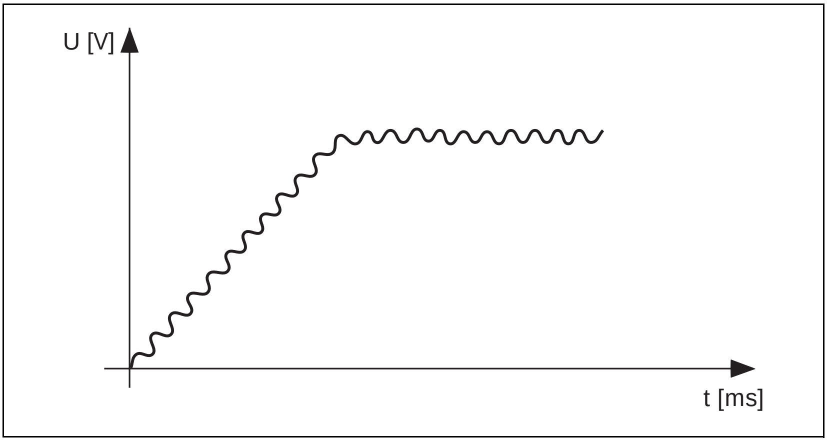


Analog axes:
For stationary axes, the integral factor has an additional effect (MP1080.x). It produces an offset adjustment.

Digital axes:
There is no offset. MP1080.x has no function.

You can influence the control of the forward-fed velocity with the k_v factor:

▶ In MP1510.x, enter a k_v factor.



Warning

If the k_v factor that you select is too large, the system will oscillate around the forward-fed nominal velocity value.

Unlike operation with following error, you must also enter the optimum k_v factor for each axis when operating with interpolated axes.

You can selectively increase the contour accuracy with a higher k_v factor . This k_v factor is activated with M105:

- In MP1515.x, define a second set of k_v factors and activate them with M105.

M105 also influences compensation of reversal spikes during circular motion. With M106 you can switch back to the original set of k_v factors:

- Enable the M functions M105/M106 with MP7440, bit 3.

MP1510.x **k_v factor for velocity feedforward control**
Input: 0.100 to 1000.000 [(m/min)/mm]

MP1515.x **k_v factor for velocity feedforward control effective after M105**
Input: 0.100 to 20.000 [(m/min)/mm]

MP7440 **Output of M functions**
Format: %xxxxx
Input: Bit 3 – Switching the k_v factors with M105/M106:
0: Function is not in effect
1: Function is effective

Feedback control with velocity semifeedforward

MP1396.x allows the operator to switch to velocity semifeedforward control. Normally, work will be carried out using velocity feedforward. For example, velocity semifeedforward is activated by an OEM cycle before roughing, in order to permit a higher following error and thereby a higher velocity, combined with a lowered accuracy, in order to traverse corners.
Before finishing, another OEM cycle can be used to switch back to velocity feedforward, in order to finish with the highest accuracy possible.

In order to use velocity semifeedforward, a factor must be entered for every axis in MP1396.x, where values toward 0 control the following error more, and values toward 1 control the velocity feedforward more. The factor can be overwritten with FN17: SYSWRITE ID600. However, the factor from MP1396.x becomes valid again at the end of a program (MP7300 = 1) and whenever a new NC program is selected.

As soon as a factor between 0.001 and 0.999 has been entered in MP1396.x, the k_V factor from MP1516.x becomes effective.

Note

For axes that are interpolated with each other, the k_V factors must be equal. In this case the smaller k_V factor determines the input value for these axes.

The values for position monitoring are interpolated according to the factor in MP1396.x between the values for servo lag (MP1710.x, MP1720.x) and the values for velocity feedforward control (MP1410.x, MP1420.x).

Feedback control with following error (servo lag)	Feedback control with velocity semifeedforward	Feedback control with velocity feedforward
MP1391 bit x = 0 MP1392 bit x = 0 MP1396.x = nonfunctional	MP1391 bit x = 1 MP1392 bit x = 1 MP1396.x = 0.001 ⟷ MP1396.x = 0.999	MP1391 bit x = 1 MP1392 bit x = 1 MP1396.x = 1

To use feedback control with velocity semifeedforward:

- Activate the velocity feedforward control with MP1391 and/or MP1392.
- Determine the k_V factor for velocity feedforward control (MP1510.x).
- Activate the velocity semifeedforward control by entering the desired factor in MP1396.x.
- Determine the k_V factor for velocity semifeedforward control (MP1516.x).
- Enter MP1396.x = 1 to return to velocity feedforward control.
- For example, you may now use FN17: SYSWRITE ID 600 in an OEM cycle to overwrite or reestablish the factor in MP1396.x.

MP1396.x	**Feedback control with velocity semifeedforward**
Input:	0.001 to 0.999 1: Velocity feedforward control

MP1516.x	**k_V Factor for velocity semifeedforward**
Input:	0.100 to 20.000 [(m/min)/mm]

Rapid traverse

- In MP1010.x, define for each axis the rapid traverse of the machine.

You can reduce this value through the PLC:

- Enter the reduced value in D596.
  If the value in D596 is larger than MP1010.x, then MP1010.x becomes effective.

After the control is switched on, or after an interruption of the PLC run, D596 is preassigned with the value 300 000 so that MP1010.x becomes effective.

Rapid traverse can be limited by the user with the F MAX soft key. This limitation is not effective if M4587 is set. In this case only limitation through D596 is effective. After M4587 is reset, both D596 and the last limit set via F MAX soft key are effective again.

For manual operation the feed rate is significantly lower than for rapid traverse:

- Enter in MP1020 a feed rate for manual operation.

The programmed feed rate and the current path feed rate are saved in D360 and D388 in mm/min. In the manual operating modes, the highest axis feed of all axes is stored in D388

The maximum possible feed rate depends on the encoder being used.

v_{max} [mm/min] = P [mm] · f_i [kHz] · 60

v_{max} = Maximum traversing speed
P = Signal period of the encoder
f_i = Input frequency of the encoder input, See "Encoder signals" on page 6 – 8 and See "Encoder Connections" on page 3 – 22.

Digital axes:

For digital axes, the maximum feed rate also depends on the number of pole pairs in the drive motor and the pitch of the ballscrew.

$$v_{max}\ [\text{mm/min}] = \frac{30\,000}{\text{No. of pole pairs}}\ [1/\text{min}] \cdot \text{ballscrew pitch [mm]}$$

Analog axes:

- In MP1050.x, enter the desired analog voltage for rapid traverse.
- Adjust the rapid traverse feed rate (v_{max}) with the analog voltage at the servo amplifier.

MP1010.x Rapid traverse

Input: 10 to 300 000 [mm/min]

MP1020.x Manual feed

Input: 10 to 300 000 [mm/min]

MP1050.x Analog axes: Analog voltage at rapid traverse

Input: 1 000 to 9 000 [V]
Digital axes: without function
Input: 1

		Set	Reset
M4587	**Feed rate limit exceeded F MAX**	PLC	PLC
D596	**Max. feed rate from PLC [mm/min]**	NC/PLC	PLC
D360	**Programmed feed rate**	NC	NC
D388	**Current tool feed rate [mm/min]**	NC	NC

Position loop resolution

The encoder signals are interpolated 1024-fold.

$$\text{Position loop resolution } [\mu\text{m}] = \frac{\text{Signal period } [\mu\text{m}]}{1024}$$

Analog axes

The iTNC outputs a voltage per position error. The 10-V analog voltage is subdivided 65536-fold with a 16-bit D/A converter. This results in a smallest voltage step of 0.15 mV.

Rapid traverse (MP1010.x) is attained at a certain voltage (MP1050.x). This results in the voltage ΔU per position error or following error s_a:

$$\Delta U = \frac{\text{MP1050.x [mV]}}{S_a [\mu\text{m}]}$$

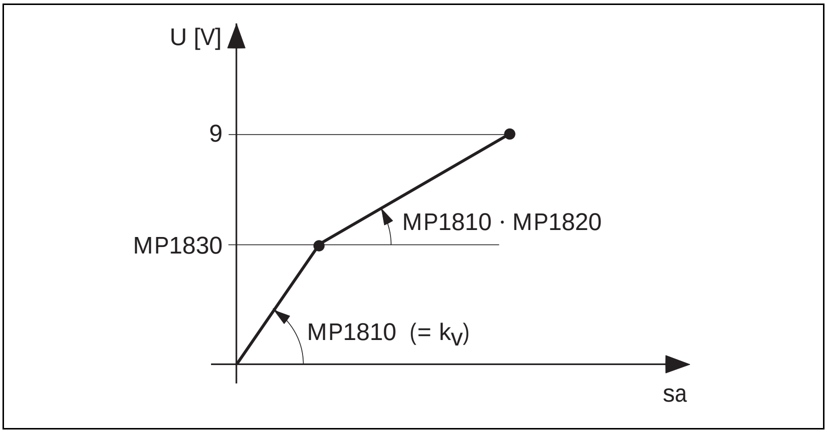
If ΔU is divided by the smallest possible voltage step (0.15 mV), the result is the number *n* of the possible voltage steps per position error.

Characteristic curve kink point (for control with following error)

For machines with high rapid traverse, you can not increase the k_v factor enough for an optimum control response to result over the entire velocity range (from standstill to rapid traverse).

In this case you can define a characteristic curve kink point, which has the following advantages:

- High k_v factor in the low range
- Low k_v factor in the upper range (beyond the machining velocity range)
- Define the position of the characteristic kink with MP1830.x. In the upper range, the k_v factor is multiplied by the factor from MP1820.x.
- Enter a multiplier in MP1820.



The characteristic curve kink point must lie above the tool feed rate!

Calculating the following error:

$$s_a = \left(\frac{MP1830.x\ [\%]}{100\ [\%]} + \frac{100\ [\%] - MP1830.x\ [\%]}{MP1820.x \cdot 100\ [\%]}\right) \cdot \frac{v_e}{k_v}$$

MP1820.x **Multiplier for the k_v factor**
Input: 0.001 to 1.000 00

MP1830.x **Characteristic curve kink point**
Input: 0.000 to 100.000 [%]

Opening the position control loop

If M4581 has been set, the control opens the loops of all axes and of the spindle, and then performs an NC stop. This makes it possible, for example, to open the position control loops and at the same time switch off the drives. As with an external emergency stop, position monitoring is shut off for the time defined in MP1150.1, and an actual-to-nominal value transfer is executed. After the time defined in MP1150.1 has expired, position monitoring is again active, for at least the time defined in MP1150.2.

If at a standstill or with an external stop, the PLC sets M4581 in the Program Run Full Sequence, Program Run Single Block, or Positioning with MDI operating modes, and then the axes are moved, the **approach position** function will be activated when the PLC resets M4581.
If MP4020 bit 8 = 1, then, if the axes are moved after an emergency stop, "Approach position" is automatically activated.

If M4580 has been set, an external EMERGENCY STOP (X42, pin 4 "control is ready") **is not** reported to the NC, but rather the function is executed like M4581.

If the position control loop is opened, the axis release in W1024 is canceled.

		Set	Reset
M4580	**Suppress EMERGENCY STOP, open all position control loops, NC stop**	PLC	PLC
M4581	**Open all position control loops, NC stop, activate "Approach position"**	PLC	PLC
W1024	**Axis release** Bits 0 to 8 correspond to axes 1 to 9 0: Position control loop open 1: Position control loop closed	NC	NC

MP1150.1 **Time period for which the monitoring function is to remain off after the fast PLC input defined in MP4130.0 is set**
Input: 0 to 65.535 [s]
Recommended: 0.2 to 0.5

MP4020 **PLC Functions**
Input: Bit 8 – Behavior after an external emergency stop
0: "Approach position" is not automatically activated
1: "Approach position" is automatically activated

Clamping the axes

After running an NC block you can clamp the axes:

- Wait until "axis in position" is set in W1026.
- Clamp the axis or axes.
- Open the position control loop with W1040.
- With Module 9161, switch the drive off.

A waiting period is necessary between "axis clamping" and "position control loop opening."

- In W1038, set the bit for the corresponding axis.

The next NC block is not run until the positioning window has been reached and the position control loop has been opened with W1040.

If the position control loop is opened, the axis release in W1024 is canceled. You can link switching off the drives via Module 9161 with W1024.

If a clamped axis is to be repositioned, the NC cancels the "axis in position" message in W1026:

- With Module 9161, switch the drive on.
- Release the clamping.
- Close the position control loop with W1040.

		Set	Reset
W1038	**Preparing opening of the position control loop** Bits 0 to 8 correspond to axes 1 to 9 0: Not active 1: Active	PLC	PLC
W1040	**Axis-specific opening of the position control loop** Bits 0 to 8 correspond to axes 1 to 9 0: Do not open the position control loop 1: Open the position control loop	PLC	PLC

Feed-rate enable

To move the axes, you must first enable the feed rate through the PLC. Until "feed-rate enable" is set, the nominal velocity value zero is output. In the status display, "F" is highlighted.

Feed-rate enable for all axes:

- Set M4563.

Axis-specific feed-rate enable:

- Reset M4563.
- In W1060, set the corresponding bits.

		Set	Reset
M4563	**Feed-rate enable for all axes**	PLC	PLC
W1060	**Axis-specific feed-rate enable** Bits 0 to 8 correspond to axes 1 to 9 0: No feed-rate enable 1: Feed-rate enable	PLC	PLC

Actual-to-nominal value transfer

During actual-to-nominal value transfer, the current position is saved as the nominal position value. This becomes necessary, for example, if the axis has been moved when the position control loop is open.

There are two ways to turn the actual position into the nominal position:

- To transfer the actual position value in the MANUAL and ELECTRONIC HANDWHEEL modes, set the corresponding bit in W1044.
- To transfer the actual position in all operating modes, use Module 9145.

Warning

Ensure that actual-to-nominal value transfer does not occur continually, since the position monitoring will not be able to detect any uncontrolled machine movements. In this case no safe machine operation would be possible.

		Set	Reset
W1044	**Actual-to-nominal value transfer** Bits 0 to 8 correspond to axes 1 to 9 0: No actual-to-nominal value transfer 1: Actual-to-nominal value transfer	PLC	PLC

Module 9145 Actual-to-nominal value transfer

An actual-to-nominal value transfer for NC axes, or for PLC and NC axes together, is possible only if the control is not active (M4176 = 0) or if there is an M/S/T/T2/G strobe.
For a transfer only of PLC axes, the module can always be called.
For a transfer via M strobe, MP7440 bit 2 must not be set. For a transfer via S/G strobe, MP3030 must not be set.

Call:
PS B/W/D/K <>axes bit-encoded>
CM 9145

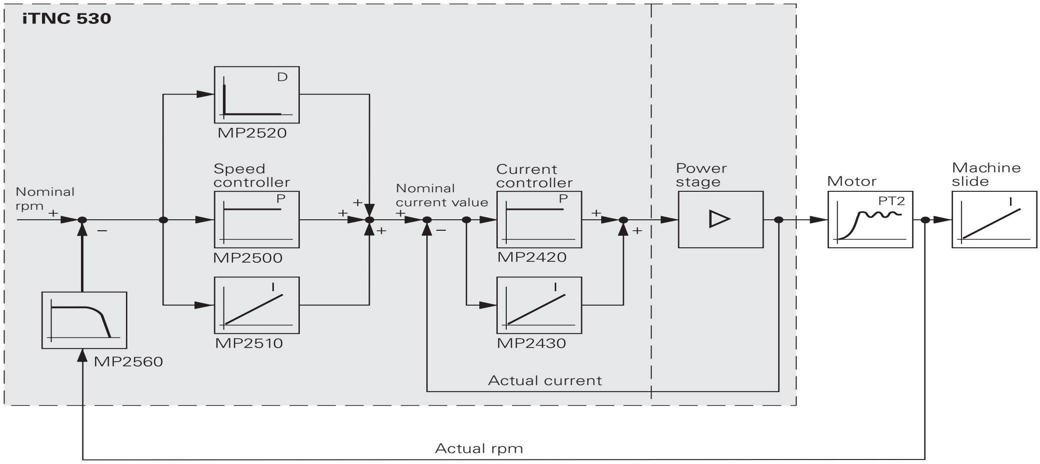
Error detection:

Marker	Value	Meaning
M4203	0	Actual value was assumed as nominal value
	1	Error code in W1022
W1022	2	Invalid axis number
	21	Missing M/S/T/T2/G strobe in M4176 = 1
	24	Module was called in a spawn job or submit job

6.8.4 Speed Controller

6 or 10 digital speed controllers for the axes and spindle(s) are integrated in the iTNC 530:

The actual speed values are measured directly at the motors with HEIDENHAIN rotary encoders. The position controller provides the nominal speed value. The speed controller is driven by the difference between nominal and actual speed values. It provides the nominal current value as output.



See "Commissioning" on page 6 – 218.

With Module 9164 you can read the actual speed value of the motors.

You can adjust the step response of the speed controller:

- With the position controller switched off, enter with MP2500.x a proportional factor and with MP2510.x an integral factor for the speed controller. Adjust the step response so that only one overshoot is visible and the settling time t_{off} is as small as possible.
  Realistic values for the settling time: 3 ms to 15 ms

MP2500.x Proportional factor of the shaft speed controller
Input: 0 to 1 000 000.000 [As]

MP2510.x Integral factor of the shaft speed controller
Input: 0 to 100 000 000 [A]

Module 9164 Reading the actual speed value of the motor

The resolution of the actual speed value depends on the encoder being used:

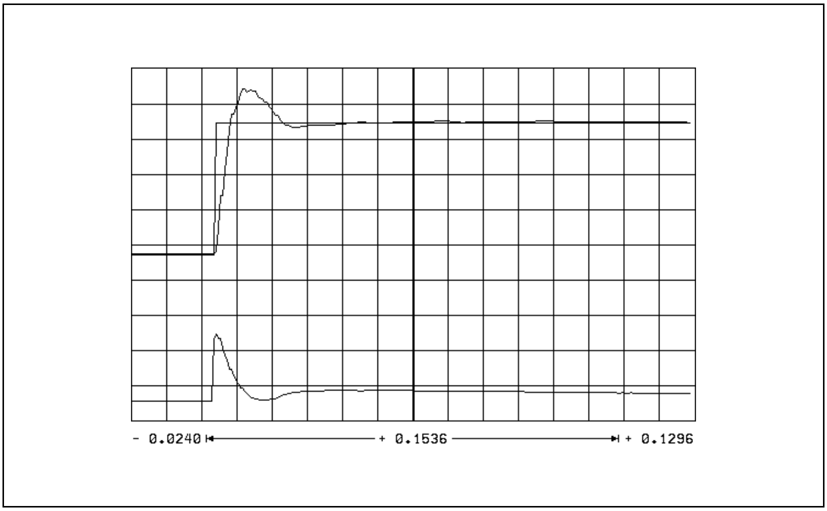
$$\text{Resolution} = \frac{1}{\text{Line count} \cdot 1024} \cdot 100\,000 \text{ [rpm]}$$

Call:

PS	B/W/D/K	<>Axis> 0 to 8: Axes 1 to 9 15: Spindle
CM	9164	
PL	B/W/D	<>Actual speed value in the format 0.001 [rpm]>

Error detection:

Marker	Value	Meaning
M4203	0	Actual speed value was read
	1	Control has no integrated current controller



The step response illustrated above is idealized. In practice, interfering oscillations are superimposed on the step response.

You can reduce these interference oscillations with the differential factor, the PT_2 second-order time-delay element, the band rejection filter and the low-pass filter of the speed controller.

Differential factor

The differential factor can reduce low-frequency oscillations. However, it increases oscillations in the high frequency range.

- In MP2520.x, enter a differential factor.

Note

Ensure that the system is stable enough!

The differential factor is not recommended on machines with motors that have belt couplings. The influence of aging and temperature is too great.

Estimating the differential factor:

$$\text{MP2520.x} \approx \frac{T \cdot \text{MP2500.x}}{8}$$

MP2520.x: Differential factor of the speed controller [As^2]
MP2500.x: Proportional factor of the speed controller
T: Period of the lowest interference frequency [s]

MP2520.x Differential factor of the shaft speed controller
Input: 0 to 1.0000 [As^2]

Low-pass filter

With the low-pass filter you can damp high frequency oscillations (> approx. 600 Hz):

- Use the oscilloscope to find the fundamental frequency of the iTNC.
- Activate the 1st or 2nd order low-pass filter (see table).

Fundamental frequency of the interference oscillation	Filter order (MP2560.x)
600 Hz to 700 Hz (approx.)	1st Order (MP2560.x = 1)
> 700 Hz (approx.)	2st Order (MP2560.x = 2)

If you cannot achieve satisfactory results with the low-pass filter, try the PT_2 element.

MP2560.x Low-pass filter of the speed controller
Input: 0: No low-pass filter
1: 1st-order low-pass filter
2: 2nd-order low-pass filter

PT_2 element of the speed controller

If the controlled system is insufficiently damped (e.g. direct motor coupling or roller bearings), it will be impossible to attain a sufficiently short settling time when the step response of the speed controller is adjusted. The step response will oscillate even with a low proportional factor:

- In MP2530.x, enter a value for damping high-frequency interference oscillations. If the value you choose is too high, the k_V factor of the position controller and the integral factor of the speed controller is reduced. Realistic input values: 0.0003 to 0.0020

MP2530.x **PT_2 element of the speed controller (2nd-order delay)**
Input: 0 to 1.0000 [s]

Band-rejection filter

With the band-rejection filter you can damp oscillations that you cannot compensate with the differential factor, the PT_2 element, or the low-pass filter:

- With the oscilloscope of the iTNC, find the fundamental frequency of the interference oscillations and enter them in MP2550.x.
- Increase MP2540.x incrementally until the interfering oscillation is minimized. If you set the damping too high, you will limit the dynamic performance of the control loop. Realistic input values: 3 to 9 [dB]

MP2540.x **Band-rejection filter damping of the speed controller**
Input: 0.0 to 18.0 [dB]

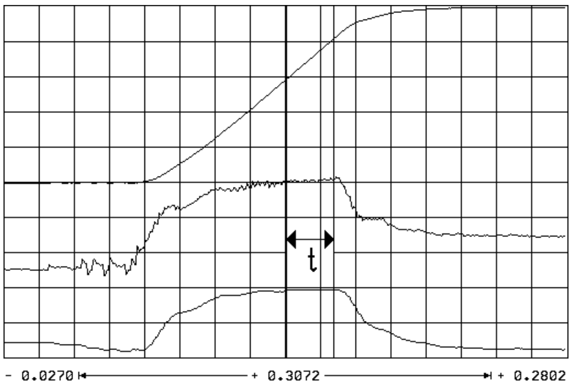
MP2550.x **Band-rejection filter center frequency of the speed controller**
Input: 0.0 to 999.9 [Hz]

Acceleration feedforward

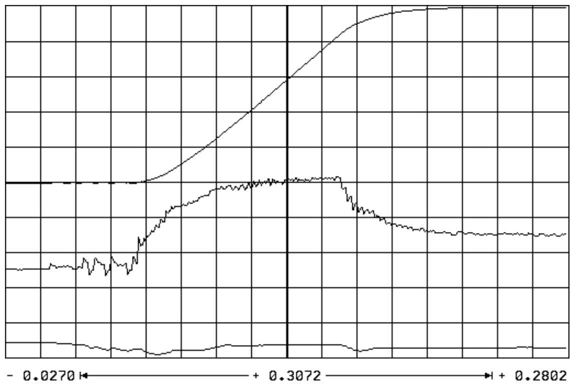
Acceleration feedforward functions only in velocity feedforward control in parallel with the speed controller.

At every change in velocity, spikes of short duration appear in the following error. With acceleration feedforward control you can minimize these spikes:

- First adjust the friction compensation. Enter values in MP2610.x to MP2620.x.
- From the integral-action component of the nominal current value I (N INT) calculate the input value for MP2600.x.
- Adjust the acceleration feedforward control with MP2600.x.



MP2600 = 0



MP2600.x at optimum setting

For calculation of the acceleration feedforward, the integral-action component of the nominal current value INTEG. RPM is recorded with the internal oscilloscope. The actual speed value V (ACT RPM) and nominal current value I NOMINAL are also recorded for better illustration.

$$MP2600.x = \frac{I\ (N\ INT)\ [A] \cdot t\ [s] \cdot 60\ [s/min] \cdot MP2020.x\ [mm]}{\Delta V\ (ACT\ RPM)\ [mm/min]}$$

I (N INT) = integral-action component of the nominal current value

t = acceleration time in which I (N INT) remains constant

ΔV (ACTUAL RPM) = actual speed value during change

MP1054.x = traverse distance per motor revolution

MP2600.x **Acceleration feedforward**
Input: 0 to 100.0000 [A/(rev/s^2)]

Limiting the integral factor

In machines with a great deal of stiction, a high integral-action component can accumulate if there is a position error at standstill. This can result in a jump in position when the axis begins moving. In such cases you can limit the integral-action component of the speed controller:

- Enter a limit in MP2512.x.
  Realistic input values: 0.1 to 2.0

MP2512.x **Limiting the integral factor of the speed controller**
Input: 0.000 to 30.000 [s]

Integral Phase Compensation IPC

An *I* factor can be set in the speed controller of the iTNC (MP2510.x). This *I* factor is needed to attain a short setting time. However, the *I* factor has a negative influence on the position controller, i.e. the position controller tends to oscillate more easily, and it is often impossible to set the k_V factor (MP1510.x) high enough.
The IPC (Integral Phase Compensation) compensates the negative influence of the I factors on the speed controller, and makes it **possible** to increase the k_V factor (MP1510.x).

The IPC is beneficial on the following types of machines:

- Machine type 1: Machines with a dominant natural frequency between 15 Hz and 80 Hz, for which it is not possible to set a sufficiently high k_V factor.
- Machine type 2: Small-to-medium size machines that are driven directly.

Note

- The acceleration (MP2600.x) feedforward must already have been carefully adjusted for both types of machines.
- If after commissioning the IPC you wish to optimize the speed controller again, you must switch off the IPC beforehand, because the IPC influences the curve form.
- Use the same test program to commission the IPC as is used to measure the jerk and the k_V factor.

Machine type 1:

- The machine is commissioned as usual until the k_V factor is to be determined.
- Enter MP2602.x = 1 and MP2604.x = 0.
- Increase the k_V factor (MP1510.x) until you reach the oscillation limit.
- Starting value: $\text{MP2604.x} = \frac{2}{3} \cdot \frac{\text{MP2600.x}}{\text{MP2500.x}}$
- Change MP2604.x until you have found the maximum k_V factor (MP1510.x). If you cannot find a maximum k_V factor, use the default value in MP2604.x.
- Starting value: $\text{MP2602.x} = \frac{\text{MP2600.x}}{\text{MP2500.x}}$
- Increase MP2602.x until you have found a maximum k_V factor (MP1510.x). If the value found for MP2602.x is significantly greater than the starting value (> factor 2), you should adjust MP2604.x again by enlarging and reducing it to find the optimum value.
- MP1510.x = 0.65 · ascertained k_V

Machine type 2:

- The machine is commissioned as usual until the k_V factor is to be determined.
- Enter MP2602.x = 1 and MP2604.x = 0.
- Increase the k_V factor (MP1510.x) until you reach the oscillation limit.
- Starting value: $MP2604.x = \frac{2}{3} \cdot \frac{MP2600.x}{MP2500.x}$
- Change MP2604.x, normally by reducing it, until the following error is at its minimum.
- MP1510.x = 0.65 · ascertained k_V

MP2602.x **IPC time constant T_1**
Input: 0.0001 to 1.0000 [s]
0: IPC inactive

MP2604.x **IPC time constant T_2**
Input: 0.0001 to 1.0000 [s]
0: IPC inactive

Minimizing the following error during the jerk phase

An increased following error during the jerk phase can be minimized with MP2606.x. The preceding adjustment of the IPC must have been carried out for this to function.
The typical entry value for MP2606.x is between 0.5 and 2.

Commissioning:

- Enter the following test program:

```
0 BEGIN PGM TEST MM
1 LBL 1
2 L X <maximum traverse> R0 FMAX
3 L X0 FMAX
4 CALL LBL1 REP 10/10
5 END PGM TEST MM
```

- Run the program at high speed.
- Use the integrated oscilloscope to record the following error.
- Change MP2606.x until a very small following error occurs in the jerk phase (positive following error: MP2606.x > 1, negative following error: MP2606 < 1)

MP2606.x **Following error in the jerk phase**
Input: 0.000 to 10.000

Holding torque

The holding torque is the torque that is required to keep a vertical axis at a standstill.

The holding torque is given by the iTNC through the integral-action component of the nominal current value. In most cases the holding torque is constant. The required holding current can therefore be fed forward through MP2630.x. This relieves the speed controller.

- To prevent the effect of stiction, measure the current at low speed in both directions (e.g. 10 rpm).
- Calculate the holding current from the mean of the measured current values and enter the result in MP2630.x.

Mean:

$$\text{MP 2630} = \frac{\text{I NOML}_1 + \text{I NOML}_2}{2}$$

Note

If the ready signal (RDY) is missing from the speed encoder inputs of vertical axes, the DSP error message **`8B40 No drive < release>`** appears. A vertical axis is defined with an entry in MP2630.x.

MP2630.x **Holding current**
Input: -30.000 to +30.000 [A]

6.8.5 Enabling the Drive Controller

At X51 to X60 the ready signal is available at pin 10b. As soon as the readiness signal is reset, the drive controllers are switched off. Normally, the error message **MOVEMENT MONITORING IN <AXIS> B** is output through the position control loop. Subsequently, the PWM signal release is switched off by the reset signal.

The drive controller cannot be switched on if the ready signal of the inverter, the global drive enabling through I32 (X4/33) or the axis group enabling through X150/151 is missing. To switch on the drive controller:

- Determine the functionality of the global drive enabling through I32 (X42/33) with MP2050.
- Assign 24 Vdc to pin 33 (I32) of connection X42 to enable the control.
- In MP2040.0 to MP2040.2, define the axis groups for drive enabling through X150 pin 1 to pin 3 (e.g., MP2040.0 = %00000000000111 determines drive enabling for axes 1 to 3 for X150 pin 1).
- With W524 bit 0, you can permanently deactivate the monitoring functions for axis group 1 for the duration from MP1150.1. This prevents the monitoring functions from becoming effective after the drive release has been deactivated.
- Activate the drive controllers with module 9161. You can use, for example, the axis release W1024 as a criterion for drive enabling.

Note

If you do not want to use drive enabling for axis groups, but rather just global drive enabling through I32 (X42/33), set all bits in MP2040.x and W524 to zero.

If you disconnect the voltage for

- X42/33, all drive controllers are switched off.
- X150/151, the drive controllers of the corresponding axis group(s) are switched off.

Note

If drive enabling through X150/151 or X42/33 is missing, the error message **8B40 No <drive release>** appears.

You can define axes for which the drives will not switch off if the global drive enabling through I32 (X42/33) is missing:

- Determine the functionality of the global drive enabling through I32 (X42/33) with MP2050.
- With Module 9169 transfer in bit code the axes that are not to be switched off.

You can determine by PLC which axes are switched off in 200 ms:

- Call Module 9159. The drives that are switched off are returned in bit code.

You can request the status of the drive controller with Module 9162, and you can determine if the drive controller is ready to be switched on with Module 9157.

The iTNC monitors the time between the switch-on of the drive hardware and the READY signal (from the PWM cable). If the READY signal is missing after the waiting time has passed, the error message **`8B40 No drive release <axis>`** appears.

▶ Enter the permissible time in MP2170.

MP2040	**Axis groups for drive enabling through X150**
Format:	%xxxxxxxxxxxxxx
Input:	0: Axis not assigned 1: Axis assigned
MP2040.0-5	Groups 1 to 6
MP2040.6-7	Reserved, enter %00000000000000

MP2050	**Functionality of drive enabling I32 (X42/33)**
Input:	0: Emergency stop for all axes, Module 9169 not effective 1: Emergency stop for all axes that are not excepted with Module 9169 2: I32 and Module 9169 have no function

MP2170	**Waiting time between the switch-on of the drive and the drive's standby signal**
Input:	0.001 to 4.999 [s] 0: 2 [s]

		Set	Reset
W524	**Monitoring functions if drive is released for axis group 1** 0: Monitoring functions not active 1: Monitoring functions active Bit 0: Axis group 1 Bit 1 to bit 15: Non-functional	PLC	PLC

Module 9157 Drive controller status

Status information about the drive controller can be ascertained with this module.

Call:

PS B/W/D/K <>Status information>
0: Drive controller readiness
1: Drive controller status (as in Module 9162)
2: Reserved
3: Reserved
CM 9157
PL B/W/D <>Axis status information bit-encoded>

Error detection:

Marker	Value	Meaning
M4203	0	Status information was ascertained
	1	Error code in W1022
W1022	2	Invalid status information was programmed
	24	Module was called in a spawn job or submit job

Module 9159 Drives that are switched off in 200 ms

Call:
CM 9159
PL W/D <>Drives, in bit code, that are switched off in 200 ms>

Module 9161 Enabling the drive controller

With this module you can switch the drive controllers (speed and current controllers) on and off for specific axes. A nominal speed value is also output when the drive controller is not enabled.

Call:

PS W/D/K <>Released axes>
Bit: 15 876543210
Axis: S xxxx 987654321
0: No drive controller enabling
1: Drive controller enabling
CM 9161

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Control has no current controller, or the call is in a spawn or submit job

Module 9162 Status request of the drive controller

Call:

CM 9162

PL B/W/D <>Drive is ready>

Bit 15 0

Axis Sxxxxxx987654321

0: Not ready

1: Ready

Module 9169 Axes for which I32 does not switch off the drives

Call:

PS B/W/D/K <>axes bit-encoded>

CM 9169

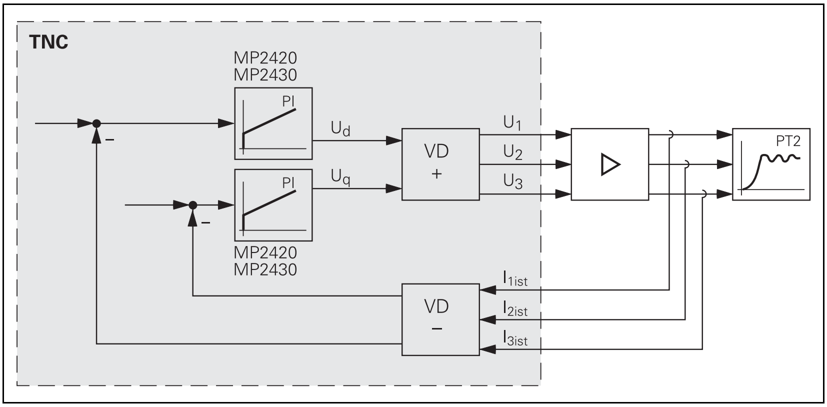
6.8.6 Current Controller

6 or 10 digital current controllers for the axes and spindle(s) are integrated in the iTNC 530:

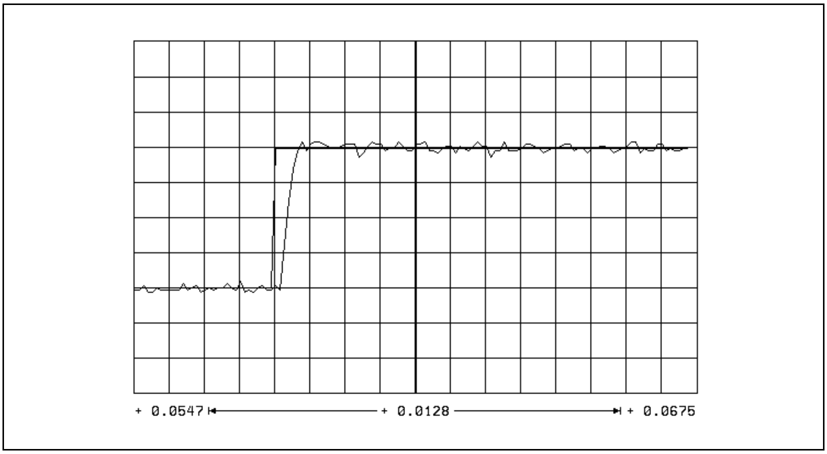
The nominal values for magnetizing current I_{dnom} and torque-producing current I_{qnom} are divided into the PWM signals U_1, U_2 and U_3 through a PI controller and vector rotator VD+, and are transferred to the power module through X51 to X60.

The actual current values I_{1act}, I_{2act} and I_{3act} are determined by the power module and are transferred to vector rotator VD– through X51 to X60. The vector rotator determines the actual values of magnetizing current I_{dist} and torque-producing current I_{qnom}.

Circuit diagram:



You adjust the current controller to attain the optimum result, with the position and speed controller switched off.



The step response is adjusted such that there is no overshoot and the rise time is as small as possible:

- In MP2420.x, define the P factor of the current controller.
- In MP2430.x, define the I factor of the current controller.

MP2420.x **P factor of the current controller**
Input: 0 to 9999.99 [V/A]

MP2430.x **I factor of the current controller**
Input: 0 to 9 999 999 [Vs/A]

6.8.7 Braking the Drives for an Emergency Stop and a Power Fail

In an emergency stop and power failure the spindle must be braked as quickly as possible. If the braking energy cannot be drawn off quickly enough, the dc-link voltage increases sharply. Under circumstances, the inverter could switch off and the spindle coast to a stop. A powerful braking of the spindle also leads to a high strain on the mechanics of the machine. Preferably the spindle should be braked in an emergency stop by limiting the braking power.
Limiting the braking power is also effective when braking the spindle with M05, if the brake ramp in M05 (MP3411 and MP3412) is steeper than the brake ramp when limiting the braking power.

Normally, in case of an emergency stop, the axes are braked at the limit of current. This can create problems:

- With gantry axes a mechanical offset can occur between the master and slave axes.
- A gear between spindle and motor can be overloaded.

Preferably the axes should be braked in an emergency stop by adding an additional braking ramp.

Note

Both of the above braking strategies are possible for axes and spindles. However, an additional braking ramp should be used for axes, and brake power limiting for spindles.
If both braking strategies are activated for an axis or spindle, they do not exclude each other; this means that in case of an emergency stop, whichever strategy responds first takes effect.

Inverters with regenerative power supplies usually do not develop problems if they are switched off. The main concern here is for the mechanics of the machine.
Problems with inverters with braking resistors can arise if the drive is switched off too early. The strain on the mechanics is reduced, but can also be influenced with braking strategies.

Braking the Axes by Entering an Additional Braking Ramp

In this strategy, the braking ramp to be used in an emergency stop is entered.

Set the axis braking ramp for an emergency stop:

- Enter as a minimum value in $MP2590.x = \frac{MP1060.x \cdot 60}{MP2020.x}$ On
- Use the emergency stop to brake the axis from rapid traverse.
- Increase the value entered in MP2590.x until the braking time is as short as possible and the mechanics of the axis are not overloaded.

If the value entered is too small, i.e. if braking is too slow, the axis brakes at the acceleration defined in MP1060.x.

Note

The value entered in MP2590.x refers to the motor speed, meaning the ballscrew pitch is not considered.

MP2590.x **Braking ramp in an emergency stop**

Input: 0.1 to 999.9 [rpm/ms]
0: Function inactive

Braking the Spindle/Spindles by Entering the Braking Power

In this strategy the maximum braking power for braking the spindle/spindles in an emergency stop or power failure is entered.

If power limiting (MP2392.x) is used in normal operation, then the maximum braking performance is limited to the lower of the two values from the power limiting and the braking power.
Example:

Function	Case 1	Case 2
Power limiting (MP2392.x)	10 kW	5 kW
Maximum braking power (MP2390.x, MP2394.x)	5 kW	10 kW
Limiting the braking performance to	5 kW	5 kW

Braking the spindle/spindles in an emergency stop

- For **inverters with regenerative power supply**, enter MP2390.x = 0 so as not to limit the braking power.
- Calculate for **inverters with braking resistors** the input value for MP2390.x from the following formula:

$$MP2390.x = \frac{U_Z^2}{R \cdot 1000}$$

R = Braking resistance [Ω]
(PW 110, PW 210 = 18 Ω, PW 120 = 10 Ω, UP 110 = 9 Ω)
U_Z = dc-link voltage [V]
(UV 130, UE 2xx, UE 2xxB = 565 V; UV 120, UV 140 = 650 V)

Braking the spindle/spindles during a power fail

During a power fail, the "SH1B" signal on X51 to X60 is maintained for 3 more seconds, in order to brake the spindle/spindles. At the same time, the control tries to reset the PLC outputs.

- If you are using an additional braking resistor (e.g. UP 110) in connection with an **inverter with regenerative power supply** , calculate the value to be entered in MP2394.x from the above formula.
- Calculate for **inverters with braking resistors** the input value for MP2394.x with the above formula.

Note

If after entry of a value in MP2390.x or MP2394.x the mechanics are overloaded by the braking process, lower the value in MP2390.x or MP2394.x until you have found an optimum between braking time and mechanical loading.

MP2390.x Max. braking performance in an emergency stop
Input: 0: No limiting of the braking power in an emergency stop
0.001 to 3 000.000 [kW]

MP2394.x Maximum braking power during a power fail
Input: 0: No limiting of the braking power in a power failure
0.001 to 3 000.000 [kW]

6.8.8 Power and Torque Limiting

You can limit the power of your spindle motor to get wider gear ranges. Wide-range motors are characterized by a larger speed range with higher torque at low speed.
One solution for bringing about this behavior is to use an oversized motor, and to limit the maximum power. However, power limiting does not reduce the high torque to the speed at which power limiting becomes effective. This high torque (until power limiting takes effect) can be reduced with torque limiting, in order to keep the mechanics of the machine from becoming overloaded.

With torque limiting you can also limit the torque of the axis motors, in order to keep the mechanics of the machine from becoming overloaded. Power limiting for axis motors is not useful.

For **axes and spindles**, the torque is limited to the value taken from either the table of power modules or the motor table, whichever is lower.

If a non-HEIDENHAIN inverter or a UE 2xx HEIDENHAIN compact inverter is used, the maximum torque current , and as a result the maximum torque, is limited to 70% of the maximum current, since these inverters do not provide any signal for an excessive dc-link current.
The modular HEIDENHAIN inverter system or the UE 2xxB HEIDENHAIN compact inverters do provide such a signal (ERR-IZ). As a result, the maximum torque current is not limited.
This monitoring function must be set for the respective inverter in MP2220.x bit 2.

The torque can be calculated for any speed:

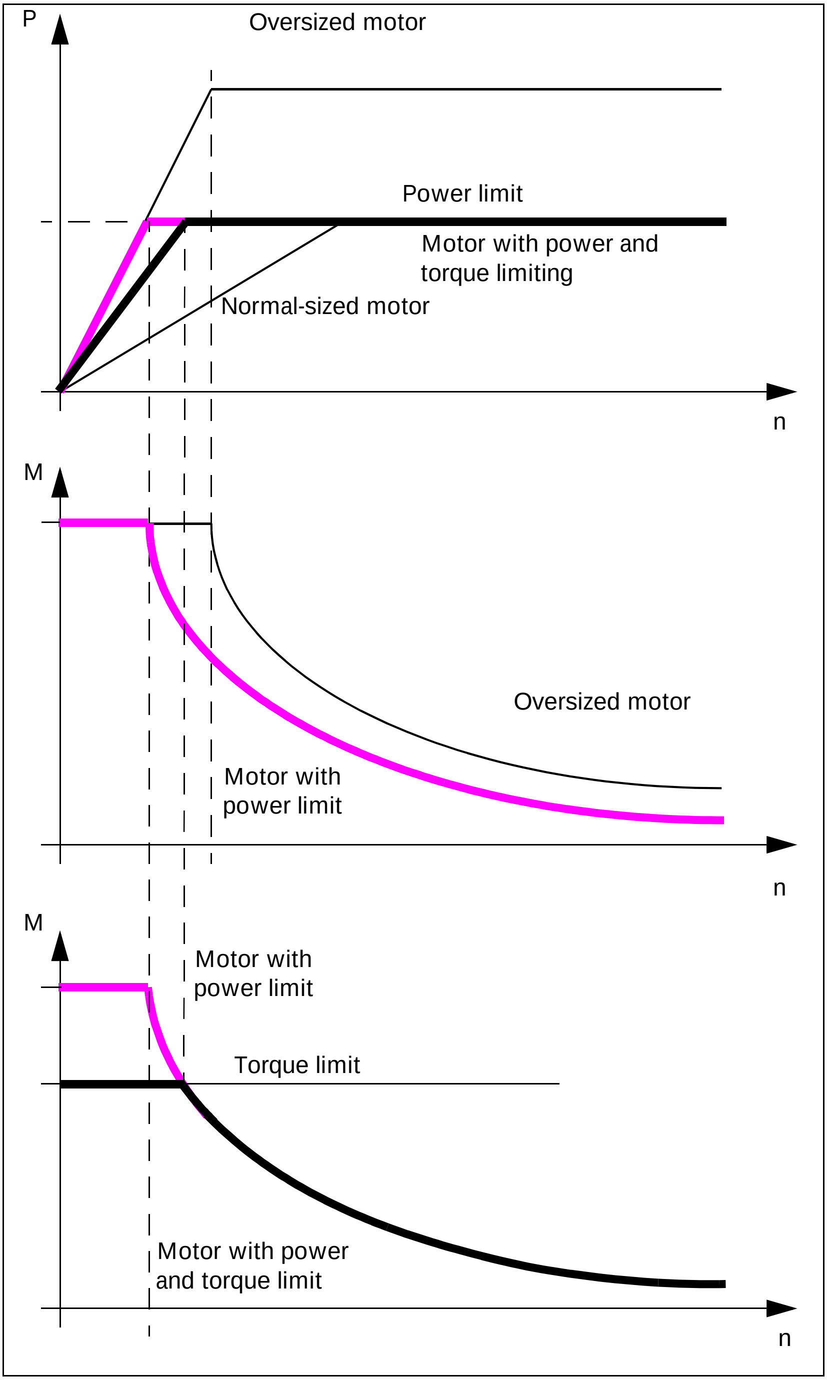
$$M = \frac{P \cdot 60}{n \cdot 2 \cdot \pi}$$

M: Torque [Nm]
P: Power [W]
n: Speed [rpm]

Note

The power and torque limiting can have an effect on the braking of the spindle in an emergency stop.

- Enter the maximum power for the spindle in MP2392.x.
- Enter the maximum torque for the spindle or axis in MP2396.x.
- For the **modular HEIDENHAIN inverter system** or the **UE 2xxB** compact inverter, activate the monitoring of the ERR-IZ signal with MP2220.x bit 2 = 1. For **non-HEIDENHAIN inverters** or the **UE 2xx HEIDENHAIN compact inverter**, deactivate the monitoring of the ERR-IZ signal with MP2220.x bit 2 = 0.


P
Oversized motor
Power limit
Motor with power and
torque limiting
Normal-sized motor
n
M
Oversized motor
Motor with
power limit
n
M
Motor with
power limit
Torque limit
Motor with power
and torque limit
n

MP2220.x Monitoring functions

Format: %xxx

Input: Bit 2 – monitoring of the ERR-IZ signals (only with HEIDENHAIN inverters except for UE 2xx)
0: Inactive
1: Active

MP2392.x Power limit

Input: 0: No power limit
0.001 to 3 000.000 [kW]

MP2396.x Maximum torque

Input: 0: No torque limiting
0.1 to 30 000.0 [Nm]

Module 9158 Maximum torque

With Module 9158 you can limit the torque of an axis or spindle. The maximum torque resulting from the data in the control's motor table cannot be exceeded. In this case the torque is limited to the value from the motor specifications. After the drive is switched off, the original torque becomes effective again.
If the torque limit is active, the standstill monitoring is inactive; only the motion monitoring remains active.

The torque-producing current required for the desired torque must be transferred to the module:

Synchronous motor	Asynchronous motor
$$I_q = \frac{M \cdot \sqrt{2}}{k_M}$$ I_q: Torque-producing current M: Desired torque k_M: Torque constant (from motor table)	■ Armature control range ($n < n_{FS}$) $$I_q = \frac{M \cdot n_N \cdot 2 \cdot \pi \cdot \sqrt{I_N^2 - I_0^2}}{P_N \cdot 60}$$ ■ Field weakening range ($n > n_{FS}$) $$I_q = \frac{M \cdot n_N \cdot n \cdot 2 \cdot \pi \cdot \sqrt{I_N^2 - I_0^2}}{P_N \cdot n_{FS} \cdot 60}$$ I_q: Torque-producing current M: Desired torque n_N: Rated speed (from motor table) n: Current speed I_N: Rated current (from motor table) I_0: No-load current (from motor table) P_N: Rated power output (from motor table) n_{FS}: Threshold speed for field weakening (from motor table)

Call:

PS B/W/D/K/S<>Axis or spindle>
  0 to 8: Axes 1 to 9
  15: Spindle
PS B/W/D/K/S<>Torque-producing current in mA>
  –1 = Torque given in motor specifications
CM 9158

Error detection:

Marker	Value	Meaning
M4203	0	Torque preset active
	1	Error code in W1022
W1022	1	0 Nm torque transferred
	2	Invalid axis number
	24	Module was called in a spawn job or submit job

6.8.9 Synchronous Motors in Field Weakening Range

Synchronous motors can also be operated with a weakened field. This is necessary, for example, for high-speed synchronous spindle motors, since the inverter voltage is not sufficient at high speeds.

If the power supply fails, the dc-link voltage increases sharply. As a result, the inverters and possibly the motor might be damaged. To protect the inverters and the motor from being damaged, you can use a braking resistor such as PW 210 for non-regenerative inverter systems and a braking-resistor module such as UP 110 or a voltage-protection module for regenerative inverter systems.

For synchronous motors, the operation with a weakened field is automatically activated if MP2160 = 1 has been entered. You do not need to make any further settings.

- If you are using a synchronous motor with an appropriate module to protect the system in the event of a power supply failure, enter MP2160 = 1 so that the synchronous motor can be operated with a weakened field.
- If you are using a synchronous motor without an appropriate module to protect the system in the event of a power supply failure, enter MP2160 = 0 so that the synchronous motor cannot be operated with a weakened field.

MP2160 Protection against failure of power supply for synchronous motor in field-weakening range

Input: 0: Do not protect
1: Protect

6.9 Offset Adjustment

Digital axes:

An offset adjustment at the output of the current controller is automatically compensated.

Analog axes:

The maximum permissible offset voltage in the control is 100 mV. If this voltage is exceeded, the error message **EXCESSIVE OFFSET IN <AXIS>** appears.

With the integral factor you can adjust an offset automatically:

- Enter an integral factor in MP1080.x. The speed with which the offset is eliminated depends on the size of the factor.
- Play in the drives can result in instability in the control loop.
  In this case, enter the factor zero.

MP1080 is effective only at a standstill.

MP1080.x	**Analog axes: Integral factor for offset adjustment**
Input:	Input 0 to 65 535
	Digital axes: nonfunctional
	Input: 0

6.10 Contouring Behavior

6.10.1 Radial Acceleration

You can define the radial acceleration of axes in addition to the simple acceleration (MP1060.x):

- Define the radial acceleration in MP1070.

MP1070 limits the feed rate during circular movement according to the formula:

$$v = \sqrt{r \cdot MP1070}$$

v = feed rate during circular movement [m/s]

r = radius [m] (of the path of the tool center)

HEIDENHAIN recommends:

$MP1070 = 0{,}5...1 \cdot MP1060$

If the programmed feed rate is less than that calculated above, then the programmed feed rate becomes effective.

MP1070 functions for operation with both following error and feedforward control.

MP1070	**Radial acceleration**
Input:	0.001 to 100 000 [m/s^2 or $1000°/s^2$]

6.10.2 Contour Velocity at Corners

To comply with a defined tolerance, the iTNC can reduce the tool velocity before machining corners, line-to-arc transitions and arc-to-arc transitions. The control can react to a potential violation velocity tolerance up to 256 blocks in advance. This feature is known as "look-ahead":

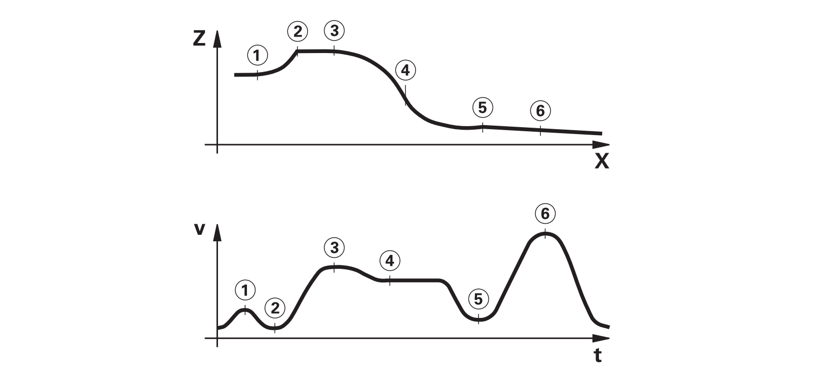
- Define the permissible tolerance for contour transitions in MP1096. The larger the tolerance, the greater the tool velocity.

The user can overwrite this tolerance with Cycle 32, "Tolerance."

Jerk limitation (See "Interpolator" on page 6 – 112) and nominal-position-value filters enable the iTNC to machine 3-D surfaces at high speed. Prerequisite: The contour must be described with short line segments.

To ensure that cutter-compensated outside corners remain exact, a spline must be inserted into the cutter midpoint path instead of a transitional arc. A spline also has the advantage of reducing the jerk:

- Enter MP7680 bit 10 = 1.



MP1096	**Tolerance for contour transitions**
Input:	0: No nominal position value filter 0.001 to 3.000 [mm]: Permissible tolerance at contour transitions

MP7680	**Machine parameter with multiple function**
Format:	%xxxxxxxxxxxxxx
Input:	Bit 10 – Cutter-radius-compensated outside corners: 0: Insertion of a circular arc 1: Insertion of a spline curve Proposed input value: %xx1xxxxxxxxxx Bit 11 – Reserved

Rounding of corners

If you program M90, the tool velocity in following-error mode is kept constant at corners without radius compensation. This causes a corner rounding that varies with the feed rate (see User's Manual).

If you program M112 or M124, defined arcs will be inserted at the corners regardless of the feed rate (see User's Manual). The rounding arcs generate twice as many NC blocks, and the feed rate is now only limited by the radial acceleration.

- With MP7680 bit 7, specify whether the rounding arcs should always be inserted or only if the acceleration from MP1060.x or MP1070 has been exceeded at the corners.
- With MP7680 bit 8, specify whether a rounding arc or a cubic spline is to be inserted between lines during the M function M112. The feed rate is reduced enough to prevent any excessive jerk. This does not apply if F MAX is programmed. The cubic spline produces an additional jerk reduction. But it takes more computing time than an inserted arc.

If you have set bit 8, you can specify with bit 9 whether the jerk will remain constant on the spline. The contour speed is adjusted for constant jerk.

MP7680 **Machine parameter with multiple function**
Format: %xxxxxxxxxxxxxx
Input: Bit 7 – Inserting a defined rounding arc or spline:
0: Defined rounding arcs are always inserted
1: Defined rounding arcs are always inserted if the acceleration from MP1060.x or MP1070 was exceeded.
Bit 8 – Insertion of rounding arc or cubic spline:
0: Rounding arc is inserted.
1: A cubic spline is inserted instead of a rounding arc.
Bit 9 – Constant jerk on spline (Bit 8 = 1):
0: No constant jerk
1: Constant jerk

6.11 Monitoring Functions

The NC monitors the axis position and the dynamic response of the machine. If the fixed values are exceeded, it displays an error message and stops the machine.

With W1042 you can switch off the following types of monitoring for individual axes:

- Position monitoring
- Standstill monitoring
- Movement monitoring
- Nominal speed value monitoring

		Set	Reset
W1042	**Deactivation of monitoring functions** Bits 0 to 8 correspond to axes 1 to 9 0: Monitoring functions active 1: Monitoring functions inactive	PLC	PLC

Warning

Safe machine operation is not possible if the monitoring functions are switched off. Uncontrolled axis movements are not detected.

If the reaction time of the PLC for switching off the monitoring functions is not sufficient, you must use a high-speed PLC input. High-speed PLC inputs are interrogated within the position control loop cycle:

- In MP4130.0, enter the number of the PLC input that is to be defined as high-speed PLC input.

Note

The inputs of the PL 4xxB cannot be used as high-speed PLC inputs.

- Define in MP4131.0 the activation criterion for the PLC input specified in MP4130.0.
- Enable MP4130.0 with W522 bit 0. As soon as the input is set, the monitoring functions are switched off, the axes stopped, and the drive is switched off. If the following error is greater than MP1030.x (positioning window), the actual value is saved as nominal value. The monitoring functions become active again if the high-speed PLC input is reset or MP4130.0 has been disabled with W522 bit 0.

MP1150.1	**Time period for which the monitoring function is to remain off after the fast PLC input defined in MP4130.0 is set**		
Input:	0 to 65.535 [s] Recommended: 0.2 to 0.5		
MP4130.0	**Number of the high-speed PLC input for switching off the monitoring functions**		
Input:	0 to 255 [no. of the PLC input] The inputs of the PL 4xx B may not be used!		
MP4131.0	**Activation criterion for fast PLC input for switching off the monitoring functions**		
Input:	0: Activation at low level 1: Activation at high level		

		Set	Reset
W522	**Enabling the high-speed PLC inputs** Bit 0: Fast PLC input is defined in MP4130.0 for switching off the monitoring functions	PLC	PLC

6.11.1 Position Monitoring

The axis positions are monitored by the iTNC as long as the control loop is closed.

The input values for position monitoring depend on the maximum possible following error (servo lag). Therefore the input ranges for operation with following error and velocity feedforward are separate.

For both modes of operation there are two range limits for position monitoring.

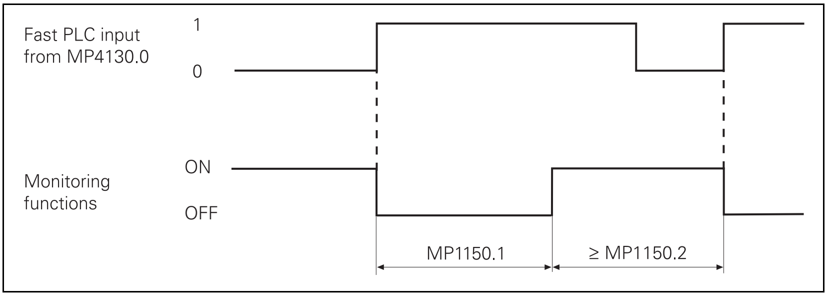
If the first limit is exceeded, the error message **EXCESSIVE SERVO LAG IN <AXIS>** appears. The machine stops.
You can clear this message with the CE key. An actual-to-nominal value transfer is then executed for the respective axes.

If the second limit is exceeded, the error message **EXCESSIVE SERVO LAG IN <AXIS>** appears. The control-is-ready signal output is reset.
You cannot clear this message. You must restart the control to correct the error.

- In the machine parameters given below, define two range limits for position monitoring in each operating mode.
- Adjust the input values to the machine dynamics.

If blocked axes are the cause of the erasable error message **EXCESSIVE SERVO LAG IN <AXIS>,** a nominal velocity value may freeze, since the machine axes can no longer be moved:

- In MP1150.0, specify the time after which the nominal velocity value is to be deleted. After this time has expired, the actual position value is assumed as nominal position value. Before this time has expired, the error message cannot be cleared with the CE key. - At this time the actual position value is assumed as nominal value, and the nominal velocity value is deleted.
- In MP1150.1, enter the time period for which the monitoring function is to remain off after the fast PLC input from MP4130.0 has been set. The monitoring functions reactivate after expiration of this time.
- In MP1150.2, specify the minimum time period after expiration of the time from MP1150.1 for which the monitoring functions should remain effective (e.g. if the input changes quickly).



MP1150	**Position monitoring**
MP1150.0	Delay time for deleting the nominal velocity value with the deletable error message: **`Excessive servo lag in <axis>`**
Input:	0 to 65.535 [s] Recommended: 0
MP1150.1	Time period for which the monitoring function is to remain off after the fast PLC input defined in MP4130.0 is set
Input:	0 to 65.535 [s] 0: Monitoring functions on Recommended: 0.2 to 0.5
MP1150.2	Minimum time period for which the monitoring functions are to remain effective after expiration of the time from MP1150.1
Input:	0 to 65.535 [s]
MP1410.x	**Position monitoring for operation with velocity feedforward control (erasable)**
Input:	0.0010 to 30.0000 [mm] Recommended: 0.5 mm
MP1420.x	**Position monitoring for operation with velocity feedforward control (EMERGENCY STOP)**
Input:	0.0010 to 30.0000 [mm] Recommended: 2 mm
MP1710.x	**Position monitoring for operation with following error (erasable)**
Input:	0.0000 to 300.0000 [mm] Recommended: 1.2 · following error
MP1720.x	**Position monitoring for operation with following error (EMERGENCY STOP)**
Input:	0.0000 to 300.0000 [mm] Recommended: 1.4 · following error

6.11.2 Nominal Speed Value Monitoring

For the axes, the nominal speed value monitoring is effective only in operation with velocity feedforward.

For the spindle, it is effective in operation with following error as long as the position control loop is closed (orientation).

If the nominal speed value calculated by the position controller is greater than the maximum possible nominal value, the blinking error message **`NOMINAL SPEED VALUE TOO HIGH <AXIS>`** appears and the control-is-ready output is reset.

Analog axes: Maximum nominal value = 10 V

Analog spindle: Maximum nominal value = 20 V

Digital axes and spindle: Maximum nominal value = maximum motor speed from motor table

6.11.3 Movement Monitoring

Movement monitoring is possible during operation both with velocity feedforward and with following error.

During movement monitoring, the actual path traveled is compared at short intervals (several servo cycles) with the nominal path calculated by the NC. If during this period the actual path traveled differs from the calculated path, the flashing error message **MOVEMENT MONITORING IN <AXIS>** appears.

Analog axes:
An existing offset during a standstill may cause a potential at the analog output without any resulting positioning movement:

- In MP1140.x, enter a threshold from which the movement monitoring should go into effect.

Digital axes:
There is no offset.

- In MP1140.x, enter the speed from which the movement monitoring should go into effect.

For digital axes, in addition to the comparison of actual and nominal values, the calculated position from the pulses of the position encoder are compared with the pulses of the speed encoder:

- Enter in MP332.x the number of signal periods and in MP331.x the path for the number of signal periods (See page 6 – 6).
- Enter the distance per motor revolution in MP1054.x. A formula can also be entered in MP1054.x.
- In MP1144.x, enter a limit value for this position difference. If you are not using a position encoder, you must enter 0 in MP1144.x as the position difference.

If the difference is greater than the input value from MP1144.x, the error message **MOVEMENT MONITORING IN <AXIS> B** appears.

Warning

If you enter the maximum value in MP1140.x or MP1144.x, no movement monitoring is active.
Safe machine operation is not possible without the movement monitoring function.

MP1140.x	**Threshold at which the movement monitoring goes into effect.**	
Input:	Analog axes:	0.030 to 10.000 [V]
	Digital axes:	0.030 to 10.000 [1000 rpm] recommended: 0.030 [1000 rpm]

MP1054.x **Linear distance of one motor revolution**
Input: Analog axes: nonfunctional
Digital axes: 0 to 100.000 [mm] or [°]

MP1144.x **Motion monitor for position and speed**
Input: Analog axes: nonfunctional
Digital axes: 0 to 99 999.999 [mm]
0: No monitoring

6.11.4 Standstill Monitoring

Standstill monitoring is effective during operation both with velocity feedforward and with following error, as soon as the axes have reached the positioning window.

If the position difference is greater than the value defined in MP2800.x, the blinking error message **STANDSTILL MONITORING IN <AXIS>** appears. The message also appears if, while moving to a position, an overshoot occurs that is larger than the input value in MP1110.x, or if the axis moves in the opposite direction when beginning a positioning movement:

- In MP1110.x, enter a threshold from which the standstill monitoring should go into effect.

MP1110.x	**Standstill monitoring**
Input:	0.0010 to 30.0000 [mm]

6.11.5 Positioning Window

The positioning window defines the limits within which the control considers a position to have been reached. After the position has been reached, the control begins running the next block. The position controller can correct a disturbance inside this window without activating the “Return to the Contour” function.

- In MP1030.x, define the size of the positioning window.

MP1030.x	**Positioning window**
Input:	0.0001 to 2.0000 [mm]

Axes in position

Once the axes have moved into the positioning window, the corresponding bits are set in W1026. This also applies to the status after the machine control voltage is switched on. Axes that are not used are considered to be in position.

The NC resets the bits as soon as you start a positioning movement or traverse the reference marks.

In the ELECTRONIC HANDWHEEL mode of operation the bit for the current handwheel axis is reset.

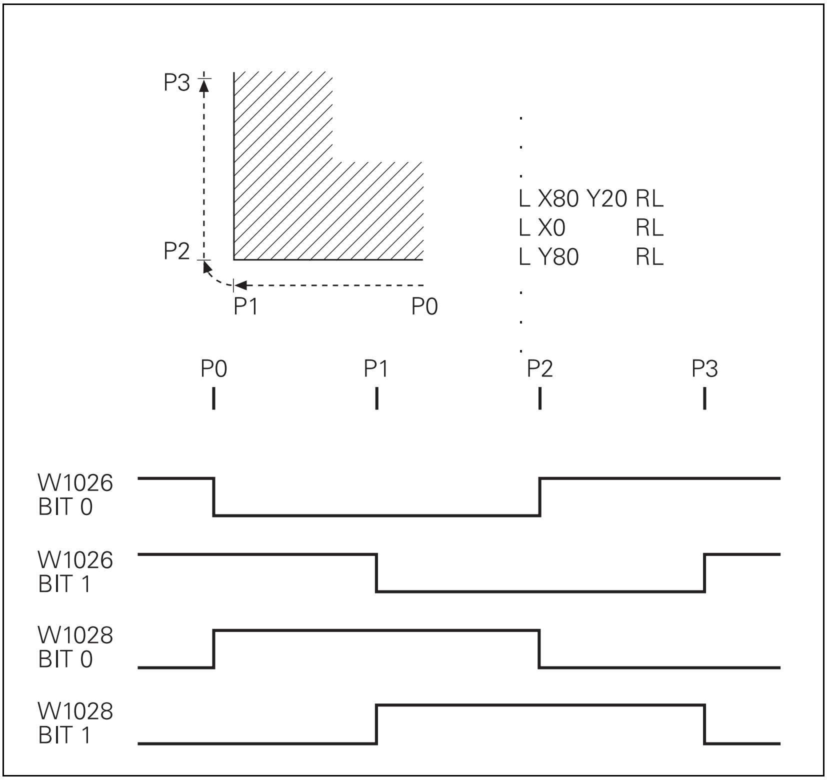
On contours that can be machined with constant surface speed, W1026 is not set.

		Set	**Reset**
W1026	**Axes in position** Bits 0 to 8 correspond to axes 1 to 9 0: Axis not in positioning window 1: Axis in positioning window	NC	NC

Axes in motion

During axis movement, the NC sets the corresponding bits in W1028.

		Set	Reset
W1028	**Axes in motion** Bits 0 to 8 correspond to axes 1 to 9 0: Axis not in motion 1: Axis in motion	NC	NC



6.11.6 Monitoring of the Power Supply Unit

The rectified supply voltage of the power supply unit is monitored. The supply voltage must lie within a defined range.
(400 V +/– 10%). If this is not the case the power supply unit reports an AC fail (PF.PS.AC).

At the same time, the dc-link voltage is monitored:

- If approx. 760 Vdc (UV 120, UV 140, UV 150, UR 2xx: approx. 800 V) is exceeded, the NC revokes the pulse release (reset) for the IGBT of the power module. The motors coast out of loop to a stop. No energy is returned to the dc link.
- If the dc-link voltage falls below approx. 385 Vdc (UV 120, UV 140, UV 150. UR 2xx: approx. 410 V), the power supply unit reports a power fail (signal PF.PS.ZK)
- If the dc-link voltage falls below approx. 155 Vdc (UV 120, UV 140, UV 150, UR 2xx, UV 105: approx. 200 V), the control is reset (signal RES.PS).
- Below approx. 135 Vdc (UV 120, UV 140, UV 150, UR 2xx, UV 105: approx. 180 V), the power supply unit switches off.

The UV 105 power supply unit reports a power fail if the dc-link voltage is < approx. 385 V and the supply voltage is < approx. 330 V.

▶ With MP2150, you define which inverter signal is to trigger the **Power fail** on the control.

Inverter signal	Meaning
AC fail (PF.PS.AC)	Failure of supply voltage for inverter
Power fail (PF.PS.ZK)	DC-link voltage failure

Since the AC fail is reported to the control before the power fail, the control has more time to react to the subsequent dc-link voltage failure.

Note

Only the following HEIDENHAIN power supply units provide the AC-fail signal:

- UV 120
- UV 140
- UV 150
- UR 2xx

For all other HEIDENHAIN components, the AC-fail signal must not be selected in MP2150.

If a power fail is triggered on the control, all drives are brought to a controlled stop. The PLC-outputs are switched off and the control displays the error message **POWERFAIL**. The control must be turned off and on again.

MP2150 **Power-fail signals on the control**
Input: 0: AC fail
1: Power fail and AC fail
2: Neither power fail nor AC fail
3: Power fail

Module 9167 Monitoring of dc-link voltage

With this module you can switch the dc-link voltage monitoring for power fail (U_Z < approx. 385 V or 410 V) on and off.

If you don’t call the module during the first PLC run-through, the supply voltage monitoring is automatically started after the first PLC run-through.

Call:

PS	B/W/D/K	<>Command code>
		0: DC-link voltage monitoring off
		1: DC-link voltage monitoring on
CM	9167	
PL	B/W/D	<>Error code>
		0: Command executed
		–1: Transferred parameter invalid

Error detection:

Marker	Value	Meaning
M4203	0	DC-link voltage monitoring on or off
	1	Error code in W1022
W1022	2	Transferred parameter invalid

6.11.7 Temperature Monitoring

Temperature of the MC 422

The internal temperature of the MC 422 is continuously being monitored. At about 55 °C the temperature warning **`TNC temperature warning`** appears. If the temperature does not fall below 55 °C, the warning is reactivated after two minutes. Beginning at about 60 °C the error message **`TNC temperature too high <temperature> °C`** appears and an emergency stop is triggered. If the machine is switched on again and the temperature does not go below 60 °C, the error message is reactivated after about 10 to 20 seconds.

The temperature of the MC 422 can be found with Module 9133.

Module 9133 Temperature of the MC422

Call:

```
PS    B/W/D/K   <>Code>
                0: Internal temperature of the MC 422
                1: Temperature of the CPU
CM    9133
PL    B/W/D     <>Temperature in °C>
```

Error detection:

Marker	Value	Meaning
M4203	0	Internal temperature was read
	1	Error code in W1022
W1022	2	Invalid code

Motor temperature

To measure the motor temperature, a KTY 84 must be connected at pins 13 and 25 of X15 to X20, X80 to X83. The temperature value is ascertained at least once per second. The maximum permissible motor temperature is taken from the motor table.

As soon as the given temperature is exceeded, the blinking error message **`MOTOR TEMPERATURE <AXIS> TOO HIGH`** appears and the drives are automatically switched off.

Module 9165 Sampling the current motor temperature

Appropriate measures can be taken before the motor reaches the maximum temperature.

Call:

```
PS    B/W/D/K   <>Axis>
                0 to 8 and 15 = Axes 1 to 9 and the spindle
CM    9165
PL    B/W/D     <>Temperature>
                Range: 0 to 255 °C
```

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Control has no current controller

Temperature of the power module's heat sink

At X51 to X60 the temperature warning signal is available at pin 13.

If the permissible temperature of the heat sink on the power module is exceeded, this signal is reset.

Warning

To avoid destroying the power module, the drives must be brought immediately to a standstill after a temperature warning.

Data on maximum permissible temperatures are available from the manufacturer of your power module.

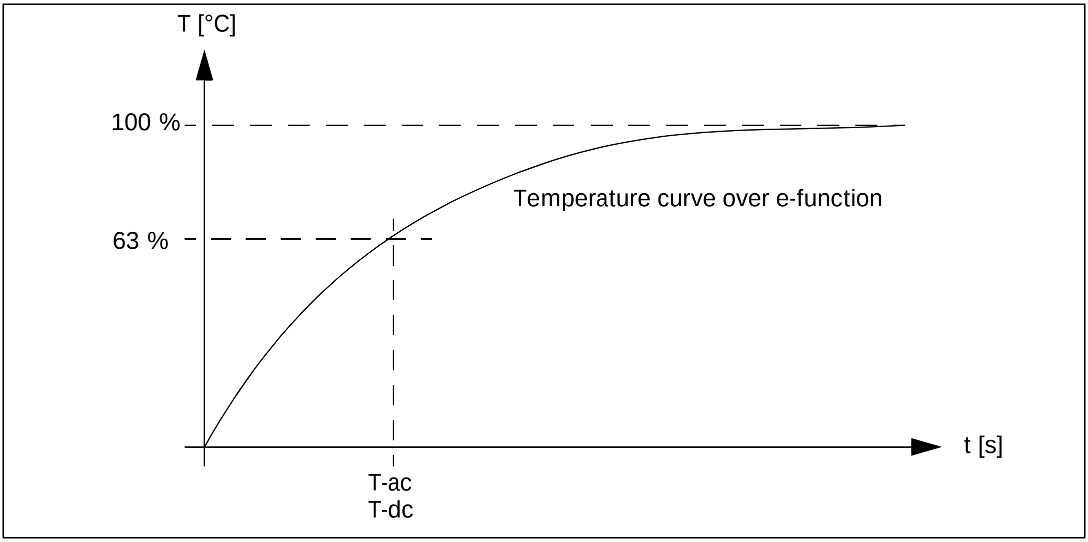
The temperature warning signal is not evaluated in the NC:

- Use Module 9160 or 9066 to interrogate the temperature warning, and take appropriate measures.

6.11.8 I^2t Monitoring

The instantaneous motor current is limited to either the maximum current of the power module, or the maximum motor current, whichever is lower. The values result from the type of power supply unit and type of motor, and are saved in the motor or power-supply-unit table.

In addition, a separate I^2t monitoring is performed for the power module and the motor:
The temperature increase of the motor and power stage is proportional to the square of the current output. Since the heat dissipation can be uneven if the motor is stationary or moving slowly, the monitor distinguishes between two ranges. This is the purpose of the F-ac entry (**`Cutoff frequency for T-ac [Hz]`**) in the motor-and-power-stage table. Above this frequency, the T-ac entry (**`Therm. time constant for ac [s]`**) applies, and below it the T-dc entry (**`Therm. time constant for dc [s]`**) applies. The T-ac and T-dc entries identify the point in the temperature curve at which 63% of the maximum temperature is reached. This defines a temperature model of the motor or power stage.



With the aid of this temperature model, a mean current value is permanently calculated. If this calculated mean current value exceeds the rated current (for motors, plus MP2302.x), the I^2-t monitoring (Module 9160) responds. In this case, you should reduce the machining feed rate in the PLC program. If the calculate mean current value is more than 1.1-fold of the rated current, (for motors, plus MP2302.x) an error message appears; the drives are not switched off.

- In MP2302.x, enter a reference value for I^2t monitoring. The input value is a factor of the rated current of the motor (1 = rated current of the motor). If you enter zero, the I^2t monitoring for the motor (not for the power supply unit) is switched off.

Note

In the oscilloscope you can display the current value of the I^2-t monitoring of the motor and power stage, as well as the current load of the drive.

If the value 0 is entered in the motor or power module table in the F-DC, T-DC, F-AC and T-AC columns, the following default values apply:

- Axis drives:
  - F-DC = 0
  - T-DC = 10
  - F-AC = 0
  - T-AC = 10
- Spindle drives:
  - F-DC = 0
  - T-DC = 150
  - F-AC = 0
  - T-AC = 150

MP2302.x Reference value for I^2t monitoring

Input: 0 to 1000.000 [· rated current of motor]
0: I^2t monitoring switched off
1: Rated current of motor as reference value

Module 9160 Status request for temperature monitoring and I^2t monitoring

Call:

```
CM   9160
PL   D      <>Temperature monitoring>
            Bit      15    876543210
            Axis:    Sxxxxx987654321
PL   D      <>I2t monitoring>
            Bit      15    876543210
            Axis     Sxxxxx987654321
```

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Control has no current controller

6.11.9 Read Actual Utilization of Drive Motors

Module 9166 provides the momentary utilization of the given drive motor as a percentage value.

Utilization means:

Speed range	$n_{act} < n_N$	$n_{act} \geq n_N$
Asynchronous motor	$\frac{\lvert M \rvert}{\lvert M_{Rated} \rvert}$	$\frac{\lvert P \rvert}{\lvert P_{Rated} \rvert}$
Synchronous motor	$\frac{\lvert M \rvert}{\lvert M_{Rated} \rvert}$	–

Instead of the drive torque, one uses the effective component I_q of the current, which is proportional to the torque.

I_{qMean} is formed as mean value of the individual current values I_{qx} of the last 20 ms:

$$I_{qMean} = \frac{\sum (I_{q1}..I_{qn})}{n}$$

$$\text{Utilization} = 100\ \% \cdot \frac{I_{qMean}}{I_{qRated}}$$

For asynchronous motors:

$$I_{qRated} = \sqrt{{I_N}^2 - {I_{mag}}^2}$$

I_N: Motor rated current
I_{mag}: Magnetizing current

For synchronous motors:

I_{qRated} = <Motor rated current>

Module 9166 Momentary utilization of the drive motor

The evaluation through MP2312.x is already calculated in the utilization of the drive motor.

Call:

PS	B/W/D/K	<>Axis>
		0 to 8 and 15 = Axes 1 to 9 and the spindle
CM	9166	
PL	B/W/D	<>Utilization of the drive in %>

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Control has no current controller

MP2312.x Reference value for utilization of motors

Input: 0 to 1000.000 [· rated current of motor]
0 or 1: Reference value is rated current of motor

6.11.10 Status of HEIDENHAIN Inverters

Status information of the HEIDENHAIN inverters can be read with Module 9066.

Module 9066 Status of HEIDENHAIN inverter

Call:

PS	B/W/D/K	<>Code> 0: HEIDENHAIN inverter
CM	9066	
PL	B/W/D	<>Status information> Bit 0: No function Bit 1: DC-link voltage too high (ERR.UZ.GR) Bit 2: Heat sink temperature too high (ERR.TEMP) Bit 3: Short-circuit of a motor phase with U_Z (AXISFAULT) Bit 4: DC-link current too high (ERR.IZ.GR) Bit 5: Power supply unit not ready (RDY.PS) Bit 6: Leakage current too high (ERR.ILEAK)

Error detection:

Marker	Value	Meaning
M4203	0	Status has been read
	1	Error code in W1022
W1022	2	Invalid code
	24	Module was called in a spawn job or submit job

6.11.11 EMERGENCY STOP monitoring

On the control there is a PLC input (X42/4) and a PLC output (X41/34) with the designation control-is-ready for the EMERGENCY STOP routine.

If a functional error is detected, the iTNC switches the control-is-ready output off. A blinking error messages appears and the PLC program is stopped. You **cannot** clear this error message with CE:

- Correct the error and restart the switch-on routine.

If the “control-is-ready signal acknowledgement” input is switched off by a process external to the control, the error message **EXTERNAL EMERGENCY STOP** appears. The NC sets M4177 and M4178. The nominal speed value 0 is output and the drives are switched off. You can clear this error message after switching the machine control voltage back on.

The “control-is-ready signal acknowledgment" input is passed directly onto the NC; it can **not** be manipulated by the PLC.

Resetting the “control-is-ready signal acknowledgement” inputs leads to position monitoring being shut off for the time defined in MP1150.1, and to an actual-to-nominal value transfer. After the time defined in MP1150.1 has expired, position monitoring is again active, for at least the time defined in MP1150.2.

If marker M4580 is set, then instead of the external emergency stop (“control-is-ready signal acknowledgement” input), the control loops of all axes and of the spindle are opened, and an NC stop is performed.

		Set	Reset
M4177	**Erasable error message is displayed**	NC	NC
M4178	**Error message EMERGENCY STOP is displayed**	NC	NC
M4580	**Suppress EMERGENCY STOP, open all position control loops, NC stop**	PLC	PLC

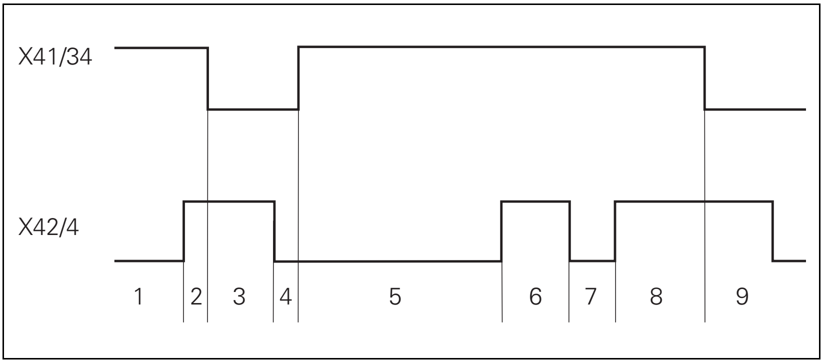
Connection diagram

In the event of an error, the control-is-ready output must trigger an emergency stop. The control therefore checks this output every time that line power is switched on.

Note

The circuitry recommended by HEIDENHAIN is illustrated in the Basic Circuit Diagram.

Ensure that the control-is-ready acknowledgment occurs within 1 second.



Step	Function	Screen display
1	Waiting for machine control voltage	**RELAY EXTERNAL DC VOLTAGE MISSING**
2	Recognition of the machine control voltage on X42/4 and switch-off of the control-is-ready signal on X41/34 by host computer (t < 66 ms)	
3	Maximum time within which the control-is-ready acknowledgment on X42/4 must go to zero (t < 1 s)	If exceeded **EMERGENCY STOP DEFECTIVE**
4	Recognition of the acknowledgment and setting of X41/34 (t < 20 ms)	
5	Waiting for machine control voltage	**RELAY EXTERNAL DC VOLTAGE MISSING**
6	Normal control operation. Control-is-ready output and acknowledgment are high.	
7	Control voltage is switched off externally.	**EMERGENCY STOP**
8	After switching on again, the machine control voltage can be switched off, and then the control operates normally.	
9	After detecting a fault, the control switches off the control-is-ready output (X41/34).	Blinking error message

6.12 Spindle

Two spindles can be controlled alternately (See page 6 – 206).
The main spindle/spindles are controlled with the PLC.

The programmed speed can be output as

- Code via PLC outputs
- Analog nominal speed command signal for an analog spindle
- Digital nominal speed value for a digital spindle

The spindle functions are of varying priorities. If several functions are output at the same time, the function with the highest priority is run, and the rest are deleted. The following spindle function priorities are valid:
1. Oriented spindle stop
2. Spindle jog
3. M3/M4
4. M5

▶ Specify in MP3010 the speed output for the spindle.

MP3010	**Output of speed, gear range**
Input:	0: No output of spindle speed
	1: Speed code, if the speed changes
	2: Speed code at every TOOL CALL
	3: Nominal speed value always, G code if the gear shifts
	4: Nominal speed value always, G code at every TOOL CALL
	5: Nominal speed value always, no G code
	6: Same as 3, but with servo-controlled spindle for oriented spindle stop
	7: Same as 4, but with servo-controlled spindle for oriented spindle stop
	8: Same as 5, but with servo-controlled spindle for oriented spindle stop

6.12.1 Position Encoder of the Spindle

Analog and digital spindles can be driven in a closed control loop. In this case the spindle needs its own position encoder:

▶ Define the position encoder input in MP111.x.

- If you have a digital spindle and would like to use the speed encoder also as a position encoder, then you must set MP111.x = 0.

▶ Enter in MP3142 the line count of the rotary encoder to be used. 1-V_{PP} signals undergo 1024-fold subdivision.

▶ Enter in MP3142 the type of mounting of the position encoder on the spindle. Due to the higher required accuracy, the position encoder must be mounted directly on the spindle, MP3143 = 0

If design considerations make this impossible:

▶ Define the encoder-to-spindle transmission ratio in MP3450.x and MP3451.x for each gear stage.

In this case there will be several reference pulses per revolution.

▶ Evaluate the reference mark with Module 9220. See "Renewed traversing of the reference marks" on page 6 – 103

If MP3143 = 2, then the reference pulse release for the spindle position encoder is set with X30, pin 1. Ensure that the same reference signal is always evaluated.

If MP3143 = 1 or 3, then X30 pin 1 is evaluated as the reference signal. The reference mark of the position encoder is not evaluated. In the case the reference signal **must** be evaluated with Module 9220 (See page 6 – 103).

Warning

Due to its low accuracy, this solution is not recommended.

MP111	**Position encoder input for the spindles**
Input:	0: No position encoder input 1 to 6: Position encoder inputs X1 to X6 35 to 38: Position encoder inputs X35 to X38
MP111.0	Position encoder input for the first spindle
MP111.1	Position encoder input for the second spindle
MP3142	**Line count of the spindle position encoder**
Input:	100 to 9 999 [lines]
MP3143	**Mounting configuration of the spindle position encoder**
Input:	0: Position encoder immediately on the first spindle 1: Position encoder via transmission (ratio in MP3450.x and MP3451.x); X30 pin 1: reference pulse 2: Position encoder via transmission (ratio in MP3450 and MP3451); X30 pin 1: reference pulse release 3: Same as input value 1, except that the second reference pulse is evaluated.
MP3450.0-7	**Number of spindle position-encoder revolutions for gear ranges 1 to 8**
Input:	0 to 65 535 0: No transmission
MP3451.0-7	**Number of spindle position-encoder revolutions for gear ranges 1 to 8**
Input:	0 to 65 535 0: No transmission

Module 9042 Reading the spindle coordinates (format 0.001°)

The following coordinate values are saved in five successive double words beginning with the specified target address:

- Actual value
- Nominal value
- Actual value in reference system
- Following error (servo lag)
- Distance to go

The value for actual, nominal, and reference value are standardized at 0° to +360.000°.
The values for servo lag and distance-to-go are displayed between –2879.912° and +2879.912°. Format: 0.001°.

If MP3010 < 6 (no closed-loop spindle), then all coordinates are read as zero.

During operation under open-loop control (M03 / M04 active or M05 and open position control loop), the nominal value is considered to be the actual value . The following error and distance to go are considered to be zero.

Call:
PS   B/W/D/K   <>Target address Cxxxx>
CM   9042

Error detection:

Marker	Value	Meaning
M4203	0	Actual speed value was read
	1	Target address is too large or is not a double-word address

Module 9044 Reading the spindle coordinates (format 0.0001°)

Call:
SEE MODULE 9042.

6.12.2 Speed Encoder of the Spindle

Digital speed control requires a shaft speed encoder:

▶ Define the speed encoder input in MP113.x.

The iTNC 530 monitors the reference mark of the speed encoder. The monitor checks whether the line count for one revolution from reference mark to reference mark is equal to the line-count entry in the motor table.
If differences occur, the DSP error message **`C3A0 Incorrect reference -position S`** appears. If this happens, check the speed encoder, encoder cable, and whether you have selected the correct motor.

With a gear wheel encoder, even if it is properly installed, monitoring can result in this error message due to its inherent inaccuracy:

▶ In this case, switch the monitoring off with MP2220 bit 0 = 1.

The iTNC 530 monitors the direction of rotation. If the nominal value of current exceeds the limit value for a certain time, the DSP error message **`C380 Motor <spindle 1/2, axis> not controllable`** appears.

At lower speeds, high-frequency spindles only have a low amount of torque. If such a spindle is having its speeds controlled, the tool changer may slightly twist the spindle, causing the limit of current to be exceeded. This leads to the above error message:

▶ In this case, switch the monitoring off with MP2221 bit 1 = 1.

Warning

For axes, the monitoring for the rotational direction (MP2220 Bit1) must **not** be deactivated. An error (e.g. one motor phase interchanged with another or incorrect entry in the DIR column of the motor table) might cause uncontrolled acceleration of the motor in one direction if the monitoring function for the rotational direction is deactivated.
This also applies to spindles. For spindles, however, an incorrect acceleration in one direction is less dangerous than for axes.

MP113	**Speed encoder for the spindle/spindles**
Input:	0: No speed encoder 15 to 20: Speed encoder inputs X15 to X20 80 to 83: Speed encoder inputs X80 to X83
MP113.0	Speed encoder for the first spindle
MP113.1	Speed encoder for the second spindle

MP2220.x	**Monitoring functions**
Input:	%xxx Bit 0 – Monitoring the reference mark 0: Monitoring active 1: Monitoring inactive Bit 1 – Monitoring the rotational direction 0: Monitoring active 1: Monitoring inactive

6.12.3 Analog and Digital Closed-Loop Spindle Control

For both analog and digital output of the nominal speed command you can program speeds of from 0 to 99 999.999 rpm.

The maximum controllable spindle speed is $\frac{80\,000}{\text{No. of pole pairs}}$.

If the load increases, the spindle speed is corrected until the maximum current is attained. If the load continues to increase in spite of the maximum current, the spindle speed is reduced. For the maximum current, the value from either the motor table or the power-module table of the drive, whichever is lower, applies.

If in MP3010 you have selected the output of the nominal speed value, M4003 is set. The programmed speed is saved in D356, the nominal speed value in W320 and the actual speed value in W322. In addition, the nominal speed value is saved in D364 and the actual speed value in D368, since speeds above 32 767 rpm cannot be represented in words W320 and W322.
With D604 you can limit the possible spindle speed through the PLC. To ensure compatibility, D604 is preassigned with 99 999 999 after control switch-on or after an interruption in the PLC scan.

Analog spindles:
The nominal speed value of the motor is output as an analog dc voltage of ±10 V at connection X8 or X9.

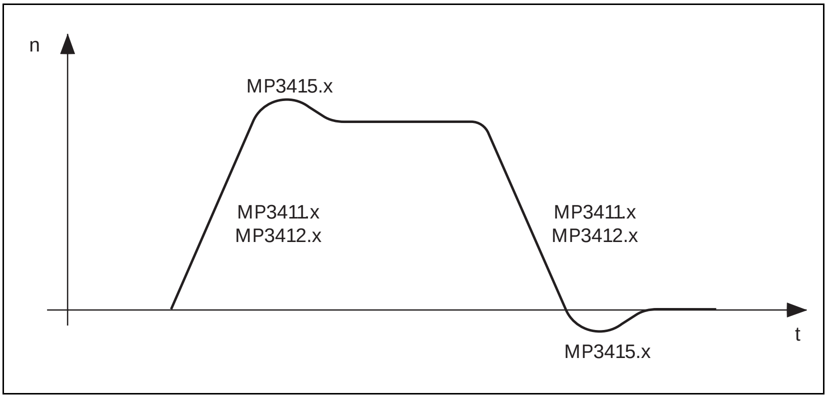
Digital spindles:
The nominal speed value is transferred to the internal speed controller.

		Set	Reset
M4003	**Nominal speed value output analog or digital (MP3010 = 3 to 8)**	NC	NC
D356	**Programmed speed [0.001 rpm]**	NC	NC
D364	**Nominal speed value [rpm]**	NC	NC
W320	**Nominal speed value [rpm]**	NC	NC
D368	**Actual speed value [rpm]**	NC	NC
W322	**Actual speed value [rpm]**	NC	NC
D604	**Maximum possible spindle speed**	PLC	NC/PLC

Nominal speed value

- In MP3411.x, define the ramp gradient for the nominal speed value at M03 and M04 for each gear range.
- With MP3412.0, specify a multiplication factor for MP3411.x, for
  - M05 (MP3412.0)
  - SPINDLE ORIENTATION (MP3412.1)
  - TAPPING (with floating tap holder) (MP3412.2)
  - RIGID TAPPING (without floating tap holder) (MP3412.3)

  The same factor applies for all gear ranges.
- Set M03, M04 and M05 MP3411 so that the motor accelerates and brakes within the current limit.
- With MP3415, define the overshoot behavior for every operating mode when the spindle is switched on with M4011. Set MP3415.0 so that only one overshoot is visible.



If the nominal speed value is in the acceleration or deceleration ramp, then M4001 is reset. This also applies if the speed is changed with the override potentiometer.

If the nominal speed value is output as zero, M4002 is set.

MP3411.0-7	**Ramp gradient of the spindle with M03 and M04 for gear ranges 1 to 8**
Input:	Analog axes: 0 to 1.999 [V/ms] Digital axes: 0 to 1.999 [1000 rpm/ms]

MP3415	**Overshoot behavior of the spindle with M03, M04 and M05**
Input:	0 to 1000 [ms]
MP3415.0	with M03, M04 and M05
MP3415.1	for spindle orientation
MP3415.2	for tapping
MP3415.3	for tapping without floating tap holder

MP3412	**Multiplication factor for MP3411.x**
Input:	0.000 to 1.999
MP3412.0	with M05
MP3412.1	with spindle orientation
MP3412.2	for tapping with floating tap holder
MP3412.3	for tapping without floating tap holder

		Set	Reset
M4001	**Nominal speed command signal of the spindle not in the ramp**	NC	NC
M4002	**Nominal speed value = 0**	NC	NC

Direction of spindle rotation

- With MP3130, define the polarity of the nominal speed value
- In MP3140, enter the counting direction of the position encoder signals.

As soon as you set M4005 for M03, or M4006 for M04, the nominal speed value is output. With M4007 for M05, the nominal speed value zero is output (spindle stop).

M4005 to M4007 also controls the miscellaneous functions in the status window.

If more than one marker is set at the same time, the error message `PLC: M4005, M4006, M4007 INCORRECT` appears.

With M4014 you can reverse the direction of rotation, in order to adjust the transmission for horizontal or vertical spindles, for example. The polarity of the nominal spindle speed is inverted.

M4019 reverses the counting direction of the spindle.

MP3130 **Polarity of the nominal spindle speed**
Input: 0: M03 positive, M04 negative
1: M03 negative, M04 positive
2: M03 and M04 positive
4: M03 and M04 negative

MP3140 **Counting direction of spindle position encoder output signals**
Input: 0: Positive counting direction with M03
1: Negative counting direction with M03

		Set	Reset
M4005	**Status display and nominal speed value output for M03**	PLC	PLC
M4006	**Status display and nominal speed value output for M04**	PLC	PLC
M4007	**Status display M05 and spindle stop**	PLC	PLC
M4014	**Reverse the direction of spindle rotation**	PLC	PLC
M4019	**Reversing the counting direction of the position encoder on the spindle**	PLC	PLC

Disable speed output for spindle

With M4008 you can block the speed output for the spindle. At the same time, M03, M04 or M05 are highlighted. The nominal speed value is zero.

		Set	Reset
M4008	**Disable speed output for spindle**	PLC	PLC

Gear ranges

You can define up to eight gear ranges:

- In MP3510.x, enter for each gear range the rated speed for S-override 100%.
  Enter the value zero for unnecessary gear ranges.
- In MP3210.x, enter for every gear range the S analog voltage or motor revolutions at rated speed.
- In MP3240.1, define the minimum nominal speed value for the motor.
- In MP3120, define whether zero is permitted as a programmed speed.

If an impermissible speed is programmed, M4004 is set and the error message **WRONG RPM** is displayed.

Note

The gear range from W256 is output when the spindle speed is 0.

MP3510.0-7 Rated speed for the gear ranges 1 to 8
Input: 0 to 99 999.999 [rpm]

MP3210.0-7 Analog nominal spindle voltage at rated speed for the gear ranges 1 to 8
Input: 0 to 100.000 [V]

MP3210.0-7 Digital spindle motor revolutions at rated speed for the gear ranges 1 to 8
Input: 0 to 100 000 [1000 rpm]

MP3240.1 Analog spindle: Minimum nominal value voltage
Input: 0 to 9.999 [V]

MP3240.1 Digital spindle: Minimum motor speed
Input: 0 to 9.999 [1000 rpm]

MP3120 Zero speed permitted
Input: 0: S = 0 permitted
1: S = 0 not allowed

		Set	Reset
M4004	**Impermissible speed was programmed**	NC	NC

Gear shifting

You control the gear shifting through PLC outputs. The NC enters the current gear range according to the programmed speed in W256. The gear range is calculated with MP3510.x. The output of the gear range is defined in MP3010. MP3030 bit 1 determines if the speed should be reduced to 0 when shifting between gears.

When the gear range is changed, the NC uses the G strobe (M4070). As soon as you confirm the gear shift with M4090, the program resumes and the G strobe (M4070) is reset by the NC.
If a TOOL CALL block is followed by the output of a T strobe and G strobe, then M4547 is set by the output of the T strobe and reset by output of the G strobe. If there is no output of either the T or G strobe, M4547 is not set.

In the PLC program you can change the programmed speed and the gear range that is calculated by the NC. This may be necessary, for example, for horizontal/vertical spindles. The programmed speed is saved by the NC in D356 and D756:

- Enter a speed in D756 and a gear range in W256. The speed must lie within the speed range of the gear.
- With M4134, activate your entries in D756 and W256.
- After the NC has reset M4134, change the gear and report with M4090 that the gear shift has been completed.

A changing nominal speed value can be output to shift gears by alternately setting and resetting M4009 and M4010. This can be realized by interrogating the timers in the PLC program. This function also works if you have used M4008 to disable the speed output for the spindle:

- In MP3240.2, define the nominal speed value that is output with M4009/M4010 to the spindle motor.

MP3030	**Behavior of the spindle**
Input:	Bit 1– Zero spindle speed when shifting to another gear range 0: Reduce speed to 0 1: Do not reduce speed to 0
MP3240.2	**Analog spindle: Spindle jog voltage for gear shifting (M4009/M4010)**
Input:	0 to 9.999 [V]
MP3240.2	**Digital spindle: Motor speed for gear shifting (M4009/M4010)**
Input:	0 to 9.999 [1000 rpm]

		Set	Reset
W256	**Gear code**	NC/PLC	NC/PLC
D356	**Programmed speed [0.001 rpm]**	NC	NC
D756	**Programmed speed or speed from PLC [0.001 rpm]**	NC/PLC	NC/PLC
M4009	**Counterclockwise spindle rotation (for gear change)**	PLC	PLC
M4010	**Clockwise spindle rotation (for gear change)**	PLC	PLC
M4070	**Strobe signal for gear code**	NC	NC
M4090	**Acknowledgment of “gear change completed”**	PLC	PLC
M4134	**Activation of a gear range and speed through the PLC**	PLC	NC
M4547	**T and G strobes with TOOL CALL**	NC	NC

Spindle override

You can change the spindle speed within certain limits with the spindle override potentiometer.

- Define the limits in MP3310.x.
- In MP3515.x, enter for every gear range a maximum attainable speed which must not be exceeded with the spindle override.

The percentage adjusted with the spindle override is entered by the NC in W492 and W764. You can change the percentage through the PLC:

- Enter the desired percentage in W764.
  As soon as a new value is entered here, it is assumed by the NC.

The spindle override functions either in 1% steps or according to a nonlinear characteristic curve:

- With MP7620, bit 3, select the mode of the override.

Value range in W492 and W764:

- 1% steps: 1 to 150
- Nonlinear characteristic curve: 0 to 15 000
  In the lowest range, 0.01% steps are available. Beginning with a value of 2.5%, the step is 0.75%

MP3310 **Limit for spindle override**
Input: 0 to 150 [%]
MP3310.0 Upper limit
MP3310.1 Lower limit

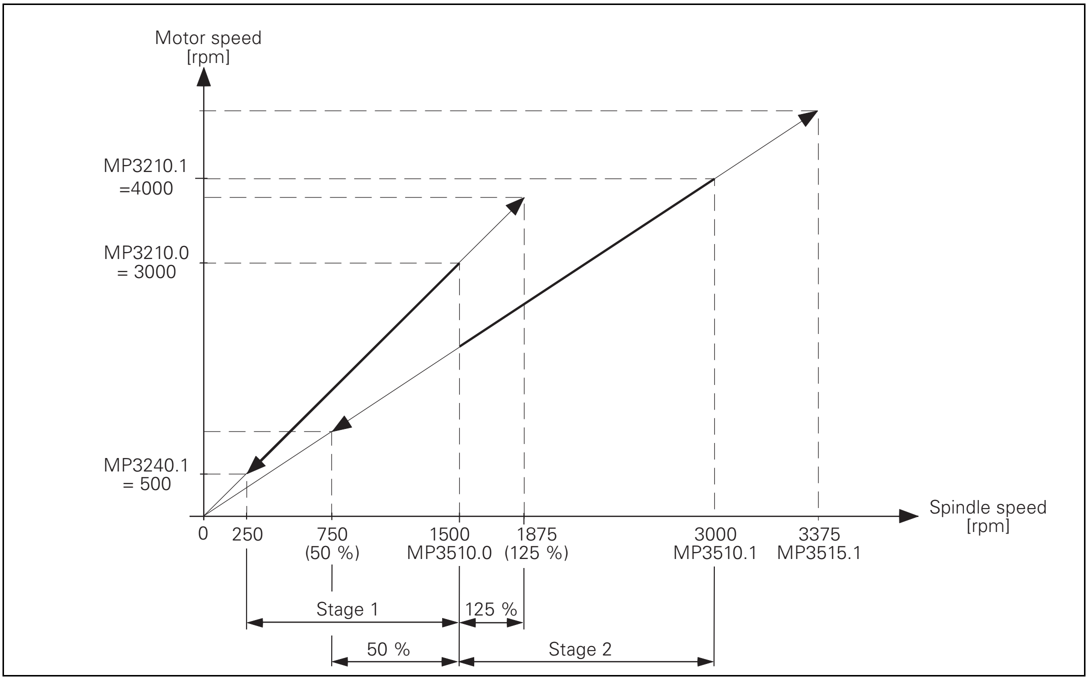
MP3515.0-7 **Maximum spindle speed for gear ranges 1 to 8**
Input: 0 to 99 999.999 [rpm]

MP7620 **Feed-rate override and spindle speed override**
Input: %xxxxxxx
Bit 3 – Feed rate override and spindle speed override in 1% increments or according to a nonlinear characteristic curve:
0: 1% steps
1: Nonlinear characteristic curve

		Set	Reset
W492	**Percentage for spindle override (NC to PLC)**	NC	NC
W764	**Percentage for spindle override (PLC to NC)**	NC/PLC	NC/PLC

Example: Two gear ranges for a digital spindle

- Gear range I: Spindle 1500 rpm with motor 3000 rpm (MP3210.0 = 3000; MP3510.0 = 1500)
- Gear range II: Spindle 3000 rpm with motor 4000 rpm (MP3210.1 = 4000; MP3510.1 = 3000)
- Upper limit for spindle override : 125% (MP3310.0 = 125)
- Lower limit for spindle override: 50% (MP3310.1 = 50)
- Maximum possible output speed for gear range II: 3375 rpm (MP3515.1 = 3375)
- Minimum motor speed: 500 rpm (MP3240.1 = 500)



6.12.4 Coded Output of Spindle Speed

If you have selected speed-code output in MP3010 (entry 1 or 2), an S code is entered in W258. You must output the speed code to the spindle drive through PLC outputs.

If the speed code is changed, the NC sets the S strobe (M4071). If you acknowledge the S code with M4091, the NC program is continued and the S strobe (M4071) is reset by the NC.

If required, the programmed spindle speed is rounded off to the next standard value by the NC and given in S code as per ISO 6983 (see S-code table). Speeds of 0 to 9000 rpm are possible:

- Specify in MP3020 the speed range and the speed increment. The S code for the minimum speed is saved in W1008.

Example:
Minimum speed = 1 rpm (S code 20)
Maximum speed = 1000 rpm (S code 80)
Speed increment = 2:

MP3020 = 20802
W1008 = 20

MP3020 **Speed range for S code output**
Format: xxyyz
xx: S code for minimum speed
yy: S code for maximum speed
z: Speed increment
Input: 0 to 99 999

		Set	Reset
W258	**S code**	NC	NC
M4071	**Strobe signal for S code**	NC	NC
M4091	**Acknowledgment of S code**	PLC	PLC
W1008	**S code for minimum speed**	NC	NC

S Code Table

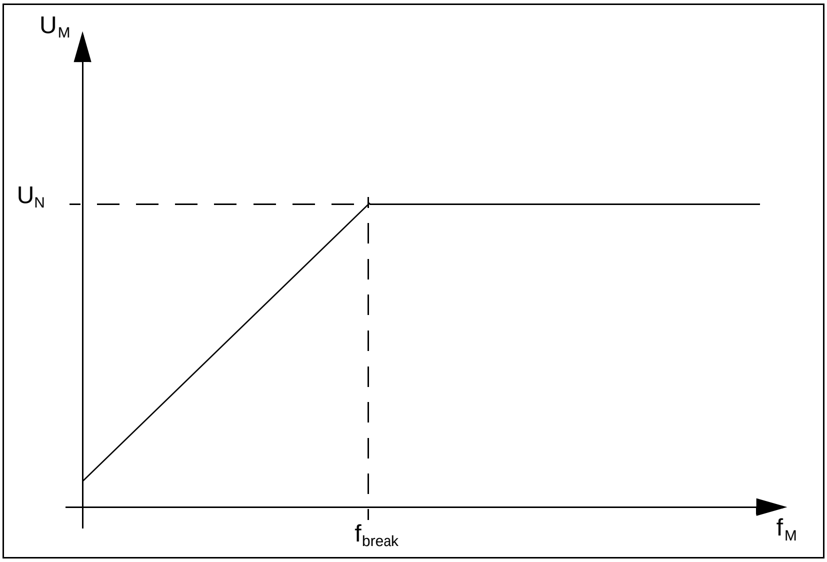
S code	rpm
S 00	0
S 01	0.112
S 02	0.125
S 03	0.14
S 04	0.16
S 05	0.18
S 06	0.2
S 07	0.224
S 08	0.25
S 09	0.28
S 10	0.315
S 11	0.355
S 12	0.4
S 13	0.45
S 14	0.5
S 15	0.56
S 16	0.63
S 17	0.71
S 18	0.8
S 19	0.9
S 20	1
S 21	1.12
S 22	1.25
S 23	1.4
S 24	1.6
S 25	1.8
S 26	2
S 27	2.24
S 28	2.5
S 29	2.8
S 30	3.15
S 31	3.55
S 32	4
S 33	4.5
S 34	5
S 35	5.6
S 36	6.3
S 37	7.1
S 38	8
S 39	9
S 40	10

S code	rpm
S 41	11.2
S 42	12.5
S 43	14
S 44	16
S 45	18
S 46	20
S 47	22.4
S 48	25
S 49	28
S 50	31.5
S 51	35.5
S 52	40
S 53	45
S 54	50
S 55	56
S 56	63
S 57	71
S 58	80
S 59	90
S 60	100
S 61	112
S 62	125
S 63	140
S 64	160
S 65	180
S 66	200
S 67	224
S 68	250
S 69	280
S 70	315
S 71	355
S 72	400
S 73	450
S 74	500
S 75	560
S 76	630
S 77	710
S 78	800
S 79	900
S 80	1000
S 81	1120

S code	rpm
S 83	1400
S 84	1600
S 85	1800
S 86	2000
S 87	2240
S 88	2500
S 89	2800
S 90	3150
S 91	3550
S 92	4000
S 93	4500
S 94	5000
S 95	5600
S 96	6300
S 97	7100
S 98	8000
S 99	9000

6.12.5 Volts-per-Hertz Control Mode

In volts-per-hertz control mode (U/f control mode), the motor is speed-controlled in an open loop. The motor voltage increases in proportion to frequency up to the break (= threshold rpm for field weakening). Then the motor voltage remains constant (= rated voltage of motor); only the frequency continues to increase.
If the spindle reaches the maximum current due to excessive load, the error message **`C380 Motor <Spindle 1/2> not controllable`** appears. For the maximum current, the value from either the motor table or the power-module table of the drive, whichever is lower, applies.



The maximum speed in the volts-per-hertz control mode corresponds to the maximum speed in closed loop operation.

To drive a motor with a U/f component:

- In the motor table, enter for your motor in the column **`Motor model`** (TYPE) UASM, in the column **`Encoder line count`** (STR.) the value 0, in the column **`Type of encoder`** (SYS) the value 0 and in the column **`Maximum temperature`** [°C] T-MAX the value 255.
- The machine parameters for current controller (MP24xx.y) and speed controller (MP25xx.y, MP 26xx.y) are nonfunctional.
- The acceleration and breaking ramp (MP341x) must be set so that the maximum current is not exceeded.

Since during volts-per-hertz (U/f) control mode no speed encoder is used, W322 = 0 (actual speed value) supplies the value 0:

- Module 9164 can determine the actual speed value while the spindle is running, but not during the acceleration and braking phases.

Note

The oscilloscope shows the actual current instead of the nominal current (I NOML), since there is no nominal current with U/f components.

6.12.6 Oriented spindle stop

For spindle orientation the spindle must be in a closed control loop:

- Mount a position encoder for the spindle.
- With MP3010 (input value 6 to 8), specify whether the control provides for spindle orientation.

In the NC's touch probe cycles and rigid tapping cycle, the NC orients the spindle directly. In these cases, the NC sets M4017. You must reset M4012 in the PLC.

To orient the spindle to a specific angle in an NC program, use FN17: SYSWRITE ID990 NR8. The conditions above must be followed. The NC program resumes after the spindle is in position (M4000).
You can ascertain the current spindle angle with FN18: SYSWRITE ID990 NR8.

If the spindle orientation is started with an M function (e.g. M19), you must activate the oriented spindle stop in the PLC.
In MP7442, enter the number of the M function (e.g., 19) which will trigger the oriented spindle stop during the machining cycles. If MP7442 = 0 (no oriented spindle stop), the error message **`ORIENTATION not permitted`** appears when a cycle which uses oriented spindle stop is called.

The spindle orientation runs asynchronously to the NC positioning commands. You may only acknowledge the orientation once the spindle is in position (M4000).

The NC starts orienting the spindle only if the drive is switched on with Module 9161.

There are three ways to orient the spindle in the PLC:

- Module 9171
- Marker M4130
- Via initiator with marker M4011

MP7442	**Number of the M function for spindle orientation in the cycles**
Input:	1 to 999: Number of the M function 0: No oriented spindle stop –1: Oriented spindle stop by the NC

Oriented spindle stop with Module 9171

The spindle speed is reduced in open-loop control along the ramp from MP3412.1 to the speed for spindle orientation (MP3520.1). As soon as this speed is reached, the control loop closes. The spindle is oriented in feedback control along the ramp from MP3412.1 to the nominal position. As long as the spindle moves in a closed loop, M4017 remains set:

- In MP3440.x, assign each gear range a k_V factor for adjusting the gear ranges.
- In MP3415.1, define the overshoot behavior of the first spindle during spindle orientation.
- Define the positioning window in MP3420. As soon as the spindle is in the positioning window, M4000 is set.

If the spindle should not remain in the position control loop after it reaches the nominal position, then you must set M4012. After the marker is set, the spindle is not feedback controlled any longer.

If M4012 always remains set, the control loop opens after every oriented spindle stop as soon as the positioning window is reached.

You can compensate a maladjustment resulting from mounting the rotary encoder:

- In MP3430, enter the offset between the nominal and actual position of the reference mark. The offset is then compensated during orientation.

After the spindle is switched on, the NC evaluates the reference mark, even if the position control loop is not closed. M4018 is set until the reference mark is evaluated. For special applications you can evaluate the reference mark again by setting M4015. The NC resets M4015 when the reference mark is evaluated.

- With MP7291, select the display mode for the spindle position. If M03 and M04 are not active, the display returns to zero every 360 degrees (modulo function).

MP3412.1 **Multiplier for MP3411 during spindle orientation**
Input: 0 to 1.999

MP3415.1 **Spindle overshoot behavior during orientation**
Input: 0 to 1000 [ms]

MP3420 **Spindle positioning window**
Input: 0 to 360.0000 [°]

MP3430 **Deviation of the reference mark from the desired position (spindle preset)**
Input: 0 to 360 [°]

MP3440.0-7 **k_V factor for spindle orientation for gear ranges 1 to 8**
Input: 0.1 to 10 [(1000°/ min) /°]

MP3520.1 **Spindle speed for oriented stop**
Input: 0 to 99 999.999 [rpm]

		Set	Reset
M4000	**Spindle in position**	NC	NC
M4012	**Opening the spindle control loop**	PLC	PLC
M4015	**Renewed evaluation of the spindle reference mark**	PLC	NC
M4017	**Spindle moving in feedback control**	NC	NC
M4018	**Reference mark for spindle not yet traversed**	NC	NC

With Module 9171 you can specify the speed, nominal position and direction of rotation for spindle orientation.

M4130 is set as long as the positioning movement lasts.

Module 9171 Oriented spindle stop

The module functions only in the cyclic PLC program. If you call the module while the spindle is rotating, the transferred direction will be ignored. The spindle will be oriented in the direction of spindle rotation.

If the values 2 to 4 are transferred as direction of rotation, the spindle will be oriented to the angle last defined in CYCL DEF 13. The transferred angle is added to the value from CYCL DEF 13.

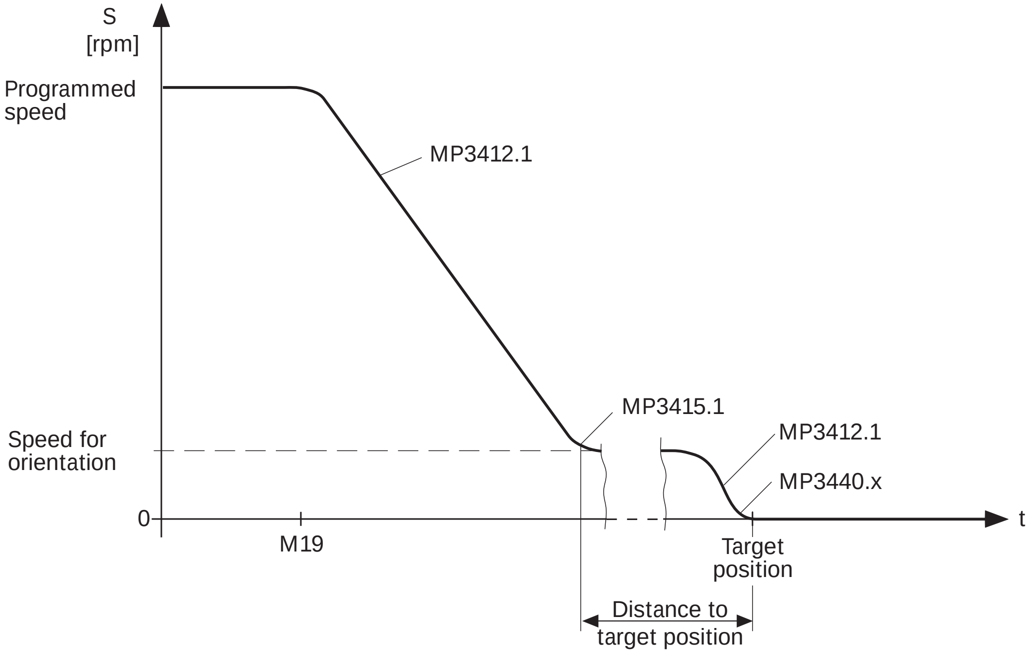
Call:

PS	B/W/D/K	<>Angle [1/10 000 °]> or additional preset if there is a value from CYCL DEF 13
PS	B/W/D/K	<>speed [1/1000 rpm]> 0: MP3520.1 is assumed
PS	B/W/D/K	<>Direction of rotation> –1: Negative direction (M04) 0: Direction of the shortest path 1: Positive direction (M03) 2: Same as –1 but angle from CYCL DEF 13 3: Same as 0 but angle from CYCL DEF 13 4: Same as +1 but angle from CYCL DEF 13
CM	9171	

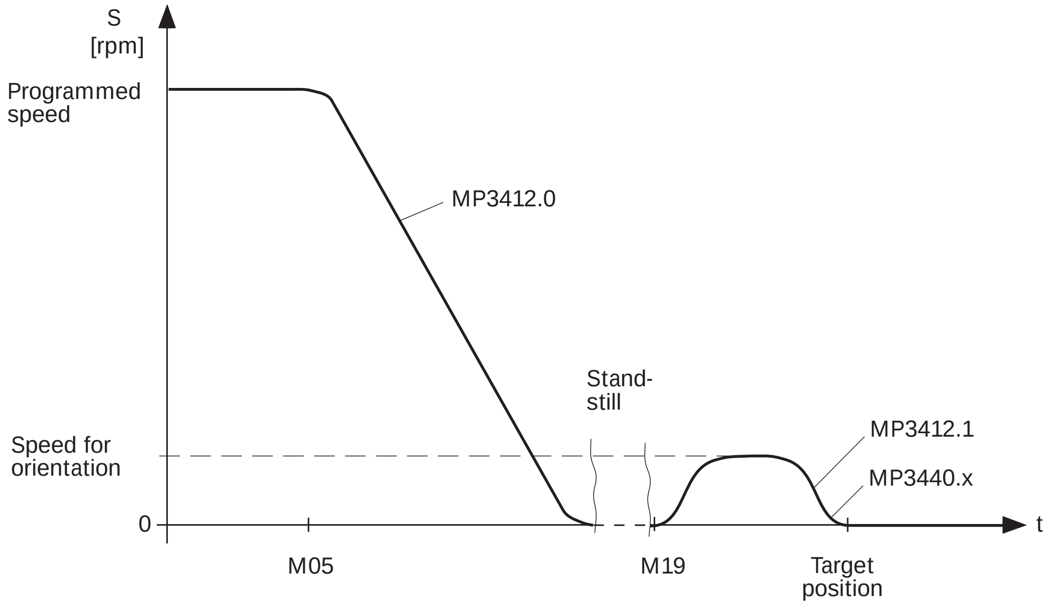
Error detection:

Marker	Value	Meaning
M4203	0	Spindle is brought to an oriented stop
	1	Error code in W1022
W1022	1	Incorrect value for direction of rotation or rotational angle
	2	Incorrect speed
	19	No feedback-controlled spindle
	24	The module was called in a spawn job or submit job
	27	A spindle orientation is already running

Orienting a moving spindle



Orienting a stationary spindle



Oriented spindle stop with M4130

You can start the spindle orientation with M4130. The nominal position is taken from D592 and the speed from MP3520.1. The nominal position is with respect to the reference point.

For example, the nominal position can be transferred with MP4210.x or taken from the oriented spindle stop cycle (CYCL DEF 13). If the value is taken from the cycle, you must set the MSB of D592 to 1 and the other bits to 0. M4016 is set during execution of Cycle 13.

From a standstill, the spindle is oriented on the shortest path. Prerequisite: At the start, the distance between the nominal and actual position must not be greater than the positioning window (MP3420). If the distance is greater than the positioning window, the spindle is positioned according to M4013 with M03 or M04.

		Set	Reset
D592	**Nominal position for spindle orientation**	PLC	PLC
M4013	**Direction for spindle orientation from a standstill (M03 = 0; M04 = 1)**	PLC	PLC
M4016	**Cycle 13 is executed**	NC	PLC
M4130	**Activation of spindle orientation, or spindle orientation has been started with Module 9171**	NC/PLC	NC

MP4210.0-47 Setting a number in the PLC (D768 to D956)
Input: -99 999.9999 to 99 999.9999

Oriented spindle stop via proximity switch with M4011

The spindle can be oriented through a proximity switch:

- Set M4011.

Then the spindle is moved in the direction from M4013 and at the speed from MP3520.0. The spindle is stopped as soon as you reset M4011. The current positioning value is shown in the status window.

MP3520.0 Speed activation through marker M4011
Input: 0 to 99 999.999 [rpm]

		Set	Reset
M4011	**Activate rotational speed MP3520.0 and direction of rotation from M4013**	PLC	PLC

Offset compensation (only analog spindles)

After spindle orientation the offset is compensated automatically. In order to give the spindle enough time to settle to a stop, the offset compensation is delayed until the spindle has been in position for at least two seconds. The offset is then compensated in intervals of 0.152 mV per second. The spindle turns slowly due to the offset voltage.

6.12.7 Tapping with Floating Tap Holder and Nominal Speed Output

For tapping with floating tap holder, the position control loop is open. M4030 is set during the tapping cycle. After the spindle is switched on with M03, this is acknowledged with M4092. The nominal spindle speed must be reached before infeed begins.

During switch-on, the spindle follows the ramp in MP3411.x. During switch-off, it follows the ramp in MP3412.2:

- In MP3412.2, enter a multiplier for MP3411 during tapping.
- In MP3415.2, define the overshoot behavior of the spindle during tapping.
- Acknowledge the output of the M functions. An NC stop cannot be executed until a previous M function is acknowledged.

If the feed-rate and spindle ramps have differing gradients, the spindle follows the slower ramp.

Example:
Speed s = 1000 rpm
MP3411.x = 0.025 [1000 rpm/ms]

$$\frac{1000\ \text{min}^{-1}}{0{,}025 \cdot [1000\ \text{min}^{-1}/\text{ms}]} = 40\ \text{ms}$$

In this example the spindle was braked 40 ms before reaching the hole depth.

Delay times permit an optimum adjustment of the floating tap holder. You can delay the switch-off:

- In MP7120.2 enter a spindle slow-down time.

The delay cannot last longer than 30 ms before reaching the hole depth. Values above 30 ms are ignored (see also diagram).

You can delay a subsequent spindle start with M04:

- In MP7120.0 enter a dwell time. The ramp follows MP3412.2

You can delay restarting the infeed:

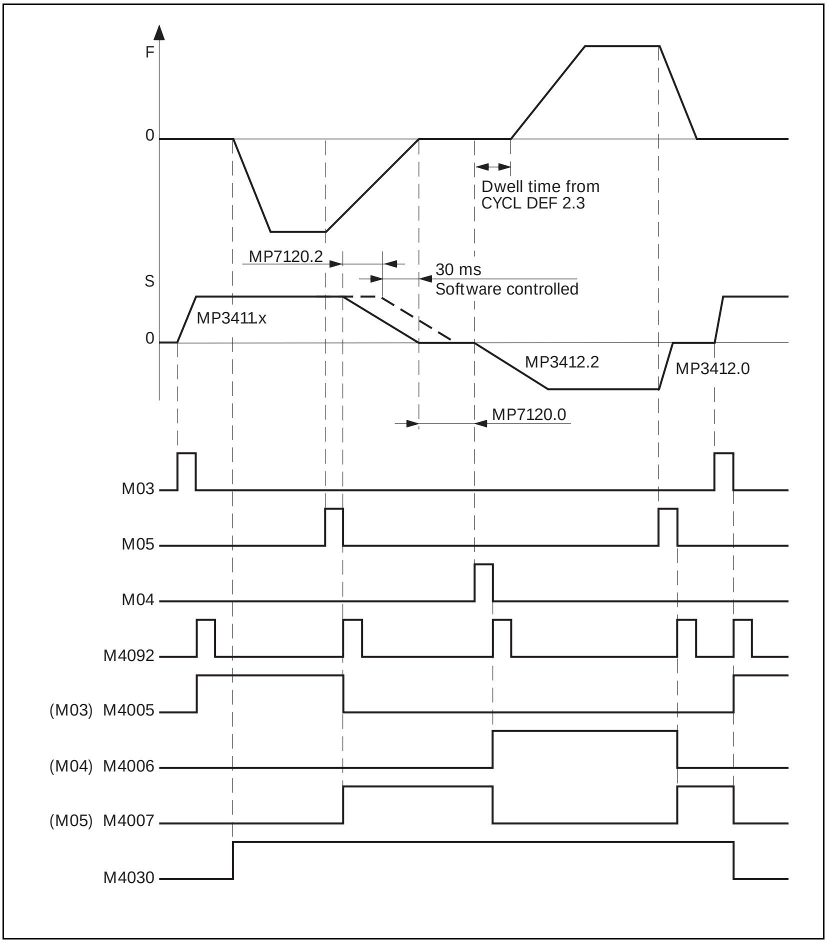
- Change the programmed dwell time in the cycle.

The NC uses M05 to switch off the spindle. The switch-off ramp follows MP3412.0. Then the spindle is switched back on with M03.

The feed rate override for tapping must be limited. Otherwise the floating tap holder may be damaged:

- Enter a limit in MP7110.x.

The following diagram shows the time sequence of the cycle:



		Set	Reset
M4030	**Cycle 2 or Cycle 17 active**	NC	NC

MP3412.2 **Multiplier for MP3411 during tapping**
Input: 0 to 1.999

MP3415.2 **Overshoot behavior of the spindle during tapping**
Input: 0 to 1000 [ms]

MP7110.0 **Minimum for feed rate override during tapping**
Input: 0 to 150 [%]

MP7110.1 **Maximum for feed rate override during tapping**
Input: 0 to 150 [%]

MP7120.0 **Dwell time for reversal of spindle rotational direction**
Input: 0 to 65.535 [s]

MP7120.2 **Spindle slow-down time after reaching the hole depth**
Input: 0 to 65.535 [s]

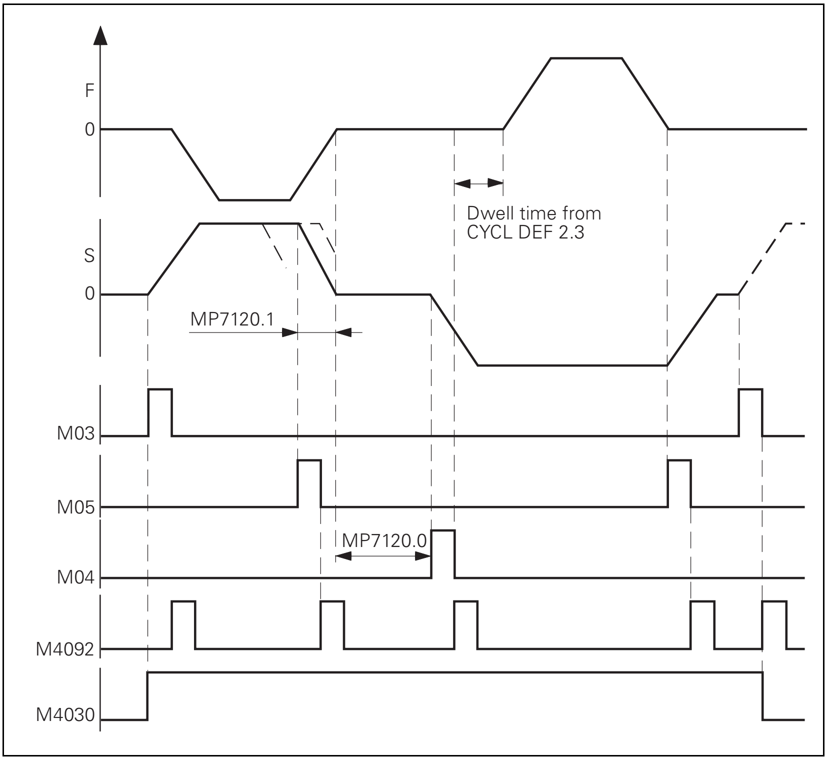
6.12.8 Tapping with Floating Tap Holder and Coded Spindle-Speed Output

If the spindle speed is output in code, the spindle and feed-rate ramps cannot be synchronized:

- Enter the advanced switching time of the spindle in MP7120.1.

The dwell time for rotational direction reversal (MP7120.0) and the programmed dwell time have the same effect as the nominal speed value output.

The following diagram shows the time sequence of the cycle:



MP7120.1 **Advanced switching time of the spindle during tapping with coded spindle-speed output**

Input: 0 to 65.535 [s]

6.12.9 Rigid Tapping

Cycle 17

- Define the rigid tapping process in the NC program with Cycle 17. While Cycle 17 is running, the iTNC switches automatically to velocity feedforward mode.
- Define the dynamic response of the spindle and the machine tool axes in machine parameters. See "The Control Loop" on page 6 – 109 und „Spindle" on page 6 – 179.

With Cycle 17 the spindle can also be feedback-controlled. This results in a better speed curve:

- Set MP7160 bit 2 = 1 to drive the spindle under position feedback control with Cycle 17.

With small thread depths and excessive spindle speeds it is possible that the programmed spindle speed may not be attained. The immediate transition from the acceleration phase to the braking phase can diminish the quality of the thread:

- Set MP7160 bit 1 = 1 in order to limit the spindle speed so that the spindle runs for about 1/3 of the tapping time at a constant speed.

During tapping, the position of the tool axis tracks the actual position of the spindle.

Please note that the use of IPC and acceleration feedforward control for the tool axis makes the tool axis sensitive to fluctuations in spindle speed caused, for example, by gear transmission. If this happens, the tool axis starts to run rough:

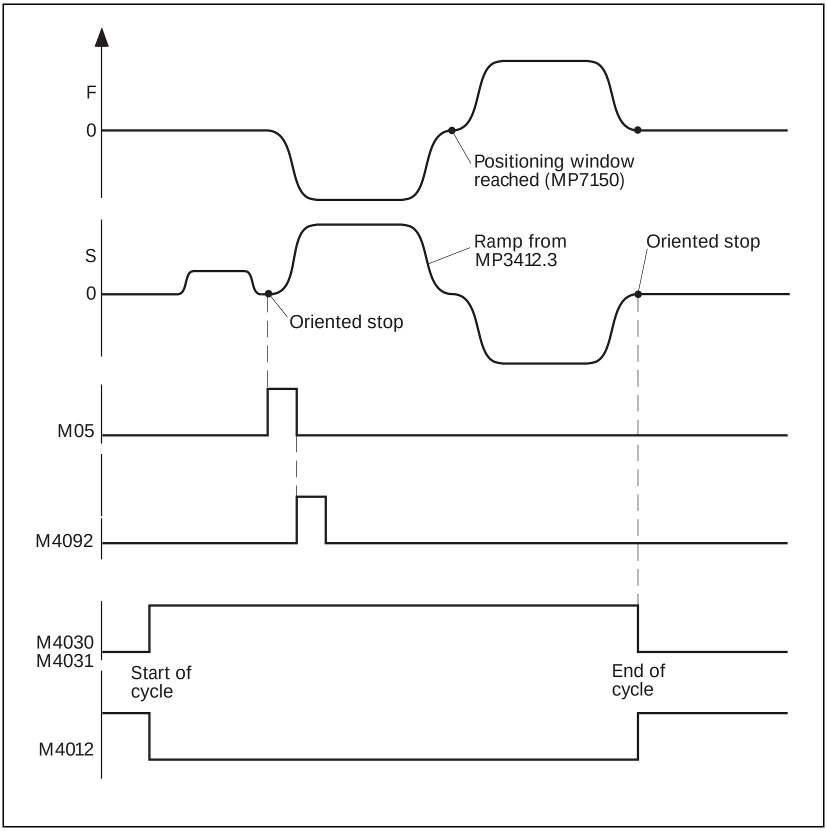
- In MP7160, set bit 3 = 1 to switch off IPC and acceleration feedforward control for Cycle 17.

Before tapping, the axes (e.g. Z and S) are synchronized through an oriented spindle stop, i.e., every Z position is assigned to a certain spindle angle. The NC orients the spindle. The NC sets M4017. The position control loop must be closed (M4012). See also „Oriented spindle stop" on page 6 – 194.

Synchronization makes it possible to cut the same thread more than once. The assigned spindle angle depends on the thread pitch entered in the cycle. You can deselect this function to save machining time:

- Set MP7160 bit 0 = 1
  In this case you cannot cut the thread more than once.

M4031 and M4030 are set while the cycle runs.

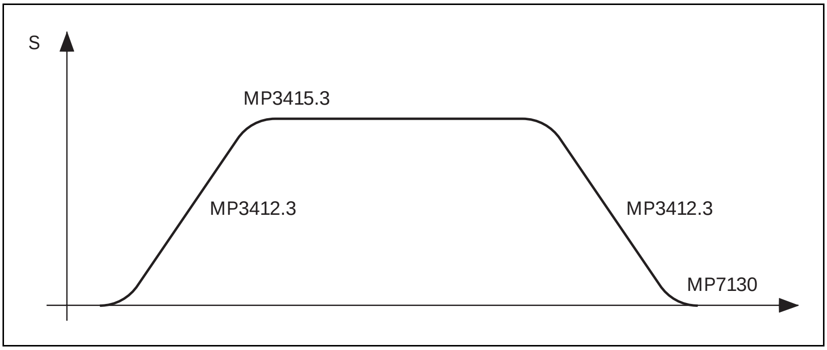


While Cycle 17 is running, the positioning window from MP7150 applies to the tool axis:

- Enter a value in MP7150 smaller than or equal MP1030.x.

Define the acceleration and braking process of the spindle during rigid tapping:

- In MP3412.3 enter a multiplier for MP3411.x.
- With MP3415.3, define the overshoot behavior of the spindle.
- With MP7130, define the run-in behavior of the spindle.



MP3412.3 **Multiplier for MP3411.x for rigid tapping**
Input: 0 to 1.999

MP3415.3 **Overshoot behavior of the first spindle during rigid tapping**
Input: 0 to 1000 [ms]

MP7130 **Run-in behavior of the spindle during rigid tapping**
Input: 0.001 to 10 [°/min]

MP7150 **Positioning window of the tool axis during rigid tapping**
Input: 0.0001 to 2 [mm]

MP7160 **Spindle response during Cycle 17, 207 and 18**
Format: %xxx
Input: Bit 0 – Oriented spindle stop with Cycles 17 and 207
0: Oriented spindle stop before execution of the cycle
1: No oriented spindle stop before execution of the cycle
Bit 1 – Spindle speed
0: Spindle speed is not limited
1: Spindle speed is limited so that it runs with constant speed approx. 1/3 of the time
Bit 2 – Spindle in position feedback control
0: Spindle operated without position feedback control
1: Spindle operated with position feedback control
Bit 3 – IPC and acceleration feedforward control
0: Active
1: Not active

		Set	Reset
M4030	**Cycle 2 or Cycle 17 active**	NC	NC
M4031	**Cycle 17 or Cycle 18 active**	NC	NC

Cycle 18

With Cycle 18 the tool axis tracks the actual position of the spindle. The starting position is the actual position. The target position is the hole depth:

- Program the approach and departure separately.

M4031 is set while Cycle 18 is running. M4012 must be reset for the cycle to be executed.

MP3412.3, MP3415.3, MP7130, MP7150 and MP7160 bit 1, bit 2 and bit 3 function as for Cycle 17.

6.12.10 Switching the Modes of Operation

For a spindle motor, two parameter blocks with the same name can be saved in the motor table. This may be necessary if

- Another parameter block applies to a spindle motor at the higher speed range.
- A wye/delta connection switchover is carried out for a motor.

The switchover can be carried out during standstill or with a revolving spindle.

As soon as the operating mode is switched with Module 9163, the NC switches the drive controller of the spindle off and activates the parameter block from the motor table and the machine parameters. You can check this with Module 9162. After the operating mode has been switched, you must reactivate the drive controller of the spindle with Module 9161.

To use the operating-mode switchover:

- Enter the two parameter blocks of your spindle motor with the same name in the motor table. Identify parameter block 1 by entering 0 in the **MODE** column, and parameter block 2 by entering 1.
- Switch between the two operating modes with Module 9163.
- With Module 9161, reactivate the drive controller.

For the two operating modes, you can use different machine parameters for the current and speed controller:

- In MP131.x you enter the y index of machine parameters MP2xxx.y for the current and speed controller in operating mode 0.
- In MP132.x you enter the y index of machine parameters MP2xxx.y for the current and speed controller in operating mode 1.

Module 9163 Switching the operating modes

Call:

PS	B/W/D/K	<>Axis> 15: Spindle
PS	B/W/D/K	<>Type of connection> 0: Operating mode 0 1: Operating mode 1
CM	9163	

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Incorrect axis, incorrect type of connection, or missing motor specifications

6.12.11 Operating a Second Spindle

With the iTNC 530 you can operate two spindles alternately, i.e., only one spindle can be active at a given time.
Both spindles can be operated as analog or digital spindles. If one spindle is to be operated as a digital spindle and the other one as an analog spindle, the first spindle must be operated as a digital spindle.

Assignment of encoder input and speed command output

The second spindle is driven instead of an axis, i.e., there are fewer axes available. An exception is analog operation of the second spindle without a position encoder. In this case all axes remain available. The assignment of position and speed encoder inputs as well as of speed command outputs is entered in MP111.x, MP113.x and MP121.x. See "Assignment for Axes" on page 6 – 13.

> **Note**
>
> If the speed encoder (with active reference mark monitoring, MP2220 bit 0) is disconnected and reconnected, the reference mark must be reevaluated (M4015) after the drive has been switched on again, otherwise the error message **`Incorrect reference position`** appears.

Switching between the spindles

You can switch between the two spindles through the PLC:

- Enter MP4020 bit 5 = 1 to activate double spindle operation.
- With Module 9175, switch between spindle 1 and spindle 2.

Commissioning the second spindle

- Digital second spindle: In MP10, deactivate one axis.
- Digital second spindle: Set MP110.x, MP112.x and MP120.x of the deactivated axis to zero.
- Machine parameters MP13010 to MP13520 are available for the second spindle. In their functions and input ranges, these parameters are identical with MP3010 to MP3520 for the first spindle. See "Spindle" on page 6 – 179.
- Current and speed controller: For commissioning, use the machine parameters MP2040.x to MP2930.x. Determine the x index to be used for the second spindle with MP131.1 (for operating mode 0) and with MP132.1 (for operating mode 1).

MP4020	**PLC Functions**
Format:	%xxxxxxxx
Input:	Bit 5 – Single- or double-spindle operation 0: Single-spindle operation 1: Double-spindle operation

MP13010 to MP13520	**Machine parameter block for the second spindle**
Input:	Function and input range are identical to MP3010 to MP3520

Module 9175 Spindle switchover

With this module you can switch between spindle 1 and spindle 2. When switching via an M strobe, MP7440 bit 2 must not be set. When switching via an S or G strobe, MP3030 or MP13030, respectively, must not be set. The module only needs to be called once.

Call:

PS	B/W/D/K	<>Spindle number>
		0: First spindle
		1: Second spindle
CM	9175	

Error detection:

Marker	Value	Meaning
M4203	0	Specified spindle active
	1	Error code in W1022
W1022	2	Invalid spindle number
	6	M4157 = 1 (RESTORE POSITION active)
	20	Module was called in a spawn job or submit job
	21	Missing strobe in M4176 = 1

6.12.12 C-Axis Operation

In C-axis operation, an axis and a spindle are driven alternately by the same motor.
Digital or analog operation of axis and spindle is possible. Axis and spindle may each be equipped with one position encoder. Because the speed encoder is built into the motor, it measures both the axis and the spindle.

Assignment of encoder inputs and speed command outputs to the axis and spindle:

- In MP110.x enter the position encoder input of the axis (if present).
- In MP111.x enter the position encoder input of the spindle (if present).
- Enter MP112.x = 0 for the axis (it uses the speed encoder of the spindle motor).
- In MP113.x enter the speed encoder input of the spindle.
- Enter the same speed command output in MP121.x for the spindle and in MP120.x for the axis.
- Enter the same y index for machine parameters MP2xxx.y of the current and speed controller in MP130.x for the axis and in MP131.x or MP132.x for the spindle.

Commissioning of the axis and the spindle:

- The current and speed controllers are commissioned only for the spindle.
- The position controllers **must** be commissioned separately for the axis and spindle.

Note

The axis position controller should be commissioned in the gear range that is actually used for positioning.
If possible, use the lowest gear range to ensure optimum control.

If you use only one position encoder for both the spindle and the axis, the axis display keeps running while the spindle is in operation:

- Before switching from the axis to the spindle, save the actual position value of the axis with Module 9146. This ensures that the axis display remains at the last value, even when the spindle is rotating.
- Before switching from the spindle to the axis, recover the actual position value of the axis with Module 9146.

If you save the actual position value with Module 9146 and then close the position control loop, or if the position control loop is closed and the actual position value is then saved with Module 9146, the error message **`Actual position value saved <Axis>`** appears. The error message triggers an emergency stop.

Switching from **spindle to axis:**

- Stop the spindle
- Switch to the gear range required for axis operation.
- Switch the spindle motor to the axis.
- With Module 9156, switch the axis from the open-loop to the servo-controlled state.
- With Module 9161 bit 15, release the current and speed controllers.
- Release the axis clamping.
- Close the position control loop of the axis by setting the corresponding bits in W1040.
- Begin axis operation

Switching from **axis to spindle:**

- Stop the axis
- Clamp the axis
- Open the position control loop of the axis by resetting the corresponding bits in W1040.
- With Module 9155, switch the feedback control for the axis off.
- Switch the spindle motor from the axis back to the spindle.
- With Module 9161 bit 15, release the current and speed controllers.
- Shift back to the original gear range.
- Begin spindle operation

Module 9146 Saving and reestablishing actual position values

Module 9146 saves and later reestablishes the actual position values of axes. If the actual position values were saved, the last value displayed remains until they are reestablished.

Call:

```
PS      B/W/D/K   <>axes bit-encoded>
PS      B/W/D/K   <>Mode>
                  0: Save actual position values
                  1: Reestablish actual position values
CM      9146
```

Error detection:

Marker	Value	Meaning
M4203	0	Actual position values saved or reestablished
	1	Error code in W1022
W1022	1	Invalid mode
	2	Invalid axes
	24	Module was called in a spawn job or submit job

Module 9155 Axis switchover from closed loop to open loop

With Module 9155 you can switch an axis from the closed-loop to the open-loop state. Now the bit can be transferred to the spindle or the axis.

Call:
PS B/W/D/K <>axes bit-encoded>
CM 9155

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	2	Invalid axis number
	21	Missing strobe or M4176 = 1
	24	Module was called in a spawn job or submit job

Module 9156 Axis switchover from open loop to closed loop

With Module 9156 you can switch an axis from the open-loop to the closed-loop state. An automatic actual-to-nominal value transfer is executed. Now the bit can be transferred to the spindle or the axis.

Call:
PS B/W/D/K <>axes bit-encoded>
CM 9156

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	2	Invalid axis number
	21	Missing strobe or M4176 = 1
	24	Module was called in a spawn job or submit job

6.13 Integrated Oscilloscope

The iTNC features an integrated oscilloscope.

With this oscilloscope you can record the following signals in up to four channels:

Signal	Meaning
SAVED	The signal last recorded is saved.
Actual pos	Actual position [mm]
Noml. pos	Nominal position [mm]
Lag	Following error of the position controller [µm]
Volt.analog	Analog axis/spindle: Analog voltage = nominal velocity value [mV]
Actl. speed	Actual value of the axis feed rate [mm/min]. Calculated from position encoder
Noml. speed	Nominal value of the axis feed rate [mm/min]. Axis feed rate calculated from the difference from the nominal position values. The following error isn't included.
Feed rate	Contouring feed rate [mm/min]
Position: I1	Signal 1 of the position encoder
Position: I2	Signal 2 of the position encoder
V (ACT RPM)	Shaft speed actual value [mm/min]; Calculated from rotary speed encoder and standardized with MP1054
V (NOM RPM)	Nominal velocity value [mm/min]: Output quantity of the position controller
I (INT RPM)	Integral-action component of the nominal current value [A]
I nominal	Nominal current value [A] that determines torque
PLC	The PLC operands (B, W, D, I, O, T, C) are recorded. Enter the operands in the input field next to the PLC.
Acceleration	Nominal value of the acceleration [m/s^2]
Jerk	Nominal value of the jerk [m/s^3]
Pos. Diff.	Difference between position and speed encoder [mm]
Current Accel.	Current acceleration value [m/s^2]. Calculated from position encoder.
Current Jerk	Current jerk value [m/s^3]. Calculated from position encoder.
I2-t (mot.)	Current value of the I^2-t monitoring of the motor [%]
I2-t (p.m.)	Current value of the I^2-t monitoring of the power module [%]
Utilization	Utilization of drive motors [%]
Block no.	Block number of the NC program
Gantry Axes	Difference between synchronous axes [mm]

The oscilloscope provides additional functions for commissioning the current controller. See "Commissioning" on page 6 – 218.

The recorded data remain stored until you start recording again or activate another graphic function.

Colors

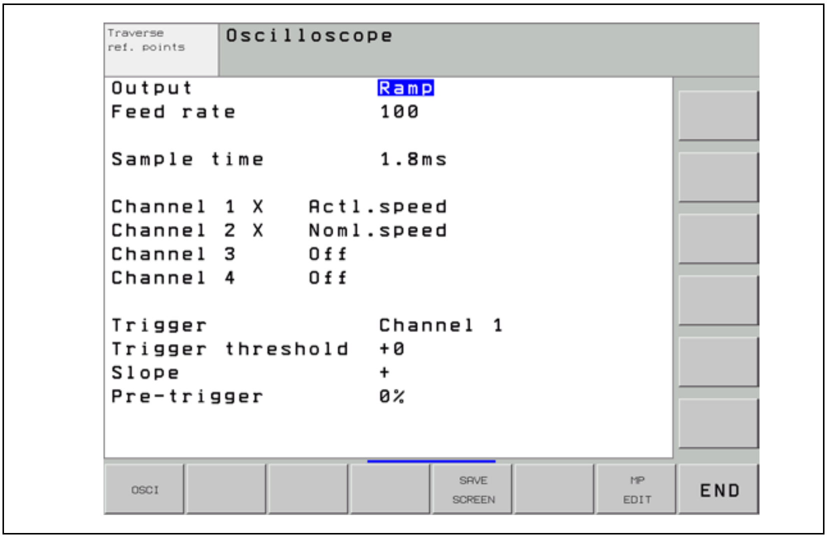
▶ In MP7365.x, define the colors for the oscilloscope.

Setup

▶ Activate the oscilloscope with the code number 688379.

After you enter the code number, the setup menu appears:

▶ Choose the parameters to be entered with the cursor keys.



Output:

▶ Select whether the nominal speed value is to be issued as a step or ramp.

- If you select ramp output, then the programmed feed rate, k_V factors, and acceleration values that you have specified with machine parameters go into effect.
- If you select step output, a step will be output as nominal velocity value when you press the axis-direction buttons in the **Manual operating mode.** During output, the position control loop is opened.

Feed rate:

▶ Enter the height of the step for the nominal velocity value (in mm/min). This entry has no effect for ramp output.

Sample time:

▶ Set the time interval for recording the signals.
Entry: 0.6 ms; 1.8 ms and 3.6 ms
4096 samples are stored. The signals are therefore stored for the following duration:

- 0.6 ms · 4096 = 2.4576 s
- 1.8 ms · 4096 = 7.3728 s
- 3.6 ms · 4096 = 14.7456 s

Channel 1 to channel 4:

▶ Assign the channels of the recorded signals to the respective axes.

Trigger:

▶ Define the type of recording.
You have the following possibilities:

- **`Free run`**: The recording is started and ended by soft key. If you press the STOP soft key, the last 4096 events are stored.
- **`Single shot`**: If you press the START soft key, the next 4096 events are stored.
- **`Channel 1`** to **`4`**: Recording begins when the triggering threshold of the selected channel is exceeded.

Trigger threshold:

▶ Enter the trigger threshold in the following dimensions:

- Velocity [mm/min]
- Position [mm]
- Shaft speed [mm/min]
- Following error [µm]
- Analog voltage [mV]
- Current [A]
- Acceleration [m/s^2]
- Jerk [m/s^3]

Slope:

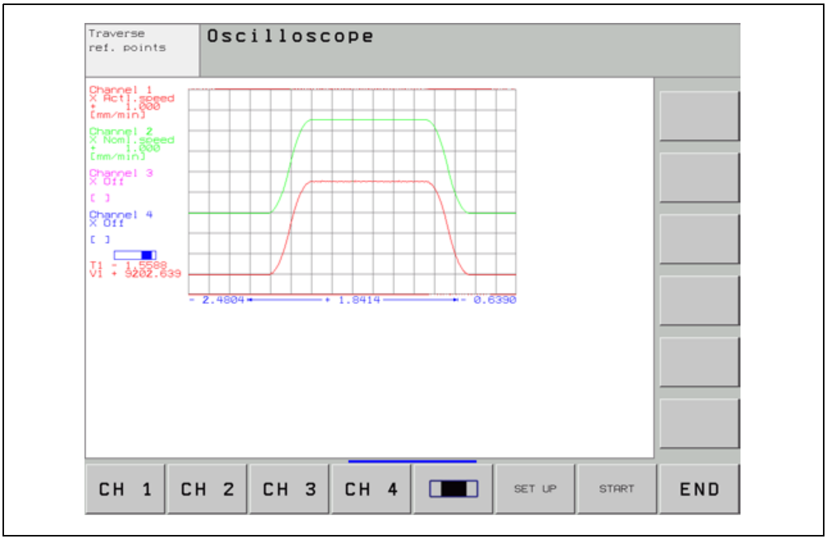
▶ Select whether the rising edge (positive slope) or falling edge (negative slope) of the signal acts as trigger.

Pre-Trigger:
Recording begins at a time preceding the trigger time point by the value entered here

▶ Enter a value.

Oscilloscope display:

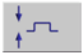
▶ Press the OSCI Soft key



During recording, the selected signals are continuously displayed. After recording ends, the memory contents are displayed. For every channel, the type of signal and the resolution are also shown. The length of the recorded range, with respect to the entire memory content, is shown as a bar in the status field.

- Move the cursor with the arrow keys. The status field shows the amplitude of the selected channel and the time with respect to the beginning of recording.
- Activate a second cursor by pressing the CURSOR 1/2 soft key. The oscilloscope displays the amplitude and time of this cursor. The time [s] of the second cursor is shown with respect to the time point of the first cursor. With this function you can measure the acceleration time of an axis, for example.

Meaning of the soft keys:

Meaning of the soft keys:		
CH 1	You select one of the four channels, and a new soft-key row with the following soft keys appears.	
	INVERT	Invert the signal.
		Move the signal down
		Move the signal up
		Decrease the vertical resolution.
		Increase the vertical resolution.
		Optimum vertical resolution. The signal is centered in the picture. With NO ENT you return to the resolution chosen originally.
	CURSOR 1/2	Switch to second cursor.
	END	Return to oscilloscope display.
	Select the memory area to be displayed. A new soft-key row with the following soft keys appears:	
		Move the signal to the left
		Move the signal to the right
		Decrease the horizontal resolution.
		Increase the horizontal resolution.
	END	Return to oscilloscope display.
SET UP	Back to setup menu.	
START	Start recording. The recording is ended either with a trigger condition or with the STOP soft key.	
END	Exit the oscilloscope function.	

Saving the recording

You can display the signal last recorded for a channel again by selecting the Saved signal.

With the SAVE SCREEN soft key in the Set up menu you can save the recorded signals with all settings in a file on the hard disk. The file must have the extension *.DTA. You can recall this file with the PLC development software PLCdesign.

6.14 Commissioning

6.14.1 Preparation

Proceed as follows:

- Check the wiring against the grounding diagram and the safety concept (See "Basic Circuit Diagram" at the end of Chapter 3).
- Check the control-is-ready function.
  See "EMERGENCY STOP monitoring" on page 6 – 176
- Check the EMERGENCY STOP circuit by pressing the EMERGENCY STOP buttons and the EMERGENCY STOP limit switch.
- Select the current machine parameter file. Determine input values using the documentation on hand. Enter temporary values for machine parameters that must be optimized during commissioning.
- Create a PLC program for interfacing the control to the machine (use the PLC development software PLCdesign).
- Ensure that in the system file OEM.SYS the instruction **PLCMAIN=** refers to the current PLC program.

6.14.2 Table for power module, supply module and motor

In the machine parameter editor you select the installed power modules and the motors:

- Call a list of power modules or motors with the corresponding soft key.
  In the list of motors, the type of motor (synchronous, asynchronous, or linear motor) and the operating mode are displayed in addition to the motor designation.

Meaning of the soft keys:	
	Call a list of power modules.
BEGIN ↑	Jump to the beginning of the list of power modules.
END ↓	Jump to the end of the list of power modules.
PAGE ↓	Scroll one page forward in the list of power modules.
PAGE ↑	Scroll one page backward in the list of power modules.
SELECT AXIS	Select a power module with the arrow keys and transfer it with the corresponding "STORE MP2100.X" soft key.
PRESENT VALUE	Open the table of power modules and jump to the selected power module.
APPEND AMPLIFIER	Add the new power module to the table of power modules.
END	Return to the machine parameter editor.

Meaning of the soft keys:	
M	Call a list of motors.
BEGIN	Jump to the beginning of the list of motors.
END	Jump to the end of the list of motors.
PAGE	Scroll one page forward in the list of motors.
PAGE	Scroll one page backward in the list of motors.
SELECT AXIS	Select a motor with the arrow keys and transfer it with the corresponding "STORE MP2200.X" soft key.
PRESENT VALUE	Open the table of motors and jump to the selected motor.
APPEND MOTOR	Add the new motor to the table of motors.
END	Return to the machine parameter editor.

After you have selected the motor and the power module, the models are automatically entered in MP2100.x and MP2200.x.

If you use motors or power modules that are not listed in the menus, please contact HEIDENHAIN.

You can overwrite standard data or add other models to the tables. If you change the table of the motor models or power modules, the changed tables are filed in the PLC partition:

- PLC:\MP\MOTOR.MOT (motor table)
- PLC:\MP\MOTOR.AMP (power-module table)

These tables are then taken into account by the iTNC. If at any time you want to use the HEIDENHAIN standard tables again, you must erase the above-mentioned tables in the PLC partition.

MP2100.x **Power module type**
Input: Name of the selected power module (entered by the iTNC)

MP2200.x **Motor model**
Input: Name of the selected motor (entered by the iTNC)

Entries in the power module table:

- Designation of power module (NAME)
- Maximum current (I-MAX) in A
- Rated current (I-N) in A at a PWM frequency of 5 kHz
- Current sensor voltage (U-IMAX) in V at I-MAX
- Permissible continuous current in stationary rotating field or until F-DC is reached
  (I-N-DC) in A
- Time constant, how long max. current can be applied to a stationary synchronous motor (T-DC) in seconds
- Lower motor base frequency down to which the motor can be loaded with I-N-DC (F-DC) in Hz
- Cycle duration for the duty cycle S6-40%(T-AC) in seconds
- Motor frequency from which I-MAX is permissible (F-AC) in seconds
- Protection time of the IGBTs (T-IGBT) in seconds
- Rated currents with PWM frequencies of 3333 Hz, 4000 Hz, 5000 Hz, 6666 Hz, 8000 Hz and 10000 Hz (I-N-AC-3333, I-N-AC-4000, I-N-AC-5000, I-N-AC-6666, I-N-AC-8000, I-N-AC-10000) in A

Entries in the power supply module table:

- Designation of power supply module (NAME)
- Type of power supply module (E/R)
  - 0 = nonregenerative
  - 1 = regenerative
- Rated power output (P-N) in W
- Peak power for the duty cycle S6-40% (P-S6-40) in W
- Peak power for 0.2 s (P-MAX02) in W
- DC-link voltage (UZ) in V
- Analog value of the dc-link voltage with HEIDENHAIN power supply modules (UZ-AN) in V/V
- Analog value of the dc-link current with HEIDENHAIN power supply modules (IZ-AN) in V/A
- Status signals of the HEIDENHAIN power supply modules
  - Bit 0: Signal $\overline{\text{PF.PS.AC}}$ (AC fail)
  - Bit 1: Signal $\overline{\text{PF.PS.ZK}}$ (power fail)
  - Bit 2: Signals $\overline{\text{ERR.TEMP}}$ (temperature)
  - Bit 3: Signal RDY.PS (ready)
  - Bits 4 to 7: reserved

Entries in the motor table:

- Motor model (TYPE)
  - UASM = Uncontrolled asynchronous motor (volts-per-hertz control mode)
  - SM = synchronous motor
  - ASM = asynchronous motor
  - LSM = linear motor
- Designation of motor (NAME)
- Operating mode (MODE)
- Rated current (I-N) in A
- Rated voltage (U-N) in V
- Rated speed (N-N) in rpm
- Rated frequency (F-N) in Hz
- No-load voltage (U0) in V
- No-load current (I0) in A
- Stator resistance cold (R1) in mΩ
- Rotor resistance cold (R2) in mΩ

- Stator leakage reactance (XStr1) in mΩ
- Rotor leakage reactance (XStr2) in mΩ
- Magnetizing reactance (XH) in mΩ
- Upper speed X-H characteristic (N-XH) in rpm
- Threshold speed for field weakening (N-FS) in rpm
- Maximum speed (N-MAX) in rpm
- Factor for X-H characteristic (%-XH)
- Factor for stalling torque reduction (%-K)
- Number of pole pairs (PZ)
- Temperature coefficient (TK) in Ω/K
- Line count of the motor encoder (STR)
- Encoder being used (SYS)
  - 0 = No speed encoder (volts-per-hertz control mode)
  - 1 = incremental rotary encoder with Z1 track
  - 2 = absolute rotary encoder with EnDat interface (aligned[1])
  - 3 = absolute linear encoder with EnDat interface
  - 4 = incremental linear encoder
  - 5 = absolute rotary encoder with EnDat interface (not aligned[1])
  - 6 = incremental rotary encoder without Z1 track
- Counting direction of the motor encoder (DIRECT.)
- Maximum temperature (T-MAX) in °C
- Maximum current (I-MAX) in A
- Rated power output (P-N) in W
- Motor mass moment of inertia (J) in kgm^2
- Inductance of the series reactor (L) in µH
- Thermal time constant for direct current (T-DC) in seconds
- Lower thermal limit frequency (F-DC) in Hz
- Thermal time constant for alternating current (T-AC) in seconds
- Upper thermal limit frequency (F-AC) in Hz; above this frequency, the maximum current I-MAX applies

The inductance of the series reactor is calculated as follows:

$$L = \frac{700\ \mu H \cdot 5000\ Hz}{f_{PWM}} - \frac{(X_1 + X_2) \cdot 1000}{2 \cdot \pi \cdot f_N}$$

- L: Inductance of the series reactor in µH
- f_{PWM}: PWM frequency [Hz]
- X_1: Stator leakage reactance [mΩ]
- X_2: Rotor leakage reactance [mΩ]
- f_N: Rated frequency [Hz]

A negative result means that there is no series reactor.

Note

If a series reactor is installed later, the current controller must be readjusted.

1. See “Field Orientation” on page 6 – 227

6.14.3 PWM Frequency

With MP2180.x, certain controller groups can be assigned different PWM frequencies.

The PWM outputs of a controller group must be assigned the same PWM frequencies with MP2180.x. Otherwise, the DSP error message **C440 DSP error <Axis>** will appear.

- Controller group 1: X51, X53, X54
- Controller group 2: X52, X55, X56
- Controller group 3: X57, X59, X60
- Controller group 4: X58

▶ With MP2180.x, you can set the same PWM frequency for the PWM outputs of a controller group (X51 = MP2180.0, X52 = MP2180.1, etc.)

If PWM frequencies of > 5000 Hz are set for a controller group, it is no longer possible to use all PWM outputs of the controller group. Then only the first PWM output of the controller group can be used. The other PWM outputs must not be entered in MP120.x or. MP121.x. Otherwise, the DSP error message **C440 DSP error <Axis>** will appear.

The following PWM outputs can be operated with a PWM frequency of > 5000 Hz:

- Controller group 1: X51 (but not X53, X54)
- Controller group 2: X52 (but not X55, X56)
- Controller group 3: X57 (but not X59, X60)
- Controller group 4: X58

Warning

The following hardware version and later versions support the entry of different PWM frequencies for controller groups and of 5 000-Hz PWM frequencies >:

- CC 422/6 control loops with Id. Nr. 359 651-02
- CC 422/10 control loops with Id. Nr. 359 652-02

If you are using another hardware version, you must enter the same value (≤ 5000 Hz) in all MP2180.x.

MP2180.x PWM frequency

Input: 0: f_{PWM} = 5000 Hz (for HEIDENHAIN inverters)
3200 to 4000: f_{PWM} = 3333 Hz
4001 to 4999: f_{PWM} = 4166 Hz
5000 to 6000: f_{PWM} = 5000 Hz
6001 to 8000: f_{PWM} = 6666 Hz
8001 to 9999: f_{PWM} = 8333 Hz
10000: f_{PWM} = 10000 Hz

PWM frequency with INDRAMAT "POWER DRIVE" inverters

▶ In MP2180.x, enter the PWM frequency 4000 Hz.

PWM frequency with SIEMENS "SIMODRIVE" inverters

The iTNC 530 operates with a PWM frequency of 5 kHz. SIEMENS power modules are normally driven with a PWM frequency of 3.2 kHz (spindle) and 4 kHz (axes).
The rated current values I_N are defined for these frequencies. If power modules are operated with a higher PWM frequency (e.g. 5 kHz), high temperatures can be caused in these modules in some cases.

This applies particularly to these SIEMENS power modules:

- 6SN1123-1AA00-0CA0 (as axis module)
- 6SN1123-1AB00-0CA0 (as axis module)

Machines that are not under full load do not exceed the maximum permissible temperature.

There are two ways to prevent the undesired heating:

▶ In MP2180.x, enter the required PWM frequency (3 200 Hz or 4 000 Hz)
or

▶ Reduce the factor for I^2t monitoring
or

▶ Reduce rated current I_N in the table of power modules.

Note

A reduction of the PWM frequency has no effect on the maximum speed, but it means that the axis and the spindle(s) must be commissioned again.

For the commissioning of new machines, HEIDENHAIN recommends adjusting the PWM frequency to fit axis modules (normally 4 kHz, see SIEMENS documentation). If the power module of the spindle gets too warm in spite of a reduction of the PWM frequency from 5 kHz to 4 kHz, then the reference value for the I^2t monitoring or the rated current I_N must be reduced in the table of power modules.

Reduction of the reference value for I^2t monitoring or rated current I_N in the table of power modules.

The reduction of the rated current I_N of the power modules, as well as the datum value for I^2t monitoring can be calculated from two values (X1, X2) that are given in the SIEMENS documentation.

The percent reduction of the rated current can be calculated with the following formula:

$$X_R[\%] = 100 - \left(\frac{(100 - X1) \cdot (8\ \text{kHz} - f_{PWM})}{8\ \text{kHz} - X2} + X1\right)$$

- X1 = Reduction factor of the current in % at a PWM frequency of 8 kHz
- X2 = PWM threshold frequency in kHz at which the electrical power reduction begins
- f_{PWM} = frequency in kHz set in MP2180.x

This results in the reference value for I^2t monitoring:

$$X_B = 1 - \frac{X_R[\%]}{100}$$

- Reduce the rated current values I_N of your power modules in the list of power modules.

$$I_{Nneu} = I_N \cdot (100\ \% - X_R[\%])$$

or

- Reduce the reference value for the I^2t monitoring.

$$\text{MP2302.x} = X_B$$

Note

A reduction of the rated current of the power module can cause a reduction of the rated torque and, as a consequence, the rated power of the motor, if equal values for rated current of the power module and the rated current of the motor were chosen.

Example for a 50-A power module:

- Axis power module with 50 A, PWM frequency of 5 kHz, X1 = 40%, X2 = 4 kHz

$$X_R[\%] = 100 - \left(\frac{(100 - 40) \cdot (8\ \text{kHz} - 5\ \text{kHz})}{8\ \text{kHz} - 4\ \text{kHz}} + 40\right) = 15\ \%$$

$$X_B = 1 - \frac{15}{100} = 0.85$$

- Spindle power module with 50 A, PWM frequency of 5 kHz, X1 = 40%, X2 = 3.2 kHz

$$X_R[\%] = 100 - \left(\frac{(100 - 40) \cdot (8\ \text{kHz} - 5\ \text{kHz})}{8\ \text{kHz} - 3{,}2\ \text{kHz}} + 40\right) = 22.5\ \%$$

$$X_B = 1 - \frac{22.5}{100} = 0.78$$

- Axis power module with 50 A, PWM frequency of 4 kHz, X1 = 40%, X2 = 4 kHz

$$X_R[\%] = 100 - \left(\frac{(100-40)\cdot(8\ \text{kHz}-4\ \text{kHz})}{8\ \text{kHz}-4\ \text{kHz}} + 40\right) = 0\ \%$$

$$X_B = 1 - \frac{0}{100} = 1,00$$

- Spindle power module with 50 A, PWM frequency of 4 kHz, X1 = 40%, X2 = 3.2 kHz

$$X_R[\%] = 100 - \left(\frac{(100-40)\cdot(8\ \text{kHz}-4\ \text{kHz})}{8\ \text{kHz}-\ 3{,}2\ \text{kHz}} + 40\right) = 10\ \%$$

$$X_B = 1 - \frac{10}{100} = 0,90$$

6.14.4 Field Orientation

If a synchronous spindle is used along with an encoder without Z1 track or a nonaligned encoder with EnDat interface, there is no assignment between the encoder and rotor magnets.
With the FIELD ORIENTATION function, which must be run once during commissioning, the iTNC 530 automatically determines the assignment between the encoder and the rotor magnets (field angle) and saves this information on the hard disk. Of the FIELD ORIENTATION function is not run, the following error message appears:

- Encoder with EnDat interface: **`8830 EnDat: no field angle <axis>`**
- Encoder without Z1 track: **`8820 field angle unknown <axis>`**

Encoder with EnDat interface	Encoder without Z1 track
As soon as the absolute position of the encoder has been read, the assignment between absolute position and field angle is determined from the file.	After the drive has been switched on, the spindle is oriented automatically. Following that, the drive is ready for operation. As soon as the reference mark is traversed during the first movement of the spindle, the assignment of the field angle is determined from the file.

- Switch on the control.
- Do **not** acknowledge the **`Power Interrupted`** message. In the **`Programming and Editing`** mode of operation, use the MOD key to enter the coder number **`688379.`** The oscilloscope is started.
- Press the I CONTROL soft key.
- In the **`Manual mode of operation,`** acknowledge the **`Power Interrupted`** message.
- Use the CHOOSE AXIS soft key in the oscilloscope to select the corresponding axis.
- Press the FIELD ORIENT. soft key.
  The PLC must
  - switch the drive on/off.
  - release and lock the brakes

The spindle rotates with rated speed for the duration of approx. 2 s. During this period the field angle at the reference mark or datum is determined and automatically saved in a file on the hard disk.

- Press the END soft key.

The control carries out a reset. Then the assignment of the field angle is available.
If an encoder with EnDat interface is used, the field angle is assigned to the zero position of the encoder.
If an encoder without Z1 track is used, the spindle is first roughly oriented after it has been started. Then the field angle can be assigned to the reference mark and the spindle starts, taking the field angle into account.

Note

If the speed encoder is exchanged, the field orientation function must be rerun.

6.14.5 Commissioning of Digital Axes

The iTNC must be adjusted in sequence for the:

- Current controller
- Speed controller
- Position controller

The signals that you need are recorded with the integral oscilloscope.

dc-link voltage

The iTNC 530 uses the dc-link voltage to calculate the maximum motor voltage:

- In MP2190, enter the dc-link voltage at the power module.

MP2190 **DC-link voltage U_Z**
Input: 0 to 10 000 [V]
HEIDENHAIN inverters:
UE 2xx, UE 2xxB, UV 130: 565 V
UR 2xx, UV 120, UV 140, UV 150: 650 V

Temporary input values

- Enter the following temporary input values when you begin commissioning:

MP	Temporary input value	Meaning
MP20.0	%00000000000000	Monitoring the absolute position of the distance-coded reference marks
MP1030.x	0,01	Positioning window
MP1054.x	?	Linear distance of one motor revolution (depends on the machine)
MP1090.x	1	Maximum permissible jerk on the tool path
MP1092	<greater than rapid traverse>	Feed rate threshold from which MP1090.1 becomes effective
MP1095	0	Single filter
MP1096	0	Position nominal value filter off
MP1099.0	5	Minimal filter order for single filters
MP1099.1	3	Minimal filter order for double filters
MP1110.x	2,0	Standstill monitoring
MP1140.x	0,03	Movement monitoring (for digital axes the minimum value is entered)
MP1144.x	0	Motion monitor for position and speed
MP1340.x	0	No evaluation of reference marks
MP1410.x	0,5	Position monitoring in operation with velocity feedforward control (erasable)
MP1420.x	2	Position monitoring in operation with velocity feedforward control (EMERGENCY STOP)
MP1510.x	1	k_v factor for velocity feedforward control

MP	Temporary input value	Meaning
MP1710.x	50	Position monitoring in operation with following error (erasable)
MP1720.x	50	Position monitoring in operation with following error (EMERGENCY STOP)
MP1810.x	1	k_V factor for control with following error
MP1820.x	1	Multiplier for the k_V factor
MP1830.x	100	Characteristic curve kink point
MP2220.x	%010	Monitoring functions
MP2400.x	0,1	Gain for current controllers
MP2500.x	0,5	Proportional factor of the shaft speed controller
MP2510.x	20	Integral factor of the motor speed controller (for axes with holding torque, e.g. vertical axes, the value 1 must be entered because otherwise the axis drifts away)
MP2512.x	0	Limiting the integral factor of the speed controller
MP2520.x	0	Differential factor of the shaft speed controller
MP2530.x	0	PT_2 element of the speed controller
MP2540.x	0	Band-rejection filter damping
MP2550.x	0	Band-rejection filter for center frequency
MP2600.x	0	Acceleration feedforward
MP2602.x	0	IPC time constant T_1
MP2604.x	0	IPC time constant T_2
MP2606.x	0	Following error in the jerk phase
MP2610.x	0	Friction compensation at low motor speed
MP2612.x	0	Delay of the friction compensation
MP2620.x	0	Friction compensation at rated speed
MP2630.x	0	Holding current

Current Controller

Use the integrated oscilloscope to adjust the current controller. The speed and position control loops are open when you adjust the current controller. You must therefore activate a special PLC commissioning program:

- Enter the name of this PLC program in the OEM.SYS file with the instruction PLCPWM=.

It suffices to program an EM (end module).

The drive must be enabled externally and the iTNC needs the "ready" signal.

As soon as the PLC program defined with PLCPWM= is active, you can use Module 9168 to interrogate the commissioning status.

Module 9168 Interrogating the commissioning status

Call:

CM	9168	
PL	D	<>Status> –1: Commissioning not active or as yet no axis is selected Bits 0 to 5 correspond to selected axes 1 to 6 Bit 15 – Spindle selected Bit 16 – Operating mode of spindle 0: Operating mode 0 1: Operating mode 1

Adjusting the current controller:

- Switch on the control.
- Do not acknowledge the **Power Interrupted** message. In the **Programming and Editing** mode of operation, use the MOD key to enter the code number **688379**. The oscilloscope is started.
- Press the I CONTROL soft key.
- In the **Manual mode of operation,** acknowledge the **Power Interrupted** message.
- Use the CHOOSE AXIS soft key in the oscilloscope to select the axis to be adjusted.
- With the I factor / P factor soft key, select the I factor and set MP2430.x = 0.
- With the FACTOR P/I soft key, select the P factor.
- Calculate the starting value of the P factor with the following formula:

$$\text{Starting value} = \frac{100\,000 \cdot L}{T_a}$$

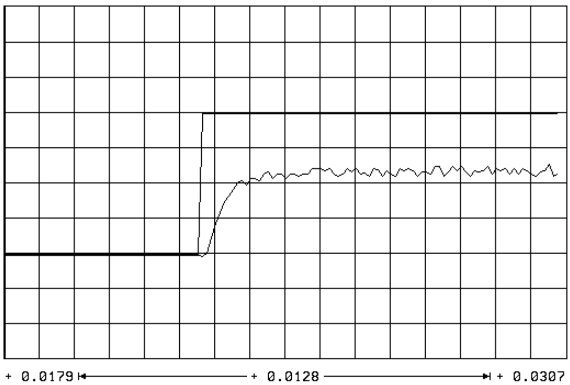
T_a	f_{PWM} (MP2180.x)
150	3 333 Hz
120	4 166 Hz
100	5 000 Hz
75	6 666 Hz
60	8 333 Hz
50	10 000 Hz

$$\text{Synchronous motor: } L = \frac{XH}{2 \cdot \pi \cdot (F\text{-}N) \cdot 1000}$$

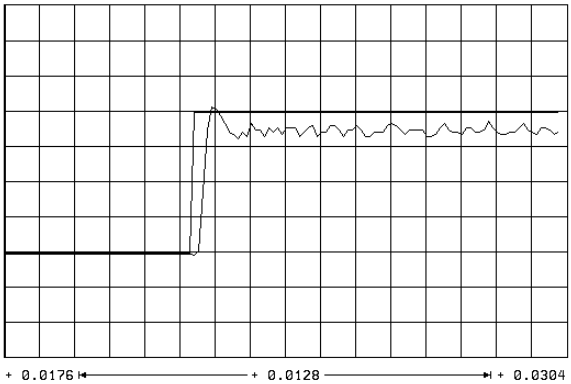
$$\text{Asynchronous motor: } L = \frac{XStr1 + XStr2}{2 \cdot \pi \cdot (F\text{-}N) \cdot 1000}$$

The values for XH (magnetizing reactance), F-N (rated frequency), XStr1 (stator leakage reactance) and XStr2 (rotor leakage reactance) can be found in the motor table. Switch to the editing mode of the motor table (APPEND MOTOR soft key).
The values for XH, XStr1 and XStr2 are specified in [mΩ] in the motor table. Use these values in the formulas. The formula already contains the conversion factor.

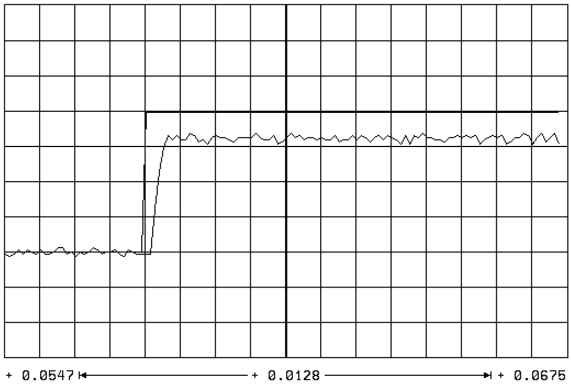
- Set this P factor (MP2420.x) with the ↑ soft key.
- Press the START STEP soft key.
  This sends a step function to the current controller and measures the step response. The height and length of the step function are automatically calculated by the iTNC.
- With the ↑ soft key, increase the P factor (MP2420.x) step by step until just barely no undershoot is visible.



MP2420.x too small



MP2420.x too large



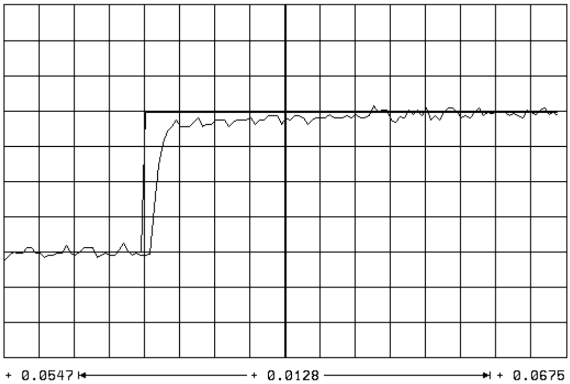
MP2420.x optimum

▶ Save this value with the STORE MP2420.x soft key.

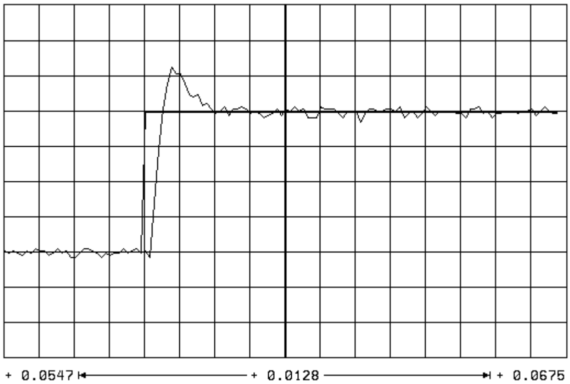
▶ With the I factor / P factor soft key, select the I factor.

▶ With the ↑ soft key, increase the I factor (MP2430.x) step by step until

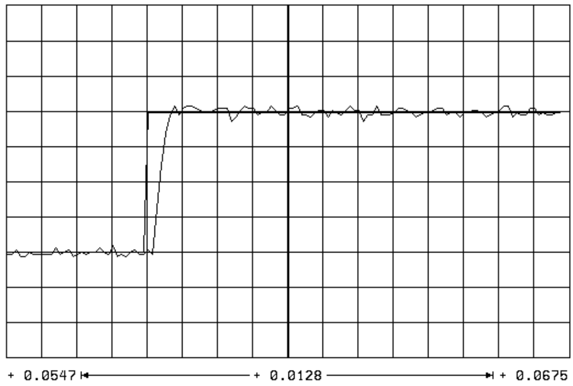
- Spindle: Just barely no overshoot is visible, and so that the nominal value is reached as quickly as possible (short rise time).
- Axes: You see an overshoot but no undershoot.



MP2430.x too small



Axes: MP2430.x optimum



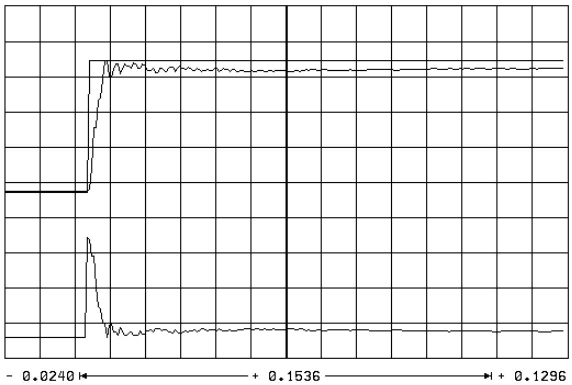
Spindle: MP2430.x optimum

- Save this value with the STORE MP2430.x soft key.
- Press the END key to exit the **Commission Current Controller** mode.

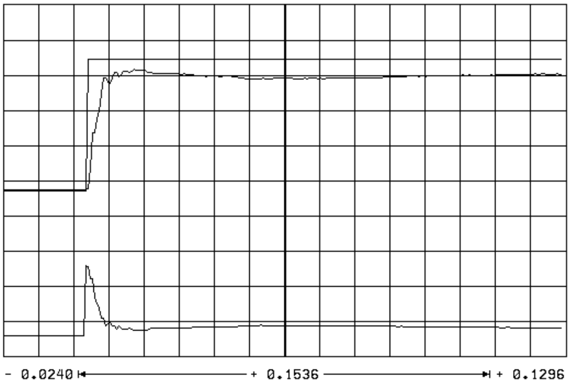
Speed Controller

Adjusting the speed controller:

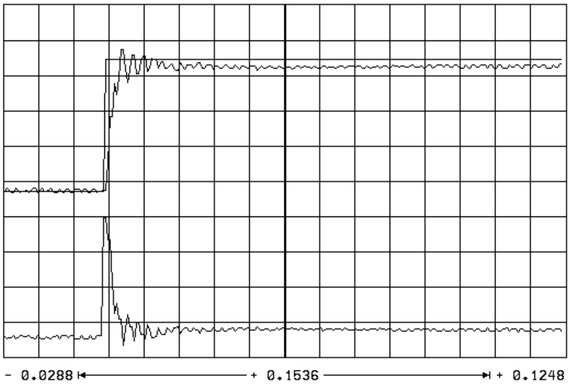
- Deselect “Pass over reference point” by setting MP1340 = 0.
- Ensure that the loaded PLC program fulfills the following conditions:
  - Position control loop is opened (W1038/W1040), because the NC opens the position control loop only during the step function. If the position controller is not optimized, error messages appear if the position controller is closed.
  - Servo drive controller is enabled (Module 9161)
  - NC stop is inactive, MP4560 = 1
  - Axis direction buttons active
  - Axes, clamping
- In the MANUAL mode, use the oscilloscope function to select a step function (approx. 500 mm/min) that will not overdrive the speed controller, i.e. that does not limit I NOMINAL.
  Display the nominal velocity value V (NOM RPM), the actual speed value V (ACT RPM) and the nominal current value I NOMINAL.
- Activate the step function with the axis direction buttons.
- To change the machine parameters, press the MP EDIT soft key in the setup menu.
- Increase MP2500.x (P factor) up to the oscillation limit.



MP2500 at the oscillation limit



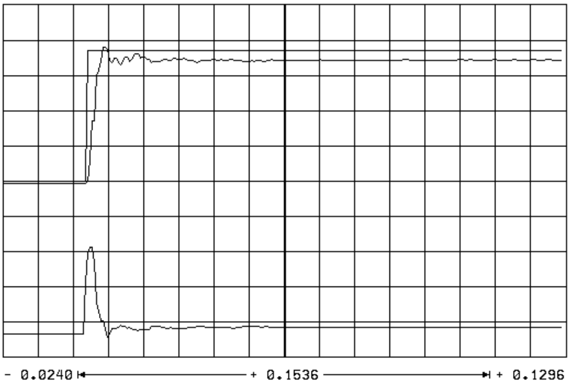
MP2500 too small



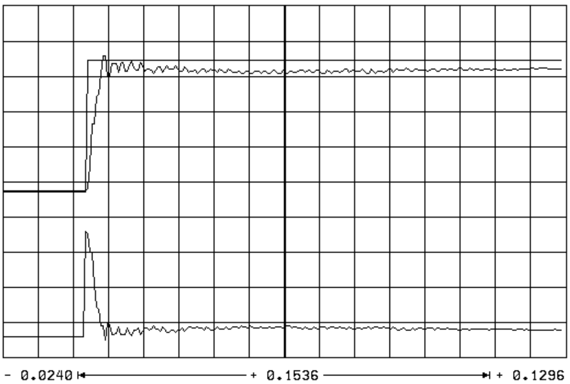
MP2500 too large

- Input value for MP2500.x = <determined value> · 0.6

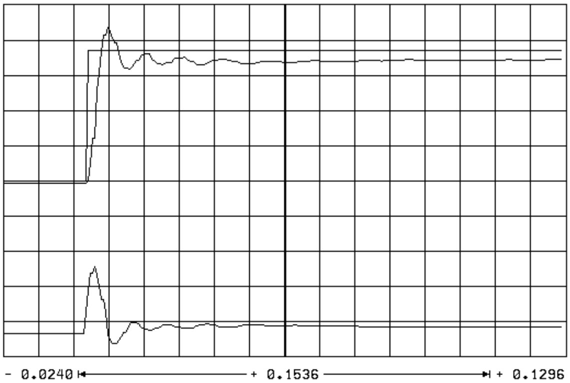
▶ Compensate high-frequency interference oscillations (> 400 Hz) with MP2530.x or MP2560.x.



MP2530 optimum



MP2530 too small



MP2530 too large

Warning

You can use MP2520.x to compensate low-frequency oscillation (< 100 Hz) on axes with mechanical problems.

However, HEIDENHAIN recommends that you avoid using MP2520.x if possible.

Do not use for axes with belt drive!

You can also compensate disturbance oscillations with the band-rejection filter:

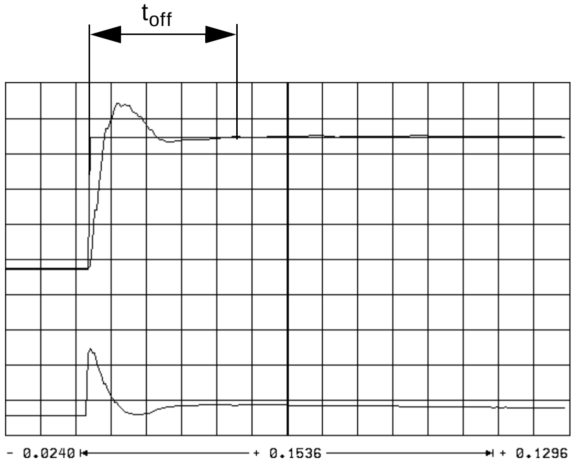
- Calculate the frequency of the oscillation and enter it in MP2550.x.
- Increase the band-rejection filter damping in MP2540.x until the interfering oscillation is minimized. Realistic input values: 3 to 9 [dB]

Note

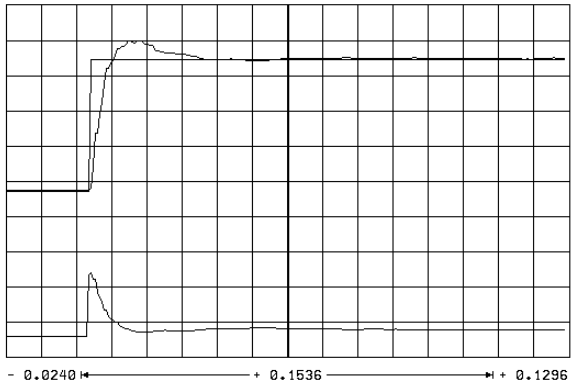
The compensation dampens the control loop. Try first to remove the mechanical causes of the disturbing oscillations.

To reduce the occurrence of disturbance oscillations, HEIDENHAIN recommends the use of motor couplings with a low tendency to oscillate (e.g. from the Rotex Company).

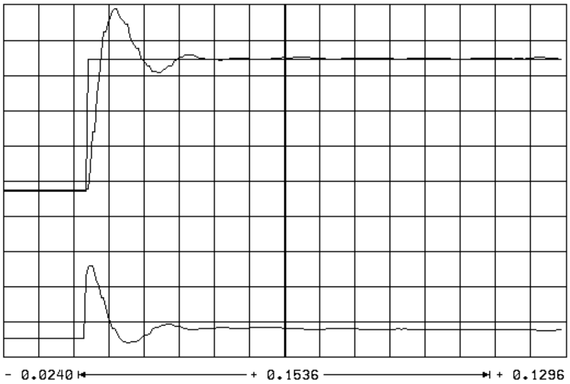
▶ Increase MP2510.x (I factor) until you see one overshoot followed by a slight undershoot and the settling time t_{off} is as small as possible (realistic value: 3 ms to 15 ms)



MP2510 optimum



MP2510 too small



MP2510 too large

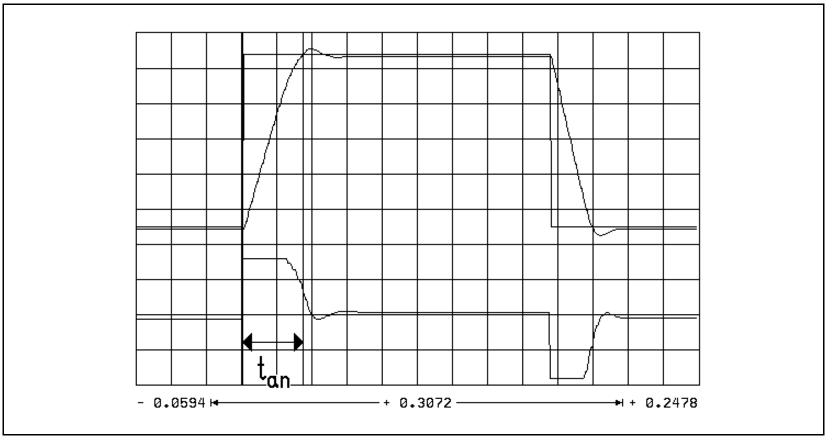
Determining the acceleration

- Clamp an object of maximum permissible weight on the machine table.
- Enter the rapid traverse as step height.
- During the step response, record the step response of the nominal velocity value V (NOM RPM), the actual speed value V (ACT RPM), and the nominal current value (I NOMINAL). It is permissible to limit the nominal current value I NOMINAL during acceleration.
- From the step response of the speed controller you determine the maximum possible acceleration (incl. 10% safety margin).

$$a = \frac{F_{max}}{t_{an} \cdot 66\,000}$$

a: Acceleration [m/s^2]
F_{max} : Maximum machining feed rate (MP1010.x) [mm/min]
t_{an} : Rise time [s]

- Enter the maximum possible acceleration in MP1060.x.



Check the counting direction

- On the oscilloscope, set TRIGGER to FREE RUN.
- To start recording:
- Change to MANUAL operating mode.
- Press the axis direction buttons.
- Check the counting direction on the display and if necessary, correct it with MP210.x.

Position Controller

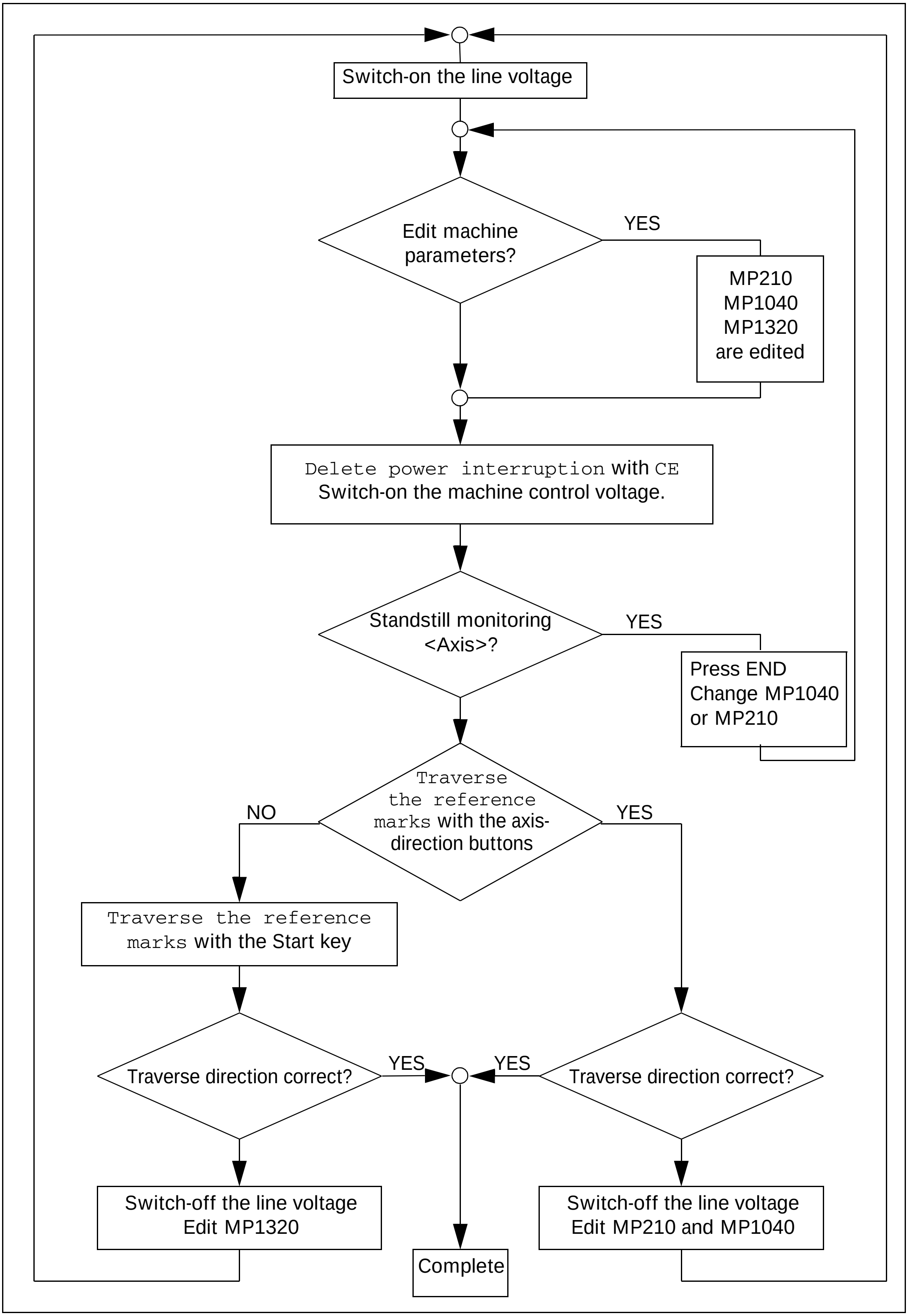
Adjusting the position control loop:

- Activate a PLC program that is adapted to the machine.
- Ensure that the position control loop is closed (W1038/W1040) and all inputs/outputs are properly operated.
- Optimize the position control loop in the following 12 steps:

If the position controller still oscillates after optimization, check the I factor (may be too high).

1. Check the traversing direction (see flowchart):

- In MP1340.x, enter the sequence in which the reference points are to be traversed.


Switch-on the line voltage
Edit machine parameters?
YES
MP210
MP1040
MP1320
are edited
Delete power interruption with CE
Switch-on the machine control voltage.
Standstill monitoring <Axis>?
YES
Press END
Change MP1040
or MP210
Traverse the reference marks with the axis-direction buttons
NO
YES
Traverse the reference marks with the Start key
Traverse direction correct?
YES
YES
Traverse direction correct?
Switch-off the line voltage
Edit MP1320
Complete
Switch-off the line voltage
Edit MP210 and MP1040

2. Set the traverse range:

You can enter up to three traverse ranges.

See "Traverse Ranges" on page 6 – 19. Define the software limit switches as follows:

- In the MANUAL operating mode, press the MOD key to select the REF display. The position displays show the distance to the machine datum (MP960.x).
- With the axis direction buttons or the handwheel, move all axes in positive and negative direction until they almost reach the EMERGENCY STOP limit switches. Write down the displayed positions with algebraic sign.
- Enter the noted values in MP91x.x and MP92x.x.
- Press the MOD key and select the ACTL display.

3. In MP1390 or MP1392, select the type of control:

For control with velocity feedforward:

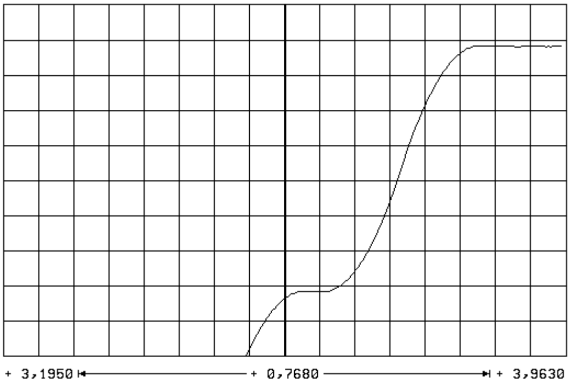
- Enter the temporary input values.

<table>
<tr><th>Machine parameters</th><th>Temporary input value</th></tr>
<tr><td>MP1391 or MP1392</td><td>Set to velocity feedforward control</td></tr>
<tr><td>MP1090.0</td><td rowspan="2">Enter a very small jerk, e.g. 1 (dependent on the machine)</td></tr>
<tr><td>MP1090.1</td></tr>
<tr><td>MP1092</td><td><greater than rapid traverse></td></tr>
<tr><td>MP1095</td><td>0</td></tr>
<tr><td>MP1096</td><td>0</td></tr>
<tr><td>MP1099.0</td><td>5</td></tr>
<tr><td>MP1099.1</td><td>3</td></tr>
</table>

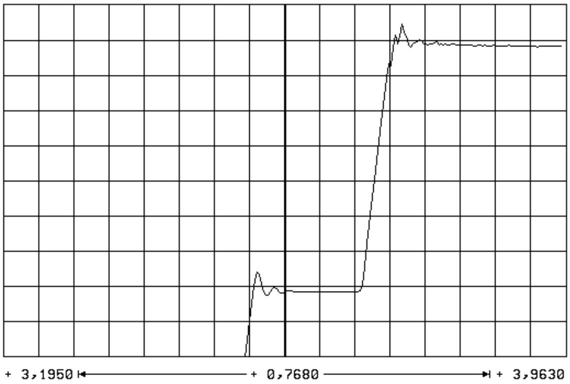
- Enter the following test program:

```
LBL 1
L X <maximum traverse>
R0 FMAX
LX0 FMAX
CALL LBL1 REP 100/100
```

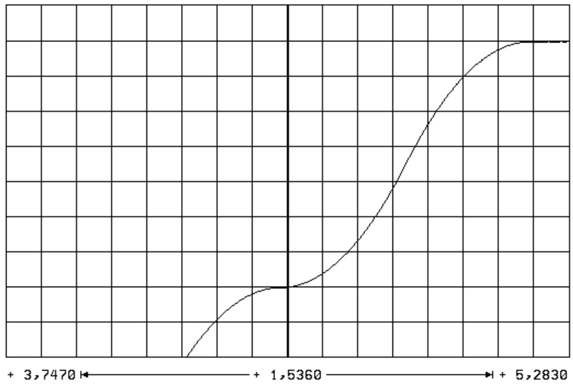
- Display the actual speed (act. speed) with the integrated oscilloscope and, if necessary, also show the following error (lag).
- Start the test program with feed rate override = 100%.
- In MP1090.0 increase the jerk until the overshoot just disappears.



MP1090 optimum

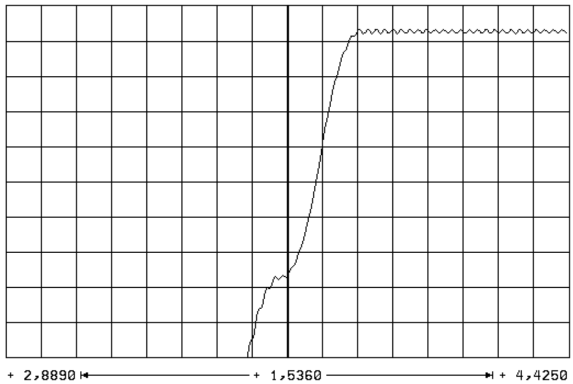


MP1090 too large

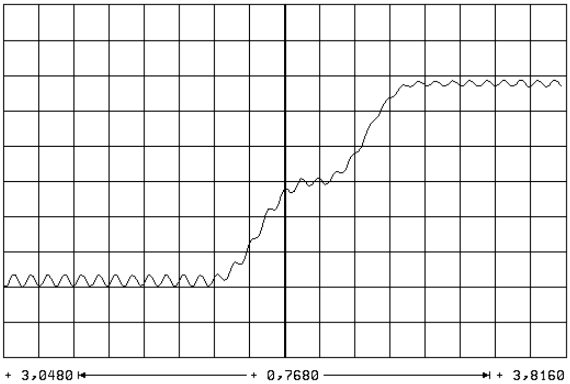


MP1090 too small

- Transfer the resulting jerk value from MP1090.0 to the axis specific parameters MP1097.x and MP1098.x.
- Increase the k_v factor until the oscillation limit is reached.
- Calculate MP1510:
  MP1510.x = <determined value> · 0.6



Oscillation limit has been reached



k_v factor too large

Unlike in operation with following error, you can also enter the optimum k_v factor for interpolated axes. You can save a number of different k_v factors in the iTNC and activate them with M functions See "The Control Loop" on page 6 – 109. MP1090.x applies to all axes. The worst axis determines the input value.

Procedure:

- Take the axis specific values in MP1097.x and MP1098.x.
- Reduce the adjusted jerk (MP1090.0) depending on the mechanical design of the machine. Do not set the jerk lower than necessary, however, because this strongly reduces the dynamic performance.
  - If at optimized jerk the maximum acceleration is not reached during the acceleration phase, enter the maximum machining feed rate in MP1092. In this case, define a higher jerk for high feed rates (> MP1092) to increase acceleration at these feed rates.

To select the nominal position value filter:

- Run a test program of short line segments.
- Use the oscilloscope to record the following error for each axis.
- Determine for each axis the oscillations on the following error. If you cannot find any oscillations, increase the jerk for the test in order to excite oscillation in the axes. Remember after the test to reset the jerk for each axis to its original value.
- Select from the following tables the input values for MP1099.x or MP1094. Consider the lowest determined frequency and the desired damping at this frequency.
- With MP1095 you select the single or double filter. With MP1094 the HSC filter is switched on, and the single and double filters are switched off.

▶ Test the three filter settings using a test part made of short line segments.

- Single filter
- Double filter
- HSC filter

Single filter (MP1099.0)

Damping [dB]	**Frequency to be damped [Hz]**										
	10	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
3	10	–	–	–	3	2	2	–	–	–	1
4	12	7	5	4	–	–	–	2	–	–	–
5	13	8	6	–	–	3	–	–	2	–	–
6	14	9	–	5	4	–	–	–	–	2	–
7	15	10	7	–	–	–	3	–	–	–	-
8	16	–	–	6	–	4	–	3	–	–	2
9	17	11	8	–	5	–	–	–	–	–	–
10	18	–	–	–	–	–	–	–	–	–	–
11	19	12	–	–	–	–	4	–	3	–	–
12	–	–	9	7	–	–	–	–	–	–	–

Double filter (MP1099.1)

Damping [dB]	**Frequency to be damped [Hz]**										
	10	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
3	7	4	3	2	–	–	1	1	–	–	–
4	8	5	–	–	2	–	–	–	1	–	–
5	9	6	4	3	–	2	–	–	–	1	–
6	10	–	–	–	–	–	–	–	–	–	1
7	11	7	5	–	3	–	2	–	–	–	–
8	–	–	–	4	–	–	–	–	–	–	–
9	12	8	–	–	–	–	–	2	–	–	–
10	13	–	6	–	–	3	–	–	–	–	–
11	–	–	–	–	–	–	–	–	2	–	–
12	14	9	–	5	4	–	–	–	–	–	–

HSC filter (MP1094)

Damping [dB]	Frequency to be damped [Hz]										
	10	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
3	12	19	24	29	34	39	44	49	54	59	64
4	10	17	22	27	32	37	42	47	52	57	62
5	6	15	21	26	31	36	41	46	51	56	61
6	1	14	20	25	30	35	39	45	50	55	60
7	–	13	18	23	28	33	38	43	48	54	59
8	–	11	17	23	28	33	38	43	48	53	58
9	–	10	16	22	27	32	37	42	47	52	57
10	–	9	16	21	26	31	36	41	46	51	56
11	–	7	15	20	25	30	35	40	45	50	55
12	–	6	14	19	24	29	34	39	44	49	54

Note

If you have selected the best nominal position value filter for your application, please note that your input value can be overwritten by the machine user through Cycle 32.
If you have switched off the nominal position value filter (MP1096 = 0), the machine user can also switch it on using Cycle 32.

Control with following error (servo lag):

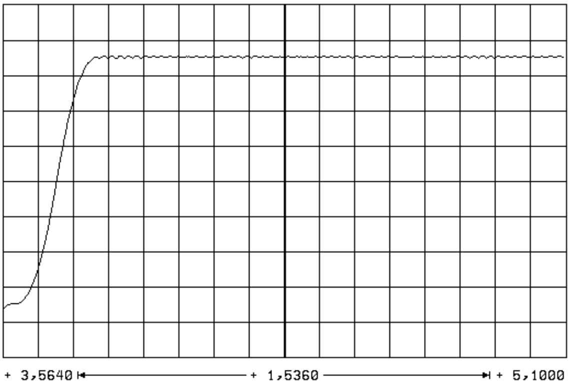
The adjusted maximum jerk works during operation with following error. MP1090 is not changed.

Procedure:

- Check the temporary input values for the machines parameters
- Specify the k_V factor for the machining feed rate:
- Enter the following test program:

```
LBL1
L X<maximum traverse> R0 F<machining feed rate>
L X0 R0 F<maximum machining feed rate>
CALL LBL1 REP 100/100
```

- Display the actual feed rate (actl. speed) with the internal oscilloscope.
- Start the test program with feed rate override = 100 %.
- Increase the value in MP1810.x up to the oscillation limit.
- Calculate MP1810.x:
  MP1810.x = <determined value> · 0.6



MP1810 at the oscillation limit

For axes that are interpolated with each other, the k_V factors must be equal. The axis with the smallest k_V factor defines the input value for all axes.

You can save a number of different k_V factors in the iTNC (MP1815.x) and activate them with M functions See "The Control Loop" on page 6 – 109.

Procedure for defining a characteristic curve kink point:

- k_V factor for rapid traverse (characteristic curve kink point):

$$\text{MP1830.x} = \frac{\text{Max. contouring feed rate} \cdot 100\ \%}{\text{Rapid traverse}}$$

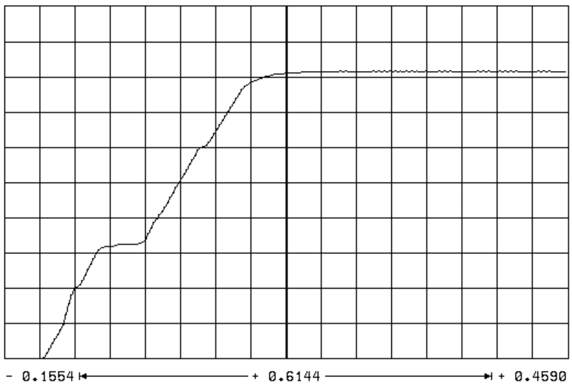
MP1820.x = 1

Set to operation with following error.

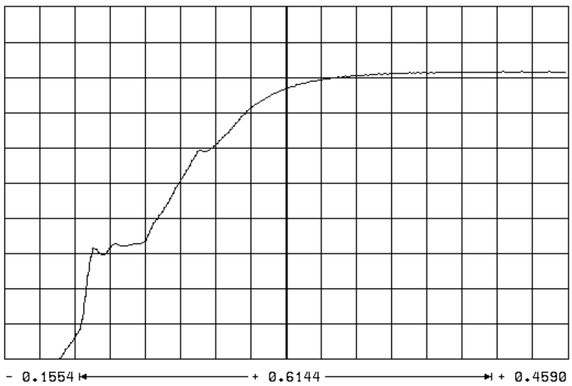
- Enter the following test program:

```
LBL2
L X<maximum traverse> R0 FMAX
L X0 R0 FMAX
CALL LBL1 REP 100/100
```

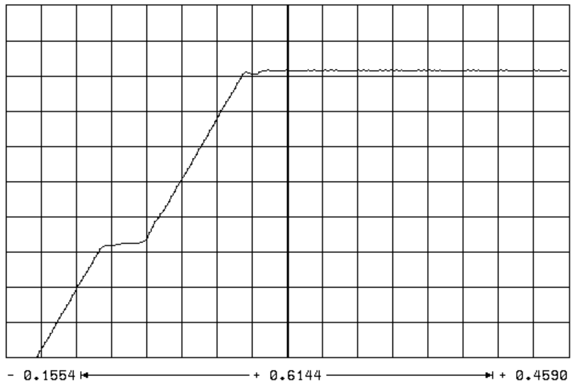
- Start the test program.
- Display the actual feed rate (actl. speed) with the internal oscilloscope:
  - If no oscillations are recognizable, no kink point is required.
  - If oscillations are visible, you must reduce MP1820.x until the oscillations have disappeared.



MP1820 optimum



MP1820 too small



MP1820 too large

4. Switch on the nominal position value filter:

- In MP1096, enter a defined tolerance (e.g. 0.02 mm).

5. Activate monitoring functions:

> **Note**
>
> To ensure that the monitoring functions become effective at the right moment, you must enter meaningful values.

HEIDENHAIN recommends the following input values. You must change these values slightly to adapt them to the design of the machine.

MP	Temporary input value	Meaning
MP1030.x	0.01 mm	Positioning window
MP1110.x	2 · MP1030.x	Standstill monitoring
MP1140.x	0.03 [1000 rpm]	Movement monitoring
MP1144.x	0.5 mm	Motion monitor for position and speed
MP1410.x	0.5 mm	Position monitoring in operation with velocity feedforward control (erasable)
MP1420.x	2 mm	Position monitoring in operation with velocity feedforward control (EMERGENCY STOP)
MP1710.x	1.2 · following error in rapid traverse	Position monitoring in operation with following error (erasable)
MP1720.x	1.4 · following error in rapid traverse	Position monitoring in operation with following error (EMERGENCY STOP)

6. Compensate the backlash:
If the cause of the backlash is outside of the control loop:

- Enter the backlash in MP710.x.

If the cause of the backlash is inside of the control loop:

- Enter the following test program:
```
LBL 1
L X100 R0 F10
L X0
CALL LBL 1 REP 100/100
```
- Use the internal oscilloscope to record ACTL. SPEED and V (ACT RPM). At the reversal point the actual feed rate follows the actual shaft speed by the time delay *t*.
- Set the machine parameters:
  - MP750 = $t \cdot \Delta$V ACTL (Keep in mind the units for *t* and ΔV ACTL)
  - MP752 = approx. 20 ms (determined in test)

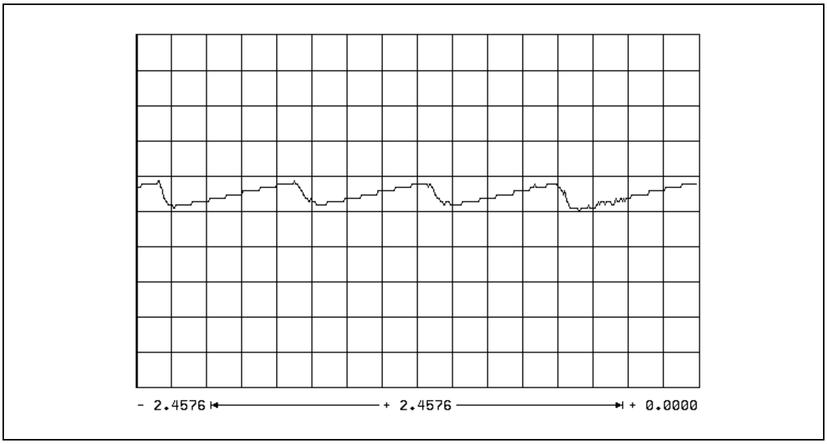
$$\Delta \text{V ACTL} = \left| \text{V ACTL} - \text{V (ACT RPM)} \right|$$

7. Compensate the static friction

- Enter the backlash, if any exists.
- Enter the following test program (static friction in the Y axis):

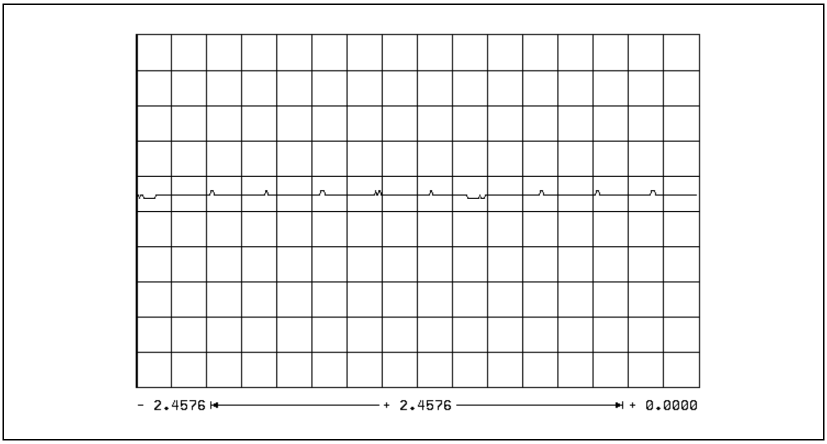
```
LBL 1
L X+400 IY+0.5 R0 F200
L X0 IY+0.5 R0
CALL LBL1 REP 100/20
```

- Set the machine parameters:
  - MP1511.x = 0
  - MP1512.x = 20
  - MP1513.x = 0
- With the integrated oscilloscope, display the following error in the Y axis (Y SDIFF).
- Start the program and adjust the feed rate override so that the following error caused by static friction becomes visible.



- Increase the feed rate until the following error is no longer measurable.
- From the current contouring feed rate, calculate the feed rate specific to the Y axis and enter the value in MP1513.1.
- Adjust the feed rate until the following error is measurable again.

▶ Increase MP1511.x in increments of 10 000 until the following error is no longer measurable.



If the machine oscillates at a standstill:

▶ Decrease MP1512.x.

8. Limit the integral factor of the shaft speed controller:
Very high static friction can cause an axis to jerk loose and “jump” around the target position.

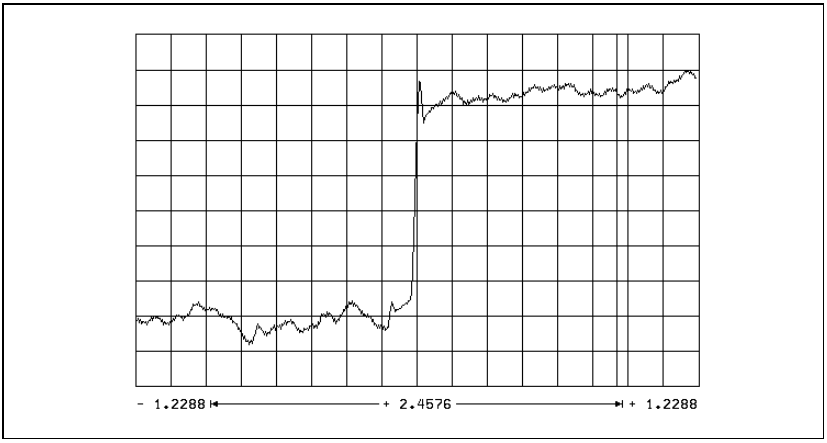
▶ Increase MP2512.x until the axis remains stationary.

9. Adjust the holding moment:

- Enter the following test program (static friction in axis Z):

```
LBL 1
L Z+2 R0 F50
L Z-2 R0 F50
CALL LBL 1/10
```

- Use the integrated oscilloscope to record the actual shaft speed (ACTUAL RPM) and the nominal current value (I NOMINAL).
- Start the program.
- With the feed rate override knob, adjust the motor speed to ±10 rpm (MP1054.x).
- Determine the current (I NOMINAL) in both directions of rotation.



- Calculate MP2630.x:

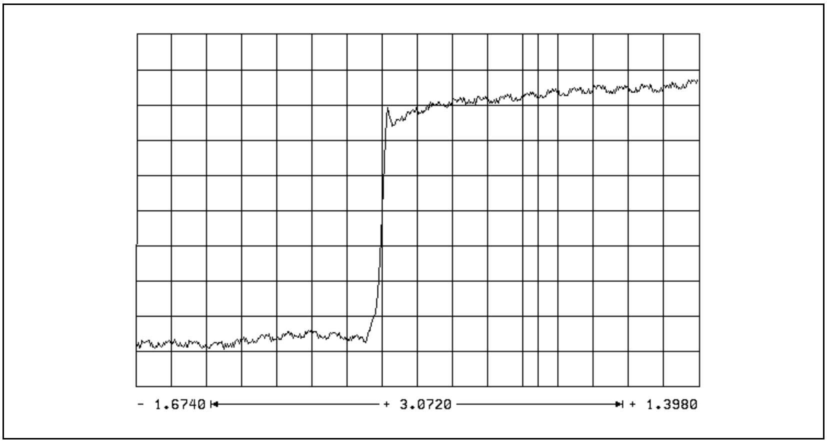
$$MP2630.x = \frac{I\ NOML_1 + I\ NOML_2}{2}$$

10. Compensate the sliding friction:

- Select operation with velocity feedforward control
- Enter the following test program (sliding friction in the X axis):

```
LBL 1
L X+2 R0 F50
L X-2 R0 F50
CALL LBL 1/10
```

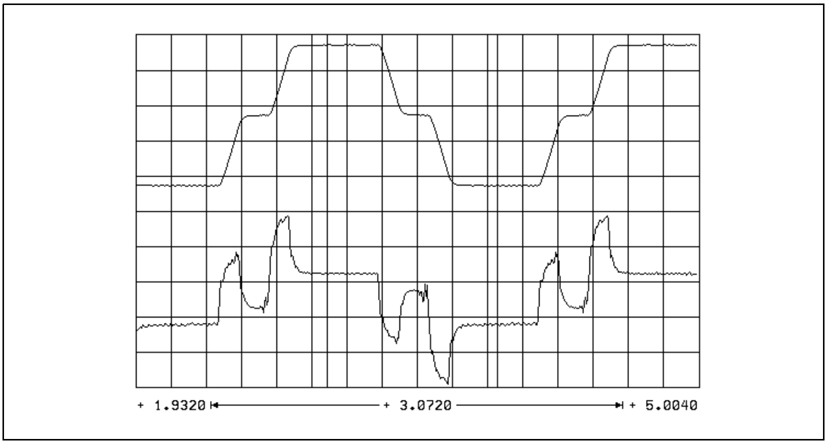
- Use the integrated oscilloscope to record the actual shaft speed (ACTUAL RPM) and the nominal current value (I NOMINAL).
- Start the test program.
- With the feed rate override knob, adjust the motor speed to 10 rpm (MP1054.x).
- Determine the current (I NOMINAL) in both directions of rotation.



- Calculate MP2610.x:

$$MP2610.x = \frac{I\ NOML_1 + I\ NOML_2}{2}$$

- Change the test program so that the motor rotates at its rated speed.
- Restart the test program.
- Determine the current (I NOMINAL) for the rated shaft speed.



▶ Calculate MP2620.x:

$$MP2620.x = \frac{I\,NOML_1 - I\,NOML_2}{2}$$

In the event that the motor cannot be driven at the rated speed:

▶ Measure I NOMINAL at maximum speed (rapid traverse) and calculate the current at rated speed as follows:

$$MP2620.x = \frac{(I_{max} - MP2610.x) \cdot \text{<rated speed>}}{n_{max}} + MP2610.x$$

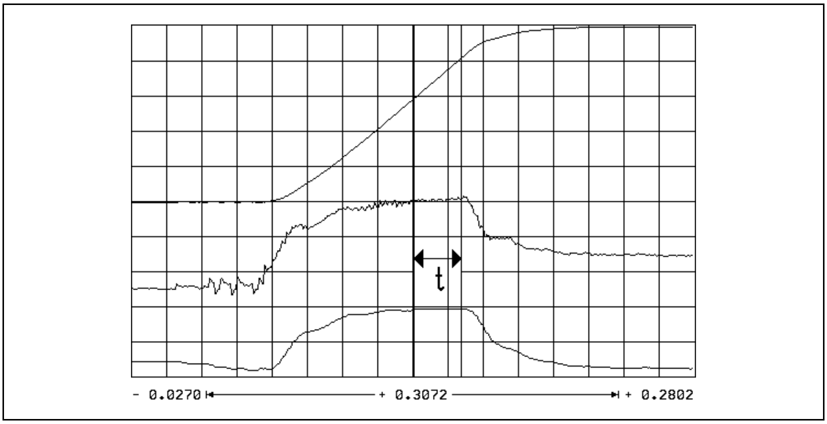
I_{nmax}: Current at rapid traverse

n_{max}: Shaft speed at rapid traverse

11. Check the acceleration feedforward:

- Select operation with velocity feedforward control
- Enter the following test program:

```
LBL 1
L X+100 R0 F5000
L X-100 R0 F5000
CALL LBL 1/10
```



- Use the integrated oscilloscope to record the actual shaft speed (ACTUAL RPM), the nominal current value (I NOMINAL), and the integral-action component of the nominal current value I (INT RPM).
- Start the test program.
- Adjust the speed with the feed rate override knob so that I NOMINAL is not limited.
- Measure the gradient of the acceleration ramp in the part in which I (INT RPM) remains constant.
- Calculate MP2600.x:

$$\text{MP2600.x} = \frac{\text{I (INT RPM) [A]} \cdot \text{t [s]} \cdot \text{60 [s/min]} \cdot \text{MP1054.x [mm]}}{\Delta\text{V(ACT RPM) [mm/min]}}$$

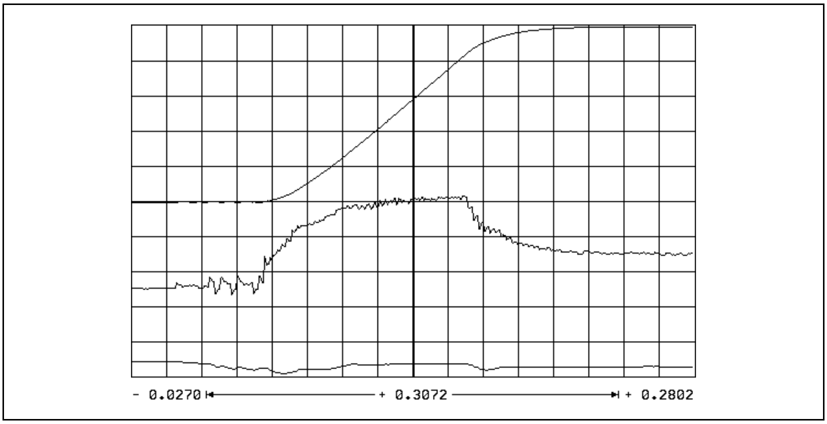
I (INT RPM) = Integral-action component of the nominal current value

t = Acceleration time in which I (INT RPM) remains constant

ΔV (ACT RPM) = Change of actual rpm during *t*

MP1054.x: traverse distance per motor revolution

- Repeat this measurement to check the input value of MP2600.x. I (INT RPM) must have approached zero.



12. Run the circular test:

With the circular test you can check the exact input values for compensating sliding friction:

- Determine the radial acceleration:
  MP1070 = 0.7 · MP1060.x
  MP1060.x represents the smallest acceleration in the working plane.
- At mid-range feed rate (approx. 500 mm/min) check the parameter MP2610. At the optimum setting the reversal peaks are at a minimum.

At feed rates greater than approx. 6000 rpm the reversal peaks might point inward as a result of overcompensation:

- In this case, increase MP2612.x until the reversal peaks no longer point inward.

6.14.6 Commissioning the Digital Spindle

Temporary input values

▶ Enter the following temporary input values when you begin:

MP	Temporary input value	Meaning
MP3010.x	3 to 8	Output of speed, gear range
MP3020	991	Speed range
MP3411.x	1.999	Ramp gradient
MP3412.x	1	Multiplier for MP3411.x
MP3415.x	0	Overshoot behavior
MP3420	1	Positioning window
MP3440.x	1	k_V factor

Note

C axis operation must be deselected for commissioning, meaning that no identical PWM outputs may be entered in MP120.x and in MP121.x.

Operating-mode switchover

During commissioning you can switch between operating mode 0 and operating mode 1 with the CONNECT STAR DELTA soft key. With Module 9168 you can interrogate the current settings in the PLC. You can switch the motor using PLC outputs and activate the corresponding machine parameters with Module 9163:

▶ Perform the adjustment for operating mode 0 and operating mode 1.

- If you do not use operating mode 1, set the corresponding machine parameters to zero.

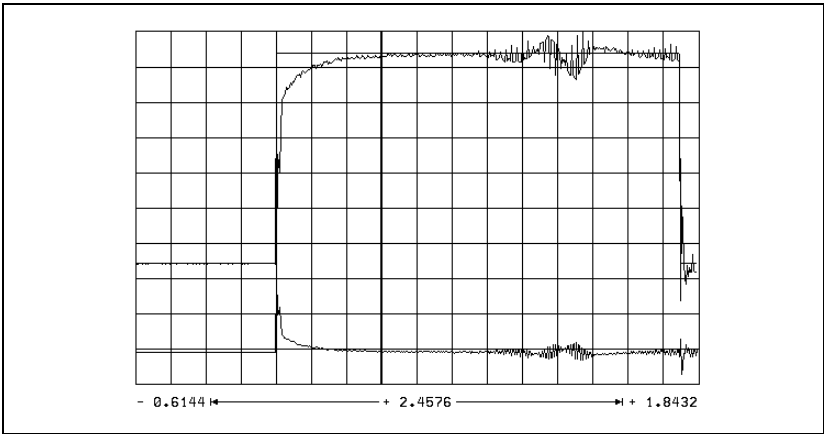
Current controller

Same procedure as for digital axes.

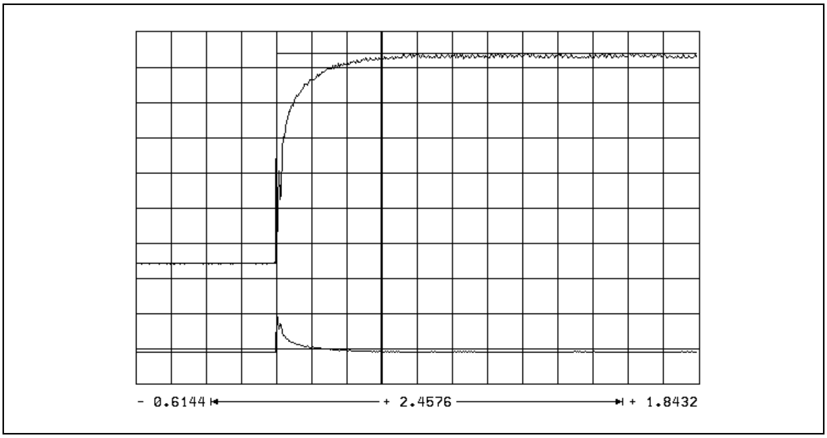
Speed controller

Define the step function:

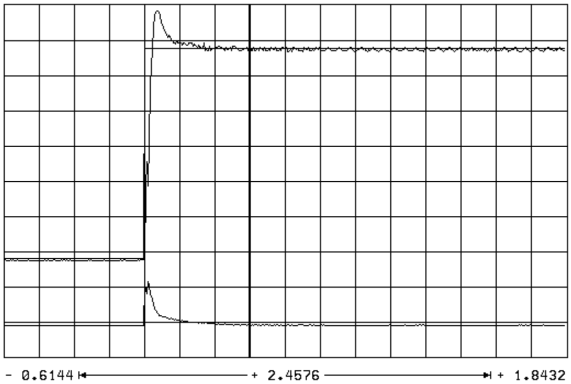
- In MP3411.x, enter the maximum acceleration and start the step by switching the spindle on.
- Activate a spindle speed from the highest gear range.
- With the integrated oscilloscope, record the nominal velocity value V (NOM RPM), the actual speed value V (ACT RPM), and the nominal current value (I NOMINAL).
- Output a step by activating the spindle-on function (M03/M04).
- Choose the height of the step function for a very low speed so as not to overload the speed controller, i.e. so that I NOMINAL is not limited.
- Increase the P factor (MP2500.x) until the system oscillates or no change is visible. To edit machine parameters, press the MP EDIT soft key in the Set up menu.



- Calculate MP2500.x: MP2500.x = MP2500.x · 0.6

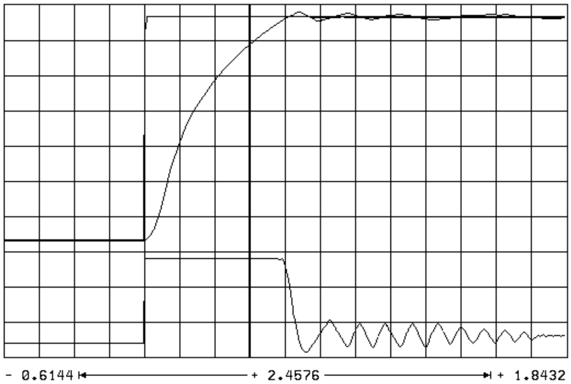


▶ Increase the I factor (MP2510.x) until you see one overshoot followed by a slight undershoot.

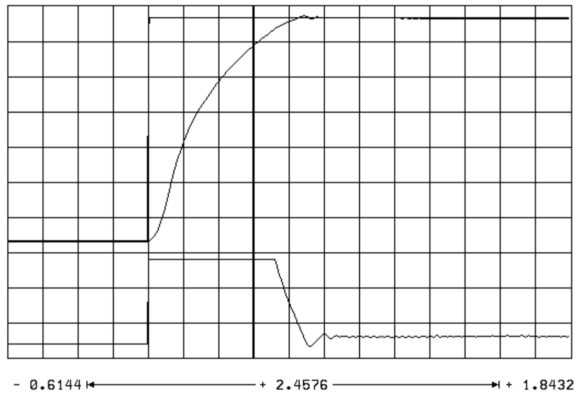


▶ Output the step with maximum shaft speed. I NOMINAL is within the limitation during acceleration. I NOMINAL must not oscillate after reaching the maximum speed. If I NOMINAL oscillates:

- Reduce MP2500.x and MP2510.x evenly until the overshoots are minimized.



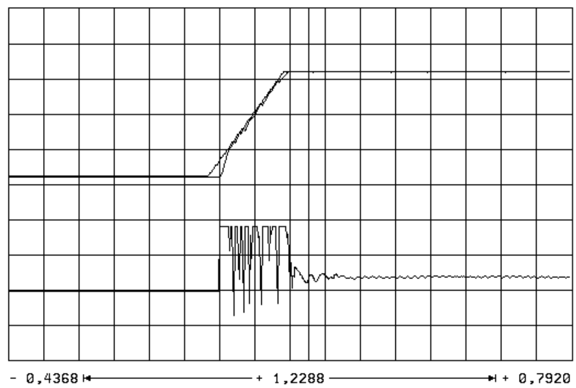
I NOMINAL oscillating



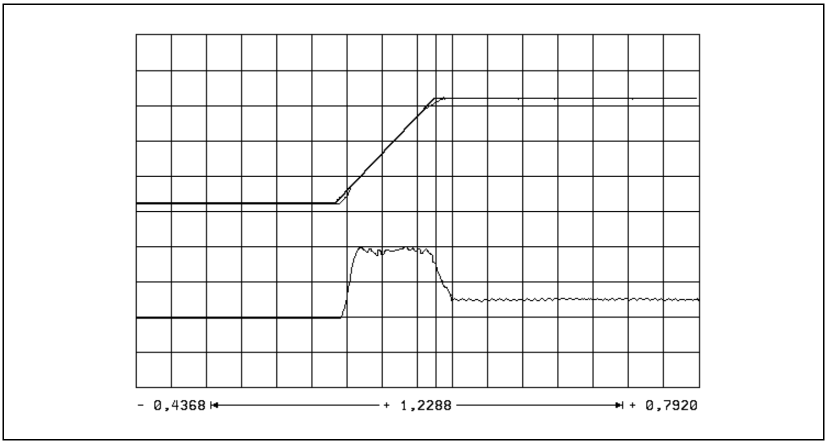
Only one overshoot

Optimize the acceleration:

- Optimize the acceleration individually for each gear range.
- Choose a ramp gradient at which the motor almost reaches the electrical current limit, and set it with MP3411.x.



▶ In MP3412.0, enter a factor for MP3411.x that becomes effective in the braking ramp with M05. It is the electrical current limit that is braked.



In the TAPPING and SPINDLE ORIENTATION modes, I NOMINAL must not reach the limit for acceleration:

▶ In MP3412.x, enter a factor for MP3411.x for these operating modes.

▶ With MP3415.x, specify an individual overshoot behavior for every spindle operating mode. Adapt the nominal value trace to the actual trace.

Checking the direction of rotation

You can check the direction of rotation of the spindle when M03 is output. If the spindle does not rotate in clockwise direction:

▶ Modify MP3130.

Position controller

The position control loop of the spindle is closed only during the spindle orientation:

▶ Close the position control loop of the spindle. See "Oriented spindle stop" on page 6 – 194.
   - If the error message “Nominal speed value S too high” appears, you must modify MP3140.

▶ Optimize the k_v factor (MP3440.x for each gear range.
A TOOL CALL must be run to transfer the modified gear-specific MPs.

6.14.7 Commissioning an Analog Axis

Temporary input values

▶ Enter the following temporary input values when you begin

MP	Temporary input value	Meaning
MP1030.x	0,01	Positioning window
MP1090.x	1	Maximum permissible jerk on the tool path
MP1092	<Maximum rapid traverse>	Feed rate threshold from which MP1090.1 becomes effective
MP1110.x	2,0	Standstill monitoring
MP1140.x	10	Movement monitoring
MP1410.x	0,5	Position monitoring in operation with velocity feedforward control (erasable)
MP1420.x	2	Position monitoring in operation with velocity feedforward control (EMERGENCY STOP)
MP1510.x	1	k_V factor for velocity feedforward control
MP1710.x	50	Position monitoring in operation with following error (erasable)
MP1720.x	50	Position monitoring in operation with following error (EMERGENCY STOP)
MP1810.x	1	k_V factor for control with following error
MP1820.x	1	Multiplier for the k_V factor
MP1830.x	100	Characteristic curve kink point

Adjusting the servo amplifier

Please note:

☞ **Note**

For analog axes, you must adjust the servo amplifier before you optimize the position controller.

Procedure:

▶ Disconnect the nominal-value connection between the servo amplifier and the MC 422.

▶ Short-circuit the nominal value input on the servo amplifier.
The input must have a 0 V voltage.

▶ Activate control enabling at the servo amplifier.

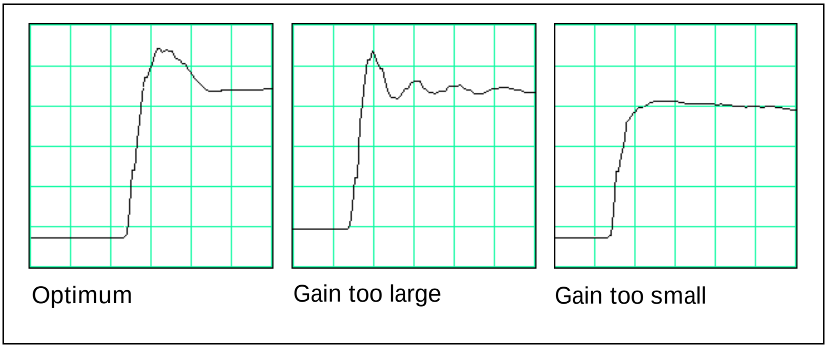
▶ Connect the supply voltage to the servo amplifier.

▶ Perform a coarse offset adjustment:

- If the axis moves in spite of the short-circuited nominal value input, you must adjust the offset potentiometer until the axis stops moving.

▶ Remove the jumper at the nominal value input and establish a nominal-value connection to the MC 422.

- Perform a coarse velocity adjustment:
  - Set MP1010.x (rapid traverse) and MP1050.x (analog voltage at rapid traverse).
  - With the internal oscilloscope functions, output the nominal value step at the height for rapid traverse.
  - Record U ANALOG and check the voltage.
  - Use a tachometer to measure the rotational speed of the motor and a tacho-potentiometer at the servo amplifier to adjust the nominal speed for rapid traverse.
  - Connect an oscilloscope to the tachometer of the motor.
  - Test the step response on the tachometer during the step output.
- Adjust the proportional (P) component and the integral-action (I) component of the speed controller at the servo amplifier



Determining the acceleration

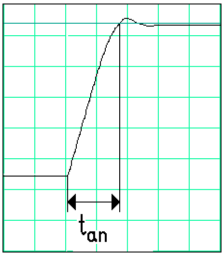
After adjusting the servo amplifier, you can determine from the step response the maximum possible acceleration:

$$a = \frac{F_{max}}{t_{an} \cdot 60\,000}$$

a: Acceleration [m/s^2]

F_{max}: Maximum machining feed rate (MP1010.x) [mm/min]

t_{an}: Rise time [s]



- Enter the maximum possible acceleration in MP1060.x.

Position controller

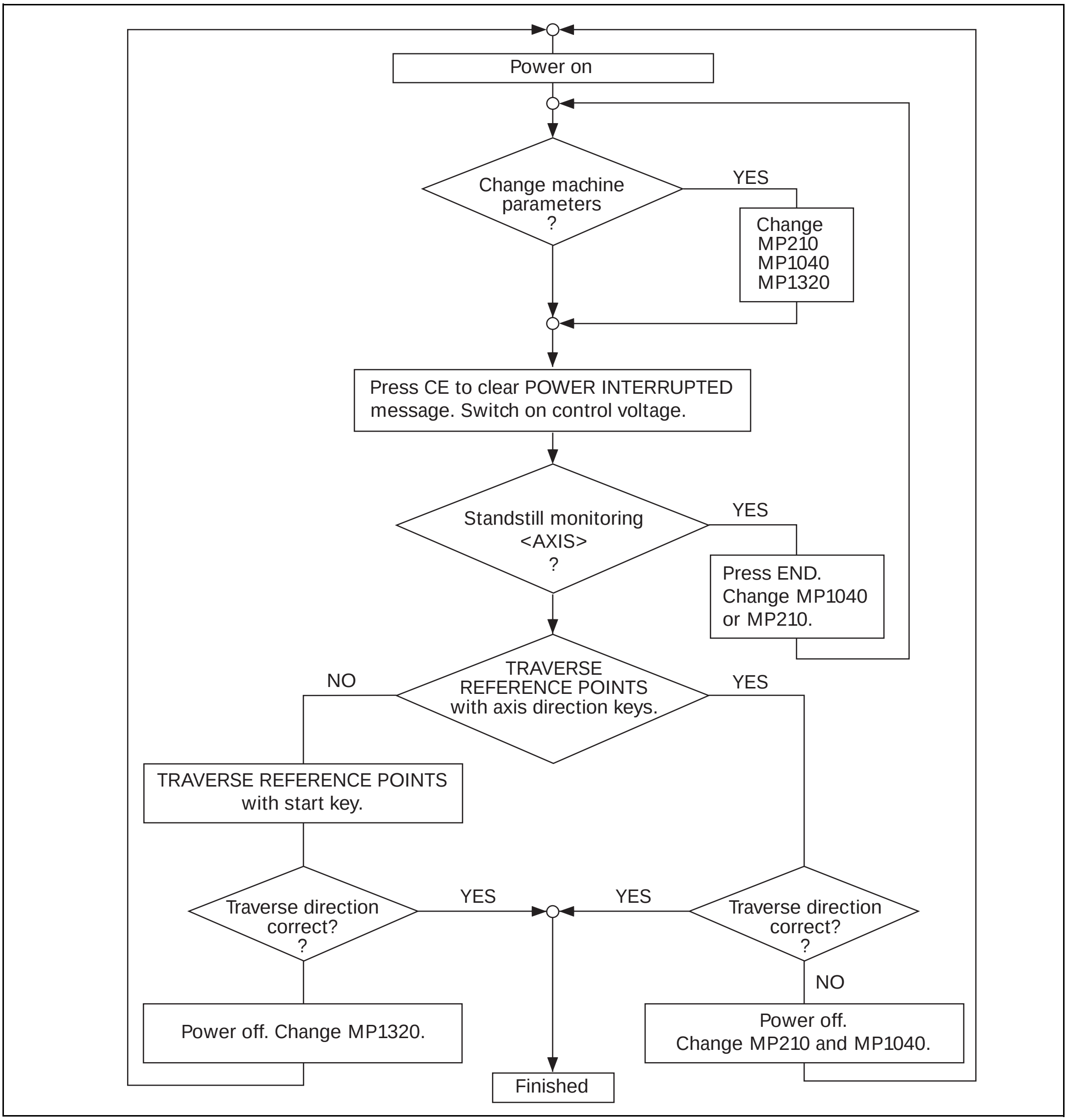
Please note:

> **Note**
>
> For analog axes, you must adjust the servo amplifier before you optimize the position controller.

Adjusting the position control loop:

- Activate a PLC program that is adapted to the machine.
- Ensure that the position control loop is closed (W1038/W1040) and all inputs/outputs are properly operated.
- To optimize the position control loop take the following steps:

1. Check the counting/traversing direction
(see flowchart)



2. Set the traverse range
Same procedure as for digital axes.

3. Specify the type of control
For control with following error, same procedure as for digital axes.

For control with velocity feedforward control, same procedure as for digital axes.

4. Perform an offset adjustment
At the iTNC: See "The Control Loop" on page 6 – 109.

5. Activate monitoring functions:

- Enter the following temporary input values when you begin: See "Commissioning of Digital Axes" on page 6 – 228

6. Compensate the backlash
Same procedure as for digital axes.

7. Compensate the static (stick-slip) friction
Same procedure as for digital axes.

6.14.8 Commissioning the Analog Spindle

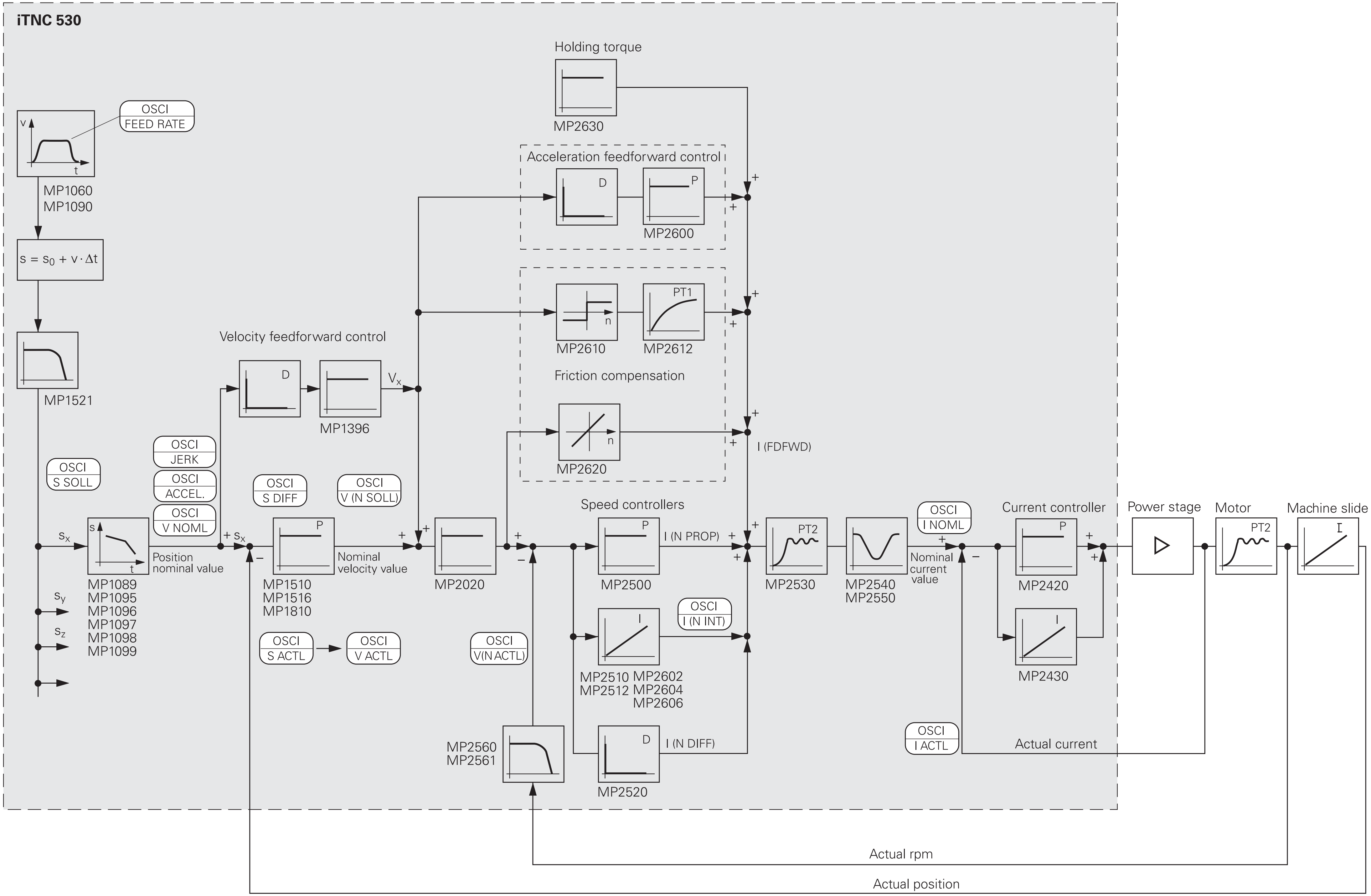
Adjusting the servo amplifier
Same procedure as for analog axes.

Acceleration
Same procedure as for digital spindle. You measure the signals directly at the servo amplifier with an external oscilloscope.

Direction of rotation
Same procedure as for digital spindle.

Position controller
Same procedure as for digital spindle.

6.15 Block Diagram iTNC 530



7 Machine Integration

7 Machine Integration

7.1 Display and Operation

You can modify the display and operating modes of the iTNC by editing the machine parameters.

The display screen is divided into separate windows. The user can select the operating functions through soft keys. (Also see the User's Manual)

7.1.1 Powering Up and Shutting Down the Control

Powering up the control

While the control is starting, a customer-specific company logo can be displayed instead of the HEIDENHAIN logo.

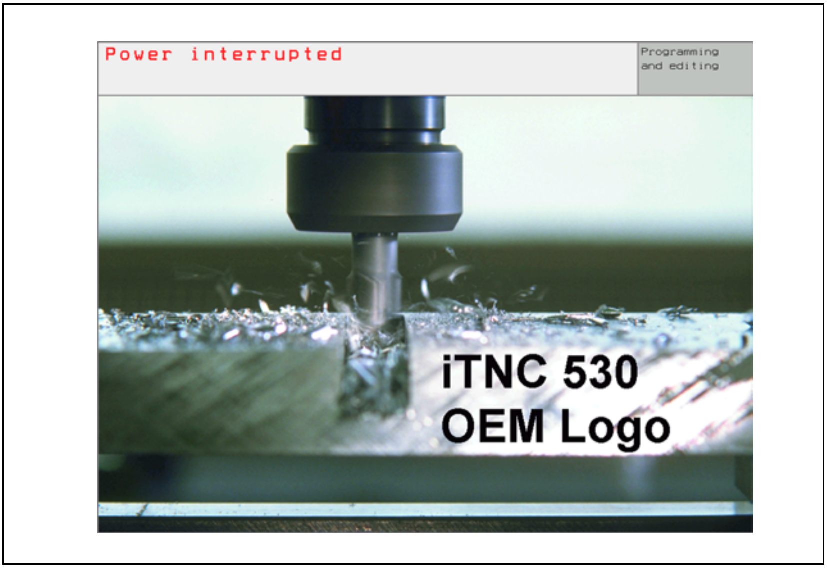
Requirements of the logo:

- The logo must be a bitmap file (*.BMP) with a color resolution of 16 or 24 bits. It is displayed in 16 bits.
- Maximum picture size
  - BF 120: 640 x 480
  - BF 150: 1024 x 768

Note

If the picture is larger than the window, it will be cropped symmetrically. If the picture is smaller than the window, it will be displayed centered.

- The logo must be designed to remain recognizable even with a reduced window:
  While the control is powering up, the complete logo is displayed. If power is interrupted, only a reduced window remains available:
  - BF 120: 636 x 424
  - BF 150: 1020 x 681



- In the OEM.SYS file, enter the keyword **LOGO =** followed by the complete path of the logo, e.g. **LOGO = PLC:\LOGO\OEM-LOGO.BMP**
- On the TNC, create a new directory, for example **PLC:\LOGO.**
- Move the logo into this directory, for example **PLC:\LOGO\OEMLOGO.BMP.**

Shutting down the control

The control must be shut down before it can be switched off. This is done either with the soft key in `Manual mode` or by the PLC with Module 9189. If the control is shut down (either with Module 9189 or with the soft key), M4179 is set, the ready signal of the drives is removed, and the hard disk is set to sleep mode.

		Set	Reset
M4179	**Control is shut down**	NC	NC

Module 9189 Shutting down the control

The control is shut down with Module 9189. After shutdown, the PLC remains operable. It can therefore react to a signal to switch off the machine after conclusion of this module.
The information windows, which appear during shutdown via soft key, do not appear.

Call:
CM 9189

Error detection:

Marker	Value	Meaning
M4203	0	Control was shut down
	1	Error code in W1022
W1022		Module was not called in a spawn job or submit job

Resetting the Control

Module 9279 Control reset

Module 9279 carries out a control reset. This means the control is shut down and then restarted (the PLC cannot be run) **or** only the control is shut down (the PLC can still be run).
In either case, no message is shown on the monitor to say that the control is being shut down.

Call:
PS B/W/D/K <Mode>
0: Shut down the control
1: Control is shut down and restarted
CM 9279

Error detection:

Marker	Value	Meaning
M4203	0	Control reset is carried out
	1	Error code in W1022
W1022	2	Invalid mode
	20	Module was not called in a spawn job or submit job

Message for power interruption

After the control powers up, the `Power interrupted` message appears.

▶ Press the CE key to acknowledge this message and compile the PLC program.

With MP7212 you can suppress this message, e.g. for unattended operation.

MP7212 **Power interrupted message**

Input: 0: Acknowledge the `Power interrupted` message with CE key
1: `Power Interrupted` message does not appear

7.1.2 Color Setting

The colors of the display unit can be defined by machine parameters.

The following color settings **cannot** be changed:

- HEIDENHAIN logo after machine switch-on (standard color)
- Error message for invalid machine parameters (red)
- Blinking error message (red)
- Plan view in the graphic display (blue)
- Cursor (inverse)

You define the desired color by mixing the basic colors red, green and blue. Every basic color has 256 difference stages of intensity. The input values for color setting are byte-oriented. HEIDENHAIN recommends hexadecimal input.

Color	Red		Green		Blue	
Adjustment	Rough	Fine	Rough	Fine	Rough	Fine
HEX ranges	0 to F	0 to F	0 to F	0 to F	0 to F	0 to F
Input for yellow: $0....	3	9	3	9	0	0

The colors can also be poorly adjusted (e.g. red error message on red background). HEIDENHAIN therefore supplies the controls with a standard color setting, which is suggested by the control during creation of the MP list.

To configure the screen saver:

▶ Enter in MP7392 the time in minutes after which the screen saver should activate itself. Enter 0 to disable the screen saver.

MP7350 **Window frames**

MP7351 **Error messages**

MP7352 **“Machine” operating mode display**
MP7352.0 Background
MP7352.1 Text for operating mode
MP7352.2 Dialog

MP7353 **“Programming” operating mode display**
MP7353.0 Background
MP7353.1 Text for operating mode
MP7353.2 Dialog

MP7354	**“Machine” program text display**
MP7354.0	Background
MP7354.1	General program text
MP7354.2	Active block
MP7354.3	Background of inactive window
MP7355	**“Programming” program text display**
MP7355.0	Background
MP7355.1	General program text
MP7355.2	Active block
MP7355.3	Background of inactive window
MP7356	**Status window and PLC window**
MP7356.0	Background
MP7356.1	Axis positions in the status display
MP7356.2	Status display other than axis positions
MP7357	**“Machine” soft-key display**
MP7357.0	Background
MP7357.1	Symbols
MP7358	**“Programming” soft-key display**
MP7358.0	Background
MP7358.1	Symbols
MP7360	**Graphics: 3-D view**
MP7360.0	Background
MP7360.1	Top surface
MP7360.2	Front face
MP7360.3	Text display in the graphics window
MP7360.4	Lateral face
MP7360.5	Lowest point of blank form
MP7360.6	Highest point of blank form (below surface)
MP7361	**Graphics: Projection in three planes**
MP7361.0	Background
MP7361.1	Top view
MP7361.2	Front and side view
MP7361.3	Axis cross and text in the graphic display
MP7361.4	Cursor
MP7362	**Additional text display in the graphic window and pocket calculator**
MP7362.0	Background of graphic window and pocket calculator
MP7362.1	Background of status display and keys of the pocket calculator
MP7362.2	Status symbols and symbols of the pocket calculator (c in ”cos”)
MP7362.3	Status values and texts of the pocket calculator (os in “cos”)
MP7363	**Programming graphics**
MP7363.0	Background
MP7363.1	Resolved contour
MP7363.2	Subprograms and frame for zooming
MP7363.3	Alternative solutions
MP7363.4	Unresolved contour

MP7364	**Color of the help illustrations for cycles**
MP7364.0-6	Colors 1 to 7 of the graphic program used
MP7364.7	Line color (color 8 of the graphic program)
MP7364.8	Color for highlighted graphic elements if defined in the help illustration
MP7364.9	Background
MP7365	**Oscilloscope**
MP7365.0	Background
MP7365.1	Channel 1
MP7365.2	Channel 2
MP7365.3	Channel 3
MP7365.4	Channel 4
MP7365.5	Selected channel
MP7365.6	Grid
MP7365.7	Cursor and text
MP7366	**Pop-up window (HELP key, pop-up menus etc.)**
MP7366.0	Background
MP7366.1	Text or foreground
MP7366.2	Active line
MP7366.3	Title bar
MP7366.4	Scroll-bar field
MP7366.5	Scroll bar
MP7366.6-14	Reserved
MP7367	**Large PLC window**
MP7367.0	Background
MP7367.1	Color 1
MP7367.2	Color 2
MP7367.3	Color 3
MP7367.4	Color 4
MP7367.5	Color 5
MP7367.6-14	Colors 6 to 14
MP7368	**Pocket calculator**
MP7368.0	Background
MP7368.1	Background of displays and keys
MP7368.2	Key texts ("os" in "cos")
MP7368.3	Key symbols
MP7369	**Directory tree in PGM MGT**
MP7369.0	Text background
MP7369.1	Text
MP7369.2	Text background of the active folder
MP7369.3	Line color of the tree structure
MP7369.4	Folders
MP7369.5	Drives
MP7369.6	Text background of the heading in the browser window
MP7392	**Screen saver**
Input:	1 to 99 [min] 0: No screen saver

The standard color setting is shown in the following list:

Machine parameters	Standard setting
MP7350	$0808080
MP7351	$0FF2020
MP7352.0	$0ECECEC
MP7352.1	$0000000
MP7352.2	$00000FF
MP7353.0	$0C0C0C0
MP7353.1	$0000000
MP7353.2	$00000FF
MP7354.0	$0FFFFFF
MP7354.1	$0000000
MP7354.2	$00000FF
MP7354.3	$0C0C0C0
MP7355.0	$0FFFFFF
MP7355.1	$0000000
MP7355.2	$00000FF
MP7355.3	$0ECECEC
MP7356.0	$0ECECEC
MP7356.1	$00000FF
MP7356.2	$00000FF
MP7357.0	$0C0C0C0
MP7357.1	$0000000
MP7358.0	$0C0C0C0
MP7358.1	$0000000
MP7360.0	$0104200
MP7360.1	$0FFAAAA
MP7360.2	$0124F72
MP7360.3	$0FFFFFF
MP7360.4	$0249EE4
MP7360.5	$0000014
MP7360.6	$0F0F0FF
MP7361.0	$0ECECEC
MP7361.1	$00000E8
MP7361.2	$00000E8
MP7361.3	$0FF0000
MP7361.4	$0FF00FF
MP7362.0	$0ECECEC
MP7362.1	$0FFFFFF
MP7362.2	$00000FF
MP7362.3	$00000FF

Machine parameters	Standard setting
MP7363.0	$0ECECEC
MP7363.1	$00000FF
MP7363.2	$0FF00FF
MP7363.3	$000EC00
MP7363.4	$0FF0000
MP7364.0	$0A80000
MP7364.1	$0FF0000
MP7364.2	$0808080
MP7364.3	$0000000
MP7364.4	$0000000
MP7364.5-6	$0000000
MP7364.7	$00000FF
MP7364.8	$000B8B8
MP7364.9	$0ECECEC
MP7365.0	$0FFFFFF
MP7365.1	$0C08030
MP7365.2	$000FF00
MP7365.3	$0FF00FF
MP7365.4	$00000FF
MP7365.5	$0FF0000
MP7365.6	$0808080
MP7365.7	$00000FF
MP7366.0	$0ECECEC
MP7366.1	$0000000
MP7366.2	$00000FF
MP7366.3	$0FF0000
MP7366.4	$0FFFFFF
MP7366.5	$0FF0000
MP7366.6	$0000000
MP7366.7	$0202020
MP7366.8	$0404040
MP7366.9	$0606060
MP7366.10	$0808080
MP7366.11	$0A0A0A0
MP7366.12	$0C0C0C0
MP7366.13	$0E0E0E0
MP7366.14	$0FFFFFF
MP7367.0	$0ECECEC
MP7367.1	$0FF0000
MP7367.2	$000FF00
MP7367.3	$00000FF
MP7367.4	$0C0C0C0
MP7367.5	$0FFFFFF
MP7367.6-14	$0000000

Machine parameters	Standard setting
MP7368.0	$0ACACAC
MP7368.1	$0FFFFFF
MP7368.2	$00000FF
MP7368.3	$0FF0040

Machine parameters	Standard setting
M7369.0	$0ECECEC
MP7369.1	$0000000
MP7369.2	$00000FF
MP7369.3	$0000000
MP7369.4	$0FF6000
MP7369.5	$0FF0040
MP7369.6	$0FF0000

7.1.3 Graphic Display

In the graphics window you can view the following graphics:

- Test graphics
- Parallel graphics
- Programming graphics
- Help illustration

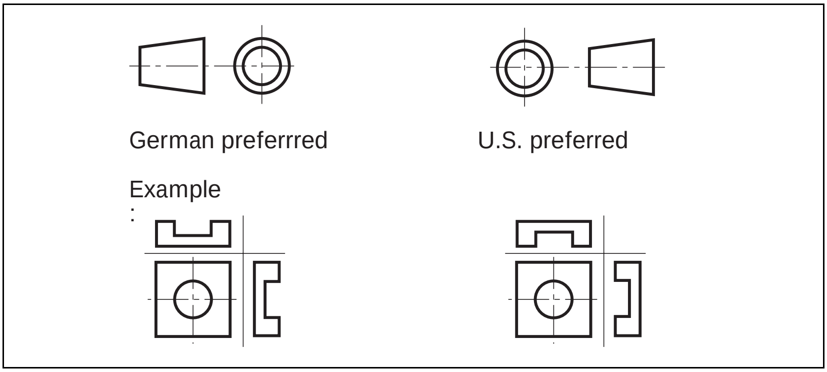
For the test graphics and parallel graphics you can choose one of three display modes:

- Projection in three planes
- Plan view
- 3-D view

Projection in three planes

The display in three planes can be shown in 1st-angle projection as preferred in Germany or in the American-style 3rd-angle projection:

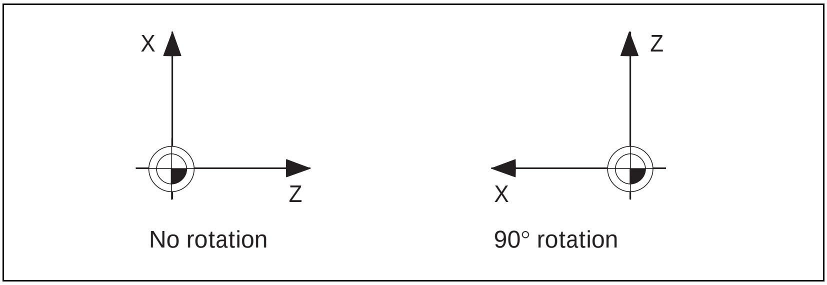
▶ Select the type of projection with MP7310, bit 0



Rotation of the coordinate system

You can rotate the coordinate system for graphic display by +90° if, for example, the Y axis is defined as tool axis.

▶ Select the angle of rotation with MP7310, bit 1



Graphic display for datum shift

In an NC program you can program several BLK forms in succession.

After datum shift with Cycle 7, the shift can be interpreted to apply also to subsequent blank forms:

- In MP7310, bit 2 define the BLK form shift.

Position of the cursors

In the display in three planes you can display the position of the cursor:

- Switch this function on with MP7310, bit 3.

Graphics: 3-D view

The iTNC offers two display modes for 3-D graphics:

- 2.5-D graphics
- 3-D graphics

The 3-D graphics allows you to display 5-axis machining operations. Due to the increased computing effort, however, the display-building process takes longer.
If you have selected the 3-D graphics with MP7310, the 3-D graphics is only activated for 5-axis machining operations. Otherwise, the 2.5-D graphics remains effective.

- With MP7310 bit 5, you activate the 3-D graphics for the **Program Test** mode.
- With MP7310 bit 6, you activate the 3-D graphics for the **Program run, full sequence** and **Program run, single block** modes.

MP7310	**Graphic display mode**
Format:	%xxxxxxxx
Input:	Bit 0 – Projection in three planes: 0: German-preferred projection 1: US-preferred projection Bit 1 - Rotating the coordinate system in the working plane by 90°: 0: No rotation 1: Rotation by +90° Bit 2 – BLK form after datum shift: 0: Shifted 1: Not shifted Bit 3 – Display of the cursor position: 0: No display 1: Display Bit 4 - Reserved Bit 5 - 3-D graphics during program test 0: 2.5-D 1: 2.5-D and 3-D Bit 6 - 3-D graphics during program run 0: 2.5-D 1: 2.5-D and 3-D Bit 7 – Reserved

7.1.4 Special characters

To enter special characters, use the following key combinations:

Key combination	Special characters
SHIFT + "	’
SHIFT + &	@
SHIFT + (	[
SHIFT +)	]
SHIFT + –	_
SHIFT + /	\
SHIFT + !		
SHIFT + ^	~
SHIFT + #	ESC

7.2 PLC Soft Keys

7.2.1 Vertical PLC Soft Keys

In the following operating modes you can display your own soft keys through the PLC:

- MANUAL
- ELECTRONIC HANDWHEEL
- POSITIONING WITH MANUAL DATA INPUT
- PROGRAM RUN, FULL SEQUENCE
- PROGRAM RUN, SINGLE BLOCK

You can create the soft keys with PLCdesign.

When a PLC soft key is pressed the NC enters the soft-key number in W302. On the rising edge of the keystroke it enters the soft-key number; on the falling edge it enters –1. The PLC can enter –1 itself after recognizing the soft-key number.

With Module 9200 you can display entire soft-key rows. With Module 9201 you can show individual soft keys. With Module 9202 you can switch to the display with PLC soft keys and PLC windows. This module works like the screen management key.

Display/delete PLC soft-key row

- In the system file PLC:\PLCSOFTK.SYS, enter the names and path of the required soft-key files. With the sequence of your entries you specify the soft-key number: Line 0 = soft-key number 0, etc. One soft-key level can consist of up to four soft-key rows, i.e. 32 soft keys per level.
- When calling the module, indicate the row to be displayed first.
- With the transfer parameter, specify how the soft keys should be displayed:
  - After the screen management key is pressed, i.e. after the PLC window is selected
  - In the current operating mode
    In this case the NC soft keys are overwritten.
- Specify whether the NC soft keys should be overwritten or whether the PLC soft keys should be appended to the NC soft keys. If you append the PLC soft keys, a separate list is opened. Only one PLC soft-key row can be appended.

		Set	Reset
W302	**Number of the horizontal PLC soft key that was pressed**	NC	NC

Module 9200 Display/delete PLC soft-key row

The soft keys to be activated are specified in a constants field by their line numbers. If there is no PLCSOFTK.SYS file, or if the lines indicated in the constants field do not exist, no soft-key row is generated.

Can only be called from the sequential program.

Call:

```
PS    B/W/D/K/KF<Select or delete soft-key address>
                1: Delete soft-key level
                KF: Address of soft-key selection
PS    B/W/D/K   <soft-key row>
                0 to 3: Soft-key row to be displayed
PS    B/W/D/K   <Soft-key mode>
                0: Soft-key row for displayed PLC window
                1: Soft-key row in current operating mode
                2: Append soft-key row to NC soft keys (as of 280 472-xx)
CM    9200
```

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	1	Incorrect transfer parameters (e.g. KF address not in address range of the PLC code)
	2	Line nr. < 0 (not –1) in the constants field
	24	Module was called in a spawn job or submit job
	25	More than 32 elements in the constants field

Display/delete PLC soft key

▶ Procedure for displaying/deleting a PLC soft key

Module 9201 Display/delete PLC soft key

If no PLCSOFTK.SYS file exists, or if the specified line does not exist, no soft key is generated. In an existing PLC soft-key level, the soft key is displayed/deleted at the specified position.

Can only be called from the sequential program.

Call:

PS	B/W/D/K	<Soft-key number (line no./delete)> 0: Line no. –1: Delete soft key
PS	B/W/D/K	<Position no.> 0 to 31
PS	B/W/D/K	<Soft-key mode> 0: Soft key for displayed PLC window 1: Soft key in current operating mode 2: Append soft key to NC soft key
CM	9201	

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	1	Transfer parameter out of value range
	2	Line nr. < –1
	24	Module was called in a submit job

Select/deselect PLC soft keys and PLC windows

Module 9202 Select/deselect PLC soft keys and PLC windows

With this Module 9202 you activate the display with PLC windows or the PLC soft-key display. This module works like the screen management key.

Call:

PS	B/W/D/K	<Display mode> 0: PLC soft key/window deselected 1: Small PLC soft key/window deselected 2: Large PLC soft key/window deselected 3: Large PLC soft key/window selected while table editor is active
CM	9202	

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	1	Transfer parameter out of value range

7.2.2 Vertical PLC soft keys (only on BF 150)

To display the vertical PLC soft keys on the BF 150, a resource file is required. The PLC soft-key structure is defined in the resource file. The number of submenus depends only on the iTNC memory.

In the OEM.SYS file, the PLC soft-key project file *.SPJ is entered through the keyword **SOFTKEYPROJECT =.** After acknowledgment of **Power interruption** the resource file of the same name *.SYS is generated from this file. The resource file is activated with PLC Module 9203. The resource handle returned by this module must be transferred to Modules 9204 to 9208.

The soft-key structure is displayed with Module 9204. This is necessary after a resource file has been activated (also after it has been activated for the first time) and after soft-key setup parameters have been edited (with Module 9205).

In the standard setting the soft-key number is transferred to the PLC via W304 after the NODE, BACK and ACTION soft keys have been pressed. When the key is released, –1 is confirmed. PULSE, CHECK and RADIO soft keys are not reported via W304 to the PLC. With Module 9205, you can also select a word address other than W304. BLANK soft keys are not reported to the PLC.

Entry in the *.SPJ	Meaning
;	Comment
SKPATH	Path of the soft-key graphic files
SOFTKEY	Soft-key definition. The name of the soft-key graphic file and the name of the soft key must be specified. The maximum permissible length of the soft-key name is 23 characters. First entry = soft-key number 0, Second entry = soft-key number 1, etc. With ACTION soft keys, the soft-key number is confirmed via W304 (unless changed by Module 9205) to the PLC.
SKMENU	Beginning of the definition of a soft-key menu. The name of the menu must be specified.
ENDSKMENU	End of the definition of a soft-key menu
NODE	Soft key jumps to a submenu. Is confirmed via W304 (unless changed by Module 9205) to the PLC. The soft-key name and the name of the submenu must be indicated.
BACK	Soft key jumps to a submenu. Is confirmed via W304 (unless changed by Module 9205) to the PLC. The soft-key name and the name of the submenu must be indicated.
BLANK	Vacant soft key. You can also specify a soft-key name.
ACTION	Function soft key. Is confirmed via W304 (unless changed by Module 9205) to the PLC. A soft-key name must be indicated.

Entry in the *.SPJ	Meaning
PULSE	For the duration of a PLC cycle, the operand assigned by Module 9206 is set. Is not confirmed to the PLC via W304 (unless changed by Module 9205). A soft-key name must be indicated.
CHECK	When the soft key is first pressed, the operand assigned by Module 9206 is set and is reset when pressed again. It is not confirmed to the PLC via W304 (unless changed by Module 9205). A soft-key name must be indicated.
RADIO	From any group of these soft-key types, no more than one soft key can be pressed. When a soft key from this group is pressed, the operand assigned by Module 9206 is set and the operands of the other soft keys are reset. It is not confirmed to the PLC via W304 (unless changed by Module 9205). It is also possible to define more than six RADIO soft keys to one group. A soft-key name must be indicated.

Note

The states of the assigned operands of the CHECK and RADIO soft keys and the display are checked cyclically. If required, the display is adjusted accordingly.

Example of a PLC soft-key project file:

```
      PLC SOFT-KEY Project File - Version 1.0

      SKPATH 'PLC:\SK\1024x768\'

0     SOFTKEY 'BACK.BMX'        BACK_SK
1     SOFTKEY 'MAG.BMX'         MAG_SK
2     SOFTKEY 'MAG_CCW.BMX'     MAG_CCW_SK
3     SOFTKEY 'MAG_CW.BMX'      MAG_CW_SK
4     SOFTKEY 'DIAG.BMX'        DIAG_SK
5     SOFTKEY 'DIAGWZW.BMX'     DIAG_T_SK
...   SOFTKEY 'SPI_ON.BMX'      SPI_ON_SK
      SOFTKEY 'SPI_OFF.BMX'     SPI_OFF_SK
      SOFTKEY 'CHIP.BMX'        CHIP_SK
      SOFTKEY 'CHIP_REV.BMX'    CHIP_BACK_SK

      SKMENU RootMenu
      NODE   MAG_SK      Magazine
      NODE   DIAG_SK     Diagnosis
      BLANK
      BLANK
      BLANK
      BLANK
      ; 2nd ROW
      CHECK  CHIP_SK
      ACTION CHIP_BACK_SK
      BLANK
      BLANK
      RADIO  SPI_OFF_SK
      RADIO  SPI_ON_SK
      ENDSKMENU

      SKMENU Magazine
      ACTION MAG_CCW_SK
      ACTION MAG_CW_SK
      BLANK
      BLANK
      BLANK
      BACK BACK_SK
      ENDSKMENU

      SKMENU Diagnosis
      ACTION DIAG_T_SK
      BLANK
      BLANK
      BLANK
      BLANK
      BACK BACK_SK
      ENDSKMENU
```

Soft-key number (confirmed to the PLC):

Definition of the soft keys with names for graphics and soft keys

Main menu

1st soft-key row

2nd soft-key row

To "Magazine" submenu

To "Diagnosis" submenu

Submenu "Magazine"

Back to the main menu

Submenu "Diagnosis"

Back to the main menu

		Set	Reset
W304	**Number of the vertical PLC soft key that was pressed**	NC	NC

Module 9203 Activate PLC soft-key resource file

With Module 9203, you activate a soft-key resource. The resource file *.SYS is entered.
At present, only vertical PLC soft keys (mode = 1) can be managed.
The PLC soft-key resource can be defined in such a way that it is effective only for specific modes of operation. This might be useful, for example, if you want to use different PLC soft-key resources for the machine and programming modes of operation.

Call:

PS	D	<Resource handle> 0 when it is called for the first time, otherwise Resource handle from Module 9203
PS	B/W/D/K/S	<String with path and name of resource file>
PS	B/W/D/K	<Number of PLC soft-key root menu> –1: First menu found in the SYS file
PS	B/W/D/K	<Mode> 1: Vertical PLC soft keys
PS	B/W/D/K	<Mode of operation> 0: Programming modes of operation 1: Machine modes of operation 2: Programming and machine modes of operation
CM	9203	
PL	D	<Resource handle> –1: Error code in W1022

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	2	Resource-handle overflow, incorrect resource handle, incorrect mode, incorrect operating mode or number of PLC soft-key root menu negative.
	3	Incorrect string number or incorrect string
	20	Module was not called in a spawn job or submit job
	44	Error in the resource file

Module 9204 Update the PLC soft keys

If you want to restructure the vertical PLC soft keys, you must call Module 9204. This is necessary each time you have called Modules 9203, 9205, 9206 and 9207.

Call:

PS	D	<Resource handle> Resource handle from Module 9203
CM	9204	

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	2	Incorrect resource handle or resource handle not identical with current soft-key handle
	20	Module was not called in a spawn job or submit job

Module 9205 Define the setup parameters for the PLC soft keys

With Module 9205, you can edit the setup parameters that affect to the resource file. They do not become effective until you have called Module 9204. You can edit setup parameters for the complete resource file, individual PLC soft-key menus or individual PLC soft keys. Changes in individual PLC soft keys affect the entire resource file.

You can define a word address other than W304 to which the PLC soft keys are transferred.

Call:

PS	D	<Resource handle> Resource handle from Module 9203
PS	B/W/D/K	<Mode> 0: complete resource file 1: individual menu 2: individual PLC soft key
PS	B/W/D/K	<Number of PLC soft-key menu/Number of PLC soft key> If "complete resource file": non-functional
PS	D	<Reserved> 0 transferred
PS	B/W/D/K	<PLC word address for PLC soft keys> –1: W304
CM	9205	

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	1	Invalid PLC word address
	2	Incorrect resource handle or incorrect mode
	3	Invalid PLC label address
	20	Module was not called in a spawn job or submit job
	44	Error during setting of setup parameters

Module 9206 Change setting of the PLC soft keys

With Module 9206, the settings of individual PLC soft keys in the PLC soft-key structure can be changed:

- PLC soft keys can be locked and unlocked. Locked PLC soft keys cannot be used and are displayed accordingly.
- PLC soft keys can be coupled to new operands.
  - ACTION: These PLC soft keys are no longer confirmed via W304 (unless changed by Module 9205) to the PLC.
  - PULSE, CHECK, RADIO: These PLC soft keys must be assigned an operand by Module 9206, since they are not acknowledged via W304 to the PLC (unless changed by Module 9205).
- Couple PLC soft-keys to operands that
  - Unlock the PLC soft keys in a set state
  - Lock the PLC soft keys in a reset state

If a locked PLC soft key is pressed, it sets the marker M4577.

Call:

PS	D	<Resource handle> Resource handle from Module 9203
PS	B/W/D/K	<Soft-key number>
PS	B/W/D/K	<Function> 0: Lock soft key 1: Unlock soft key 2: Decouple soft key from assigned operand 3: Couple new operand to soft key 4: Decouple the soft-key unlocking/locking from the assigned operand 5: Couple the soft-key unlocking/locking with the operand
PS	B/W/D/K	<Operand address> Only for function 3 and 5, otherwise transfer 0
PS	B/W/D/K	<Operand type> Only for function 3 and 5, otherwise transfer 0 0: Marker M 1: Input I 2: Output O 3: Counter C 4: Timer T
CM	9206	

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	2	Incorrect resource handle or resource handle not identical with current soft-key handle, or incorrect function
	20	Module was not called in a spawn job or submit job
	44	Error during setting of setup parameters

Module 9207 Replace PLC soft keys

With Module 9207, individual PLC soft-keys can be replace by another PLC soft key. The change can be applied to the entire resource file or only to an individual menu. If a soft key is to be replaced in the entire resource file, the source menu is excepted from it so that the soft key can remain to make it possible to reverse the replacement.

Call:

PS	D	<Resource handle> Resource handle from Module 9203
PS	B/W/D/K	<PLC soft-key number source>
PS	B/W/D/K	<Number of PLC soft-key menu source>
PS	B/W/D/K	<PLC soft-key number target>
PS	B/W/D/K	<Number of soft-key menu target> –1: Entire resource file except source menu
PS	B/W/D/K	<Function> 0:
CM	9207	

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	2	Incorrect resource handle or resource handle not identical with current soft-key handle, or incorrect function
	20	Module was not called in a spawn job or submit job
	44	Error during setting of setup parameters

Module 9208 Status information of PLC soft-key structure

Call:

PS	D	<Resource handle> Resource handle from Module 9203
PS	B/W/D/K	<Function> 0: Number of the current soft-key menu
PS	B/W/D/K	<reserved> 0 transferred
CM	9208	
PL	D	<status information>

Error detection:

Marker	Value	Meaning
M4203	0	No error
	1	Error code in W1022
W1022	2	Incorrect resource handle or resource handle not identical with current soft-key handle, or incorrect function
	20	Module was not called in a spawn job or submit job
	44	Error finding the status information

7.3 Log

The log serves as a troubleshooting aid. There are 4 MB of memory available for this purpose.

All entries in the log are marked with the current date and time.

Entry		Description
RESET		Powering up the control
BERR		Blinking error message
BREG		Register contents with a blinking error message
ERR		Error message P: PLC error message with the line number in the PLC error text file N: NC error message with number
KEY		Key strokes
STIB[a]	ON	Control-in-operation on
	OFF	Control-in-operation off
	BLINK	Control-in-operation symbol blinking
INFO	MAIN START	Control model and NC software
INFO	MAIN FILE DEL	Faulty files on the hard disk, to be erased when started up
INFO	MAIN HDD	Hard disk designation
INFO	MAIN CYCLES	Test results for fixed cycles and touch probe cycles

a. STIB = control-in-operation symbol in the screen display

Entry			Description
INFO	MAIN PGM		Started NC program or NC macro
INFO	MAIN LINE		Line number of the started NC program or NC macro
INFO	MAIN PATH	PLCEDIT	File for PLC Editor
		NCEDIT	File for NC Editor
		RUNPGM	Main program for program run
		RUNPALET	Pallet table for program run
		RUNDATUM	Datum table for program run
		RUNTOOL	Tool table for program run
		RUNTCH	Pocket table for program run
		SIMPGM	Main program for program test
		SIMDATUM	Datum table for program test
		SIMTOOL	Tool table for program test
		RUNBRKPGM	Stopping point for block scan
		SIMBRKPGM	Stopping point for program test
		RUNPRINT	Path for FN15: PRINT for program run
		SIMPRINT	Path for FN15: PRINT for program test
		MDIPGM	File for positioning with manual data input
		NCFMASK	Mask for file management in the NC area
		PLCFMASK	Mask for file management in the PLC area
		EASYDIR	Paths for standard file management
		TCHPATH	Datum table for manual measurement
		SIMTAB	Freely definable table in program test
		RUNTAB	Freely definable table in program run
		KINTAB	Active kinematic table
		PGMEND	Information about the program end in program run Byte 0/1 00 01 Emergency stop 00 02 Positioning error 00 03 Programmed stop 00 04 Block end in single block mode 00 05 Geometry error 00 06 END PGM, M02 00 07 TNC STOP button 00 08 Data transmission error (V.24/V.11) Byte 2/3 xx xx Internal error class Byte 4...7 xx xx xx xx Internal error code
INFO WARNING ERROR	PLC <log identifier>		Entries through PLC Modules 9275 and 9276

Entry		Description
INFO	REMO A_LG	Log in with LSV2 protocol
	REMO A_LO	Log out with LSV2 protocol
	REMO C_LK	LSV2 protocol: Locking and releasing the keyboard; the key codes between locking and releasing are sent via LSV2 protocol

You can read out the log in two ways:

- After entering the code word LOGBOOK, enter the path and name of an ASCII file and the time and date from which the log should record, as well as the time and date up to which it should record. After that, an ASCII file is generated and opened with the log entries.
- The PC software PLCdesign, TNCremo, or TNCremoNT offers you several functions for reading out the log.

Example of a log entry

The following example shows possible entries in the log:

```
INFO:      MAIN   START                     21.11.2001 07:30:51
           iTNC 530
INFO:      MAIN   START                     21.11.2001 07:30:51
           NC-SOFTWARE = 340420 01
INFO:      MAIN CYCLES                      21.11.2001 07:30:55
           CYCLE data are up to date
INFO:      MAIN CYCLES                      21.11.2001 07:30:55
           TCHPROBE data are up to date
ERR:       N-1 Power interruption           21.11.2001 07:31:02
Key:       0x01AE -> CE                     21.11.2001 07:31:15
Error:     P88 88 MPs are being read ...    21.11.2001 07:31:19
Key:       0x01F0 -> NC Start               21.11.2001 07:31:22
Key:       0x01F0 -> NC Start               21.11.2001 07:31:23
Key:       0x01F0 -> NC Start               21.11.2001 07:31:24
Key:       0x01F0 -> NC Start               21.11.2001 07:31:24
Key:       0x01F0 -> NC Start               21.11.2001 07:31:24
Key:       0x01F0 -> NC Start               21.11.2001 07:31:25
Key:       0x01C3 -> Auto                   21.11.2001 07:31:27
Key:       0x01F0 -> NC Start               21.11.2001 07:31:30
STIB:      ON                               21.11.2001 07:31:30
INFO:      MAIN PGM                         21.11.2001 07:31:30
           TNC:\STEFAN\GRAVUR.H
INFO:      MAIN LINE                        21.11.2001 07:31:30
           0
STIB:      OFF                              21.11.2001 07:31:31
INFO:      MAIN PGMEND                      21.11.2001 07:31:31
           01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
           00 05 00 08 00 00 00 38
           |                    |
         Byte 0               Byte 7

INFO:      MAIN PATH                        21.11.2001 07:31:32
           RUNBRKPGM = TNC:\STEFAN\GRAVUR.H
ERR:       N56 Limit switch X+              21.11.2001 07:31:32
Key:       0x01AE -> CE                     21.11.2001 07:31:43
```

The log can also be written to by the PLC for diagnostic purposes:

- With Module 9275 you can write ASCII data into the log.
- With Module 9276 you can write the contents of the operands into the log.

Note

Do not use Modules 9275 and 9276 in the PLC program as shipped. Instead, use it only for debugging. Otherwise the processing times could be increased and the hard disk could be written to unnecessarily, so that the log can no longer fulfill its function of recording keystrokes and error messages.

Module 9275 Writing ASCII data into the log

With Module 9275 you can write ASCII data into the log. For later editing the entry can be given an identifier.

Call:

```
PS     B/W/D/K/S<Log entry>
                 –1: No entry
PS     B/W/D/K/S<Log identifier>
                 –1: No entry
PS     B/W/D/K   <Priority>
                 0: Information
                 1: Warning
                 2: Error
CM     9275
```

Error detection:

Marker	Value	Meaning
M4203	0	Entry was written
	1	Error code in W1022
W1022	1	Invalid priority
	2	Invalid string number or invalid immediate string
	12	No string end identifier
	20	Module was not called in a spawn job or submit job

Module 9276 Writing operand contents into the log

With this module you can write the contents of operands (inputs, outputs, markers, bytes, words, double words, timers, counters) into the log. For later editing the entry can be given an identifier.

Call:

PS	B/W/D/K	<Identifier operand name> 0: M (marker) 1: I (input) 2: O (output) 3: C (counter) 4: T (timer) 5: B (byte) 6: W (word) 7: D (double word)
PS	B/W/D/K	<Address of the first operand>
PS	B/W/D/K	<Number of operands>
PS	B/W/D/K/S	<Log identifier> –1: No entry
PS	B/W/D/K	<Priority> 0: Information 1: Warning 2: Error
CM	9276	

Error detection:

Marker	Value	Meaning
M4203	0	Entry was written
	1	Error code in W1022
W1022	1	Invalid priority
	2	Invalid identifier for operand name
	3	Invalid first operand address
	4	Sum of first operand address and number of operands invalid
	5	Address is not a word/double-word address
	12	No string end identifier
	20	Module was not called in a spawn job or submit job
	36	Entry in the log was shortened to 210 characters

8 PLC Programming

8 PLC Programming

8.1 PLC Functions

The integrated PLC of the iTNC contains its own text editor for creating the list of statements for the PLC program. You enter PLC commands and comments through the TNC keyboard. It's easier, however, to create your PLC programs on a PC with the PLC compiler software **PLCdesign.** For more information on **PLCdesign,** contact HEIDENHAIN.

To prevent errors in the PLC program, the iTNC runs a syntax monitor during program input. The iTNC supports you with the COMPILE function, which checks the PLC program for logical errors, and the TRACE and TABLE functions, with which you can check the condition of the operands.

The process memory works with a compiled PLC program up to a size of 512 KB. Every 12.5 ms—the PLC cycle time—the iTNC begins a new PLC scan, i.e. every 12.5 ms the inputs are reread and the outputs are reset. The PLC cycle time can be set with MP7600.1 and ascertained with Module 9196.

Module 9196 Finding the PLC cycle time

The PLC cycle time is determined in ms.

Call:

```
CM    9196
PL    D        <PLC cycle time in ms>
```

MP7600.1 PLC cycle time
= MP7600.1 * Position controller cycle time
= MP7600.0 * MP7600.0 * 0.6 ms

Input: 1 to 20 (recommended input value: 7)

8.1.1 Selecting the PLC Mode

Select PLC Mode:

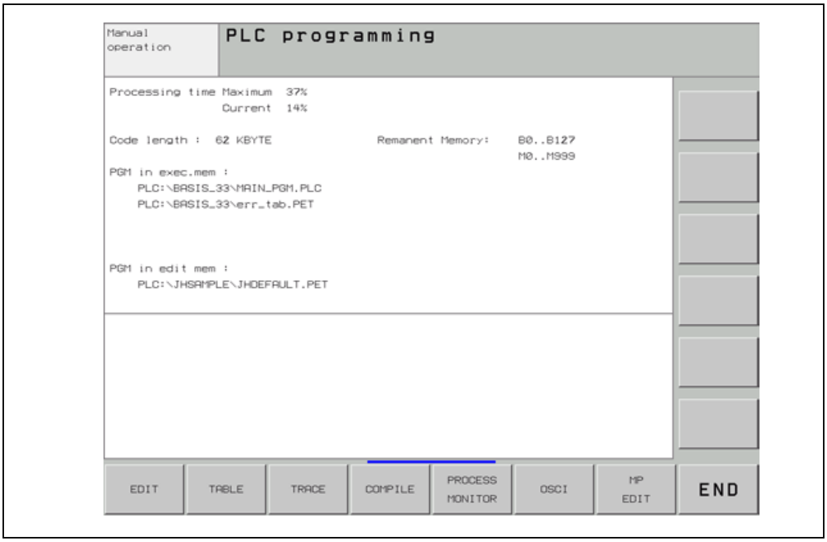
- Select the **Programming and Editing** operating mode.
- Press the MOD key.
- Enter the code number 807667 and confirm your entry with the ENT key, or if you already entered the code number, press the PLC EDIT soft key.

Exit PLC mode:

- Press the END hard key or soft key.

8.1.2 PLC Main Menu

After you have entered the code number (or pressed the PLC EDIT soft key) the TNC displays the PLC main menu:



`Processing time maximum:`
Maximum run time of the PLC program
The PLC processing time (time for a PLC scan) is given as a percentage of the maximum time: 3.5 ms is the equivalent of a run time of 100%!
The maximum run time of the sequential program must not exceed 300% (=10.5 ms). If it is higher, the TNC triggers the blinking error message **`PLC: time out.`**

`Processing time current:`
The time taken for the latest PLC scan in %.

`Code length:`
Length of the compiled sequential program in KB. Maximum value: 512 KB.

`PGM in exec.mem:`
Name of the last compiled PLC program (program in process memory).
During switch-on, the TNC automatically compiles the program that was selected in process memory before switch-off. The PLC program is not active until it has been compiled!

`PGM in edit mem:`
Name of the file located in RAM memory.

PLC functions of the main menu

From the PLC main menu you can use soft keys to access the following PLC functions:

Soft key	Function
EDIT	Editing the file located in RAM memory.
TABLE	Display the logical states of the PLC memory, See page 8 – 10
TRACE	Display the TRACE Function or logic diagram, See page 8 – 6 and Page 8–8
COMPILE	Compile PLC program.
PROCESS MONITOR	Process monitor
OSCI	Activate the integrated oscilloscope, Page 6–212
MP EDIT	Display a list of machine parameters
END	Exit the PLC mode
EDIT	Editing the file located in RAM memory.

8.1.3 File Management

File management in PLC mode is largely the same as in the **Programming and Editing** mode of operation (see User's Manual for iTNC 530). If you press the PGM MGT key while in the PLC mode, the iTNC displays also the PLC partition at the upper left next to the TNC partition.

Differences from file management of NC part programs

File types displayed by the iTNC when you press the SELECT TYPE soft key:

Soft key	Function
ALLE ANZ.	Show all files
.PLC FILES	Show only PLC programs (*.PLC)
SHOW .A	Show only ASCII files (*.A)
.HLP FILES	Show only help files (*.HLP)
.SYS FILES	Show only system files (*.SYS)
.COM FILES	Show only compensation value tables (*.COM)
.CMA FILES	Show only tables with compensation value assignments (*.CMA)
.PET FILES	Show only PLC error tables (*.PET)
.SRC FILES	Show only PLC source files (*.SRC)
.SPJ FILES	Show only soft-key project files (*.SPJ)
END	Return to previous menu

8.1.4 The TRACE Function

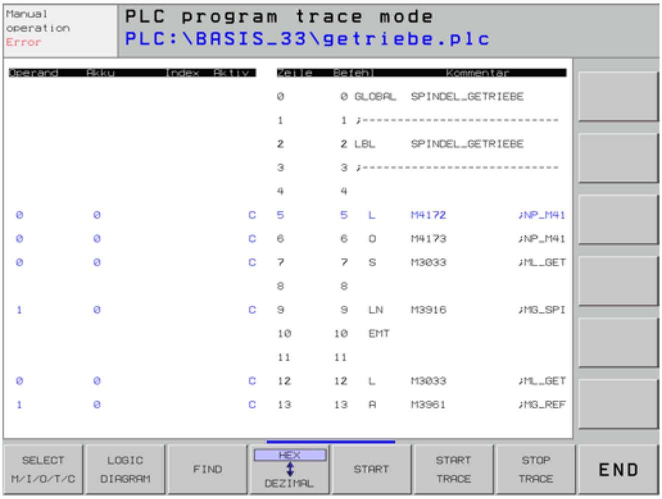
With the TRACE function you can:

- Control the logical states of markers, inputs, outputs, timers, and counters
- Check the content of bytes, words and double words

Select the TRACE function through the TRACE soft key in the PLC main menu. The TNC displays:

- The statement list (STL) of the selected PLC program
- For every program line, the content of the operand and the accumulator in HEX or decimal code (selectable by soft key)

The TNC identifies every cyclically executed command with an asterisk **(*)**.
With the arrow keys or the GOTO function you can select the program section that you would like to see on the screen.
The PLC program to be selected is chosen with PGM MGT, and must be the currently active main program or a file integrated with USES.



Soft keys within the TRACE function:

Soft key	Function
SELECT M/I/O/T/C	Select the operand type for logic diagram
LOGIC DIAGRAM	Show the logic diagram
SUCHEN	Search for text in STL (TRACE IN CODE)
HEX ↕ DEZIMAL	Show operand or accumulator contents in hexadecimal or decimal notation
STOP	Stop dynamic display of the operand content, the accumulator content, and the logic diagram with STOP , continuously update again with START .
START TRACE	Start the trace
STOP TRACE	End the trace
END	Return to previous menu

8.1.5 The Logic Diagram

Soft keys within the LOGIC DIAGRAM function:

Soft key	Function
SELECT M/I/O/T/C	Select **M**arkers/**I**nputs/**O**utputs/**T**imers/**C**ounters for a logic diagram.
TRACE IN-CODE	Display the trace in code
SAVE TRACE BUFFER	Save current logic diagram in an ASCII file (*.A)
RESTORE TRACE BUFFER	Show the saved logic diagram
START	Stop dynamic display of the operand content, the accumulator content, and the logic diagram with STOP , continuously update again with START .
STOP	
START TRACE	Start the trace
STOP TRACE	End the trace
END	Return to previous menu

With the LOGIC DIAGRAM function you can graphically display the logical states of up to 16 operands (M/I/O/T/C) at once, during which the TNC records up to 1024 PLC scans.

The operands to be shown must be saved in a table that you create with the SELECT M/I/O/T/C soft key. The iTNC asks per dialog for the individual positions in the table. To delete incorrect entries, simply press DEL.

For each operand you can enter one trigger condition. The iTNC records 512 states both before and after a trigger event. The following are possible trigger conditions:

- **1**: Record if operand is logically 1 (trigger on positive edge).
- **0**: Record if operand is logically 0 (trigger on negative edge).

If you do not need a trigger condition, answer the dialog prompt with NO ENT. If you enter no trigger condition for any of the operands, the TNC records the states of the operands continuously. The 1024 most recent states remain saved.

To start recording:

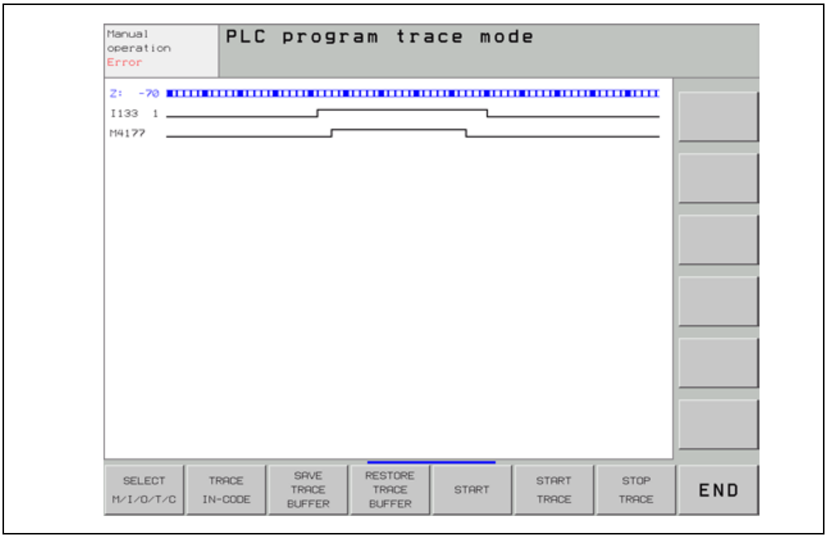
▶ Press the soft key START TRACE.

To stop recording:

▶ Press the STOP TRACE soft key, or the iTNC terminates recording automatically as soon as the trigger event occurs.

The ”PCTR” indicator blinks in the status window as long as the iTNC is recording logical states. As soon as recording ends, you can use the arrow keys to select the desired area in the TRACE buffer.

Example of logic diagram



8.1.6 The Table Function

From the main menu, choose the TABLE soft key to select the table of the PLC memory in order to show its states dynamically on the screen. To select a certain operand, use the cursor keys or the GOTO key. Press the END key to return to the main menu.

Soft keys within the Table function:

Soft key	Function
SET	Set the selected operand
RESET	Reset the selected operand
MARKER	Show a list of the markers
INPUT	Show a list of the inputs
OUTPUT	Show a list of the outputs
COUNTER	Show a list of the counters
TIMER	Show a list of the timers
BYTE	Show a list of the bytes
WORD	Show a list of the words
DOUBLE	Show a list of the double words
HEX ↕ DEZIMAL	Show contents of operands in hexadecimal or decimal.
STRING	List of strings (only the first 70 characters). Overwriting is not possible.
SAVE M/B/W/D	Save states of selectable operand areas in an ASCII file. Areas of more than one operand can be saved, e.g. M0 to M100, W100 to W118.
RESTORE M/B/W/D	Display saved ASCII file with states of operands
END	Return to previous menu

8.2 Conditional Compilation

Depending on the machine parameters, a PLC program can be conditionally compiled on the iTNC. This allows you to select and deselect machine options by entering the options in machine parameters. Therefore, only one PLC program is necessary for all variants of machine options.

- Enter the commands for the conditional compilation in the PLC program.
- Create the Config. file.
- In OEM.SYS, enter **`PLCCOMPCFG =`** followed by the path for the Config. file.
- Enter the machine options in the machine parameters MP4000.x.
- Reset the iTNC or recompile the PLC program.

Example:

```
OEM.SYS:
...
PLCCOMPCFG = PLC:\OEM\OEM.CFG
...

OEM.CFG:
DEFINE TOOLCHANGER = 1
DEFINE  STAR_DELTA = %MP4000.1%
DEFINE %MP4000.2%
DEFINE %MP4000.3%

MP4000.1 : YES
MP4000.2 : CHIP_CONVEYOR
MP4000.3 : SWIVEL_HEAD = 3

#if SWIVEL_HEAD = 3
...
#endif

#ifdef CHIP_CONVEYOR
...
#endif

#if STAR_DELTA = YES
...
#endif

#if TOOLCHANGER = 1
...
#endif
```

MP4000.0-15 Options for the conditional compilation of the PLC program

8.3 Hard-Disk Organization

The hard disk of the TNC is divided into three partitions:

TNC partition

User-specific data such as NC programs, tool tables, datum tables, and pallet tables.

PLC partition

Your OEM-specific data such as system files, PLC programs, machine parameters, help files, PLC dialogs, PLC error tables, compensation value tables and OEM cycles. The PLC partition is visible only after you have entered the code number 807667.

As a machine tool builder, you are concerned primarily with the PLC partition.

SYS partition

System-specific files such as system files, NC dialogs, HEIDENHAIN cycles, etc. The SYS partition is not visible and cannot be selected.

Warning

Alterations in the system partition can impair proper function of the iTNC!

Size of the partitions

Partition	Content	Size
SYS	System data	2 GB
PLC	OEM data	2 GB
TNC	User data	Remaining memory on hard disk (at least 2 GB)

Directory structure HEIDENHAIN recommends creating the following directory structure in the PLC partition:

PLC:\	System files *.SYS
BASIS_33	PLC programs *.PLC (main program and modules)
CORRECT	Compensation value tables *.CMA and *.COM
CYCLE	OEM cycles
JH	Machine parameter description, CycleDesign files
JHSAMPLE	Standard PLC error table *.PET
KINEMAT	Kinematics tables
LANGUAGE	PLC dialogs and error messages *.A; Help files *.HLP
LOGO	OEM logo
MFUNCT	M-function macros
MP	Machine parameter files, motor tables
NC_MACRO	NC macros
NET	Network settings
PROTO	Prototypes for tables
SOFTKEYS	Pictures for PLC soft keys

Note

In the PLC and SYS partition, a maximum of 512 entries each can be stored in the root directory, otherwise an error message appears.

8.4 System Files

8.4.1 OEM.SYS

In the OEM.SYS file you must enter code words to call certain functions. After the code word, and separated by an equal sign **=** you enter the directory in which the files for these functions are to be found, as well as the file names themselves.

You must make your entries in the OEM.SYS file either manually or with Module 9271 (MPFILE and PLCMAIN can only be entered manually). Module 9271 overwrites the content of existing code words and inserts non-existent code words at the end of the OEM.SYS file.

With Module 9270 you can read all entries in the OEM.SYS file.

The following code words are defined:

MPFILE = (mandatory entry): Path for the active MP file. If you have loaded an MP file editor and you exit the editor, the TNC automatically enters this MP file in the OEM.SYS file!

Input example: **MPFILE = PLC:\MP\NC530V02.MP**

PLCMAIN = (mandatory entry): Path for the active PLC program. If you compile a PLC program, the TNC automatically enters it in the OEM.SYS file!

Input example: **PLCMAIN = PLC:\PLC_PGM\MAIN_530.PLC**

PLCPWM = Path for PLC program for commissioning of digital axes

Input example: **PLCPWM = PLC:\IB_PGM\IB530.PLC**

PLCERRTAB = (mandatory entry for PLC error messages): Path for PLC error message table. If you compile a PLC program, the TNC automatically enters it in the OEM.SYS file!

Input example: **PLCERRTAB = PLC:\ PLC_PGM \ERR_TAB.PET**

PLCERROR = Name for text file with PLC error messages; the path for the text file is permanently defined.

Input example: **PLCERROR = PLC_ERR.A**

PLCERRFIX = Path for "Corrective action" help text.

Input example: **PLCERRFIX = FIX.A**

PLCERRREASON = Path for "Cause of error" help text.

Input example: **PLCERRREASON = REASON.A**

PLCDIALOG = Name for text file with PLC dialogs; the path for the text file is permanently defined.

Input example: **PLCDIALOG = DIALOG.A**

PLCSOFTVERS = (mandatory entry): TNC displays PLC software version when the MOD key is pressed.

Input example: `PLCSOFTVERS = BASIS--33-03`

TABCMA = Path for compensation value tables for axis error compensation. (See “Nonlinear Axis Error Compensation” on page 6 – 37)

Input example: `TABCMA = PLC:\AXIS_COR\CORRECT.CMA`

MODEHELP = Path for help texts and machine commands.

Input example: `MODEHELP = PLC:\LANGUAGE\GERMAN\OPTIMIER.HLP`

PLCPASSWORD = Code number for calling the PLC mode (instead of 807667).

Input example: `PLCPASSWORD = 123456789`

Note

Do not enter a code number that has already been defined by HEIDENHAIN!

MPPASSWORD = Code number for calling the machine parameter file (instead of 95148).

Input example: `MPPASSWORD = MP`

Note

Do not enter a code number that has already been defined by HEIDENHAIN!

MPLOCKFILE = Path of a machine parameter subfile. If there are differences between this file and the current machine parameter file, an error message appears and the value from this subfile is offered for acceptance.

Input example: `MPLOCKFILE = PLC:\MP\340420.MPL`

TTYP = Path and file name for list of the tool types.

PLCEVENTS = Path for event list (SPAWN command).

Input example: `PLCEVENTS = PLC:\EVENTS.PEV`

LSV2TIME0 = Timeout for block reception (STX to ETX).

LSV2TIME1 = Timeout for acknowledging ENQ or check sum.

LSV2TIME2 = Timeout during transmission of DLE 0, DLE 1 or NAK until reception of a valid character.

KINEMATIC =	Path for the assignment table of the tilting-axis geometry description. Input example: **KINEMATIC = PLC:\KINELIST.TAB**
REMOTE. LOCKSOFTKEY VISIBLE =	Display **External access ON/OFF** soft key. Input example: **REMOTE.LOCKSOFTKEYVISIBLE = YES**
REMOTE. PLCPASSWORD NEEDED =	Access to the PLC partition using the LSV2 protocol only with the password from **PLCPASSWORD =** Input example: **REMOTE.PLCPASSWORDNEEDED = YES**
REMOTE. PLCPASSWORD FORCED =	Setup, machine backup and full backup only with the password from **PLCPASSWORD =** Input example: **REMOTE.PLCPASSWORDFORCED = YES**
AXISNUMBER =	Number of the indexes of the machine parameters (except MP2xxx.y) in the machine-parameter file. Input example: **AXISNUMBER = 6**
PWM PARAMETER =	Number of the indexes of machine parameters MP2xxx.y (for the current and speed controller) in the machine-parameter file. Input example: **PWMPARAMETER = 6**
NUMBERMP4111 =	Number of required timers > 96. The corresponding number of machine parameters MP4111.96 to MP4111.x is created. Input example: **NUMBERMP4111 = 10** (machine parameters MP4111.96 to MP4111.105 are created)
LOGO =	Path for customer-specific company logo during control power-up Input example: **LOGO = PLC:\LOGO\OEM-LOGO.BMP**
SOFTKEY PROJECT =	Path for PLC soft-key project file *.SPJ with the structure of the vertical PLC soft key Input example: **SOFTKEYPROJECT = PLC:\SOFTKEY.SPJ**

Module 9270: Reading a code word

With Module 9270 you can read an entry from the OEM.SYS file.

Call:

```
PS    B/W/D/K/S<String with code word>
PS    B/W/D/K   <String number for result [0 to 7]>
CM    9270
```

Error detection:

Marker	Value	Meaning
M4203	0	Interface was released
	1	Error. See W1022.
W1022	3	Not a valid string for code word or result
	12	String for code word is too long
	20	Module was not called in a spawn job or submit job
	30	Code word was not found

Module 9271: Writing a code word

With Module 9271 you can write an entry into the OEM.SYS file.

Call:

```
PS    B/W/D/K/S<String with code word>
PS    B/W/D/K   <String number for result [0 to 3]>
CM    9271
```

Error detection:

Marker	Value	Meaning
M4203	0	Interface was released
	1	Error. See W1022.
W1022	3	Entry was written
	6	PLCMAIN or MPFILE was transferred
	12	String for code word is too long
	30	Module was not called in a spawn job or submit job

8.4.2 NCMACRO.SYS

The NC macros are defined in this file. Certain NC macros are predefined. You can also define new NC macros, See “Module 9291 Calling an NC macro” on page 8 – 19.

The following NC macros are predefined:

- TC = <Name of the tool change macro>
- PALETT = <Name of the pallet change macro>
- CLAMP = <Name of the NC macro for changing the fixture (FIX)>
- RUNCANCEL = <Name of the macro called when an NC program is cancelled.>
- RESETINIT = <Name of the macro called when **traverse reference point** is left>
- STARTUPCANCEL = <Name of the macro called when mid-program startup is not completed with **Restore machine status.**>

Example entry: TC=PLC:\NC_MACRO\TOOLCALL.H

In order to increase the speed with which NC macros are executed, limit-switch monitoring can be turned off with FN17: SYSWRITE ID230 NR5. At the end of an NC macro the limit switch monitoring is always switched on.

PGM CALL, including NC macros, and **CYCL CALL** (for cycles greater than 68) are calculated automatically with the look-ahead function and run without exact stop. At the beginning and end of the called program or cycle, it can happen that a missing synchronization between machine status and look-ahead calculation may lead to problems.
Example:
A **TOOL CALL** is run in look-ahead calculation. In this **TOOL CALL** a PLC function is needed (e.g. opening the tool changer gate). The tool is automatically changed on the machine. During this time the look-ahead calculation reaches another **TOOL CALL**. Since the PLC function has been fulfilled (the tool changer gate is open), the look-ahead calculation is continued. After the first tool change has been completed, the PLC function is no longer fulfilled (the tool changer gate is closed). The second **TOOL CALL** would be executed if the PLC function is not fulfilled (the tool changer gate is closed).
The function **FN20: WAIT FOR SYNC** provides a remedy for this problem. If this function is programmed at the beginning of an NC program (NC macro) or cycle, in the look-ahead calculation the **PGM CALL** (NC macro call) or **CYCLE CALL** is not executed until the calling program has actually reached the **PGM CALL** (NC macro call) or **CYCL CALL.**

Module 9291 Calling an NC macro

With Module 9291, you can call an NC macro in any operating mode. They are executed like cycles, without block display. The control-in-operation symbol is displayed while the macro is being executed. No macros can be activated if there is the error message **External emergency stop.**

The predefined code words of the NCMACRO.SYS file and the code words defined by the user can be transferred. They only need to be entered in NCMACRO.SYS to be defined. To prevent name conflicts with future HEIDENHAIN code words, your code words should begin with the character ”P$” or with the name of the company.

Call:
PS B/W/D/K/S<Code word>
CM 9291

Error detection:

Marker	Value	Meaning
M4203	0	NC macro was executed
	1	Error code in W1022
W1022	2	NCMACRO.SYS does not exist, code word does not exist, or invalid string
	7	Macro cannot be executed.
	8	External emergency stop is active
	20	Module was not called in a spawn job or submit job
	28	NC program or other macro is already running
	29	The file given under the code word is not an NC program (*.H or *.I).
	36	The file given under the code word does not exist.

8.4.3 MGROUPS.SYS

In the system files PLC:\MGROUPS.SYS and PLC:\MSPLIT.SYS, you define the M functions to be output after a block scan.

8.4.4 MSPLIT.SYS

M functions that are effective in several groups are divided in the MSPLIT.SYS file into function components.

8.4.5 PLCSOFTK.SYS

Path for the file names of the PLC soft-key pictures. (See "PLC Soft Keys" on page 7 – 13)

8.4.6 CYCLE.SYS

Definition of the soft-key structure, if you have integrated OEM cycles. This file is created automatically by the PC software CycleDesign (see OEMCYC directory).

8.4.7 TNC.SYS

The end user can define certain paths and functions in this file:

- TMAT = <Path for list of tool materials>
- WMAT = <Path for list of workpiece materials.>
- PCDT = <Path for cutting data tables.>
- REMOTE.TNCPASSWORD = <Password for LSV2 access.>
- REMOTE.TNCPRIVATEPATH = <Path to be protected by the password.>

8.5 Data Transfer NC → PLC, PLC → NC

Information is exchanged between PLC and NC by markers, bytes, words and double words. The function of the individual markers, bytes, words and double words is fixed.

The transfer of certain data to the PLC is controlled by strobes:

- M codes
- S codes
- T codes
- G codes
- Q codes

Example:

If an M function is output, the NC sets the strobe signal M4072. After evaluating the M function, the PLC sets the acknowledgement marker M4092. The PLC must then reset M4092, otherwise no further strobes can be sent by the NC.

8.5.1 Data transfer of NC program → PLC (FN19: PLC =)

With the Q-parameter function `FN19: PLC =` you can transfer two values from an NC program to the PLC. The iTNC stores the transferred values as integer values of the form 1/10 000 in the double words D280 and D284. M4570 defines the unit of measure of both numerical values. During transfer, the marker M4075 is set by the NC. The PLC must acknowledge the transfer by setting marker M4095.

		Set	Reset
M4075	**Transfer active with FN19**	NC	NC
M4095	**Acknowledgment of transfer with FN19**	PLC	PLC
M4570	**Unit of measure for transfer with FN19** 0: mm 1: inches	NC	NC
D280	**First numerical value from FN19**	NC	NC
D284	**Second numerical value from FN19**	NC	NC

8.5.2 Data Transfer PLC → NC Program (Q Parameters)

Data transfer from the PLC to the NC program goes through Q parameters Q100 to Q107, i.e., from the PLC you can overwrite Q parameters Q100 to Q107:

- In double word D528, enter the numerical value to be transferred.
- In word W516, define the target parameter (0=Q100, 7=Q107).
- Activate transfer with strobe marker M4131.
- The TNC transfers the values with the next strobe.

		Set	Reset
M4131	**Activation of Q-parameter transfer to the NC; data from D258, Q number from W516**	PLC	NC
D528	**Double word with multiple function, here data for transfer from PLC to NC**	PLC	PLC
W516	**Q No. 0-7 for numerical data transfer PLC → NC**	PLC	PLC

8.5.3 Data Transfer NC Program → NC (FN17 SYSWRITE)

You can use the **`FN17: SYSWRITE`** function particularly for OEM cycles if you wish to overwrite certain NC data, e.g., an active basic rotation, from the NC program. A group number, a system data number, and an index specify the particular item of system data that you write: **`FN17: SYSWRITE IDxxxx NRxxxx IDXxxxx = Qxxx`** or numerical value; comment. In the NC program you must enter the code number 555 343 before you can define function FN17 (soft keys: Q-parameter programming, special functions). After a control reset, the code number must be entered again if you wish to program **`FN17.`** The iTNC provides the following functions:

Group name	Group number ID....	System data number NR....	System data index IDX....	System data item
Spindle switchover				
	20	13	–	0 = Spindle 1 1 = Spindle 2
Data from the tool table				
	50	1	Tool no.	Tool length L
		2	Tool no.	Tool radius R
		3	Tool no.	Tool radius R2
		4	Tool no.	Oversize in tool length DL
		5	Tool no.	Oversize in tool radius DR
		6	Tool no.	Oversize in tool radius DR2
		7	Tool no.	Tool locked TL 0 = not locked, 1 = locked
		8	Tool no.	Number of the replacement tool RT
		9	Tool no.	Maximum tool age TIME1
		10	Tool no.	Maximum tool age TIME2
		11	Tool no.	Current tool age CUR. TIME
		12	Tool no.	PLC status
		13	Tool no.	Maximum tooth length LCUTS
		14	Tool no.	Maximum plunge angle ANGLE
		15	Tool no.	TT: Number of tool teeth CUT
		16	Tool no.	TT: Wear tolerance in length LTOL
		17	Tool no.	TT: Wear tolerance in radius RTOL
		18	Tool no.	TT: Direction of rotation DIRECT 0 = positive, –1 = negative
		19	Tool no.	TT: Offset in plane R-OFFS R = 99 999.9999
		20	Tool no.	TT: Offset in length L-OFFS
		21	Tool no.	TT: Break tolerance in length LBREAK
		22	Tool no.	TT: Break tolerance in radius RBREAK
		23	Tool no.	PLC value

Group name	Group number ID....	System data number NR....	System data index IDX....	System data item
Coordinate transformation				
	210	1	–	Basic rotation (manual)
		3	–	Active mirrored axes Bits 0 to 2 and 6 to 8: Axes X, Y, Z and U, V, W
		6	–	Tilt working plane during Program Run (0 = inactive, –1 = active)
		7	–	Tilt working plane in Manual (0 = inactive, –1 = active)
Exchange tool axis				
	212	–	–	0: Tool axis Z 1: Tool axis X 2: Tool axis Y 3: Tool axis from TOOL CALL
Traverse range				
	230	2	1 to 9	Negative software limit switches in axes 1 to 9
		3	1 to 9	Positive software limit switches in axes 1 to 9
		4	Number of axes whose software limit switches are to be overwritten	Number of the first of several consecutive Q parameters 1. Q: Neg. limit switch in 1st axis 2. Q: Pos. limit switch in 1st axis 3. Q: Neg. limit switch in 2nd axis etc.
		5	–	Limit switch monitoring (1 = off, 0 = on)
Tilting axes				
	290	1	–	Tilting axis geometry description
TS touch-trigger probe				
	350	10	–	Tool axis
		11	–	Effective radius
		12	–	Effective length
		13	–	Radius of calibration ring
		14	1	Center offset (reference axis)
			2	Center offset (minor axis)
		15	–	Center offset direction

Group name	Group number ID....	System data number NR....	System data index IDX....	System data item
TT touch probe for tool measurement				
	350	20	1	Center of axis 1
			2	Center of axis 2
			3	Center of axis 3
		21	–	Effective radius
		22	1	Probing position 1 in axis X
			2	Probing position 1 in axis Y
			3	Probing position 1 in axis Z
		23	1	Probing position 2 in axis X
			2	Probing position 2 in axis Y
			3	Probing position 2 in axis Z
		24	1	Probing position 3 in axis X
			2	Probing position 3 in axis Y
			3	Probing position 3 in axis Z
		25	1	Probing position 4 in axis X
			2	Probing position 4 in axis Y
			3	Probing position 4 in axis Z
Coordinate transformation				
	420	0	0	0 = Globally effective
Write values into active datum table				
	500	Line	Column	Depends on MP7475
	501	Line	Column	
Velocity semifeedforward control				
	600	1	Axis	Factor for velocity semifeedforward
		2	0 or NO ENT	Use factor from MP1396.x
Touch probe cycles				
	990	1	–	Approach behavior: 0 = Standard behavior 1 = Effective radius, safety clearance zero
		2	–	0 = Probe monitoring off 1 = Probe monitoring on
		3	–	Place probe data of the manual probing cycles into the tool table
		6	–	Touch probe cycle 3 0.0 = Input X12 1.0 = Input X13

Group name	Group number ID....	System data number NR....	System data index IDX....	System data item
Coordinate transformation				
		4	1	Transformation of the manual mode coordinate system into the active coordinate system (e.g. rotated, shifted).
			2	Transformation of the active coordinate system (e.g. rotated, shifted) into the manual mode coordinate system.
		5	5	Ask if due to a tilt motion, an axis is shown in an untilted coordinate system on top of another axis. The number of the first of two sequential Q parameters must be given. It contains the axis to be asked (0 = X, 1 = Y, 2 = Z). The second Q parameter should return the corresponding image (0 = X, 1 = Y, 2 = Z, –1 = Axis has no image).
		8	–	Spindle orientation including the angle
PLC data				
	2000	10	Marker no.	PLC markers

8.5.4 Data Transfer NC → NC program (FN17: SYSREAD)

You can use the **`FN18: SYSREAD`** function particularly for OEM cycles if you wish to access certain NC data, e.g., active tool compensation values, from the NC program. A group number, a system data number, and an index specify the particular item of system data that you read:
`FN18: SYSREAD Qxxx = IDxxxx NRxxxx IDXxxxx` (xxxx: Q parameter or numerical value); comment

Group name	Group number ID....	System data number NR....	System data index IDX....	System data item
Program information				
	10	1	–	mm = 0, inch = 1
		2	–	Overlap factor for pocket milling
		3	–	Number of the active fixed cycle
		4	–	Number of the last DEF-active OEM cycle
Machine state				
	20	1	–	Tool number
		2	–	Prepared tool number
		3	–	Active tool number 0 = X 6 = U 1 = Y 7 = V 2 = Z 8 = W
		4	–	Programmed spindle speed
		5	–	Active spindle status –1 = Spindle status undefined 0 = M3 active 1 = M4 active 2 = M5 active after M3 3 = M5 active after M4
		8	–	Active coolant status 0 = off, 1 = on
		9	–	Active feed rate
		11	–	Index of the active tool
		15	Number of the logical axis	Assignment of the logical axes and geometrical axes (0 = X, 1 = Y, 2 = Z, 3 = A, 4 = B, 5 = C, 6 = U, 7 = V, 8 = W)

Group name	Group number ID....	System data number NR....	System data index IDX....	System data item
Cycle parameters				
	30	1	–	Setup clearance
		2	–	Total hole depth/milling depth
		3	–	Plunging depth
		4	–	Feed rate for plunging
		5	–	First side length of pocket
		6	–	Second side length of pocket
		7	–	First side length of slot
		8	–	Second side length of slot
		9	–	Radius of circular pocket
		10	–	Feed rate for milling
		11	–	Rotational direction of the milling path
		12	–	Dwell time
		13	–	Thread pitch
		14	–	Finishing allowance
		15	–	Roughing angle
Data from the tool table				
	50	1	Tool no.	Tool length L
		2	Tool no.	Tool radius R
		3	Tool no.	Tool radius R2
		4	Tool no.	Oversize in tool length DL
		5	Tool no.	Oversize in tool radius DR
		6	Tool no.	Oversize in tool radius DR2
		7	Tool no.	Tool locked TL 0 = not locked, 1 = locked
		8	Tool no.	Number of the replacement tool RT
		9	Tool no.	Maximum tool age TIME1
		10	Tool no.	Maximum tool age TIME2
		11	Tool no.	Current tool age CUR. TIME
		12	Tool no.	PLC status
		13	Tool no.	Maximum tooth length LCUTS
		14	Tool no.	Maximum plunge angle ANGLE
		15	Tool no.	TT: Number of tool teeth CUT
		16	Tool no.	TT: Wear tolerance in length LTOL
		17	Tool no.	TT: Wear tolerance in radius RTOL
		18	Tool no.	TT: Direction of rotation DIRECT 0 = positive, –1 = negative
		19	Tool no.	TT: Offset in plane R-OFFS R = 99 999.9999
		20	Tool no.	TT: Offset in length L-OFFS

Group name	Group number ID....	System data number NR....	System data index IDX....	System data item
		21	Tool no.	TT: Break tolerance in length LBREAK
		22	Tool no.	TT: Break tolerance in radius RBREAK
		23	Tool no.	PLC value
Data from the pocket table				
	51	1	Pocket number	Tool number
		2	Pocket number	0 = not a special tool 1 = special tool
		3	Pocket number	0 = not a fixed pocket 1 = fixed pocket
		4	Pocket number	0 = not a locked pocket 1 = locked pocket
		5	Pocket number	PLC status
Tool pocket				
	52	1	Tool number	Pocket number P
Values programmed in TOOL CALL				
	60	1	–	Tool number T
		2	–	Active tool number 0 = X 6 = U 1 = Y 7 = V 2 = Z 8 = W
		3	–	Spindle speed S
		4	–	Oversize in tool length DL
		5	–	Oversize in tool radius DR
		6	–	Automatic TOOL CALL 0 = yes, 1 = no
		7	–	Oversize in tool radius DR2
		8	–	Tool index
Position programmed in TOOL CALL				
	70	1	–	1 = Valid position
		2	1	Position in X axis
			2	Position in Y axis
			3	Position in Z axis
		3	–	Feed rate (-1 = no feed rate programmed)
Tool compensation				
	200	1	–	Active radius (including oversizes) with algebraic signs
		2	–	Active length (including oversizes)

Group name	Group number ID....	System data number NR....	System data index IDX....	System data item
Coordinate transformation				
	210	1	–	Basic rotation (manual)
		2	–	Programmed rotation
		3	–	Active mirrored axes Bits 0 to 2 and 6 to 8: Axes X, Y, Z and U, V, W
		4	1	Active scaling factor in X
			2	Active scaling factor in Y
			3	Active scaling factor in Z
			7	Active scaling factor in U
			8	Active scaling factor in V
			9	Active scaling factor in W
		5	1	3-D ROT A
			2	3-D ROT B
			3	3-D ROT C
		6	–	Tilt working plane in Program Run (0 = inactive, –1 = active)
		7	–	Tilt working plane in Manual (0 = inactive, –1 = active)
		8	–	Angle of misalignment between the spindle and the tilted coordinate system
	214	8	–	Tolerance programmed in Cycle 32 or MP1096
	220	2	1 to 9	Current datum shift of the axes 1 to 9
		3	1 to 9	Difference between reference point and datum point
		4	1 to 9	Current PLC datum shift of the axes 1 to 9
Traverse range				
	230	2	1 to 9	Negative software limit switches in axes 1 to 9
		3	1 to 9	Positive software limit switches Axes 1 to 9
Nominal position in the REF system				
	240	1	1 to 9	Axes 1 to 9
Current position in the active coordinate system				
	270	1	1 to 9	Axes 1 to 9
M128 active				
	280	1	–	–1 = M128 active, 0 = M128 not active
		2	–	Feed rate programmed with M128

Group name	Group number ID....	System data number NR....	System data index IDX....	System data item
Tilting axes				
	290	1	–	Current tilting axis geometry description
		2	Number of the bit	Values of the individual bits of the active MP7500 (kinematics table or machine parameters).
M144 active				
	310	144	–	–1 = M144 active 0 = M144 not active
TS touch-trigger probe				
	350	10	–	Tool axis
		11	–	Effective radius
		12	–	Effective length
		13	–	Radius of calibration ring
		14	1	Center offset (reference axis)
			2	Center offset (minor axis)
		15	–	Direction of the center offset with respect to spindle 0°
TT touch probe for tool measurement				
	350	20	1	Center of axis 1
			2	Center of axis 2
			3	Center of axis 3
		21	–	Effective radius
		22	1	Probing position 1 in axis X
			2	Probing position 1 in axis Y
			3	Probing position 1 in axis Z
		23	1	Probing position 2 in axis X
			2	Probing position 2 in axis Y
			3	Probing position 2 in axis Z
		24	1	Probing position 3 in axis X
			2	Probing position 3 in axis Y
			3	Probing position 3 in axis Z
		25	1	Probing position 4 in axis X
			2	Probing position 4 in axis Y
			3	Probing position 4 in axis Z

Group name	Group number ID....	System data number NR....	System data index IDX....	System data item
Datum from touch probe cycle				
	360	1	1 to 9	Last datum of a manual touch probe cycle or last touch point from cycle 0 for the axes 1 to 9 without probe length compensation, but with probe radius compensation (workpiece coordinate system)
		2	1 to 9	Last datum of a manual touch probe cycle or last touch point from cycle 0 for the axes 1 to 9 without probe length or radius compensation (machine coordinate system)
		3	–	Measurement result of touch probe cycles 0 and 1 without probe radius and length compensation
Read values from active datum table				
	500	Line	Column	Read values
	501	Line	Column	Read REF values
	505	1	–	0 = no datum table selected 1 = datum table selected
Write values from active pallet table				
	510	1	–	Active lines
		2	–	Pallet number from column **Name**
		3	–	Active line of the pallet table
		4	–	Last line of the NC program of the current pallet
		5	1 to 9	Tool-Oriented Machining 0 = Safety height not programmed 1 = Safety height programmed
		6	1 to 9	Programmed safety height in a pallet table for tool-oriented machining
Touch probe cycles				
	990	1	–	Approach behavior 0 = Standard behavior 1 = Effective radius, safety clearance zero
		2	10	0.0 = Execution not in block scan 1.0 = Execution in block scan –1.0 = Invalid index
			16	0.0 = Execution not in Automatic operating mode 1.0 = Execution in Automatic operating mode –1.0 = Invalid index

Group name	Group number ID....	System data number NR....	System data index IDX....	System data item
Coordinate transformation				
		3	No. of the 1st of 9 consecutive Q parameters for axes X, Y, Z, A, B, C, U, V, W	Number of axes that are programmed in the selected datum table
		8	–	Current spindle angle
Machine parameters				
	1000	MP number	MP index	Value of the machine parameter (not for machine parameters for which a formula must be entered)
	1010	MP number	MP index	0 = MP does not exist 1 = MP exists
PLC data				
	2000	10	Marker no.	PLC markers
		20	Input no.	PLC input
		30	Output no.	PLC output
		40	Counter no.	PLC counter
		50	Timer no.	PLC timer
		60	Byte no.	PLC byte
		70	Word no.	PLC word
		80	Double-word no.	PLC double word

8.5.5 Data Transfer of Machine Parameters → PLC

In the PLC there are 122 machine parameters reserved for data transfer to the PLC. The iTNC saves the contents of machine parameters MP4210.x, MP4220.x and MP4310.x in PLC words. You must call the contents of MP4230.x and MP4231.x by using Module 9032. In these machine parameters you can save, for example, PLC positioning, datum shifts, feed rates for PLC positioning or coding for the release of certain PLC functions. You must evaluate the transmitted numerical values in your PLC program. The iTNC internally rounds input values less than 0.001 mm (or °) to 0.001 mm (or °).

		Set	Reset
D768	**Value from MP4210.0**	NC	NC
D772	**Value from MP4210.1**	NC	NC
D776	**Value from MP4210.2**	NC	NC
D780	**Value from MP4210.3**	NC	NC
D784	**Value from MP4210.4**	NC	NC
D788	**Value from MP4210.5**	NC	NC
D792	**Value from MP4210.6**	NC	NC
D796	**Value from MP4210.7**	NC	NC
D800	**Value from MP4210.8**	NC	NC
D804	**Value from MP4210.9**	NC	NC
D808	**Value from MP4210.10**	NC	NC
D812	**Value from MP4210.11**	NC	NC
D816	**Value from MP4210.12**	NC	NC
D820	**Value from MP4210.13**	NC	NC
D824	**Value from MP4210.14**	NC	NC
D828	**Value from MP4210.15**	NC	NC
D832	**Value from MP4210.16**	NC	NC
D836	**Value from MP4210.17**	NC	NC
D840	**Value from MP4210.18**	NC	NC
D844	**Value from MP4210.19**	NC	NC
D848	**Value from MP4210.20**	NC	NC
D852	**Value from MP4210.21**	NC	NC
D856	**Value from MP4210.22**	NC	NC
D860	**Value from MP4210.23**	NC	NC
D864	**Value from MP4210.24**	NC	NC
D868	**Value from MP4210.25**	NC	NC
D872	**Value from MP4210.26**	NC	NC
D876	**Value from MP4210.27**	NC	NC
D880	**Value from MP4210.28**	NC	NC
D884	**Value from MP4210.29**	NC	NC
D888	**Value from MP4210.30**	NC	NC
D892	**Value from MP4210.31**	NC	NC
D896	**Value from MP4210.32**	NC	NC

		Set	Reset
D900	**Value from MP4210.33**	NC	NC
D904	**Value from MP4210.34**	NC	NC
D908	**Value from MP4210.35**	NC	NC
D912	**Value from MP4210.36**	NC	NC
D916	**Value from MP4210.37**	NC	NC
D920	**Value from MP4210.38**	NC	NC
D924	**Value from MP4210.39**	NC	NC
D928	**Value from MP4210.40**	NC	NC
D932	**Value from MP4210.41**	NC	NC
D936	**Value from MP4210.42**	NC	NC
D940	**Value from MP4210.43**	NC	NC
D944	**Value from MP4210.44**	NC	NC
D948	**Value from MP4210.45**	NC	NC
D952	**Value from MP4210.46**	NC	NC
D956	**Value from MP4210.47**	NC	NC
W960	**Value from MP4220.0**	NC	NC
W962	**Value from MP4220.1**	NC	NC
W964	**Value from MP4220.2**	NC	NC
W966	**Value from MP4220.3**	NC	NC
W968	**Value from MP4220.4**	NC	NC
W976	**Value from MP4310.0**	NC	NC
W978	**Value from MP4310.1**	NC	NC
W980	**Value from MP4310.2**	NC	NC
W982	**Value from MP4310.3**	NC	NC
W984	**Value from MP4310.4**	NC	NC
W986	**Value from MP4310.5**	NC	NC
W988	**Value from MP4310.6**	NC	NC
M4300 to M4315	**Value from MP4310.0**	NC	NC
M4316 to M4331	**Value from MP4310.1**	NC	NC
M4332 to M4347	**Value from MP4310.2**	NC	NC
M4348 to M4363	**Value from MP4310.3**	NC	NC
M4364 to M4379	**Value from MP4310.4**	NC	NC
M4380 to M4395	**Value from MP4310.5**	NC	NC
M4396 to M4411	**Value from MP4310.6**	NC	NC

MP4210.0-47 Setting a number in the PLC (D768 to D956)
Input: -99 999.9999 to +99 999.9999

MP4220.0-4 Setting a number in the PLC (W960 to W968)
Input: 10 to 30 000

MP4230.0-31 Setting a number in the PLC (Module 9032)
Input: -99 999.9999 to +99 999.9999

MP4231.0-31 Setting a number in the PLC (Module 9032)
Input: -99 999.9999 to +99 999.9999

MP4310.0-6 Setting a number in the PLC (W976 to W988, M4300 to M4411)
Input: 10 to 30 000

Module 9032 Read machine parameters

With this module you can read the value of the given machine parameter from the active machine parameter file. The input value is transferred as a natural number with the decimal point shifted by the number of possible decimal places.

Only the value from the editable machine parameter file is read, not any value modified in the run-time memory by PLC Module 9031.

For non-indexed machine parameters, zero must be transferred as the index.

Call only in a submit job.

Call:

PS	B/W/D/K	<MP number>
PS	B/W/D/K	<MP index>
CM	9032	
PL	B/W/D	<MP value / Error code> 1: MP number does not exist 2: No separator (:) 3: MP value out of range 4: MP not found in file 5: No MP file found 6: Call was not in a submit job 7: MP is of the “string” type 8: No system memory

8.5.6 Interrogate PLC Operands in the NC Program (FN20: WAIT FOR)

With **`FN20: WAIT FOR`** you can interrupt the NC program until the condition programmed in the FN20 block is fulfilled. These conditions can be comparisons of a PLC operand with a constant. Permitted PLC operands: M, B, W, D, T, C, I, O

Operator	Function
==	Equal
!= or <>	Not equal
<	Less than
>	Greater than
<=	Less than or equal
>=	Greater than or equal

If you enter no condition, the interruption will continue until the operand = 0.

Examples:

`FN20: WAIT FOR I10==1`
Continue the NC program, if PLC input I10 is set.

`FN20: WAIT FOR I10`
Continue the NC program, if PLC input I10 equals zero.

`FN20: WAIT FOR B3000>255`
Continue the NC program, if the content of B3000 is greater than 255.

8.6 Operands

8.6.1 Operand Overview

Operand	Short designation	Address range
Marker	M	**M0 to M9999** **M0 to M999** are free. They are deleted only after entering the code number 531210, not during a reset (nonvolatile area). The range can be reduce in the *.CFG file of the PLC compiler. **M1000 to M3999** free, are deleted upon reset **M4000 to M4999** reserved for NC/PLC interface **M5000 to M5999** reserved for NC/PLC interface **M6000 to M9999** are free. They are deleted during reset.
Input	I	**I0 to I31** (MC 422) **I128 to I152** (machine operating panel) **I64 to I127** (first PL input/output board) **I192 to I255** (second PL) **I256 to I319** (third PL) **I320 to I383** (fourth PL)
Output	O	**O0 to O30** (MC 422) **O0 to O7** (via machine operating panel) **O32 to O62** (first PL) **O64 to O94** (second PL) **O128 to O158** (third PL) **O160 to O190** (fourth PL)
Counter	C	Set counter: **C0 to C48** Counter contents: **C48 to C95** Counter pulse release: **C96 to C144**
Timer	T	Timer start: **T0 to T47** Timer is running: **T48 to T95 and T96 to T559**
Byte Word Double word	B W D	**B0 to B9999** (8 bits) **B0 to B127** are free. They are deleted only after entering the code number 531210, not during a reset (nonvolatile area). The range can be reduce in the *.CFG file of the PLC compiler. **B128 to B2047** are reserved for NC/PLC interface. **B2048 to B9999** are free. They are deleted by a reset.
Constant	K	**–2 147 483 647 to +2 147 483 647**
String	S	**S0 to S15**

8.6.2 Operand Addressing (Byte, Word and Double Word)

The memory for operands B (8 bits), W (16 bits), D (32 bits) is only 8 bits wide. Since the operands can be 8, 16 or 32 bits wide, an overlap of the memory areas will occur, which you must take into account when addressing the memory.

Double word	Word	Byte	Memory	Word address	Double word address
D0	W2	B3	8 bits	High byte	Highest byte
		B2	8 bits	Low byte	
	W0	B1	8 bits	High byte	
		B0	8 bits	Low byte	Lowest byte
D4	W6	B7	8 bits	High byte	
		B6	8 bits	Low byte	
	W4	B5	8 bits		
		B4	8 bits		
• • •	• • •	• • •	• • •	• • •	• • •
D9996	W9998	B9999	8 bits	High byte	Highest byte
		B9998	8 bits	Low byte	
	W9996	B9997	8 bits	High byte	
		B9996	8 bits	Low byte	Lowest byte

During byte addressing, every address is accessible; during word addressing, every second address; and during double word addressing, every fourth of 0 to 9996. The address parameter indicates the low byte of the word address (W) and the lowest byte of the double-word address (D).

Markers, timers and counters are addressed with the corresponding code letters M, T or C followed by the operand number (e.g. M500, T7, C18).

8.6.3 Timers

The PLC has over 512 timers, which you control through special markers with the symbol T. You define the run time of the timers T0 to T47 in MP4110.x, and the run time of timers T96 to T512 in MP4111.x. MP4111.x is defined by entering the keyword **NUMBERMP4111 =** followed by the required number of timers in the OEM.SYS file. The unit of time (input value 1 in MP4110.x and MP4111.x) is seconds.

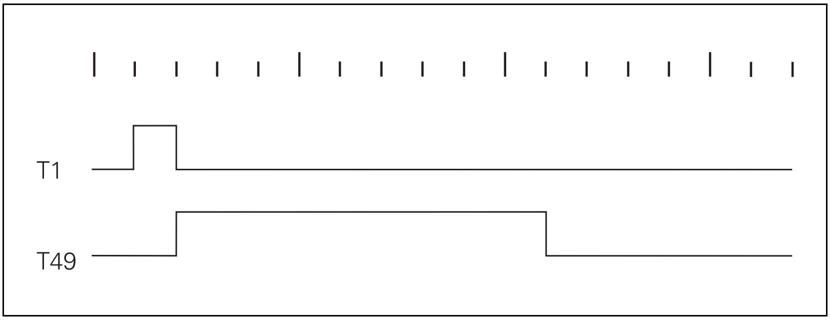
You can start the first 48 timers by setting one of the timers T0 to T47 for at most one PLC scan (otherwise the iTNC restarts the timer with the negative edge for each additional scan). The iTNC reserves the timer with the duration defined in MP4110.x, and sets the markers T48 to T95 (timer is running) until the defined duration has expired.

You can also set and start the timers T0 to T47 with Module 9006. Timers T96 to T559 can be started only through Module 9006.

Module 9197 can define and start cyclic timers (> T96). They are reset for a PLC cycle and are then automatically restarted.

Example:

Start of timer 1
Run time in MP4110.1 = 9 (PLC cycles)



Timer starts	Timer is running	Machine parameters
T0	T48	MP4110.0
T1	T49	MP4110.1
T2	T50	MP4110.2
T3	T51	MP4110.3
T4	T52	MP4110.4
T5	T53	MP4110.5
T6	T54	MP4110.6
T7	T55	MP4110.7
T8	T56	MP4110.8
T9	T57	MP4110.9
T10	T58	MP4110.10
T11	T59	MP4110.11

Timer starts	Timer is running	Machine parameters
T12	T60	MP4110.12
T13	T61	MP4110.13
T14	T62	MP4110.14
T15	T63	MP4110.15
T16	T64	MP4110.16
T17	T65	MP4110.17
T18	T66	MP4110.18
T19	T67	MP4110.19
T20	T68	MP4110.20
T21	T69	MP4110.21
T22	T70	MP4110.22
T23	T71	MP4110.23
T24	T72	MP4110.24
T25	T73	MP4110.25
T26	T74	MP4110.26
T27	T75	MP4110.27
T28	T76	MP4110.28
T29	T77	MP4110.29
T30	T78	MP4110.30
T31	T79	MP4110.31
T32	T80	MP4110.32
T33	T81	MP4110.33
T34	T82	MP4110.34
T35	T83	MP4110.35
T36	T84	MP4110.36
T37	T85	MP4110.37
T38	T86	MP4110.38
T39	T87	MP4110.39
T40	T88	MP4110.40
T41	T89	MP4110.41
T42	T90	MP4110.42
T43	T91	MP4110.43
T44	T92	MP4110.44
T45	T93	MP4110.45
T46	T94	MP4110.46
T47	T95	MP4110.47

MP4110.0-47 Run time PLC timer T0 to T47
Input: 0 to 1 000 000.000 [s]

MP4111.96-x Run time PLC timer T96 to x (defined in OEM.SYS)
Input: 0 to 1 000 000.000 [s]

Module 9006:Set and start PLC timer

With Module 9006 you can set the cycle time for a PLC timer and start the timer. Constraints:

- If during a PLC scan a timer from T0 to T47 is set in the PLC program, and the same timer is activated through Module 9006, then the direct activation through T0 to T47 has priority regardless of whether the module is called before or after setting T0 to T47.
- Immediately after the module call, one of the markers T48 to T96 is set. T0 to T47 are not set.
- The iTNC rounds the actual run time to integral PLC cycle times.
- Cancel run time: Reset timers T48 to T559.

Call:

PS	B/W/D/K	<timer number> Input value: 0 to 559
PS	B/W/D/K	<run time> 0 to 1 000 000 000 [ms] –1: Run time from MP4110.x or MP4111.x
CM	9006	

Error detection:

Marker	Value	Meaning
M4203	0	Timer started
	1	Error. See W1022.
W1022	1	Invalid timer number or excessive run time
	3	Timer is started as cyclic timer (Module 9197)

Module 9197 Start cyclic timer

Module 9197 can define and start a timer > T96 as cyclic timer. After expiration of the defined time, the timer is reset for a PLC cycle and afterwards is automatically restarted.

- Stop timer: Transfer run time 0
- The iTNC rounds the actual run time to integral PLC cycle times.

Call:

PS	B/W/D/K	<timer number> 96 to 559
PS	B/W/D/K	<run time> 0 to 1 000 000 000 [ms] –1: Run time from MP4111.x
CM	9197	

Error detection:

Marker	Value	Meaning
M4203	0	Timer started
	1	Error. See W1022.
W1022	1	Excessive run time
	3	Invalid timer number

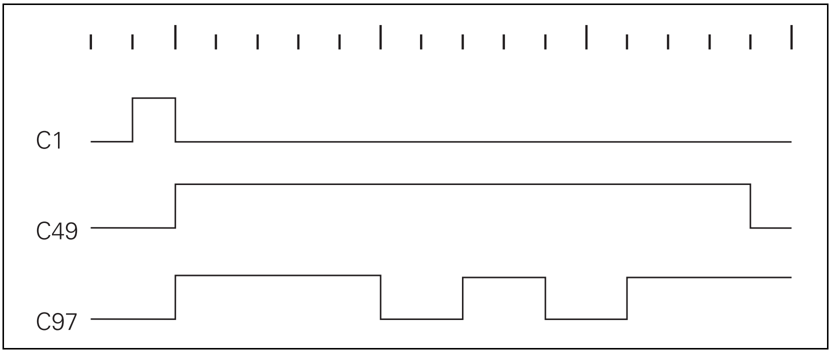
8.6.4 Counters

The PLC has 48 counters, which you control through special markers with the symbol C. After you have set a marker from the C0 to C47 range, the iTNC loads the counter with the value that is saved in machine parameter MP4120.x. The marker range C48 to C95 indicates whether the count has expired. With markers C96 to C144 you can start and stop the counter.

MP4020 bit 11 defines whether the counter is defined in PLC cycles or seconds. In this way, the counters can also be used as timers. With this definition of counters in PLC cycles, the decimal places are not evaluated by MP4120.x.

Example:

Logic diagram for counter C1
Preset value in MP4120.1 = 10 (PLC cycles or seconds)



Counter is set	Counter is running	Counter is started	Machine parameters
C0	C48	C96	MP4120.0
C1	C49	C97	MP4120.1
C2	C50	C98	MP4120.2
C3	C51	C99	MP4120.3
C4	C52	C100	MP4120.4
C5	C53	C101	MP4120.5
C6	C54	C102	MP4120.6
C7	C55	C103	MP4120.7
C8	C56	C104	MP4120.8
C9	C57	C105	MP4120.9
C10	C58	C106	MP4120.10
C11	C59	C107	MP4120.11
C12	C60	C108	MP4120.12
C13	C61	C109	MP4120.13
C14	C62	C110	MP4120.14
C15	C63	C111	MP4120.15
C16	C64	C112	MP4120.16
C17	C65	C113	MP4120.17

Counter is set	Counter is running	Counter is started	Machine parameters
C18	C66	C114	MP4120.18
C19	C67	C115	MP4120.19
C20	C68	C116	MP4120.20
C21	C69	C117	MP4120.21
C22	C70	C118	MP4120.22
C23	C71	C119	MP4120.23
C24	C72	C120	MP4120.24
C25	C73	C121	MP4120.25
C26	C74	C122	MP4120.26
C27	C75	C123	MP4120.27
C28	C76	C124	MP4120.28
C29	C77	C125	MP4120.29
C30	C78	C126	MP4120.30
C31	C79	C127	MP4120.31
C32	C80	C128	MP4120.32
C33	C81	C129	MP4120.33
C34	C82	C130	MP4120.34
C35	C83	C131	MP4120.35
C36	C84	C132	MP4120.36
C37	C85	C133	MP4120.37
C38	C86	C134	MP4120.38
C39	C87	C135	MP4120.39
C40	C88	C136	MP4120.40
C41	C89	C137	MP4120.41
C42	C90	C138	MP4120.42
C43	C91	C139	MP4120.43
C44	C92	C140	MP4120.44
C45	C93	C141	MP4120.45
C46	C94	C142	MP4120.46
C47	C95	C143	MP4120.47

MP4120.0-47 Preset value for PLC counters

Input: 0 to 1 000 000.000 [s or PLC cycles, depending on MP4020, bit 11]

9 Datenschnittstellen

9 Data Interfaces

9.1 Ethernet Interface

9.1.1 Software

The TNC requires an NFS server (Network File System) as the remote station. The NFS server must work according to the TCP/IP protocol principle. The remote station must be an NFS server.

OSI 7-layer model		**TNC**
7	Application layer	NFS
6	Presentation layer	
5	Communications layer	
4	Transport layer	TCP protocol
3	Network layer	IP protocol
2	Data link layer	Ethernet card
1	Physical layer	

Before networking, the TNC must be properly configured. Please discuss the required settings with your network supervisor.

iTNC settings

▶ Press the MOD key in the **Programming and Editing** operating mode and enter the code number NET123. With the soft keys you can select the required network options:

Soft key	Option	Meaning
DEFINE NET	Settings on the iTNC 530 for networking	
	ADDRESS	Network address of the iTNC: Enter as four decimal numbers separated by points (dotted-decimal notation). Your network supervisor of the iTNC can give you an internet address.
	MASK	Subnet mask; serves to distinguish the net and host ID of the network: Enter as four decimal numbers separated by points (dotted-decimal notation). Your network supervisor of the iTNC can give you a subnet-mask.
	BROADCAST	The broadcast address of the iTNC; is needed only if it is different from the standard setting: Enter as four decimal numbers separated by points (dotted-decimal notation). The standard setting is made of net and host ID, in which all bits are set to 1.
	ROUTER	Network address of default router: Enter as four decimal numbers separated by points (dotted-decimal notation). This entry is required only if your network consists of several subnetworks interconnected by router.
	HOST	Host name: This is the name used by the iTNC in the network. If you use a host-name server, you must enter the Fully Qualified Host Name here. If you leave this entry blank, the iTNC will use the so-called null authentication. If you work with null authentication, the entries under UID, GID, DCM and FCM will be ignored.
	DOMAIN	Domain name of the iTNC
	NAMESERVER	Network address of the domain server (at present without function)

☞ **Note**

The protocol is not entered. The data transfer protocol as per RFC 894 is used.

Soft key	Option	Meaning
DEFINE MOUNT	Definition of the devices in the network that can be addressed from the iTNC. For each device you define a separate line in the table.	
	MOUNTDEVICE	Device name to be mounted: This is formed from the network address of the device, a colon, and the name of the directory. Entry of the network address as four decimal numbers separated by points (dotted-decimal notation). When entering the path name, pay attention to capitalization.
	MOUNTPOINT	Device name: The device name entered here is displayed at the TNC in the program management for the mounted network, e.g. WORLD:. The name must end with a colon.
	FILESYSTEMTYPE	File system type: at present only NFS
	OPTIONS	Options that concern the file system type: Options are entered without spaces, separated only by commas. Pay attention to capitalization. Options: **rsize**: Packet size for data reception in bytes. Input range: 512 to 8192 **wsize**: Packet size for data transmission in bytes. Input range: 512 to 8192 **timeo**: Time in tenths of a second after which the iTNC repeats a Remote Procedure Call not answered by the server. Input range 0 to 100000. If there is no entry, the standard value 7 is used. Use higher values only if the iTNC must communicate with the server over more than one router. Your network specialist determines this value. **soft**: The Remote Procedure Call is repeated until the NFS server answers. If `soft` is entered, it is not repeated.
	AM	Auto mount (yes = 1, no = 0): Here you define whether during power-on the iTNC automatically mounts the network. Devices that are not mounted automatically can be mounted at any time in the program management.
DEFINE UID / GID	TNC USER ID	Definition of which user identification the end user uses to access files in the network. Your network specialist determines this value.
	OEM USER ID	Definition of which user identification the machine tool builder uses to access files in the network. Your network specialist determines this value.
	TNC GROUP ID	Definition of which group identification is used to access files in the network. The group identification is the same for end users and machine tool builders. Your network specialist determines this value.
	UID for mount	Definition of the user identification with which the logon process is executed. **USER**: The logon is with the USER identification. **ROOT**: The logon is with the identification of the ROOT user.

10 Error messages

10 Error messages

10.1 DSP Error Messages

10.1.1 Non-Axis-Specific Error Messages without Control Reset

Error message	Cause	Corrective action	As of NC SW
8010 LSV2 transmission error	■ Interrupted LSV2 connection. ■ Internal software error.	■ Check the LSV2 connection. ■ Inform your service agency. • Check software version.	340 420-01
8040 Heat-sink temperature UV 1xx	■ Temperature of UV 1xx power supply unit's heat sink too high. ■ If the heat-sink temperature continues to increase, the unit will be switched off.	■ Stop the machine and let it cool down. ■ Continue working with lower power (reduce the feed rate).	340 420-01
8041 Iz of UV 1xx too high	■ DC-link current of UV 1xx too high.	■ Continue working with lower power (reduce the feed rate).	340 420-01
8042 Leakage current of UV 1xx too high	■ Isolation problem (e.g. defective motor).	■ Inform your service agency. • Check the motor. • Check the wiring.	340 420-01
8080 Uz of UV 1xx too high	■ DC-link voltage of the power supply unit too high.	■ Inform your service agency. • Check the machine parameters (deceleration of spindle). • If required, check the braking resistor. • Replace the power supply unit.	340 420-01
8082 MCU command unknown	■ Internal software error.	■ Inform your service agency. • Check software version.	340 420-01
8086 Probing already active	■ An internal software error has occurred.	■ Inform your service agency. • Check software version.	340 420-01
8092 Pos. contr. cyc. time error	■ MCU is outputting incorrect cycle time for CCU position controller. ■ A hardware error has occurred.	■ Inform your service agency. • Check machine parameter MP7600.x. • Exchange drive control board.	340 420-01
9800 MCU command unknown	■ An internal software error has occurred.	■ Inform your service agency. • Check software version.	340 420-01
A000 Error during T2 test	■ Error during the test of emergency-stop loop 2.	■ Inform your service agency. • Check the wiring. • Check the emergency-stop key. • Replace the hardware.	340 420-01

Error message	Cause	Corrective action	As of NC SW
A001 Op. state MCU not equal CCU	■ The automatic, SRG, SBH, and SH operating states of the MCU and CCU are compared cyclically. If the states are unalike for over 200 ms, a stop 1 is output.	■ Press CE to acknowledge the error message. ■ Switch on the machine. ■ Inform your service agency. • Check software version.	340 420-01
A080 Op. state MCU not equal CCU	■ The automatic, SRG, SBH, and SH operating states of the MCU and CCU are compared cyclically. If the states are unalike for over 200 ms, a stop 1 is output.	■ Press CE to acknowledge the error message. ■ Switch on the machine. ■ Inform your service agency. • Check software version.	340 420-01
B800 Safe inputs <Input> not equal	■ Wiring error X65, X66 (, X67). ■ Safety module defective.	■ Inform your service agency. • Check the wiring X65, X66 (, X67). • Exchange the safety module.	340 420-01
B900 Error in supply voltage	■ The Vcc supply voltage was out of range. ■ Excessive load from external components (e.g. encoder). ■ The power supply unit (UVxxx) is defective.	■ Inform your service agency. ■ Measure the supply voltage. • If below range (< 4.75 V): Check the encoder connections. • If above range (> 5.40 V): Exchange the power supply unit (UVxxx).	340 420-01
BA00 Error in operating temperature	■ The permissible operating temperature was exceeded. ■ Temperature sensor on PCB is defective. ■ Insufficient ventilation of the electrical cabinet (fan defective). ■ Ambient temperature is too high.	■ Check the ventilation conditions. ■ Inform your service agency.	340 420-01

10.1.2 Axis-Specific Error Messages without Control Reset

<Axis>: 1 to 9 = axes 1 to 9
S1 = spindle 1
S2 = spindle 2

Error message	Cause	Corrective action	As of NC SW
8100 Warning motor temperature from <axis>	■ If the motor temperature continues to increase, the unit will be switched off. • Motor overload. • Machine parameters incorrect.	■ Reduce the motor load. ■ Inform your service agency. • Reduce machine parameters.	340 420-01
8110 Warning I2t monitoring of <axis>	■ If the motor current continues to increase, the unit will be switched off. • Motor or power module overload. • Machine parameter MP230x.x incorrect.	■ Reduce motor or power module load. ■ Inform your service agency. • Check machine parameter MP230x.x.	340 420-01
8120 Heat-sink temperature UM 1xx <axis>	■ Temperature of UM1xx power modules' heat sinks too high. ■ If the heat-sink temperature continues to increase, the unit will be switched off.	■ Stop the machine and let it cool down. ■ Continue working with lower power (reduce the feed rate).	340 420-01
8130 DIR <axis> motor table OK?	■ DIR in motor table may be incorrect.	■ Change DIR in motor table.	340 420-01
8140 Error <axis> field orientation	■ No field orientation possible. ■ Incorrect relation between electrical field and mechanical motor motion. ■ Incorrect motor encoder signal. ■ Incorrect motor connection. ■ Mechanical brakes not released.	■ Inform your service agency. • Check entry in MP331 and MP332. • Check entry in MP2020. • For linear motors: In motor table, check distance per electrical motor revolution. • Check motor encoder connection. • Check motor connection. • Release brakes during orientation.	340 420-01
8400 No drive-on command for <axis>	■ Speed controller waiting for drive-on command; PLC is not sending a drive-on command.	■ Check the PLC program. ■ Inform your service agency. • Check software version.	340 420-01

Error message	Cause	Corrective action	As of NC SW
8410 I2T value is too high <axis>	■ Excessive load over the time of the drive.	■ Reduce the load or the duration. ■ Check the motor table, power module table, and machine parameters. ■ Check whether the motor and power module are designed for the load. ■ Inform your service agency.	340 420-01
8430 Load is too high <axis>	■ Drive has maximum current and cannot accelerate. ■ Excessive load (torque, power) on the drive.	■ Reduce the load on the drive. ■ Check the motor table, power module table, and machine parameters. ■ Check whether the motor and power module are designed for the load. ■ Inform your service agency.	340 420-01
8440 Field orient. successful <axis>	■ Field has been properly oriented.	■ Press CE to acknowledge the message.	340 420-01
8800 Signal LT-RDY inactive <axis>	■ Undesired inverter switch-off during closed-loop control of a vertical axis (cause = vertical axis)	■ Check the PLC program. ■ Check the wiring of the inverter. ■ Inform your service agency.	340 420-01
8810 Signal LT-RDY inactive <axis>	■ Undesired inverter switch-off during closed-loop control of a vertical axis (cause = vertical axis)	■ Check the PLC program. ■ Check the wiring of the inverter. ■ Inform your service agency.	340 420-01
8820 Field angle unknown <axis>	■ The field angle of the motor at the reference point of the encoder has not yet been ascertained.	■ In the "current controller adjustment" mode, find the field angle (press the “Field Orien.” key). Caution: The motor must be free to rotate (no jamming, hanging axes or mechanical restrictions). ■ Check the entry of the encoder type in the motor table.	340 420-01
8830 EnDat: No field angle <axis>	■ The field angle of the motor with non-aligned EnDat encoder was not found. ■ The EnDat serial number read does not match the saved EnDat serial number.	■ In the "current controller adjustment" mode, find the field angle (press the “Field Orien.” key). ■ Check the entry of the encoder type in the motor table.	340 420-01
8840 Axis not available <axis>	■ The starting command was not sent to an available axis.	■ Inform your service agency. ■ Check software version.	340 420-01

Error message	Cause	Corrective action	As of NC SW
8850 Drive still active <axis>	■ Position definition (Z1 track, EnDat encoder) was started, although the drive was still active.	■ Inform your service agency. ■ Check software version.	340 420-01
8B00 Zn track <axis> error	■ Contamination of the motor encoder (Zn track). ■ Motor encoder cable is defective. ■ Motor control board defective.	■ Inform your service agency. • Exchange the motor. • Check the motor encoder cable. • Exchange the motor drive control board.	340 420-01
8B10 Traverse direction <axis> incorrect	■ DIR entry in motor table is incorrect. ■ Check MP1040. ■ Incorrect motor power connection.	■ Inform your service agency. • Check the DIR entry in the motor table. • Check MP1040. • Check the motor power connection.	340 420-01
8B20 Error <axis> field orientation	■ No field orientation possible. ■ Incorrect relation between electrical field and mechanical motor motion. ■ Incorrect motor encoder signal. ■ Incorrect motor connection. ■ Mechanical brakes not released.	■ Inform your service agency. • Check entry in MP331.x and MP332.x. • Check the entry in MP2020.x. • For linear motors: In motor table, check distance per electrical motor revolution. • Check motor connection. • Release brakes during orientation.	340 420-01
8B30 Motor temperature <axis> too high	■ Measured motor temperature too high. ■ No temperature sensor. ■ Motor encoder cable is defective. ■ Entry in motor table is incorrect. ■ Incorrect or defective temperature sensor was installed.	■ Let the motor cool down. • Inform your service agency. • Check the motor encoder cable. • Check the entry in the motor table. • Measure the temperature sensor (2 kW at 25 °C).	340 420-01

Error message	Cause	Corrective action	As of NC SW
8B40 Power supply unit <axis> not ready	■ Inverter is not ready for operation. ■ No pulse release for the power module. ■ U_z too high. ■ Power-fail signal is active. ■ If M control: NE2 input is active. ■ If P control: drive release at X50 is inactive. ■ Motor control board defective. ■ PWM cable defective. ■ Noise pulses.	■ Inform your service agency. • Check the control and cabling of the pulse release. ■ Check U_z. ■ Check the emergency stop circuit. ■ If the power supply is not regenerative: Is the braking resistor connected? ■ If the power supply is regenerative: Is energy recovery activated? ■ Check the grounding and shielding of the cable. ■ Exchange the power module. ■ For P controls: Exchange the interface card. ■ Exchange the motor drive control board.	340 420-01
8B50 Axis module <axis> not ready	■ No pulse release for the power module. ■ U_z too high. ■ 5 V power supply too weak. ■ Inverter is not ready for operation. ■ Motor control board defective. ■ PWM cable defective. ■ Noise pulses.	■ Inform your service agency. • Check the control and cabling of the pulse release. • Check U_z. • If the power supply is not regenerative: Is the braking resistor connected? • If the power supply is regenerative: Is energy recovery activated? • Check the grounding and shielding of the cable. • Exchange the power module. • For P controls: Exchange the interface card. • Exchange the motor drive control board.	340 420-01
8B60 Axis module <axis> IGBT error	■ Undervoltage, temperature, or short-circuit monitor of an IGBT in the inverter has responded.	■ Let the inverter cool down. ■ Inform your service agency. ■ Examine the motor for a short circuit in the windings. ■ Exchange the power module.	340 420-01

Error message	Cause	Corrective action	As of NC SW
8B70 External drive lock <axis>	■ The drive switch-on is blocked by one or more external signals: • EMERGENCY STOP (TNC 4xx P and M) • PFAIL (TNC 4xx P and M) • NO (TNC 4xx P)	■ Check the external enabling signals. ■ Check the PLC program. ■ Check the external wiring. ■ Inform your service agency.	340 420-01
8B80 External drive stop <axis>	■ The drive is switched off through an external signal: • EMERGENCY STOP (TNC 4xx P and M) • PFAIL (TNC 4xx P and M) • NO (TNC 4xx P)	■ Check the external enabling signals. ■ Check the PLC program. ■ Check the external wiring. ■ Inform your service agency.	340 420-01
8B90 No field orientation <axis>	■ No field orientation was performed. ■ Serial number has changed. ■ Field orientation was not possible.	■ Run a field orientation. ■ Inform your service agency.	340 420-01
8BA0 Incorrect line count <axis>	■ Incorrect entry in motor table. ■ Faulty reference signal. ■ Noise pulses. ■ Encoder cable is defective.	■ Inform your service agency. • Check the entry in the motor table. • Check the motor encoder cable. • Exchange the motor encoder cable. • Exchange the motor.	340 420-01
8BC0 Motor current <axis> too high	■ Incorrect current controller parameters. ■ Incorrect parameters in the motor table. ■ Power module defective. ■ Motor cable defective. ■ Motor defective. ■ Motor control board defective.	■ Inform your service agency. • Are the correct motor and power module selected? • Check the current control adjustment. • Check the motor and motor cable for a short circuit. • Exchange the power module or drive control board.	340 420-01

Error message	Cause	Corrective action	As of NC SW
8BD0 Excessive following error in <axis>	■ The following error of a moved axis is greater than the value entered in machine parameter MP1720 (for following error mode) or MP1420 (for feedforward mode). ■ The acceleration entered is too large. ■ The motor is not moving even though drive-on was given.	■ Reduce machining feed rate, increase speed. ■ Remove possible sources of vibration. ■ If this occurs frequently: Inform your service agency. ■ Inform your service agency. • Check MP1060.x. • The motor current must not be limited during acceleration.	340 420-01
A110 Safe speed SRG exceeded <axis>	■ The rotational speed limit SBH was exceeded while the protective door was open and the key switch was turned to "automatic."	■ Inform your service agency.	340 420-01
AC00 Mot. enc. amp. too high <axis>	■ Noise on motor encoder signal. ■ Short circuit in motor encoder cable. ■ Motor encoder signal amplitude too high.	■ Inform your service agency. • Check connection of motor encoder (ground connection). • Check the motor encoder.	340 420-01
AC10 <Axis> amplitude too small	■ Interruption in motor encoder cable. ■ Motor encoder signal amplitude missing.	■ Inform your service agency. • Check connection of motor encoder. • Check the motor encoder.	340 420-01
AC20 <Axis> frequency too high	■ Noise on motor encoder signal.	■ Inform your service agency. • Check connection of motor encoder (ground connection). • Check the motor encoder.	340 420-01
E130 Mot. enc. amp. too high <axis>	■ Noise on motor encoder signal. ■ Short circuit in motor encoder cable. ■ Motor encoder signal amplitude too high.	■ Inform your service agency. • Check connection of motor encoder (ground connection). • Check the motor encoder.	340 420-01

10.1.3 Non-Axis-Specific Error Messages with Control Reset

Error message	Cause	Corrective action	As of NC SW
C000 No data exchange with MCU	■ Communication with the MCU was interrupted. ■ An internal software error has occurred.	■ Inform your service agency.	340 420-01
C001 Undefined error	■ Internal software error.	■ Inform your service agency. • Check software version.	340 420-01
C002 MCU command invalid	■ Internal software error.	■ Inform your service agency. • Check software version.	340 420-01
C003 MCU/CCU system clock mismatch	■ Hardware error (quartz generator). ■ Software error.	■ Inform your service agency. • Exchange the drive control board or processor board. • Check software version.	340 420-01
C004 Undefined interrupt	■ Software error. ■ Hardware error: Disturbance results in internal interrupt.	■ Switch off the machine. ■ Switch on the machine. ■ Inform your service agency. • Check software version. • Check the grounding.	340 420-01
C005 Unknown hardware identifier	■ Software does not fit the hardware. ■ Hardware defective.	■ Inform your service agency. • Check software version. • Exchange drive control board.	340 420-01
C006 I-CTRL communication: TIME	■ Communication error between speed and current controllers.	■ Inform your service agency.	
C007 DC-link voltage too low	■ Line power interrupted. ■ Inverter defective.	■ Check your line power supply. ■ Inform your service agency. • Check the inverter.	340 420-01
C008 I-CTRL communication: QUEUE	■ Communication error between speed and current controllers.	■ Inform your service agency.	
C009 Stack overflow	■ Internal software error.	■ Inform your service agency. • Check software version.	340 420-01
C00A PWM triangular signal error	■ Hardware error: Triangular signal does not oscillate or it oscillates at the wrong frequency.	■ Inform your service agency. • Exchange drive control board.	340 420-01
C00B Too little main memory	■ Internal software error.	■ Inform your service agency. • Check software version.	340 420-01
C00C LSV2, incorrect number of data	■ The number of LSV2 data to be read is incorrect ■ Internal software error of the LSV2 transmitter.	■ Check the LSV2 transmission software.	340 420-01

Error message	Cause	Corrective action	As of NC SW
C00D Program checksum error	■ Internal software or hardware error.	■ Inform your service agency. • Check software version. • Exchange drive control board.	340 420-01
C00E Controller software timeout	■ Internal software or hardware error.	■ Inform your service agency. • Check software version. • Exchange drive control board.	340 420-01
C00F Error in software timer	■ Internal software error.	■ Inform your service agency. • Check software version.	340 420-01
C011 Softw. synchronization err.	■ Internal software error.	■ Inform your service agency. • Check software version.	340 420-01
C012 Pos. control err. Cycle time	■ MCU is outputting erroneous cycle time for CCU position controller. ■ Hardware error.	■ Inform your service agency. • Check machine parameter MP7600.x. • Exchange drive control board.	340 420-01
C013 PWM frequency error	■ Entered PWM frequency in MP2180 lies outside the permissible input range.	■ Inform your service agency. • Check MP2180.	340 420-01
C014 Interpolator, PWM invalid	■ Invalid relation between interpolator clock and PWM frequency.	■ Change the relation between interpolator clock and PWM frequency. ■ For possible relations, see the User's Manual.	340 420-01
C015 Interpolator, PWM changed	■ Interpolator clock or PWM frequency was changed.	■ Restart the control.	340 420-01
D000 DP RAM area overlap	■ An internal software error has occurred.	■ Inform your service agency. • Check software version.	340 420-01
D100 Software error	■ An internal software error has occurred.	■ Inform your service agency. • Check software version.	340 420-01
E001 Status NR1/NR2 not equal	■ NR2 input incorrectly connected. ■ Internal software error.	■ Inform your service agency. • Check the wiring. • Check software version.	340 420-01
E002 Status NE1/NE2 not equal	■ NE2 input incorrectly connected. ■ Internal software error.	■ Inform your service agency. • Check the wiring. • Check software version.	340 420-01
E003 PLC module 9169 illegal	■ PLC Module 9169 in safety-oriented software (illegal). ■ Internal software error.	■ Inform your service agency. • Check the PLC program. • Check software version.	340 420-01
E006 Wrong RDY status of spindle	■ Cabling to inverter defective. ■ Spindle not connected (spindle release relay). ■ Inverter defective.	■ Inform your service agency. • Check the inverter and cabling.	340 420-01

Error message	Cause	Corrective action	As of NC SW
E007 Wrong RDY status of axes	■ Cabling to inverter defective. ■ No axis connected (axis release relay). ■ Inverter defective.	■ Inform your service agency. • Check the inverter and cabling.	340 420-01
E008 SRG speed too high	■ Safe reduced rotational velocity (SRG) was exceeded. ■ No standstill in safe controlled stop (SBH) operating mode.	■ Inform your service agency.	340 420-01
E009 Incorrect gear range	■ Internal software error.	■ Inform your service agency. • Check software version.	340 420-01
E00A Safe machine parameter erroneous	■ CRC checksum does not fit the entered safe MPs.	■ Inform your service agency. • Check the safe machine parameters.	340 420-01
E00B Cutout channels test error	■ Machine key depressed (ZT.HR, ZT.MB, MT signal).	■ Inform your service agency. • Check the wiring X65, X66, (X67). • Check the machine keys.	340 420-01
E00C Error in MP transfer	■ MP3210 or MP3510 incorrect. ■ Software error MCU.	■ Inform your service agency. • Check MP3210 and MP3510. • Check software version.	340 420-01
E00D Error in MP3510 transfer	■ MP3510 incorrect. ■ Software error MCU.	■ Inform your service agency. • Check MP3510. • Check software version.	340 420-01
E00E Error in MP2020 transfer	■ MP2020 incorrect. ■ Software error MCU.	■ Inform your service agency. • Check MP2020. • Check software version.	340 420-01
E010 Error in CCU watchdog test	■ CCU watchdog signal does not switch to low level	■ Inform your service agency.	340 420-01
E011 Error in CCU watchdog test	■ CCU watchdog signal does not switch to high level	■ Inform your service agency.	340 420-01

10.1.4 Axis-Specific Error Messages with Control Reset

<Axis>: 1 to 9 = axes 1 to 9
S1 = spindle 1
S2 = spindle 2

Error message	Cause	Corrective action	As of NC SW
C110 Unknown motor type <axis>	■ Error in MP file or in motor table. ■ Internal software error.	■ Inform your service agency. • Check MP file and motor table. • Check software version.	340 420-01
C140 Pole pair no. too large <axis>	■ Incorrect entry in motor table.	■ Inform your service agency. • Check the motor table.	340 420-01
C150 Field current error <axis>	■ Incorrect entry in motor table.	■ Inform your service agency. • Check the motor table.	340 420-01
C160 Grating per. of motor encoder <axis>	■ Measured grating period does not agree with entry in the motor table.	■ Inform your service agency. ■ Check the motor table. ■ Check the motor.	340 420-01
C170 Rotor time constant err. <axis>	■ The rotor time constant calculated from the rotor table is invalid.	■ Inform your service agency. • Check the motor table.	340 420-01
C180 Rated speed error <axis>	■ Incorrect entry in motor table.	■ Inform your service agency. • Check the motor table.	340 420-01
C1D0 Current sensor voltage <axis>	■ Incorrect entry in power module table.	■ Inform your service agency. • Check the power module table.	340 420-01
C1E0 Imax of power module <axis>	■ Incorrect entry in power module table.	■ Inform your service agency. • Check the power module table.	340 420-01
C210 Tmax of motor table <axis>	■ Incorrect temperature entry in motor table.	■ Inform your service agency. • Check the motor table.	340 420-01
C230 Oscilloscope error <axis>	■ Internal software error.	■ Inform your service agency. • Check software version.	340 420-01
C240 Irated of power module <axis>	■ Incorrect entry in power module table.	■ Inform your service agency. • Check the power module table.	340 420-01
C250 Irated of motor <axis> incorrect	■ Incorrect entry in motor table.	■ Inform your service agency. • Check the motor table.	340 420-01
C260 Imax of motor <axis> incorrect	■ Incorrect entry in motor table.	■ Inform your service agency. • Check the motor table.	340 420-01
C270 Nmax of motor <axis> incorrect	■ Incorrect entry in motor table.	■ Inform your service agency. • Check the motor table.	340 420-01
C280 Field angle <axis> incorrect	■ Incorrect entry in MP2340 or MP2350.	■ Inform your service agency. • Check entry in MP2340/ MP2350.	340 420-01
C290 Uz <axis> incorrect	■ Incorrect entry in MP2190 (dc-link voltage Uz).	■ Inform your service agency. • Check the entry in MP2190.	340 420-01

Error message	Cause	Corrective action	As of NC SW
C2A0 Encoder input <axis>	■ Incorrect entry in MP112 or MP113 (speed encoder). ■ An internal software error has occurred.	■ Inform your service agency. • Check the entry in MP112/ MP113. • Check software version.	340 420-01
C2B0 PWM output <axis>	■ Incorrect entry in MP120 or MP121 (nominal speed output). ■ An internal software error has occurred.	■ Inform your service agency. • Check the entry in MP120/ MP121. • Check software version.	340 420-01
C2C0 Band filter parameter <axis>	■ Incorrect entry in MP2540, MP2541, MP2550 or MP2551. ■ An internal software error has occurred.	■ Inform your service agency. • Check the entry in MP2540, MP2541, MP2550 and MP2551. • Check software version.	340 420-01
C2D0 Motor encoder line count <axis>	■ Motor encoder line count was changed during operation.	■ Restart control with the END key.	340 420-01
C2E0 Motor pole-pair number <axis>	■ Motor pole-pair number was changed during operation.	■ Restart control with the END key.	340 420-01
C2F0 DIR in motor table <axis>	■ DIR in motor table was changed during operation.	■ Restart control with the END key.	340 420-01
C300 Zn track <axis> error	■ Contamination of the motor encoder (Zn track). ■ Motor encoder cable is defective. ■ Motor control board defective.	■ Inform your service agency. • Exchange the motor. • Check the motor encoder cable. • Exchange the motor drive control board.	340 420-01
C310 Z1 track <axis> error	■ Contamination of the motor encoder (Z1 track). ■ Motor encoder cable is defective. ■ Motor control board defective.	■ Inform your service agency. • Exchange the motor. • Check the motor encoder cable. • Exchange the motor drive control board.	340 420-01
C330 Motor temp. too high <axis>	■ Measured motor temperature is too high. ■ No temperature sensor. ■ Motor encoder cable is defective. ■ Entry in motor table is incorrect. ■ Incorrect or defective temperature sensor was installed.	■ Let the motor cool down. ■ Inform your service agency. • Check the motor encoder cable. • Check the entry in the motor table. • Measure the temperature sensor (2000 [Ohm] at 25 [°C]).	340 420-01

Error message	Cause	Corrective action	As of NC SW
C340 Unknown counter range <axis>	■ Hardware defective. ■ Incorrect software version.	■ Inform your service agency. • Check software version. • Exchange drive control board.	340 420-01
C350 Axis module <axis> not ready	■ No pulse release for the axis module. ■ Uz too large. ■ 5-V power supply too weak. ■ Inverter is not ready for operation. ■ Motor control board defective. ■ PWM cable defective. ■ Noise pulses.	■ Inform your service agency. • Check the control and cabling of the pulse release. • Check Uz. • If the power supply is not regenerative: Is the braking resistor connected? • If the power supply is regenerative: Is energy recovery activated? • Check the grounding and shielding of the cable. • Exchange the power module. • For P controls: Exchange the interface card. • Exchange the motor drive control board.	340 420-01
C370 Angular deviation of motor encoder <axis>	■ Motor encoder defective. ■ Motor encoder cable defective. ■ Drive control board defective.	■ Inform your service agency. • Check motor encoder and leads. • Exchange drive control board.	340 420-01
C380 Motor <axis> not controllable	■ Motor cable switched (e.g., X with Y). ■ Motor encoder cable switched. ■ Phases incorrectly connected to motor. ■ Motor encoder cable defective. ■ Incorrect motor table entry (direction of rotation). ■ Motor defective.	■ Check motor cabling. ■ Inform your service agency. • Check motor and motor encoder cable. • Check motor table entry.	340 420-01
C390 Error 3-D touch probe system <axis>	■ Software error. ■ Hardware error: control board.	■ Inform your service agency. • Exchange the motor drive control board. • Check software version.	340 420-01

Error message	Cause	Corrective action	As of NC SW
C3A0 Incorrect Ref position <axis>	■ Incorrect motor selected (MP2200). ■ Ground error on the motor encoder cable (noise on Ref). ■ Motor encoder defective.	■ Inform your service agency. • Check motor selection (MP2200). • Check motor encoder cabling (ground). • Exchange the motor.	340 420-01
C3B0 Motor <axis> is not turning	■ Inverter is not ready. ■ Noise on the RDY input of the PWM output connector. ■ Motor jammed. ■ Inverter defective. ■ Motor defective. ■ Incorrect motor selected (MP2200). ■ Assignment of PWM outputs incorrectly entered in MP120. ■ Assignment of encoder inputs incorrectly entered in MP112. ■ Motor power cable switched. ■ Motor encoder cable switched. ■ Incorrect motor connection.	■ Inform your service agency. • Check the inverter. • Check motor and cabling. • Check machine parameters.	340 420-01
C3C0 Motor current <axis> too high	■ Incorrect current controller parameters. ■ Incorrect parameters in the motor table. ■ Power module defective. ■ Motor defective. ■ Motor control board defective.	■ Inform your service agency. • Is the correct motor and power module selected? • Check the current control adjustment. • Check the motor and motor cable for a short circuit. • Exchange power module or drive control board	340 420-01
C3D0 PWM component defect <axis>	■ An internal hardware error has occurred.	■ Inform your service agency. • Exchange drive control board.	340 420-01
C3E0 Incorrect rated U of motor <axis>	■ Rated motor voltage outside of the permitted input range.	■ Inform your service agency. • Check the entry in the motor table.	340 420-01
C3F0 EnDat not found <axis>	■ EnDat communication is faulty. In the motor table an EnDat encoder was selected (EnDat encoder, EnDat cable defective or too long, hardware defective, disturbances).	■ Check the encoder, cable, hardware, and encoder entry in the motor table. ■ Exchange the cable or hardware.	340 420-01

Error message	**Cause**	**Corrective action**	**As of NC SW**
C400 Encoder line count incorrect <axis>	■ The values for the encoder line count from the motor table do not match the read values.	■ Check the motor type in the machine parameters. ■ Check the motor table. ■ Check the mounted encoder. ■ Inform your service agency.	340 420-01
C410 Rotor position <axis> undefined	■ Contamination of the motor encoder (Zn track). ■ Motor encoder cable is defective. ■ Motor control board defective.	■ Restart the control. ■ Inform your service agency. • Exchange the motor. • Check the motor encoder cable. • Exchange the motor drive control board.	340 420-01
C420 V control <axis> is not possible	■ Incorrect speed control parameters (Kv, Ki) ■ Incorrect speed control filter parameters	■ Check machine parameters. ■ Inform your service agency. • Check speed controller parameters. • Check speed controller filter. • Install new speed controller software.	340 420-01
C430 No position module <axis>	■ Position module with position encoder does not exist. ■ Position module with position encoder is not correctly connected. ■ Position module with position encoder is defective.	■ Inform your service agency. • Install position module with position encoder. • Check the connection of the position module with position encoder. • Exchange the position module with position encoder.	340 420-01
C440 PWM frequency <axis> incorrect	■ PWM frequency within an axis group is incorrect.	■ PWM frequency > 5 kHz only with suitable hardware and only with PWM output X51, X52, X57 or X58 ■ PWM frequency <= 5 kHz: For the following PWM outputs, the associated PWM frequency entries must be identical: 1) X51-X53-X54, 2) X52-X55-X56, 3) X57-X59-X61, or 4) X58 ■ Entry must not be less than 3200; exception 0 corresponds to 000	340 420-01

Error message	Cause	Corrective action	As of NC SW
C450 Incorrect encoder <axis>	■ Incorrect encoder selected in the motor table, e.g. linear encoder instead of rotary encoder, EnDat encoder instead of encoder with Z1 track. ■ Motor encoder cable is defective. ■ Motor encoder defective. ■ Motor control board defective.	■ Inform your service agency. • Correct the encoder entry in the motor table. • Check the motor encoder cable. • Exchange the motor. • Exchange the motor drive control board.	340 420-01
C460 Motor speed too high <axis>	■ The selected contouring feed rate (MP1010.x) is greater than the maximum motor speed.	■ Inform your service agency. • Check the entry in MP1010.x.	340 420-01
E120 Safe function call error	■ Internal software error.	■ Inform your service agency. • Check software version.	340 420-01
E140 Current to axis <axis> not equal 0	■ Motor current was determined during cutout channel test (24-hour test).	■ Inform your service agency. • Check the inverter.	340 420-01
E150 Inverter <axes> ready	■ RDY status of the inverter is HIGH instead of LOW.	■ Inform your service agency. • Check the inverter. • Check the cabling of the cutout channels.	340 420-01
E160 Inverter <axis> not ready	■ RDY status of the inverter is LOW instead of HIGH.	■ Inform your service agency. • Check the inverter. • Check the cabling of the cutout channels.	340 420-01
E130 Position error too large <axis>	■ MP650 too small. ■ Incorrect mounting of position encoder. ■ Incorrect temperature compensation, linear or nonlinear compensation, or reversal error.	■ Inform your service agency. • Correct MP640. • Check the encoder mounting. • Check the compensation.	340 420-01

10.2 iTNC Error Messages during Data Transfer

The following error messages can occur during data transfer through an interface:

General error messages:	
Interface already assigned	The interface is already transmitting, or the transmission was not concluded.
Program incomplete	A transmission was broken off or the file was not correctly concluded (no END character or END block).
Ext. input/output not ready	The interface is not connected, or the peripheral unit is switched off or defective.
Data transfer erroneous x	x = error code (see table).

Error codes:

Error code	Meaning
E	During data transfer with BCC, the <NAK> signal was received 15 times in succession.
A to H except E	Error code of the receiver module with one of the following causes: ■ The transfer rate setting of the iTNC and peripheral device do not match. ■ The parity bit is erroneous. ■ Erroneous data frame (e.g.: no stop bit). ■ The receiver module of the interface is defective.
K	During transmission of an error to the iTNC, the <1> character was not transmitted after the <ESC> character.
L	After the error sequence <ESC><1> an incorrect error number was received (error numbers 0 to 7 are permitted).
N	An expected acknowledgment <ACK> or <NAK> was not transmitted by a certain time.
M	During data transfer with BCC, the <NAK> signal was transmitted 15 times in succession.

Codes K and L are shown only during transmission with the standard data transmission protocol.

10.3 Error Messages of the File System

The following error messages can be displayed on the iTNC:

Error message	Error correction
File system error 1	Inform your service agency.
File system error 2	
File system error 3	
File system error 4	
File system error 5	
File system error 6	
File system error 7	
File system error 8	
File system error 9	
File system error 10	
File system error A	
File system error B	
File system error C	
File system error D	
File system error E	
File system error F	
File system error G	
File system error H	
File system error I	
File system error J	
File system error K	
File system error L	

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