HEIDENHAIN

TNC 640 HSCI

The Contouring Control for Milling-Turning Machines and Machining Centers

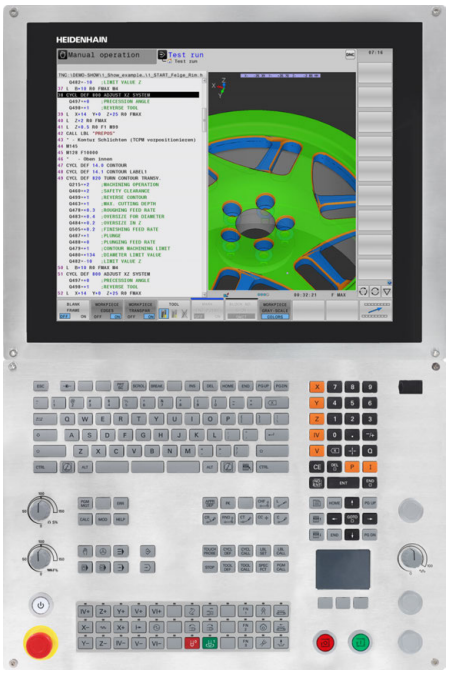
Information for the Machine Tool Builder

June 2017

TNC contouring control with drive system from HEIDENHAIN
General information

TNC 640

- Contouring control for **milling/turning machines and machining centers**
- Axes: 20 control loops, of which up to 4 are configurable as spindles
- For operation with HEIDENHAIN inverter systems and preferably with HEIDENHAIN motors
- Uniformly digital with HSCI interface and EnDat interface
- TFT color flat-panel display:
  – 19″ or 15″ versions with operating keys
  – 19″ version with touchscreen for multitouch operation
- Storage medium: HDR hard disk with 160 GB or SSDR solid state disk with 32 GB
- Programming in HEIDENHAIN conversational format or according to DIN/ISO
- Comprehensive cycle package for milling and turning operations
- Constant surface speed for turning operations
- Tool-tip radius compensation
- Touch probe cycles
- Free contour programming (FK)
- Special function for fast 3-D machining
- Short block processing time (0.5 ms)



System test

Controls, motors and encoders from HEIDENHAIN are in most cases integrated as components in larger systems. In these cases, comprehensive tests of the complete system are required, irrespective of the specifications of the individual devices.

Expendable parts

In particular the following parts in controls from HEIDENHAIN are subject to wear:

- Hard disk
- Buffer battery
- Fan

Standards

Standards (ISO, EN, etc.) apply only where explicitly stated in the catalog.

Note

Microsoft, Windows, Windows Vista and Internet Explorer are registered trademarks of Microsoft Corporation.

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Validity

The features and specifications described here apply for the following control and NC software versions:

TNC 640 with NC software versions
340590-07 SP2 (export license required)
340591-07 SP2 (no export license required)

This brochure supersedes all previous editions, which thereby become invalid. **Subject to change without notice.**

Requirements

Some of these specifications require particular machine configurations. Please note also that, for some functions, a special PLC program must be created by the manufacturer.

Functional safety

Unless explicitly stated, the information and data apply for both standard and FS components (FS = functional safety), (e. g. TE 745, TE 745 FS).

Contents

Please refer to the **page references** in the **tables** with the specifications.

Overview tables
Components

Control systems		15″ design	19″ design	Page
Main computer	*For operating panel*	**MC 7522** (screen integrated)	**MC 8532** (integrated touchscreen)	16
			MC 7532 (screen integrated)	
	For electrical cabinet	**MC 6541**, **MC 6542** or **MC 6641**		
Memory medium	*MC 75x2; MC 6x42*	**SSDR** solid state disk		18
	MC 6x41	**HDR** hard disk		
NC software license		On **SIK component**		18
Screen		**BF 750** (integrated in MC 7522)	**BF 860** (with touchscreen)	27
			BF 760 (integrated in MC 7532)	
Keyboard		**TE 720** or **TE 730** or **TE 735**	**TE 740** or **TE 745**	27
Machine operating panel		**MB 720** (integrated in TE 735)	Integrated in TE 745	27
		PLB 600x (HSCI adapter for OEM machine operating panel)		33
Controller unit	6 control loops	**CC 6106**		22
	8 control loops	**CC 6108**		22
	10 control loops	**CC 6110**		22
	12 control loops	**CC 6106 + CC 6106**		22
	14 control loops	**CC 6108 + CC 6106**		22
	16 control loops	**CC 6108 + CC 6108**		22
	18 control loops	**CC 6106 + CC 6106 + CC 6106** or **CC 6110 + CC 6108**		22
	20 control loops	**CC 6110 + CC 6110**		22
Voltage supply[*)]		**PSL 130 / PSL 135**		32
PLC inputs/ outputs[1)]	With HSCI interface	**PL 6000** consisting of PLB 62xx basic module (system PL) or PLB 61xx (extension PL) and I/O modules		30
		On UEC		23
		On UMC		25
Additional modules[1)]		**CMA-H** for analog axes/spindles in the HSCI system		34
		Modules for fieldbus systems		
Inverter systems		Compact inverters and modular inverters		[*)]
Inverters with integrated controller unit	4 control loops	**UEC 111**		23
		UMC 111		25
	5 control loops	**UEC 112**		23
	6 control loops	**UEC 113**		
Connecting cables				50

[*)] For further information, refer to the *Inverter Systems for HEIDENHAIN controls* brochure
[1)] May be necessary depending on the configuration

Please note: The MC main computer does not have any PLC inputs/outputs. Therefore one PL 6000, UEC or UMC is necessary for each control. They feature safety-relevant inputs/outputs as well as the connections for touch probes.

Accessories

Accessories	TNC 640	Page
Electronic handwheels	• **HR 510** portable handwheel or • **HR 520** portable handwheel with display or • **HR 550 FS** portable wireless handwheel with display, or • **HR 130** panel-mounted handwheel or • Up to three **HR 150** panel-mounted handwheels via HRA 110 handwheel adapter	37
Workpiece touch probes	• **TS 260**[1] touch trigger probe with cable connection or • **TS 460**[1] touch trigger probe with radio or infrared transmission or • **TS 444** touch trigger probe with infrared transmission or • **TS 642** touch trigger probe with infrared transmission or • **TS 740** touch trigger probe with infrared transmission	35
Tool touch probes	• **TT 160**[1] touch trigger probe with cable connection or • **TT 460**[1] touch trigger probe with radio or infrared transmission or • **TL Nano** laser system for contact-free tool measurement or • **TL Micro** laser system for contact-free tool measurement	36
USB hub	✓	91
Programming station	Control software for PCs for programming, archiving, and training • Single-station license with original control keyboard • Single-station license with virtual keyboard • Network license with virtual keyboard • Demo version with virtual keyboard or PC keyboard—free of charge	[2]
Control system for auxiliary axes	**PNC 610**	43
Industrial PC	**ITC 755** – additional operating station with touch screen and ASCII keyboard **ITC 750/ITC 760/ITC 860** – additional operating station; separate TE 7xx necessary **IPC 6641**—industrial PC for Windows **IPC 6490** – Industrial PC for PNC 610	41
Camera system	**VS 101** camera system for monitoring the working space	45
Snap-on keys	For the control For handwheels	48 46

[1] New generation of touch probes
[2] For more information, refer to the *TNC Programming Station* brochure.

Accessories / Software	TNC 640	Page
PLCdesign[1]	PLC development software	87
KinematicsDesign[1]	Software for kinematic configuration	78
M3D Converter[3]	Software for creation of high-resolution collision bodies in M3D format	79
TNCremo[2]	Data transfer software	91
TNCremoPlus[2]	Data transfer software with "live" screen	91
ConfigDesign[1]	Software for configuring the machine parameters	83
CycleDesign[1]	Software for creating cycle structures	89
TNCkeygen[1]	Software for enabling SIK options for a limited time, and for day-by-day access to the OEM area	18
TNCscope[1]	Software for data recording	84
TNCopt[1]	Software for putting digital control loops into service	84
IOconfig[1]	Software for configuring PLC I/O and fieldbus components	31

[1] Available to registered customers for downloading from the Internet
[2] Available to all customers (without registration) for downloading from the Internet
[3] Included in the KinematicsDesign installation package as of version 3.1 (software release module required)

Accessories / Software	TNC 640	Page
TeleService[1]	Software for remote diagnostics, monitoring, and operation	84
RemoTools SDK[1]	Function library for developing customized applications for communication with HEIDENHAIN controls	
virtualTNC[1]	Control component for virtual machines	92
TNCtest[1]	Software for creation and execution of acceptance tests	84
TNCanalyzer[1]	Software for the analysis and evaluation of service files	85

1) Available to registered customers for downloading from the Internet
2) Available to all customers (without registration) for downloading from the Internet
3) Included in the KinematicsDesign installation package as of version 3.1 (software release module required)

Specifications

Specifications	TNC 640	Page
Axes	20 control loops, of which up to 4 are configurable as spindles	62
Rotary axes	Max. 3	
Synchronized axes	✓	
PLC axes	✓	
Main spindle	*Milling:* Max. 4; second, third, and fourth spindle can be controlled alternately with the first *Turning:* max. 2 Milling spindle or lathe spindle activated via NC command	67
Speed	Max. 60 000 rpm (with option 49: max. 120 000 rpm)	67
Operating mode switchover	✓	67
Position-controlled spindle	✓	67
Spindle orientation	✓	67
Gear shifting	✓	67
NC program memory	*MC 6x41:* ≈ 144 GB on HDR hard disk *MC 6542, MC 75x2:* ≈ 21 GB on SSDR solid state disk	16
Input resolution and display step		62
Linear axes	0.1 µm, 0.01 µm with option 23	
Rotary axes	0.0001°, 0.00001° with option 23	
Functional safety	With FS components, SPLC and SKERN	59
For applications up to	• SIL 2 according to EN 61 508 • Category 3, PL d according to EN ISO 13 849-1: 2008	
Interpolation	**MC**	
Straight line	In 4 axes; in 5 axes with option 9	
Circular	In 2 axes; in 3 axes with option 8	
Helical	✓	
Axis feedback control		69
With following error	✓	
With feedforward	✓	
Axes, clamping	✓	62
Maximum feed rate	$\frac{60000\ \text{rpm}}{\text{No. of motor pole pairs}} \cdot \text{Screw pitch [mm]}$ at f_{PWM} = 5000 Hz	62

Specifications	TNC 640		Page
Cycle times of main computer	**MC**		70
Block processing	0.5 ms		71
Cycle times of controller unit	**CC/UEC/UMC**		70
Path interpolation	3 ms		70
Fine interpolation	*Single speed:* 0.2 ms *Double speed:* 0.1 ms (option 49)		
Position controller	*Single speed:* 0.2 ms *Double speed:* 0.1 ms (option 49)		
Speed controller	*Single speed:* 0.2 ms *Double speed:* 0.1 ms (option 49)		
Current controller	f_{PWM} 3333 Hz 4000 Hz 5000 Hz 6666 Hz with option 49 8 000 Hz with option 49 10 000 Hz with option 49	T_{INT} 150 µs 125 µs 100 µs 75 µs with option 49 62.5 µs with option 49 50 µs with option 49	
Permissible temperature range	Operation: In electrical cabinet: 5 °C to 40 °C In operating panel: 0 °C to 50 °C Storage: –20 °C to 60 °C		

1) As ordered
2) On motors with two pole pairs

Interfacing to the machine

Interfacing to the machine	TNC 640	Page
Error compensation	✓	80
Linear axis error	✓	80
Nonlinear axis error	✓	80
Backlash	✓	80
Reversal spikes during circular movement	✓	80
Hysteresis	✓	80
Thermal expansion	✓	80
Static friction	✓	80
Sliding friction	✓	80
Integrated PLC	✓	86
Program format	Statement list	86
Program input at the control	✓	86
Program input by PC	✓	86
Symbolic PLC-NC interface	✓	86
PLC memory	> 1 GB	86
PLC cycle time	9 ms to 30 ms (adjustable)	86
PLC inputs/outputs	A PLC system can consist of max. seven PLB 61xx and max. 2 MB 7xx, one TE 7x5 or one PLB 6001. A total maximum of 1000 inputs/outputs is supported.	30, 23
PLC inputs, DC 24 V	Via PL, UEC, UMC	30
PLC outputs, DC 24 V	Via PL, UEC, UMC	30
Analog inputs ± 10 V	Via PL	30
Inputs for PT 100 thermistors	Via PL	30
Analog outputs, ± 10 V	Via PL	30
PLC functions	✓	86
Small PLC window	✓	86
PLC soft keys	✓	86
PLC positioning	✓	87
PLC basic program	✓	88
Integration of applications		87
High-level language programming	Python programming language used in combination with the PLC (option 46)	87
User interfaces can be custom-designed	Create specific user interfaces of the machine tool builder with the programming language Python. Programs up to a memory limit of 10 MB are enabled in standard mode. Additional enabling via option 46.	87

Interfacing to the machine	TNC 640	Page
Commissioning and diagnostic aids		83
DriveDiag	Software for diagnosis of digital drive systems	83
TNCopt	Software for putting digital control loops into service	84
ConfigDesign	Software for creating the machine configuration	83
KinematicsDesign	Software for creating the machine kinematics, initialization of DCM	78
Integrated oscilloscope	✓	83
Trace function	✓	84
API DATA function	✓	84
Table function	✓	84
OLM (online monitor)	✓	84
Log	✓	84
TNCscope	✓	84
Bus diagnostics	✓	84
Data interfaces	✓	
Ethernet	2 x 1000BASE-T	90
USB	*Rear:* 4 x USB 3.0 *Front:* USB 2.0	90
RS-232-C	✓	90
Protocols		90
Standard data transfer	✓	90
Blockwise data transfer	✓	90
LSV2	✓	90

Encoder inputs		CC 6106	CC 6108	CC 6110	UEC 111	UMC 111	UEC 112	UEC 113	68
Position		6	8	10	4	-	5	6	68
	Incremental	1 V_{PP}							68
	Absolute	EnDat 2.2							68
Speed		6	8	10	4	4	5	6	68
	Incremental	1 V_{PP}							68
	Absolute	EnDat 2.2							68
Nominal-value outputs		CC 6106	CC 6108	CC 6110	UEC 111	UMC 111	UEC 112	UEC 113	68
PWM		6	8	10	-	-	-	-	21
Motor connections		-	-	-	4	4	5	6	21

User functions

User function	Standard	Option	TNC 640
Short description	✓		Basic version: 3 axes plus closed-loop spindle
		0-7	A total of 14 additional NC axes or 13 additional NC axes plus second spindle
		77	
		78	
	✓		Digital current and speed control
Program entry	✓		HEIDENHAIN Klartext conversational
	✓		According to ISO
		42	Direct loading of contours or machining positions from DXF files and saving as conversational contouring programs, or as point tables
Position entry	✓		Nominal positions for lines and arcs in Cartesian coordinates or polar coordinates
	✓		Incremental or absolute dimensions
	✓		Display and entry in mm or inches
Tool compensation	✓		Tool radius in the working plane and tool length
	✓		Radius-compensated contour look ahead for up to 99 blocks (M120)
		9	Three-dimensional tool-radius compensation for changing tool data without having to recalculate an existing program
Tool tables	✓		Multiple tool tables with any number of tools
Cutting data	✓		Automatic calculation of spindle speed, cutting speed, feed per tooth and feed per revolution
Constant contour speed	✓		Relative to the path of the tool center
	✓		Relative to the tool's cutting edge
Parallel operation	✓		Creating a program with graphical support while another program is being run
3-D machining	✓		Motion control with smoothed jerk
		9	3-D tool compensation through surface normal vectors
		9	Using the electronic handwheel to change the angle of the swivel head during program run without affecting the position of the tool point (TCPM = Tool Center Point Management)
		9	Keeping the tool normal to the contour
		9	Tool radius compensation normal to the tool direction
		9	Manual traverse in the active tool-axis system
		92	3-D radius compensation depending on the tool's contact angle
Rotary table machining		8	Programming of cylindrical contours as if in two axes
		8	Feed rate in distance per minute
Turning		50	Program-controlled switchover between milling and turning
		50	Constant surface speed
		50	Tool-tip radius compensation
		50	Cycles for roughing, finishing, recessing, thread turning and recess turning
		50	Blank form updated in contour cycles
		50	Turning-specific contour elements for recesses and undercuts
		50	Orientation of the turning tool for outside or inside machining
		50	Inclined turning
		50	Speed limiting
		50	Eccentric turning (additionally required: option 135)
Contour elements	✓		Straight line
	✓		Chamfer
	✓		Circular path
	✓		Circle center
	✓		Circle radius
	✓		Tangentially connecting circular arc
	✓		Corner rounding
		50	Recess
		50	Undercut

User function	Standard	Option	TNC 640
Approaching and departing the contour	✓ ✓		Via straight line: tangential or perpendicular Via circular arc
Adaptive feed control		45	AFC: Adaptive Feed Control adjusts the contouring feed rate to the current spindle power
Collision monitoring		40 40 40	Dynamic Collision Monitoring (DCM) Graphic depiction of the active collision objects (high-resolution M3D format) Tool carrier monitoring
FK free contour programming	✓		FK free contour programming in HEIDENHAIN conversational format with graphic support for workpiece drawings not dimensioned for NC
Program jumps	✓ ✓ ✓		Subprograms Program section repeats Calling any program as a subprogram
Fixed cycles	✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	 50 50 50 50 50+ 135 96	Drilling, tapping with a floating tap holder, rigid tapping Peck drilling, reaming, boring, counterboring, centering Area clearance cycles, longitudinal and transverse, paraxial and contour parallel Recessing cycles, radial/axial Radial/axial recess turning cycles (combined recessing and roughing motion) Milling internal and external threads Turning internal and external threads Hobbing Interpolation turning (not with functional safety (FS)) Clearing level and oblique surfaces Multi-operation machining of straight and circular slots Multioperation machining of rectangular and circular pockets Cartesian and polar point patterns Contour train, contour pocket Contour slot with trochoidal milling OEM cycles (special cycles developed by the machine tool builder) can be integrated Engraving cycle: Engrave text or numbers in a straight line or on an arc
Coordinate transformation	✓ 	 8	Shifting, rotating, mirroring, scaling (axis specific) Tilting the working plane, PLANE function
Q parameters Programming with variables	✓ ✓ ✓ ✓ ✓ ✓		Mathematical functions =, +, –, *, /, sin α, cos α, tan α, arcus sin, arcus cos, arcus tan, a^n, e^n, ln, log, square root of a, square root of $(a^2 + b^2)$ Logical operations (=, = /, <, >) Calculating with parentheses Absolute value of a number, constant π, negation, truncation of digits before or after the decimal point Functions for calculation of circles Functions for text processing
Programming aids	✓ ✓ ✓ ✓ ✓ ✓		Calculator Complete list of all current error messages Context-sensitive help function for error messages TNCguide: The integrated help system. User information available directly on the TNC 640; context-sensitive Graphic support for programming cycles Comment and structure blocks in the NC program
CAD viewer	✓		Display of standardized CAD data formats on the TNC
Teach-In	✓		Actual positions can be transferred directly into the NC program
Test graphics Display modes	✓ ✓ ✓		Graphic simulation before a program run, even while another program is running Plan view / projection in 3 planes / 3-D view, also in tilted working plane Magnification of details

User function	Standard	Option	TNC 640
3-D line graphics	✓		For verification of programs created offline
Programming graphics	✓		In the Programming and Editing mode, the contours of the NC blocks are drawn on screen while they are being entered (2-D pencil-trace graphics), even while another program is running
Program-run graphics **Display modes**	✓ ✓		Graphic simulation during real-time machining Plan view / projection in 3 planes / 3-D view
Machining time	✓ ✓		Calculation of machining time in the Test Run operating mode Display of the current machining time in the Program Run operating modes
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, contour departure and return
Datum management	✓		One table for storing presets
Datum tables	✓		Several datum tables for storing workpiece-related datums
Pallet tables	✓		Tool-oriented or execution of pallet tables with any number of entries for selection of pallets, NC programs and datums
Parallel secondary axes	✓ ✓ ✓		Compensating movement in the secondary axes U, V, W through the principal axes X, Y, Z Including movements of the parallel axis in the position display of the associated principal axis (sum display) Defining the principal and secondary axes in the NC program makes it possible to run programs on different machine configurations
Touch probe cycles	✓ ✓ ✓ ✓	 48	Calibrating the touch probe Compensation of workpiece misalignment, manual or automatic Datum setting, manual or automatic Automatic tool and workpiece measurement Automatic measurement and optimization of machine kinematics
Conversational languages	✓		English, German, Czech, French, Italian, Spanish, Portuguese, Dutch, Swedish, Danish, Finnish, Norwegian, Slovenian, Slovak, Polish, Hungarian, Russian (Cyrillic), Romanian, Turkish, Chinese (traditional and simplified), Korean

Options

Option number	Option	As of NC software 34059x-	ID	Remark	Page
0	Additional axis 1	01	ID 354540-01	Additional control loop 1	20
1	Additional axis 2	01	ID 353904-01	Additional control loop 2	20
2	Additional axis 3	01	ID 353905-01	Additional control loop 3	20
3	Additional axis 4	01	ID 367867-01	Additional control loop 4	20
4	Additional axis 5	01	ID 367868-01	Additional control loop 5	20
5	Additional axis 6	01	ID 370291-01	Additional control loop 6	20
6	Additional axis 7	01	ID 370292-01	Additional control loop 7	20
7	Additional axis 8	01	ID 370293-01	Additional control loop 8	20
8	Advanced function set 1	01	ID 617920-01	**Rotary table machining** • Programming of cylindrical contours as if in two axes • Feed rate in distance per minute	62
				Coordinate transformation • Tilting the working plane, PLANE function	63
				Interpolation • Circular in 3 axes with tilted working plane	
9	Advanced function set 2	01	ID 617921-01	**3-D machining** • 3-D tool compensation through surface normal vectors • Using the electronic handwheel to change the angle of the swivel head during program run without affecting the position of the tool point (TCPM = Tool Center Point Management) • Keeping the tool normal to the contour • Tool radius compensation normal to the tool direction • Manual traverse in the active tool-axis system **Interpolation** • Linear in 5 axes (export license required)	63
18	HEIDENHAIN DNC	01	ID 526451-01	Communication with external PC applications over COM component	92
23	Display step	01	ID 632986-01	**Display step** to 0.01 µm or 0.000 01°	62
24	Gantry axes	01	ID 634621-01	Gantry axes in master-slave torque control	
40	DCM collision	02	ID 526452-01	Dynamic collision monitoring (DCM)	77
42	DXF converter	02	ID 526450-01	Load and convert DXF contours	
45	Adaptive Feed Control (AFC)	02	ID 579648-01	Adaptive Feed Control	72
46	Python OEM process	01	ID 579650-01	Execute Python applications	87
48	KinematicsOpt	01	ID 630916-01	Touch probe cycles for automatic measurement of rotary axes	81
49	Double-speed axes	01	ID 632223-01	Short control-loop cycle times for direct drives	70

Option number	Option	As of NC software 34059x-	ID	Remark	Page
50	Turning	01	ID 634608-01	Turning functions • Tool management for turning • Tool-tip radius compensation • Switching between milling and turning modes of operation • Lathe-specific contour elements • Package of turning cycles	65
52	KinematicsComp	05	ID 661879-01	Spatial compensation of error in rotary and linear axes (subject to export permit).	82
77	4 additional axes	01	ID 634613-01	4 additional control loops	20
78	8 additional axes	01	ID 634614-01	8 additional control loops	20
92	3D-ToolComp	07	ID 679678-01	3-D radius compensation depending on the tool's contact angle (only with software option Advanced Function Set 2)	82
93	Extended tool management	01	ID 676938-01	Extended tool management	
96	Adv. spindle interp.	05	ID 751653-01	Additional functions for an interpolated spindle • Interpolation turning, coupling • Interpolation turning, contour finishing	
101 - 130	OEM option	02	ID 579651-01 to ID 579651-30	Options of the machine tool builder	
131	Spindle synchronism	05	ID 806270-01	Synchronization of two or more spindles	92
133	Remote Desktop Manager	01	ID 894423-01	Display and remote operation of external computer units (e.g. a Windows PC)	92
135	Synchronizing functions	04	ID 1085731-01	Expanded synchronization of axes and spindles	64
136	Visual Setup Control	06	ID 1099457-01	VSC: Camera-based monitoring of the setup situation	64
141	Cross Talk Comp.	02	ID 800542-01	CTC: Compensation of axis couplings	75
142	Pos. Adapt. Control	02	ID 800544-01	PAC: Position-dependent adaptation of control parameters	75
143	Load Adapt. Control	02	ID 800545-01	LAC: Load-dependent adaptation of control parameters	76
144	Motion Adaptive Control	02	ID 800546-01	MAC: Motion-dependent adaptation of control parameters	76
145	Active Chatter Control	02	ID 800547-01	ACC: Active suppression of chatter	73
146	Active Vibration Damping	04	ID 800548-01	AVD: Active vibration damping	75

HSCI control components
Main computer

Main computer

The **MC** main computers feature:
- Processor
- RAM memory
- HSCI interface to the CC 6xxx or UEC controller unit and to other control components
- HDL interface to the BF 7xx display unit or BF 860
- USB 3.0 interface to the TE 7x5 operating panel

To be ordered separately, and installed in the main computer by the OEM:
- **HDR** or **SSDR** storage medium with the NC software
- The **System Identification Key** (SIK) component holds the NC software license for enabling control loops and software options.

The following HSCI components are necessary for operation of the TNC 640:
- MC main computer
- Controller unit
- PLC I/O unit **PLB 62xx** (system PL; integrated in UEC)
- **MB 720** machine operating panel (integrated in TE 7x5) or HSCI adapter **PLB 600x** for connection of an OEM machine operating panel

Interfaces

The standard MC main computers feature USB 3.0, RS-232-C and Ethernet interfaces for use by the end user. Connection to PROFINET-IO or PROFIBUS-DP is possible via an additional module.

Voltage supply

DC 24 V of power are supplied to the main computer and other HSCI components by the PSL 13x supply unit. For the entire HSCI system, this DC 24 V NC supply voltage is required to be safely separated voltage. It must not be connected to the DC 24 V supply voltage for PLC components (e. g. holding brakes). This DC 24 V PLC is a supply voltage for electric circuits with basic insulation that must not be connected to each other or mixed with safely separated electric circuits.

Export version

Because the entire NC software is saved on the memory card (HDR or SSDR), no export version is required for the main computer itself. Export versions are available only for the easily replaceable storage medium and the SIK component.

Versions

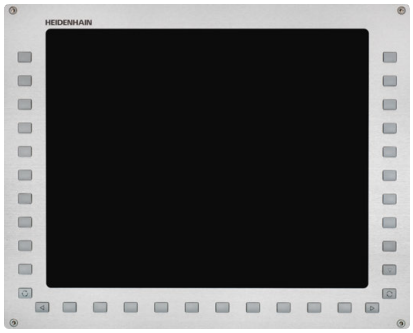
Various versions of the MC main computer are available:

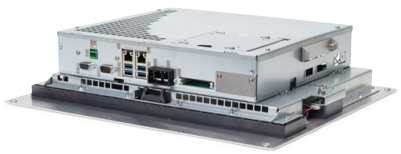
- For installation in the **electrical cabinet** with operating keys
  The MC 6x4x is installed in the electrical cabinet. HSCI, USB and HDL cables to the operating panel are required as control lines
- For installation in the **operating panel** with operating keys
  Together with the BF display unit, the MC 75x2 forms a unit and is installed directly into the operating panel.
  Advantage: except for the power supply line, only one HSCI connecting cable to the electrical cabinet is necessary. The MC is not supported until as of NC software 34059x-04
- For installation in the **operating panel** for touchscreen operation
  Together with the BF display unit, the MC 8532 forms a unit and is installed directly into the operating panel.
  Advantage: except for the power supply line, only one HSCI connecting cable to the electrical cabinet is necessary. The MC is not supported until as of NC software 34059x-07 SP2

The MC main computers feature the HEROS 5 operating system. Connection of the fieldbus systems is possible selectably via an appropriate additional module.

MC 6x41

MC 654x





MC 7532 with main computer installed on the back

MC 8532 with main computer installed on the back

	To be installed in	Memory medium	Processor	RAM memory	Power consumption	Mass	
MC 6541	Electrical cabinet	HDR	Intel Core i7-3 1.7 GHz, dual-core	4 GB	48 W	4.0 kg	ID 1081185-xx
MC 6542	Electrical cabinet	SSDR	Intel Core i7-3 1.7 GHz, dual-core	4 GB	48 W	4.0 kg	ID 1081188-xx
MC 6641	Electrical cabinet	HDR	Intel Core i7-3 2.1 GHz, quad-core	4 GB	75 W	4.0 kg	ID 811550-xx
MC 7522	Operating panel	SSDR	Intel Core i7-3 1.7 GHz, dual-core	4 GB	60 W	6.5 kg	ID 1071597-xx
MC 7532	Operating panel	SSDR	Intel Core i7-3 1.7 GHz, dual-core	4 GB	75 W	7.5 kg	ID 1124449-xx
MC 8532	Operating panel	SSDR	Intel Core i7-3 1.7 GHz, dual-core	4 GB	75 W	7.5 kg	ID 1189190-xx

Options

The capabilities of the TNC 640 can also be adapted retroactively with options to meet new requirements. These options are described on page 14. They are enabled by entering keywords based on the SIK number, and are saved in the SIK component. Please indicate your SIK number when ordering new options.

Memory medium

The storage medium is removable and must be ordered separately from the main computer. It contains the NC software 34059x-xx. Depending on the main computer, the HDR hard disk or the SSDR solid state disk is used as a storage medium. The NC software is based on the HEIDENHAIN HEROS 5 operating system.

HDR hard disk

Free capacity	144 GB
For main computer	MC 6541, MC 6641
Export license required	ID 617779-07
No export license required	ID 617779-57

SSDR solid state disk

Free capacity	21 GB
For main computer	MC 6542, MC x5x2
Export license required	ID 810288-07
No export license required	ID 810288-57

HDR hard disk

SSDR solid state disk

SIK component

The SIK component contains the **NC software license** for enabling control loops and software options. It gives the main computer an unambiguous ID code—the SIK number. The SIK component is ordered and shipped separately. It must be inserted in a special slot in the MC main computer.

The SIK component with the NC software license is available in various versions, depending on the enabled control loops and options. Further control loops—up to the maximum number available (see Controller unit)—can be enabled later by entering a keyword. HEIDENHAIN provides the keyword, which is based on the SIK number.

When ordering, please indicate the SIK number of your control. When the keywords are entered in the control, they are saved in the SIK component. This enables and activates the options. Should service become necessary, the SIK component must be inserted in the replacement control to enable all required options.

SIK component

Master keyword (General Key)

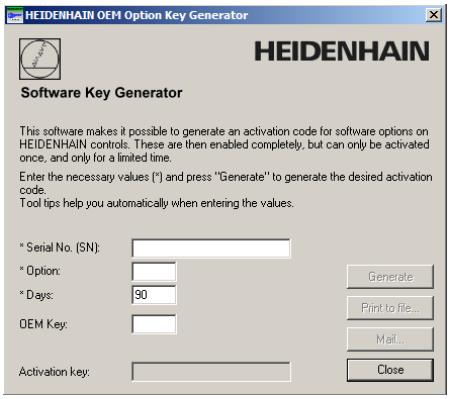
For commissioning the TNC 640, a general key can be used that will unlock all control loop options for a duration of 90 days. After this period, only those options with the correct keywords will be active. The general key is activated via a soft key.

TNCkeygen (accessory)

TNCkeygen is a collection of PC software tools for generating time-limited enabling keys for HEIDENHAIN controls.

OEM Key Generator is used to generate enabling keys for software options by entering the SIK number, the option to be enabled, the duration and a manufacturer-specific password. The enabling period is limited to 10 to 90 days. Each option can only be enabled once. Option enabling is independent of the general key.

The **OEM daily key generator** generates an enabling key for the protected area of the machine tool builder. This grants the operator access to the area on the day the key was generated.



NC software license and enabling of control loops depending on the CC

Active control loops	Recommended combinations						NC software license			
	CC 6106	CC 6108	CC 6110	2 x CC 6106	CC 6106 + CC 6108	2 x CC 6108	Without software option	Incl. option 1	Incl. options 1 + 2	Incl. options 1, 2 + 50
							SIK	SIK	SIK	SIK
4	✓						ID 674989-20 *ID 674989-70*	ID 674989-09 *ID 674989-59*	ID 674989-01 *ID 674989-51*	ID 674989-28 *ID 674989-78*
5	✓						ID 674989-24 *ID 674989-74*	ID 674989-17 *ID 674989-67*	ID 674989-02 *ID 674989-52*	ID 674989-29 *ID 674989-79*
6	✓						ID 674989-25 *ID 674989-75*	ID 674989-18 *ID 674989-68*	ID 674989-03 *ID 674989-53*	ID 674989-30 *ID 674989-80*
7		✓					ID 674989-26 *ID 674989-76*	ID 674989-19 *ID 674989-69*	ID 674989-04 *ID 674989-54*	ID 674989-31 *ID 674989-81*
8		✓					ID 674989-27 *ID 674989-77*	ID 674989-23 *ID 674989-73*	ID 674989-05 *ID 674989-55*	ID 674989-32 *ID 674989-82*
9			✓				Only through subsequent enabling of control loops (additional axes)		ID 674989-06 *ID 674989-56*	ID 674989-33 *ID 674989-83*
10			✓						ID 674989-07 *ID 674989-57*	ID 674989-34 *ID 674989-84*
11				✓					ID 674989-10 *ID 674989-60*	ID 674989-35 *ID 674989-85*
12				✓					ID 674989-11 *ID 674989-61*	ID 674989-36 *ID 674989-86*
13					✓				ID 674989-12 *ID 674989-62*	ID 674989-37 *ID 674989-87*
14					✓				ID 674989-13 *ID 674989-63*	ID 674989-38 *ID 674989-88*
15						✓			ID 674989-14 *ID 674989-64*	ID 674989-39 *ID 674989-89*
16						✓			ID 674989-15 *ID 674989-65*	ID 674989-40 *ID 674989-90*
17 - 20							Only through subsequent enabling of control loops (additional axes)			

(Italics: Export version)

Enabling further control loops

Further control loops can be enabled either as groups or individually. The combination of control-loop groups and individual control loops makes it possible to enable any number of control loops. A maximum of **20 control loops** are possible.

Control-loop groups	**Option**	
4 additional control loops	77	ID 634613-01
8 additional control loops	78	ID 634614-01

Individual control loops	**Option**	
1st additional control loop	0	ID 354540-01
2nd additional control loop	1	ID 353904-01
3rd additional control loop	2	ID 353905-01
4th additional control loop	3	ID 367867-01
5th additional control loop	4	ID 367868-01
6th additional control loop	5	ID 370291-01
7th additional control loop	6	ID 370292-01

Controller unit

Controller unit

Due to the very short cycle times of the position, speed and current controllers, the controller units from HEIDENHAIN are equally suited for conventional drives, for direct drives (linear motors, torque motors) and for HSC spindles. They permit a high loop gain and short reaction times to changing machining forces, and so make the high contour accuracy and surface quality of the workpiece possible.

Single speed
Double speed

Single-speed control loops are usually sufficient for linear or torque motors and for conventional axes. **Double-speed control loops** are preferred for HSC spindles and axes that are difficult to control (Option 49). In the default setting, all axes are set to single speed. Each axis that is switched from single speed to double speed can reduce the number of available control loops by one. At a PWM frequency greater than 5 kHz, double speed is always required. This requires option 49 to be enabled.

Cycle times

At f_{PWM}	Current controller	Speed controller		Position controller
		Single-speed	Double-speed[1)]	
3333 Hz	150 µs	300 µs	150 µs	Same as **speed controller**
4000 Hz	125 µs	250 µs	125 µs	
5000 Hz	100 µs	200 µs	100 µs	
6666 Hz[1)]	75 µs	–	150 µs	
8000 Hz[1)]	60 µs	–	125 µs	
10 000 Hz[1)]	50 µs	–	100 µs	

[1)] Possible only with option 49

Number of control loops

The number of enabled control loops depends on the SIK (see *Main computer*), or on additionally enabled control loops, which can also be ordered as needed later.

Versions

- Modular CC 61xx controller units with PWM interface to the inverters
- Compact UEC/UMC inverters with integrated controller unit

Controller units, main computers and inverters operate in any desired combination.

CC 61xx

The **CC 61xx** controller units feature:

- Position controller, speed controller, current controller
- HSCI interfaces
- PWM interfaces to the UM, UR, UE power modules
- Interfaces to the speed and position encoders
- Interfaces for power supply (via inverter or PSL 135)
- SPI interfaces for expansion modules (e.g. CMA-H)

CC 6110

	CC 6106	**CC 6108**	**CC 6110**
Digital control loops	Max. 6 (single speed)	Max. 8 (single speed)	Max. 10 (single speed)
Speed inputs	6 x 1 V_{PP} or EnDat 2.2	8 x 1 V_{PP} or EnDat 2.2	10 x 1 V_{PP} or EnDat 2.2
Position inputs	6 x 1 V_{PP} or EnDat 2.2	8 x 1 V_{PP} or EnDat 2.2	10 x 1 V_{PP} or EnDat 2.2
PWM outputs	6	8	10
SPI expansion slots	2	4	4
Power consumption (without encoders)	25 W	35 W	40 W
Mass	4.1 kg	4.7 kg	4.8 kg
	ID 662636-xx	ID 662637-xx	ID 662638-xx

For more than 10 control loops, an HSCI line is used to combine the controller units. For example:

CC 6106 + CC 6106 for up to 12 control loops
CC 6106 + CC 6108 for up to 14 control loops
CC 6110 + CC 6108 for up to 18 control loops

Constraints:

- Max. 20 control loops can be activated, of which up to 4 can be configured as spindles
- Maximum of 4 controller motherboards are permissible in the HSCI system (CC 6106 contains one motherboard, CC 6108/CC 6110 each have two)

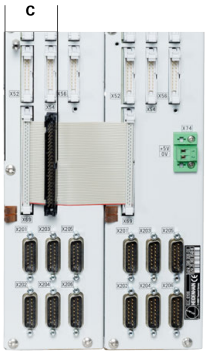
Ribbon cable for supply voltage

Additional ribbon cables are necessary if multiple CC 6xxx units are combined.

Combination	Length	Dimension c	
2 x CC 6108, or 2 x CC 6110, or CC 6108 and CC 6110	160 mm[1)]	26.5 mm	ID 325816-22
2 x CC 6106	110 mm	31.5 mm	ID 325816-24

[1)] In order to reduce the voltage drop, the long ribbon cable is led doubled.

With a combination of CC 6108 and/or CC 6110, the short ribbon cable included in delivery is not needed. They are only necessary for connecting sockets X69 A and X69 B if the CC units are used separately.



For more information about connecting a CC 6xxx to a supply unit via ribbon cables, see the *Inverter Systems* brochure.

UEC 11x

The UEC 11x compact inverters not only include the inverter, but also a controller with PLC inputs and outputs and an integrated braking resistor. They form a complete solution for machines with a limited number of axes and low power demands.

Controllers
- Position controller, speed controller, current controller
- HSCI interface
- Interfaces to the speed and position encoders
- SPI interface

Inverters
- Power electronics
- Connections for axis motors and spindle motor
- Braking resistor
- Connections for motor holding brakes
- Additional DC-link connection on the front for connection of a PSL 130

System PL
- Interfaces for one workpiece touch probe and one tool touch probe
- Integrated PLC (expandable with PL 61xx)
  UEC 11x: 38 free inputs, 23 free outputs (of which 7 can be switched off)
  UEC 11x FS: 38 free inputs, 28 free outputs (of which 7 can be switched off), 8 free FS inputs, 8 free FS outputs
- Configuration with IOconfig PC software

UEC 113

		UEC 111/UEC 112/UEC 113		
Controllers		4/5/6 digital control loops		
Speed inputs		4/5/6 x 1 V_{PP} or EnDat 2.2		
Position inputs		4/5/6 x 1 V_{PP} or EnDat 2.2		
Inverters		*2/3/4 axes*	*1 axis*	*Spindle*
Rated current I_N/ Maximum current I_{max}[1] at a PWM frequency of	**3333 Hz**	**6.0/12.0 A**	**9.0/18.0 A**	**24.0/36.0 A**
	4000 Hz	5.5/11.0 A	8.3/16.5 A	22.0/33.0 A
	5000 Hz	5.0/10.0 A	7.5/15.0 A	20.0/30.0 A
	6666 Hz	4.2/8.4 A	6.3/12.6 A	16.8/25.2 A
	8000 Hz	3.6/7.3 A	5.5/11.0 A	14.6/21.9 A
	10 000 Hz	3.0/6.0 A	4.6/9.2 A	12.2/18.3 A
Supply voltage		3AC 400 V (± 10 %); 50 Hz or 3AC 480 V (+6 %/–10 %); 60 Hz		
Rated power of DC link		**14 kW**		
Peak power[2] of DC link		18 kW / 25 kW		
Power loss at I_N		≈ 450 W		
DC-link voltage		DC 565 V		
Integral braking resistance[3]		2.1 kW / 27 kW		
Power pack for HSCI components		DC 24 V / 3.5 A		
Module width		150 mm		
Mass		≈ 14 kg		
Functional safety		-	✓	
UEC 111 **UEC 112** **UEC 113**		ID 1081002-xx ID 1081003-xx ID 828471-xx	ID 1075825-xx ID 1075826-xx ID 1038694-xx	

1) Axis: 0.2 s cyclic duration factor for cycle duration of 10 s with 70 % rated current preload
Spindle: 10 s cyclic duration factor for cycle duration of 60 s with 70 % rated current preload

2) 1st 1st value: 40 % cyclic duration factor for cycle duration of 10 minutes (S6-40 %)
2nd value: 4 s cyclic duration factor for cycle duration of 20 s

3) 1st value: Continuous power
2nd value: Peak power (1.5 % cyclic duration factor for cycle duration of 120 s)

UMC 11x FS

The UMC 111 FS is a compact inverter with integrated controller unit and PLC inputs/outputs. As opposed to the UEC, it is used exclusively for controlling axis motors and is powered by an external DC link. The UMC automatically enables the control loops needed for auxiliary axes. Further options are unnecessary.

Please note: The UMC does not expand the number of possible axes. Interpolation with NC axes is not possible.

UMC 111 FS

Controllers
- Position controller, speed controller, current controller
- HSCI interface
- Interfaces to the speed encoders
- SPI interface

Inverters
- Power electronics
- Connections for axis motors
- Connections for motor holding brakes

System PL
- Interfaces for one workpiece touch probe and one tool touch probe with signal transmission by cable
- Integrated PLC, expandable with PL 61xx
  UMC 111 FS: 38 free inputs, 28 free outputs (7 of which can be switched off)
  8 FS inputs, 8 FS outputs
- Configuration with IOconfig PC software

		UMC 111 FS
Controllers		4 digital control loops
Speed inputs		4 x 1 V_{PP} or EnDat 2.2
Inverters		*4 axes*
Rated current I_N/ Maximum current I_{max}[1] at a PWM frequency of	**3333 Hz**	**9.0/18.0 A**
	4000 Hz	8.3/16.5 A
	5000 Hz	7.5/15.0 A
	6666 Hz	6.3/12.6A
	8000 Hz	5.5/11.0 A
	10 000 Hz	4.6/9.2 A
Power loss at I_N		≈ 300 W
DC-link voltage		DC 565 V or DC 650 V
24 V PLC current consumption		DC 24 V / 2 A
Module width		150 mm
Mass		≈ 11 kg
UMC 111 FS		ID 664231-xx

[1] Axis: 0.2 s cyclic duration factor for cycle duration of 10 s with 70 % rated current preload
Spindle: 10 s cyclic duration factor for cycle duration of 60 s with 70 % rated current preload

Adapter connector for temperature sensor

The adapter connector makes it possible for applications with purely serial EnDat 2.2 encoders to connect an external KTY or PT 1000 temperature sensor (e.g. of linear and torque motors) and lead it to the speed encoder input of the controller unit.

The adapter connector can also be used in conjunction with encoders with EnDat02 or 1 V_{PP} interface. The adapter connector is plugged directly onto the speed encoder input (X15 to X20) of the controller unit.

Adapter connectors

KTY adapter connector ID 367770-xx
Mass ≈ 0.1 kg

Additional cables are required for the use of two or more adapter connectors on one controller unit because the connector for an external KTY or PT 1000 temperature sensor does not permit two or more adapter connectors in a row at the CC 61xx.

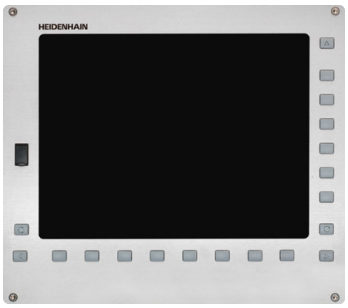
	Encoders with EnDat interface (EnDat2.1, EnDat2.2)	**Encoders with 1 V_{PP} interface**
1 m cable	ID 336377-01	ID 312533-01
3 m cable	ID 336377-03	ID 312533-03

15″ screen and keyboard

BF 750 color flat-panel display

- Voltage supply: DC 24 V/≈ 50 W
- **15.1-inch**; 1024 x 768 pixels
- HDL interface to the MC 6xxx
- 8 horizontal soft keys, 6 vertical soft keys for PLC
- Soft-key row switchover
- Selectable screen layout
- Operating mode switchover
- USB port with cover cap on front
- Integrated USB hub with four USB interfaces on the rear

BF 750 ID 785080-xx
Mass ≈ 4 kg



BF 750

TE 730 keyboard

- For BF 750 or MC 7522
- Axis keys
- The keys for axes IV and V are exchangeable snap-on keys.
- Contouring keys
- Operating mode keys
- ASCII keyboard
- Spindle-speed and feed-rate override potentiometer
- USB interface to the MC
- Touchpad

TE 730 ID 805489-xx
Mass ≈ 2.4 kg


TE 730

TE 720 keyboard

Same features as TE 730 but without touchpad

TE 720 ID 805488-xx

TE 735 keyboard unit with integrated machine operating panel

- For BF 750 or MC 7522
- NC keyboard same as TE 730
- USB interface to the MC main computer
- Machine operating panel (same as MB 720)
- HSCI interface

TE 735 ID 771898-xx
TE 735 FS ID 805493-xx
Mass ≈ 3.4 kg


TE 735

MB 720 machine operating panel

- Voltage supply: DC 24 V/≈ 4 W
- 36 exchangeable snap-on keys with status LED, freely definable via PLC (assignment according to PLC basic program: 12 axis keys, spindle start, spindle stop, 22 further function keys
- Further operating elements: NC start[1], NC stop[1], emergency-stop key, control voltage On[1], two bore holes for additional keys or keylock switches
- HSCI interface
- MB 720: 7 free PLC inputs and 5 free PLC outputs
  MB 720 FS: 4 free FS inputs and 5 free PLC outputs; additional dual-channel FS inputs for emergency stop and permissive buttons of the handwheel.

[1] Keys illuminated, addressable via PLC

MB 720 ID 784803-xx
MB 720 FS ID 805474-xx
Mass ≈ 1 kg

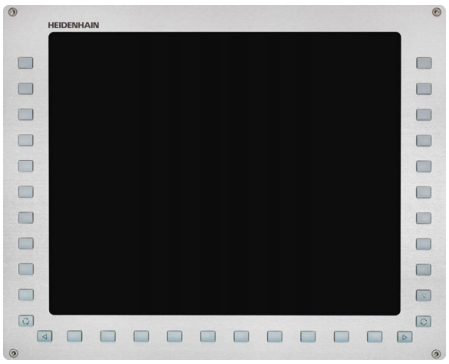

MB 720

19″ screen and keyboard

BF 760 color flat-panel display

- Voltage supply: DC 24 V/≈ 65 W
- **19-inch**; 1280 x 1024 pixels
- HDL interface to the MC 6xxx
- 10 horizontal NC soft keys, 8 + 10 vertical soft keys for PLC
- Soft-key row switchover
- Selectable screen layout
- Operating mode switchover
- Integrated USB hub with six USB interfaces on the rear

BF 760 ID 732589-xx
Mass ≈ 7.8 kg



BF 760

BF 860 color flat-panel display

- Voltage supply: DC 24 V/≈ 65 W
- **19-inch**; 1280 x 1024 pixels
- HDL interface to the MC in the electrical cabinet
- Integrated USB hub with 4 USB ports on the rear
- Touchscreen for multitouch operation

Via touchscreen operation
- Soft-key row switchover
- Selectable screen layout
- Operating mode switchover

BF 860 ID 1169174-xx
Mass ≈ 7.1 kg

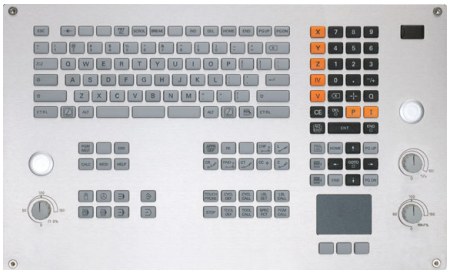
BF 860

TE 740 keyboard

- Suitable for BF 760 (19″ design)
- Axis keys
- The keys for axes IV and V are exchangeable snap-on keys.
- Contouring keys
- Operating mode keys
- ASCII keyboard
- Spindle-speed, feed-rate and rapid-traverse override potentiometers
- USB interface to the MC main computer
- Touchpad
- USB port with cover cap on front

A PLB 6001 is required for connection of an OEM-specific machine operating panel.

TE 740 ID 886546-xx
Mass ≈ 3.2 kg



TE 740

TE 745 keyboard unit with integrated machine operating panel

Same as TE 740, but with integrated machine operating panel

- Voltage supply: DC 24 V/≈ 4 W
- 36 exchangeable snap-on keys with status LEDs, freely definable via PLC
- 36 exchangeable snap-on keys with status LED, freely definable via PLC (assignment according to PLC basic program: 12 axis keys, spindle start, spindle stop, 22 further function keys
- Further operating elements: NC start[1)], NC stop[1)], emergency-stop key, control voltage On[1)], two bore holes for additional keys or keylock switches
- Connection for HR handwheel
- HSCI interface
- TE 745: 7 free PLC inputs and 5 free PLC outputs
  TE 745 FS: 4 free FS inputs and 5 free PLC outputs; additional dual-channel FS inputs for emergency stop and permissive buttons of the handwheel.

[1)] Keys illuminated, addressable via PLC

TE 745 ID 679817-xx
TE 745 FS ID 805482-xx
Mass ≈ 4.3 kg

TE 745

PL 6000 PLC input/output systems with HSCI

PL 6000

The PLC inputs and outputs are available via external modular PL 6000 PLC input/output systems. They consist of a basic module and one or more input/output modules. A total maximum of 1000 inputs/outputs is supported. The PL 6000 units are connected to the MC main computer via the HSCI interface. The PL 6000 units are configured with the IOconfig PC software.

PLB 62xx

Basic modules

There are basic modules with **HSCI interface** available for 4, 6 or 8 I/O modules. Mounted on standard NS 35 rails (DIN 46 227 or EN 50 022)

Supply voltage	24 V DC
Power consumption[1)]	≈ 48 W at DC 24 V-NC ≈ 21 W at DC 24 V-PLC
Mass	0.36 kg (bare)

[1)] PLB 6xxx completely filled, incl. TS, TT. For more details regarding power supply for DC 24 V NC, see *Power supply for HSCI components*.

System PL

- Required once for each control system (except with UEC)
- Includes connections for TS and TT touch probes, as well as TL
- Safety-relevant inputs/outputs
- *Without FS*: 12 free inputs, 7 free outputs
  With FS: 6 free FS inputs, 2 free FS outputs

PLB 6204	For 4 I/O modules	ID 591832-xx
PLB 6204 FS	For 4 I/O modules	ID 586789-xx
PLB 6206	for 6 I/O modules	ID 630054-xx
PLB 6206 FS	for 6 I/O modules	ID 622721-xx
PLB 6208	For 8 I/O modules	ID 630055-xx
PLB 6208 FS	For 8 I/O modules	ID 620927-xx

Expansion PL

For connection to the system PL to increase the number of PLC inputs/outputs

PLB 6104	For 4 I/O modules	ID 591828-xx
PLB 6104 FS	for 4 I/O modules	ID 590479-xx
PLB 6106	for 6 I/O modules	ID 630058-xx
PLB 6106 FS	for 6 I/O modules	ID 804755-xx
PLB 6108	for 8 I/O modules	ID 630059-xx
PLB 6108 FS	for 8 I/O modules	ID 804756-xx

Up to seven PLB 6xxx can be connected to the control.

I/O modules for HSCI

There are I/O modules with digital and analog inputs and outputs. For partially occupied basic modules, the unused slots must be occupied by an empty housing.

PLD-H 16-08-00	I/O module with 16 digital inputs and 8 digital outputs	ID 594243-xx
PLD-H 08-16-00	I/O module with 8 digital inputs and 16 digital outputs	ID 650891-xx
PLD-H 08-04-00 FS	I/O module with 8 digital FS inputs and 4 digital FS outputs	ID 598905-xx
PLD-H 04-08-00 FS	I/O module with 4 digital FS inputs and 8 digital FS outputs	ID 727219-xx
PLD-H 04-04-00 HSLS FS	I/O module with 4 digital FS inputs and 4 high-side/low-side FS outputs	ID 746706-xx
Total current	Outputs 0 to 7: ≤ 2 A per output (≤ 8 A simultaneously)	
Power output	Max. 200 W	
Mass	0.2 kg	
PLA-H 08-04-04	Analog module for PL 6xxx with • 8 analog inputs, ± 10 V • 4 analog outputs, ± 10 V • 4 analog inputs for PT 100 thermistors	ID 675572-xx
Mass	0.2 kg	

Empty housing For unused slots ID 383022-xx

IOconfig (accessory) PC software for configuring HSCI and PROFIBUS components

Accessories
Power supply for HSCI components

PSL 13x

To power the HSCI components, HEIDENHAIN offers the PSL 13x power supply unit. Either line voltage and DC-link voltage or only line voltage is provided to the PSL 13x. The PSL 13x provides the safely separated 24 V DC NC power supply required for the HSCI components by EN 61 800-5-1. The NC supply voltage and the PLC supply voltage are separated from each other by basic insulation.

PSL 130

Supply voltage
- PSL 13x (L1, L2): AC 400 V (360 V to 480 V), 50/60 Hz
- PSL 13x (DC-link voltage): DC 400 V to 750 V
- Power consumption ≤1000 W

Outputs
NC: DC 24 V/≤ 20 A (double insulation from line power)
DC 5 V/≤ 16 A (only for PSL 135) electrically connected with DC 24 V NC
PLC: DC 24 V/≤ 20 A (basic insulation from line power)
Total: ≤ 32 A/750 W

The **PSL 130** serves as a DC 24 V power supply unit for supplying the HSCI components. It is not necessary in connection with the UEC if the total current consumption of the connected HSCI components does not exceed 3.5 A.

HSCI components		**Current consumption DC 24 V NC**
Main computer	MC 6541, MC 6542 MC 6641, MC 7532 MC 7522	2.0 A 3.2 A 2.5 A
Machine operating panel	PLB 600x MB 7x0	0.2 A (without handwheel) 0.2 A (without handwheel)
Keyboard	TE 7x5 (MB integrated)	0.2 A (without handwheel)
PLC inputs/outputs	PLB 62xx PLB 61xx PLD PLA	0.3 A (without touch probe) 0.2 A 0.05 A 0.1 A
Screen	BF 750 BF 760	2.1 A 2.5 A
Handwheels	HR 520 HRA 551 FS + HR 550 FS HR 510 HR 130 HRA 110 + 3 x HR 150	0.05 A 0.5 A (in charging process) 0.05 A 0.05 A 0.2 A
Touch probes	See specifications of the touch probes	

The **PSL 135** has an additional DC 5 V output and is therefore suited for supplying the CC controller unit and the MC main computer. It might be necessary with multi-row configuration.

	Module width	**Degree of protection**	**Mass**	
PSL 130	50 mm	IP 20	2.1 kg	ID 575047-xx
PSL 135	50 mm	IP 20	2.5 kg	ID 627032-xx

The current UV(R) supply units also feature an integrated power supply that provides DC 24 V to HSCI components.

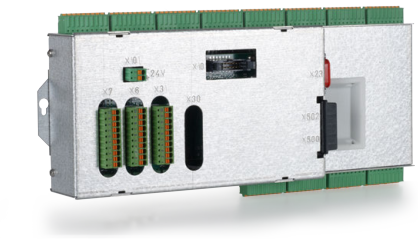
HSCI adapter for OEM machine operating panel

PLB 600x

The PLB 600x HSCI adapter is required in order to connect an OEM-specific machine operating panel to the TNC 640. The spindle-speed and feed-rate override potentiometers of the TE 7xx and the HR handwheel are also connected to these adapters.

- HSCI interface
- Connection for HR handwheel
- Inputs/outputs for keys/key illumination
  PLB 6001: Terminals for 72 PLC inputs and 40 PLC outputs
  PLB 6001 FS: Terminals for 36 FS inputs and 40 PLC outputs
  PLB 6002 FS: Terminals for 4 FS inputs, 64 PLC inputs and 40 PLC outputs
- Screw fastening or top-hat-rail mounting
- Configuration of the PLC inputs/outputs with the IOconfig computer software

PLB 6001	ID 668792-xx
PLB 6001 FS	ID 722083-xx
PLB 6002 FS	ID 1137000-xx
Mass	≈ 1.2 kg



PLB 6001

Additional modules

Overview

The additional modules are directly connected to the HSCI control system through a slot on the MC main computer, CC controller unit or UEC/UMC inverter.

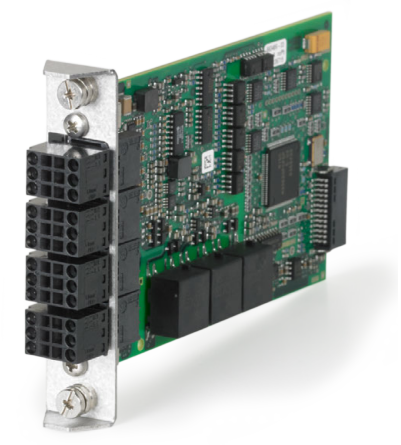
Module for analog axes

Digital drive designs sometimes also require analog axes or spindles. The additional module CMA-H 04-04-00 (Controller Module Analog—HSCI) makes it possible to integrate analog servo drives in an HSCI system.

The CMA-H is connected to the HSCI control system through a slot on the underside of the CC or UEC. Every controller unit has slots for two boards. The CMA-H does not increase the total number of available axes: every analog axis used reduces the number of available digital control loops by one. Analog control loops also need to be enabled on the SIK. The analog control-loop outputs can only be accessed via the NC, not via the PLC.

Additional module for analog axes/spindles:
- Expansion board for CC 61xx or UEC controller units
- 4 analog outputs, ± 10 V for axes/spindle
- Spring-type plug-in terminals

CMA-H 04-04-00 ID 688721-xx



CMA-H 04-04-00

Field bus systems

An expansion board can be used to provide the TNC 640 with a PROFIBUS or PROFINET interface at any time. The modules are integrated in the control system by using a slot on the MC. This makes the connection to an appropriate fieldbus system as master possible. As of version 3.0, the interface is configured with IOconfig.

PROFIBUS-DP module

Additional module for PROFIBUS-DP:
- Expansion board for the MC main computer
- Connection for D-sub connector (female) 9-pin to X121

PROFIBUS-DP additional module ID 828539-xx

PROFIBUS-DP module

PROFINET-IO module

Additional module for PROFIBUS-DP:
- Expansion board for the MC main computer
- RJ45 connection at X621 and X622

PROFINET-IO additional module ID 828541-xx

PROFINET-IO module

Combined PROFIBUS-DP/ PROFINET IO module

Additional module for PROFIBUS-DP and PROFINET-IO:
- Expansion board for the MC main computer
- Connection for RJ45 connector to X621 (PROFINET-IO) and M12 connector to X121 (PROFIBUS-DP)

Additional module for PROFIBUS-DP and PROFINET-IO ID 1160940-xx

Combined module

Touch probes

Overview

Touch probes for tool and workpiece measurement are connected via the system PL 62xx or the UEC/UMC. These touch probes generate a trigger signal that saves the current position value to the NC. For more information on the touch probes, ask for our brochure titled *Touch Probes*.

Workpiece measurement

The TS touch trigger probes have a stylus for probing workpieces. The HEIDENHAIN controls provide standard routines for presetting and workpiece measurement and alignment. The touch probes are available with various taper shanks. Assorted styli are available as accessories.

Touch probes with **cable connection for signal transmission** for machines with manual tool change:

TS 260

New generation touch probe for NC machines

TS 260

Touch probe with **radio and infrared transmission** for machines with automatic tool change (see page 36 for the fitting transmitter/receiver unit):

TS 460

New generation touch probe with compact dimensions
- Hybrid technology: Signal transmission via radio and infrared signals
- Large transmission range and long operating time
- Mechanical collision protection and thermal decoupling

TS 460

Touch probes with **infrared transmission** for machines with automatic tool change (see page 36 for the fitting transmitter/receiver unit):

TS 444

Compact dimensions, battery-free—power supply through integrated air turbine generator over central compressed air supply

TS 642

Activation via switch in taper shank

TS 740

High probing accuracy and reproducibility, low probing force

Tool measurement

The touch probes for tool measurement from HEIDENHAIN are suited for probing stationary or rotating tools directly on the machine. The TNC 640 has standard routines for measuring the length and diameter of the tool as well as the individual teeth. The TNC 640 automatically saves the results of measurement in a tool table. It is also possible to measure tool wear between two machining steps. The TNC 640 automatically corrects the tool data for the following operation or switches to a sister tool—just as after tool breakage.

With the triggering **TT touch probes**, the disk-shaped probe contact is deflected from its resting position by contact with the stationary or rotating tool and a trigger signal is transmitted to the TNC 640.

TT 160

New generation touch probe; signal transmission to the control over connecting cable

TT 160

TT 460

Next generation touch probe, hybrid technology: signal transmission via radio or infrared beam (see below for fitting transmitter/receiver unit)

TL Micro/TL Nano

The **TL laser systems** operate without any contact. A laser beam probes the length, diameter or contour of the tool. Special measuring cycles in the TNC 640 evaluate the information.

Transceiver unit

The radio or infrared transmission is established between the TS or TT touch probe and the SE transceiver unit.

SE 660 For radio and infrared transmission (hybrid technology); common SE unit for TS 460 and TT 460; new generation
SE 540 For infrared transmission; integration in the spindle head
SE 642 For infrared transmission; shared SE for TS and TT

The following combinations are possible:

	SE 660	SE 540	SE 642
TS 444	-	Infrared	Infrared
TS 460	Radio/infrared	Infrared	Infrared
TS 642	-	Infrared	Infrared
TS 740	-	Infrared	Infrared
TT 460	Radio/infrared	Infrared	Infrared

SE 660

Electronic handwheels

Overview

Support of electronic handwheels is standard on the TNC 640
- **HR 550 FS** radio handwheel, or
- **HR 510** or **HR 520** portable handwheel, or
- **HR 130** panel-mounted handwheel or
- Up to three **HR 150** panel-mounted handwheels via **HRA 110**

It is possible to operate up to five handwheels or handwheel adapters on a single TNC 640:
- One handwheel via the handwheel input of the main computer
- One handwheel each on up to four HSCI machine operating panels or the PLB 600x HSCI adapter

A mixed operation of handwheels with and without display is not possible. Handwheels with functional safety are cross-circuit-proof due to their special permissive-button logic.

HR 510

Portable electronic handwheel with
- Keys for actual-position capture and the selection of 5 axes
- Keys for traverse direction and three preset feed rates
- Three keys for machine functions (see below)
- Emergency stop button and two permissive buttons (24 V)
- Magnetic holding pads

All keys are designed as snap-on keys and can be replaced by keys with other symbols (see overview for HR 510 in *Snap-on keys for HR*).

	Keys	Without detent	With detent
HR 510	NC start/stop, spindle start (for basic PLC program)	ID 1119971-xx	ID 1120313-xx
	FCT A, FCT B, FCT C	–	ID 1099897-xx
	Spindle right/left/ stop	ID 1184691-xx	–
HR 510 FS	NC start/stop, spindle start (for basic PLC program)	ID 1120311-xx	ID 1161281-xx
	FCT A, FCT B, FCT C	–	ID 1120314-xx
	Spindle right/left/ stop	–	ID 1119974-xx

Mass ≈ 0.6 kg

HR 510

HR 520

Portable electronic handwheel with
- Display for operating mode, actual position value, programmed feed rate and spindle speed, error messages
- Override potentiometer for feed rate and spindle speed
- Selection of axes via keys or soft keys
- Actual position capture
- NC start/stop
- Spindle on/off
- Keys for continuous traverse of the axes
- Soft keys for machine functions of the machine manufacturer
- Emergency stop button

	Without detent	With detent
HR 520	ID 670302-xx	ID 670303-xx
HR 520 FS	ID 670304-xx	ID 670305-xx

Mass ≈ 1 kg

HR 520

Mount for HR 520 For fastening on machine ID 591065-xx

HR 550 FS

Electronic handwheel with wireless transmission. Display, operating elements and functions same as HR 520.

In addition:
- Functional safety
- Radio transmission range up to 20 m (depending on environment)

HR 550 FS	W/o detent	ID 598515-xx
	With detent	ID 606622-xx
Replacement battery	For HR 550 FS	ID 623166-xx

HR 550 FS with HRA 551 FS

HRA 551 FS

Handwheel holder for HR 550 FS
- For docking the HR 550 on the machine
- Integrated battery charger for HR 550 FS
- Connections to the control and the machine
- Integrated transmitter/receiver unit

HRA 551 FS	ID 731928-xx
Mass	≈ 1.0 kg

For more information see the Product Information document *HR 550 FS*.

Connecting cables

	HR 510	HR 510 FS	HR 520	HR 520 FS	HR 550 FS with HRA 551 FS	
Connecting cable (spiral cable) to HR (3 m)	–	–	✓	✓	–	ID 312879-01
	✓	✓	–	–	–	ID1117852-03
Connecting cable with metal armor	–	–	✓	✓	–	ID 296687-xx
	✓	✓	–	–	–	ID 1117855-xx
Connecting cable without metal armor	–	–	✓	✓	–	ID 296467-xx
	✓	✓	–	–	–	ID 1117853-xx
Adapter cable for HR/ HRA to MC	✓	✓	✓	✓	✓[1]	ID 296466-xx
Extension cable to adapter cable	✓	✓	✓	✓	✓[1]	ID 281429-xx
Adapter cable for HRA to MC	–	–	–	–	✓[2]	ID 749368-xx
Extension cable to adapter cable	–	–	–	–	✓[2]	ID 749369-xx
Dummy plug for standard handwheels	✓	–	✓	–	–	ID 271958-03
Dummy plug for handwheels with FS	–	✓	–	✓	–	ID 271958-05

[1] For maximum cable lengths up to 20 m between the MB and HRA 551 FS
[2] For maximum cable lengths up to 50 m between the MB and HRA 551 FS

See also *Cable overview* on Page 50.

HR 130

Panel-mounted handwheel with ergonomic control knob.
It is attached to the MB 7x0 or the TE 7x5 either directly or via an extension cable.

HR 130	Without detent	ID 540940-03
	With detent	ID 540940-01
Mass	≈ 0.7 kg	

HR 130

HR 150

Panel-mounted handwheel with ergonomic control knob for connection to the **HRA 110** handwheel adapter.

HR 150	Without detent	ID 540940-07
	With detent	ID 540940-06
Mass	≈ 0.7 kg	

HR 150

HRA 110

Handwheel adapter for connection of up to three **HR 150** panel-mounted handwheels and two switches for axis selection and for selecting the subdivision factor. The first two handwheels are permanently assigned to axes 1 and 2. The third handwheel is assigned to the axes over a selection switch (accessory) or by machine parameters. The position of the second step switch (accessory) is evaluated over the PLC, for example to select the subdivision factor.

HRA 110 ID 261097-xx
Mass ≈ 1.5 kg

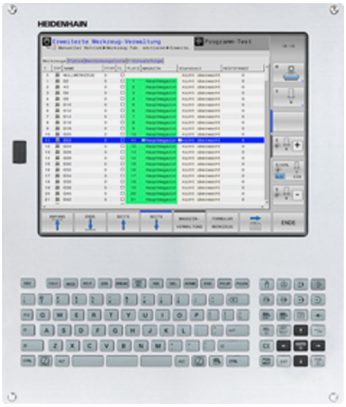
HRA 110

Industrial PC

Additional operating station

The additional ITC operating stations from HEIDENHAIN are convenient solutions for an additional, remote station for operating the machine or a machine unit, such as a tool-changing station. The remote operation, which was designed for the TNC, permits very simple connection of the ITC via a standard Ethernet connection with a cable of up to 100 meters

It is surprisingly simple to connect an ITC: As soon as the TNC identifies an ITC, it provides it with a current operating system. After the ITC has been started, the complete content of the main screen is mirrored 1:1 to the ITC's screen. Due to this plug & play principle, it is not necessary for the hardware manufacturer to pre-configure the operating station. With a standard X116 Ethernet interface, the TNC automatically integrates the ITC in the system.



ITC 755

With touchscreen

The **ITC 755** is a compact additional operating station for control systems with a 15" or 19" main screen. Besides an ASCII keyboard and a touchscreen, it also includes the most important TNC function keys. The ITC 755 adjusts its resolution automatically to fit the size of the main screen. The soft keys are operated using the touch screen.

The **ITC 860** (19" screen) together with the separately ordered TE 74x keyboard unit make up a complete second operating station. Besides a touchscreen, it also includes the most important TNC function keys. The soft keys are operated using the touch screen.

ITC 860

ITC 755[1)]	ID 1039527-xx
ITC 860[1)]	ID 1174935-xx

With soft keys

Together with the TE 73x or TE 74x keyboard unit, which must be ordered separately, the **ITC 750** (15-inch screen) and **ITC 760** (19-inch screen) each make up one complete second operating station. They are operated in the same way as the TNC.

ITC 750[1)]	with 15" screen for TE 73x
	ID 1039544-xx
ITC 760[1)]	with 19" screen for TE 74x
	ID 827086-xx

[1)] No NRTL approval

IPC 6641 for Windows

With the IPC 6641 industrial PC you can start and remotely operate Windows-based applications via the TNC's user interface. The user interface is displayed on the control screen. Option 133 is required.

Since Windows runs on the industrial PC, it does not influence the NC machining process. The IPC is connected to the NC main computer via Ethernet. No second screen is necessary, since the Windows applications are displayed on the TNC's screen via remote accesses.

In addition to the IPC 6641 industrial PC, a separately ordered hard disk is required for operation. The operating system Windows 7, 8 or 10 can be installed on this empty data medium.

IPC 6641

IPC 6641		ID 1039543-xx
	To be installed in	Electrical cabinet
	Processor	Intel Core i7-3 2.1 GHz, quad-core
	RAM memory	4 GB
	Mass	4.0 kg
HDR hard disk		ID 1074770-51
	Empty data carrier for Windows operating system	
	Free capacity	≈ 160 GB

Control system for auxiliary axes

PNC 610

The PNC 610 control system for auxiliary axes is solution for controlling PLC axes independent of a TNC. The PNC 610 has no NC channel and therefore cannot execute interpolated movements. With the IPC 6490 auxiliary computer, SIK and CFR memory medium, the PNC 610 is its own HSCI system that can be expanded by HEIDENHAIN inverters. This system is identical in its composition with the TNC. All relevant HEIDENHAIN tools and a basic program can be used. The position information can be transmitted independent of the platform via PROFIBUS-DP (optional), PROFINET-IO (optional) or TCP/IP (integrated, no real-time system).

The IPC 6490 has no connection for a BF display unit. The user interface must be displayed with a remote desktop connection or an ITC 7xx.

Auxiliary computer

The IPC 6490 auxiliary computer includes the following:
- Processor
- RAM memory
- HSCI interface to the CC 6xxx or UEC controller unit and to other control components
- USB 3.0 interface

The following components must be ordered separately by the OEM and installed in the auxiliary computer:
- CFR CompactFlash memory card with the NC software
- System Identification Key component (SIK) for enabling software options

The following HSCI components are necessary for operation of the TNC 640:
- IPC 6490 auxiliary computer
- Controller unit
- PLB 62xx PLC input/output unit (system PL; integrated in UEC/UMC)

Interfaces

The MC offers the end user USB 3.0, V.24/RS-232-C and Ethernet interfaces. Connection to PROFINET-IO or PROFIBUS-DP is through an additional module.

Voltage supply

The DC 24 V voltage supply to the auxiliary circuit and other HSCI components is provided by the PSL 13x supply unit or by the voltage supply of a UEC compact converter. For the entire HSCI system, this DC 24 V NC supply voltage is required to be safely separated voltage (PELV). It must not be connected to the DC 24 V supply voltage for PLC components (e.g. holding brakes). This DC 24 V PLC is a supply voltage for electric circuits with basic insulation that must not be connected to each other or mixed with safely separated electric circuits.

Design

For installation in the electrical cabinet. The listed auxiliary computer is not supported until NC software 817591-05

IPC 6490		ID 1039541-xx
	To be installed in	Electrical cabinet
	Processor	Intel Celeron Dual Core, 1.4 GHz
	RAM memory	2 GB
	Power consumption	48 W
	Mass	2.3 kg

Export version

Because the complete NC software is saved on the CFR CompactFlash storage medium, no export version is required for the main computer itself. The NC software of the PNC 610 needs no export license.

Options

The capabilities of the PNC 610 can also be adapted retroactively with options to meet new requirements. Options are enabled by entering keywords based on the SIK number, and are saved in the SIK component. Please indicate your SIK number when ordering new options.

Option number	Option	ID	Remark	Page
18	HEIDENHAIN DNC	ID 526451-01	Communication with external PC applications over COM component	92
24	Gantry axes	ID 634621-01	Gantry axes in master-slave torque control	
46	Python OEM process	ID 579650-01	Execute Python applications	87
135	Synchronizing functions	ID 1085731-01	Expanded synchronization of axes and spindles	64
141	Cross Talk Comp.	ID 800542-01	CTC: Compensation of axis couplings	75
142	Pos. Adapt. Control	ID 800544-01	PAC: Position-dependent adaptation of control parameters	75
143	Load Adapt. Control	ID 800545-01	LAC: Load-dependent adaptation of control parameters	76
144	Motion Adaptive Control	ID 800546-01	MAC: Motion-dependent adaptation of control parameters	76

Memory medium

The storage medium is a CFR (= CompactFlash Removable) compact flash memory card. It carries the NC software 817591-xx. The storage medium is removable and must be ordered separately from the main computer. The NC software is based on the HEIDENHAIN HEROS 5 operating system.

CFR CompactFlash 8 GB ID 1102057-55
No export license required
Free capacity for PLC programs 350 MB

SIK component

The SIK component holds the NC software license for enabling software options. It gives the main computer an unambiguous ID code—the SIK number. The SIK component is ordered and shipped separately. It must be inserted in a special slot in the IPC auxiliary computer. The SIK component of the PNC can enable four axes. The UMC compact inverter is required for expansion by enabling up to ten axes.

SIK component for PNC 610 ID 617763-53

TNCkeygen (accessory)

TNCkeygen is a collection of PC software tools for generating time-limited enabling keys for HEIDENHAIN controls; see "TNCkeygen(accessory)", Page 19.

Camera system

VS 101

The VS 101 camera system, in conjunction with software option 136 Visual Setup Control, enables you to monitor the working space of the machine. The sealed and extremely sturdy VS 101 camera system is designed for integration into the machine's working space. The protective housing features a closing cover and connections for sealing air to prevent the camera optics from being damaged. The VS 101 camera system can be connected directly to the control's main computer over a Gigabit Ethernet interface.

The camera system can be adapted using various lenses to the respective machine size. The proper lens selection depends on various factors. For more information, please contact HEIDENHAIN.

VS 101 ID 1137063-xx
Mass ≈ 2.3 kg

VS 101

Snap-on keys for HR

Snap-on keys

The snap-on keys make it easy to replace the key symbols. In this way, the HR handwheel can be adapted to different requirements. The snap-on keys are available in packs of 5 keys.

Overview for HR 520/HR 550

Axis keys

Orange

A	ID 330816-42	X	ID 330816-24	U	ID 330816-43	IV	ID 330816-37
B	ID 330816-26	Y	ID 330816-36	V	ID 330816-38		
C	ID 330816-23	Z	ID 330816-25	W	ID 330816-45		

Gray

A–	ID 330816-95	V+	ID 330816-69	X′–	ID 330816-0W	Y+	ID 330816-0R
A+	ID 330816-96	W–	ID 330816-0G	X′+	ID 330816-0V	Y–	ID 330816-0D
B–	ID 330816-97	W+	ID 330816-0H	X–	ID 330816-0N	Y+	ID 330816-0E
B+	ID 330816-98	IV–	ID 330816-71	X+	ID 330816-0M	Z–	ID 330816-65
C–	ID 330816-99	IV+	ID 330816-72	Y–	ID 330816-67	Z+	ID 330816-66
C+	ID 330816-0A	X–	ID 330816-63	Y+	ID 330816-68	Z–	ID 330816-19
U–	ID 330816-0B	X+	ID 330816-64	Y′–	ID 330816-21	Z+	ID 330816-16
U+	ID 330816-0C	X–	ID 330816-18	Y′+	ID 330816-20	Z′–	ID 330816-0L
V–	ID 330816-70	X+	ID 330816-17	Y–	ID 330816-0P	Z′+	ID 330816-0K

Machine functions

SPEC FCT	ID 330816-0X	FN 3	ID 330816-75		ID 330816-0T		ID 330816-86
SPEC FCT	Black ID 330816-1Y	FN 4	ID 330816-76		ID 330816-81		ID 330816-87
FCT A	Black ID 330816-30	FN 5	ID 330816-77		ID 330816-82		ID 330816-88
FCT B	Black ID 330816-31		ID 330816-78		ID 330816-83		ID 330816-94
FCT C	Black ID 330816-32		ID 330816-79		ID 330816-84		ID 330816-0U
FN 1	ID 330816-73		ID 330816-80		ID 330816-89		ID 330816-91
FN 2	ID 330816-74		ID 330816-0S		ID 330816-85		ID 330816-3L

Spindle functions

	Red ID 330816-08		ID 330816-40	0	Red ID 330816-47		ID 330816-48
	Green ID 330816-09		ID 330816-41	1	Green ID 330816-46		ID 385530-5X

Other keys

	Black ID 330816-01		Red ID 330816-50		ID 330816-90		ID 330816-93
	ID 330816-61		ID 330816-33		Black ID 330816-27	0	ID 330816-0Y
NC I	Green ID 330816-11		ID 330816-34		Black ID 330816-28	X	Black ID 330816-4M
NC 0	Red ID 330816-12		ID 330816-13		Black ID 330816-29		ID 330816-3M
	Green ID 330816-49		Green ID 330816-22		ID 330816-92		ID 330816-3N

Overview of HR 510

Axis keys
Orange

A	ID 1092562-02	X	ID 1092562-05	U	ID 1092562-36	IV	ID 1092562-08
B	ID 1092562-03	Y	ID 1092562-06	V	ID 1092562-09		
C	ID 1092562-04	Z	ID 1092562-07	W	ID 1092562-37		

Grey

X+	ID 1092562-28	Y–	ID 1092562-31	IV+	ID 1092562-24	V–	ID 1092562-27
X–	ID 1092562-29	Z+	ID 1092562-32	IV–	ID 1092562-25		
Y+	ID 1092562-30	Z–	ID 1092562-33	V+	ID 1092562-26		

Machine functions

FCT A	Black ID 1092562-14	FCT B	Black ID 1092562-15	FCT C	Black ID 1092562-16		ID 1092562-42
	ID 1092562-43		ID 1092562-44				

Spindle functions

	ID 1092562-18		ID 1092562-19		Green ID 1092562-22		Red ID 1092562-17
	Red ID 1092562-38		ID 1092562-41				

Other keys

	Black ID 1092562-01	NC	Green ID 1092562-23		ID 1092562-13		ID 1092562-35
	Green ID 1092562-20		ID 1092562-11		Black ID 1092562-10		ID 1092562-39
	Red ID 1092562-21		ID 1092562-12		ID 1092562-34		Orange ID 1092562-40

Snap-on keys for control

Snap-on keys

The snap-on keys make it easy to replace the key symbols. In this way, the keyboard can be adapted to different requirements. The snap-on keys are available in packs of 5 keys.

Overview of control keys

Keys Orange

V	ID 679843-31	A	ID 679843-54	X	ID 679843-C8	U	ID 679843-D4
IV	ID 679843-32	W	ID 679843-55	B	ID 679843-C9		
Z	ID 679843-53	C	ID 679843-88	Y	ID 679843-D3		

Gray

X+	ID 679843-03	VI+	ID 679843-13	Y+	ID 679843-93	Z+	ID 679843-B9
X–	ID 679843-04	VI–	ID 679843-14	Y–	ID 679843-94	Z–	ID 679843-C1
Y+	ID 679843-05	Y–	ID 679843-43	B–	ID 679843-B1	X–	ID 679843-C2
Y–	ID 679843-06	Y+	ID 679843-44	B+	ID 679843-B2	X+	ID 679843-C3
Z+	ID 679843-07	C+	ID 679843-67	U–	ID 679843-B3	X'	ID 679843-C4
Z–	ID 679843-08	C–	ID 679843-68	U+	ID 679843-B4	X'	ID 679843-C5
IV+	ID 679843-09	A+	ID 679843-69	Y–	ID 679843-B5	X–	ID 679843-D9
IV–	ID 679843-10	A–	ID 679843-70	Y+	ID 679843-B6	X+	ID 679843-E1
V+	ID 679843-11	Z+	ID 679843-91	W–	ID 679843-B7		
V–	ID 679843-12	Z–	ID 679843-92	W+	ID 679843-B8		

Machine functions

	ID 679843-01		ID 679843-30		ID 679843-74		ID 679843-C6
	ID 679843-02		ID 679843-40		ID 679843-76	FCT C	Black ID 679843-C7
	ID 679843-16		Green ID 679843-56	FCT A	Black ID 679843-95	SPEC FCT	ID 679843-D6
	ID 679843-22		Red ID 679843-57	FCT B	Black ID 679843-96		ID 679843-E3
	ID 679843-23	+	ID 679843-59		Black ID 679843-A1	FCT RC	ID 679843-E4
FN 1	ID 679843-24	–	ID 679843-60	FN 4	ID 679843-A2		ID 679843-E6
FN 2	ID 679843-25		ID 679843-61	FN 5	ID 679843-A3		ID 679843-E7
FN 3	ID 679843-26		ID 679843-62		ID 679843-A4		ID 679843-E8
	ID 679843-27	FCT	ID 679843-63		ID 679843-A5		
	ID 679843-28		ID 679843-64		ID 679843-A6		
	ID 679843-29		ID 679843-73		ID 679843-A9		

Spindle functions

	ID 679843-18		ID 679843-47		Red ID 679843-52		ID 679843-99
	ID 679843-19		ID 679843-48		ID 679843-65		Green ID 679843-D8
	ID 679843-20		ID 679843-49		Green ID 679843-71		ID 679843-F3
	ID 679843-21		ID 679843-50		ID 679843-72		
	ID 679843-46		ID 679843-51		Red ID 679843-89		

Other keys

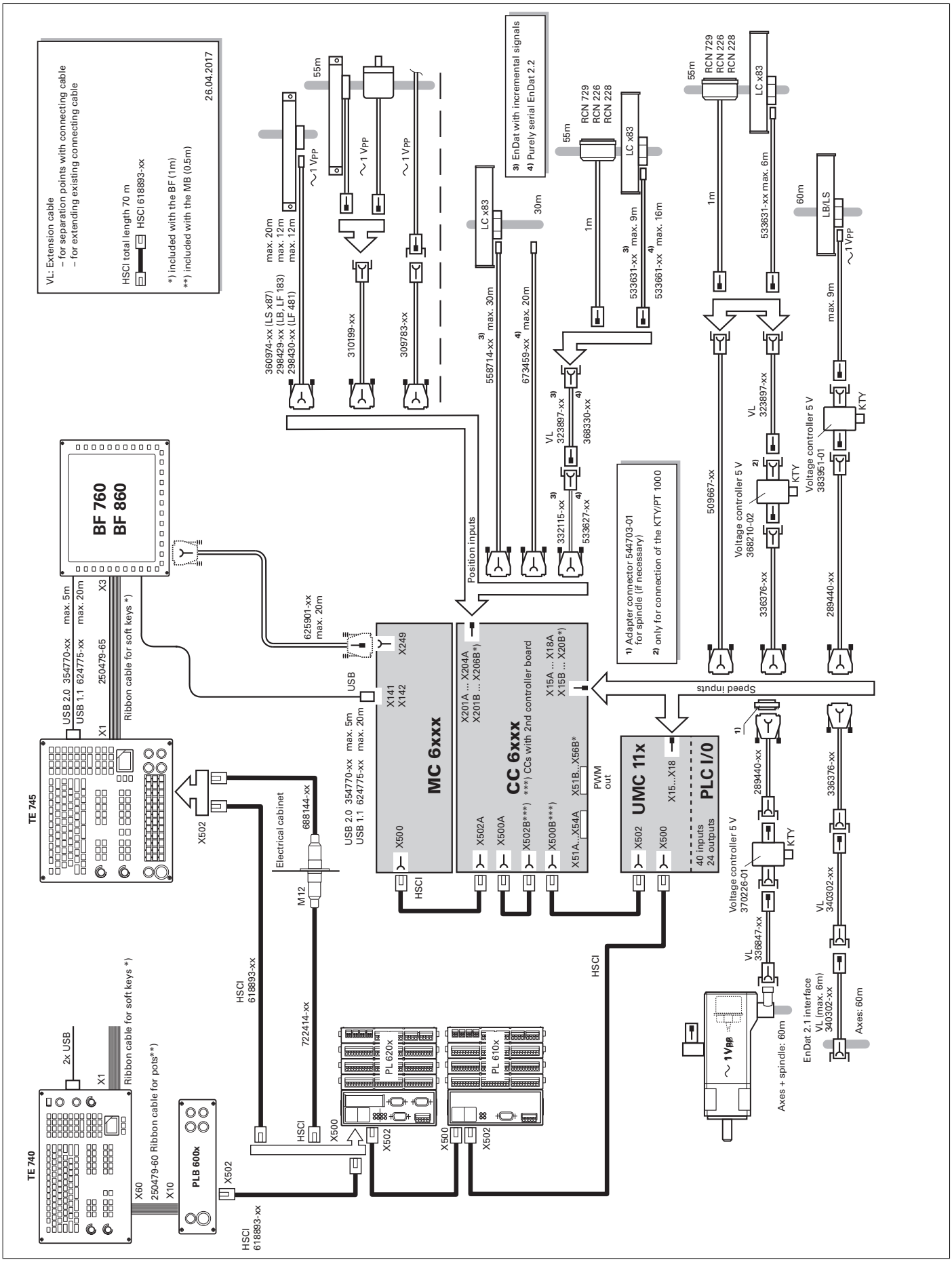
	ID 679843-15		ID 679843-39		ID 679843-97		Black ID 679843-E2
	ID 679843-17		ID 679843-41		ID 679843-98		ID 679843-E5
	ID 679843-33		ID 679843-42		ID 679843-A7		ID 679843-F2
	Black ID 679843-34		Red ID 679843-45		ID 679843-A8		ID 679843-F4
	Orange ID 679843-35		ID 679843-58		Black ID 679843-D1		ID 679843-F5
	ID 679843-36		ID 679843-66		Black ID 679843-D2		ID 679843-F6
	ID 679843-37		ID 679843-75		ID 679843-D5		
	ID 679843-38		Green ID 679843-90		Red ID 679843-D7		

Special keys

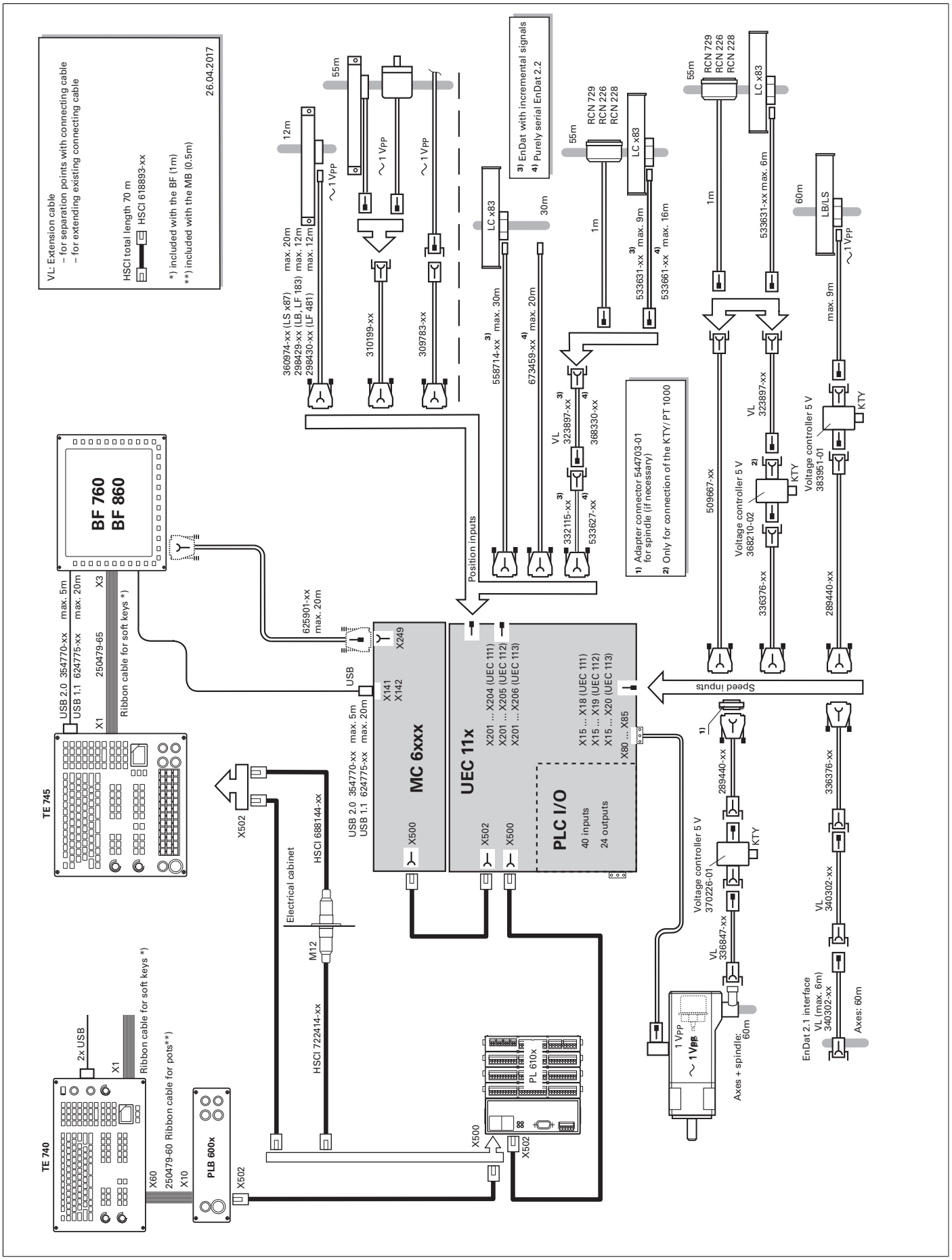
Snap-on keys with customized symbols for special applications can also be manufactured. The laser labeling differs optically from the labeling of the standard keys.

Cable overview

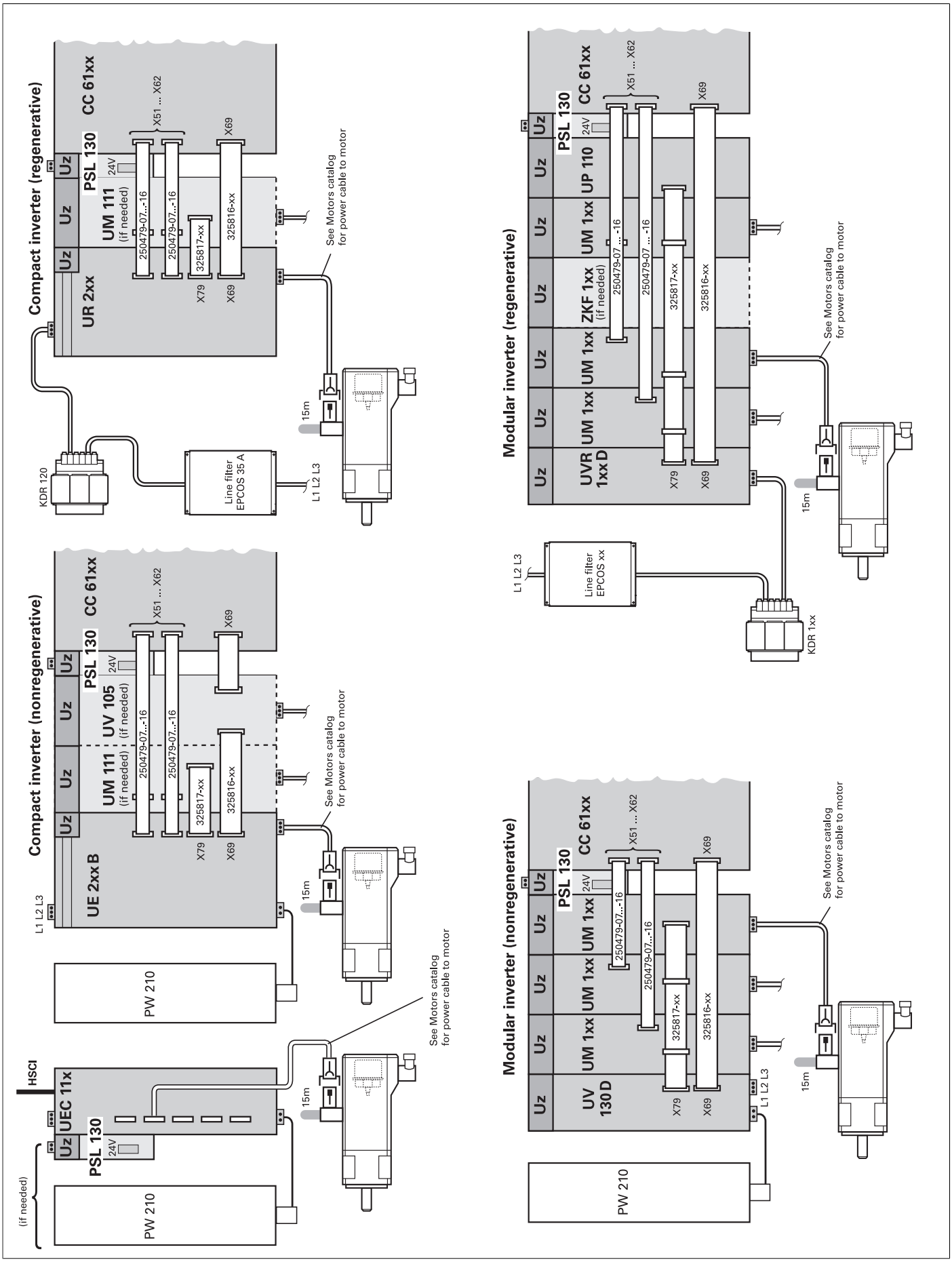
Control systems with CC



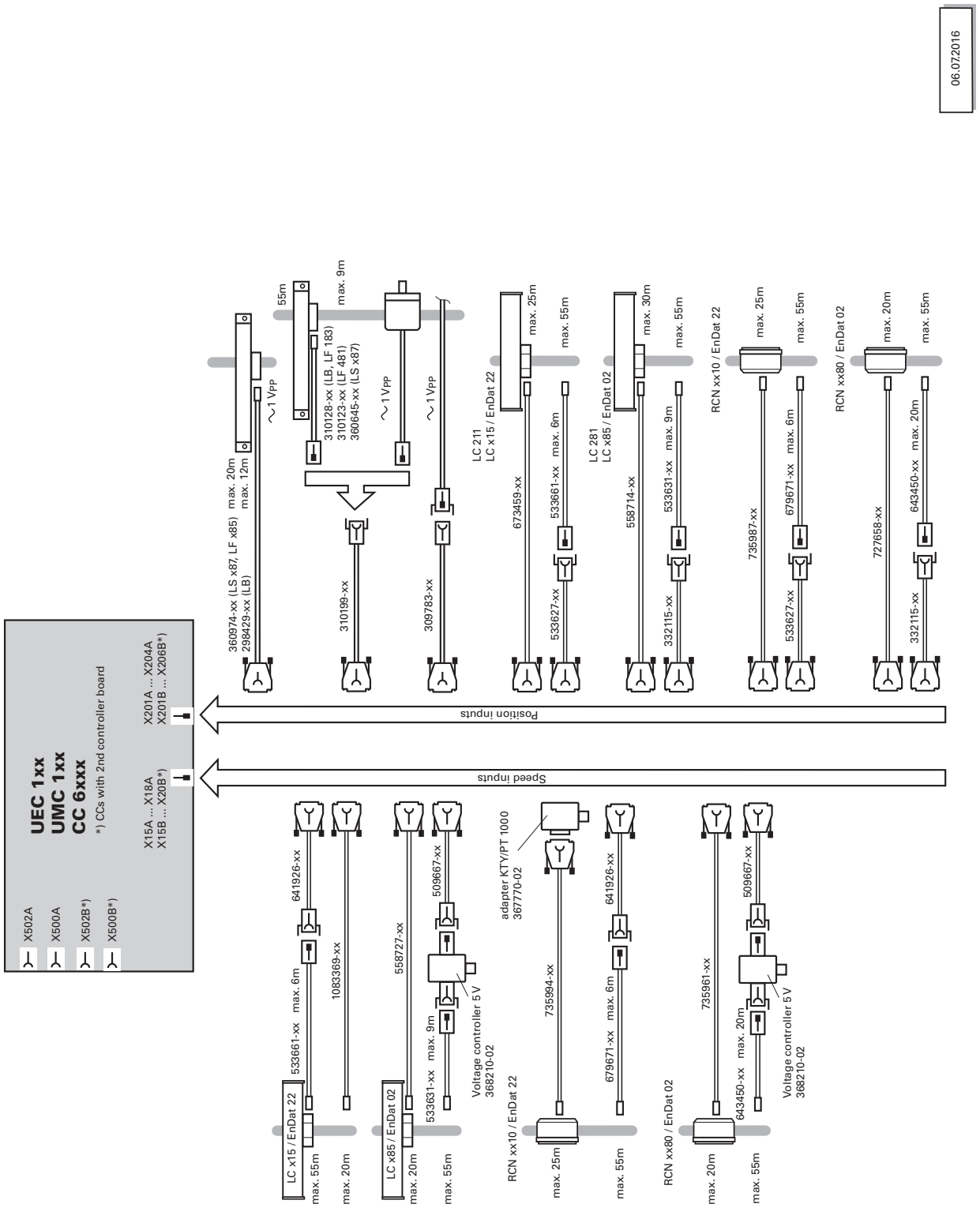
Control systems with UEC



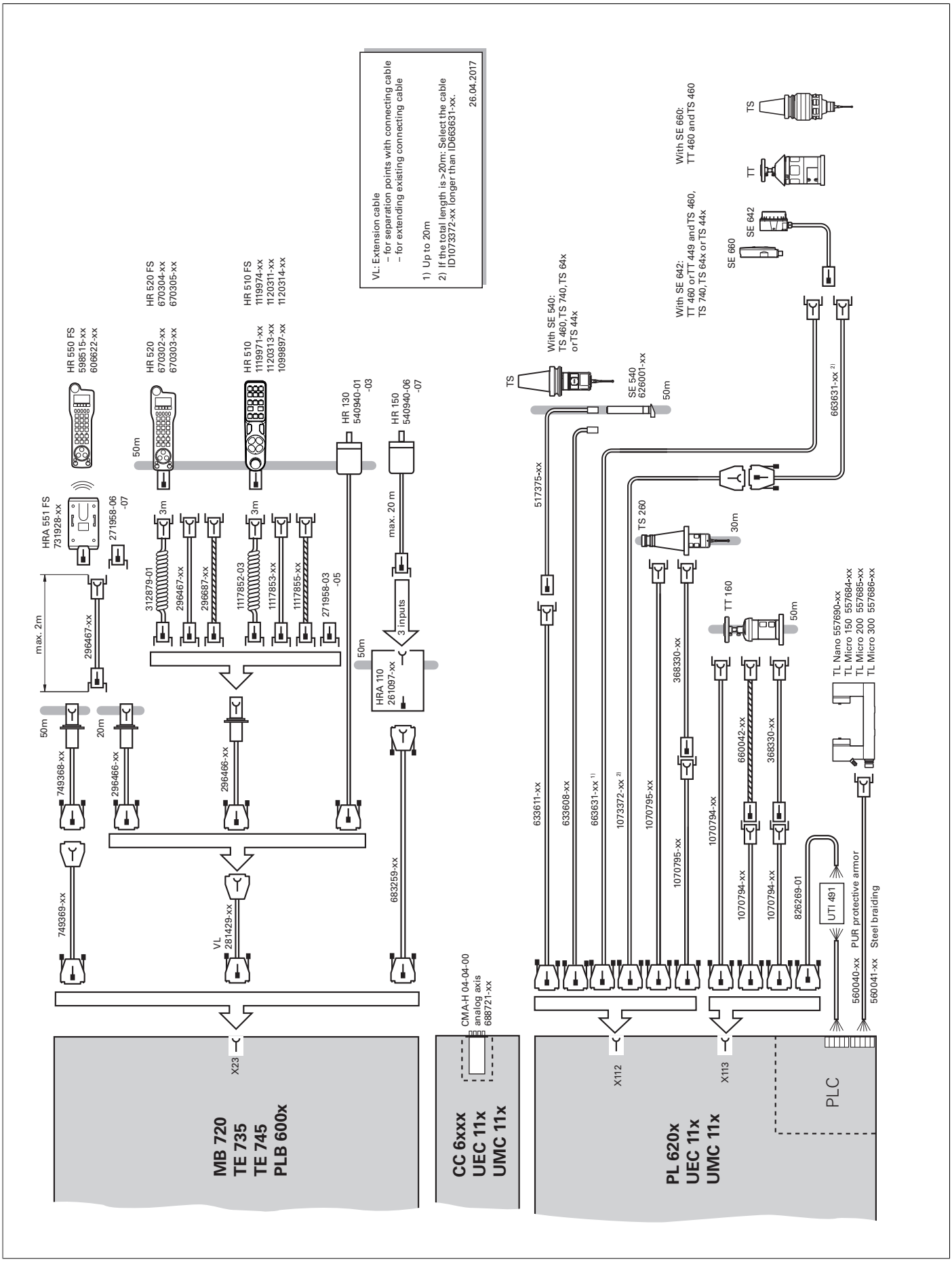
Inverter system



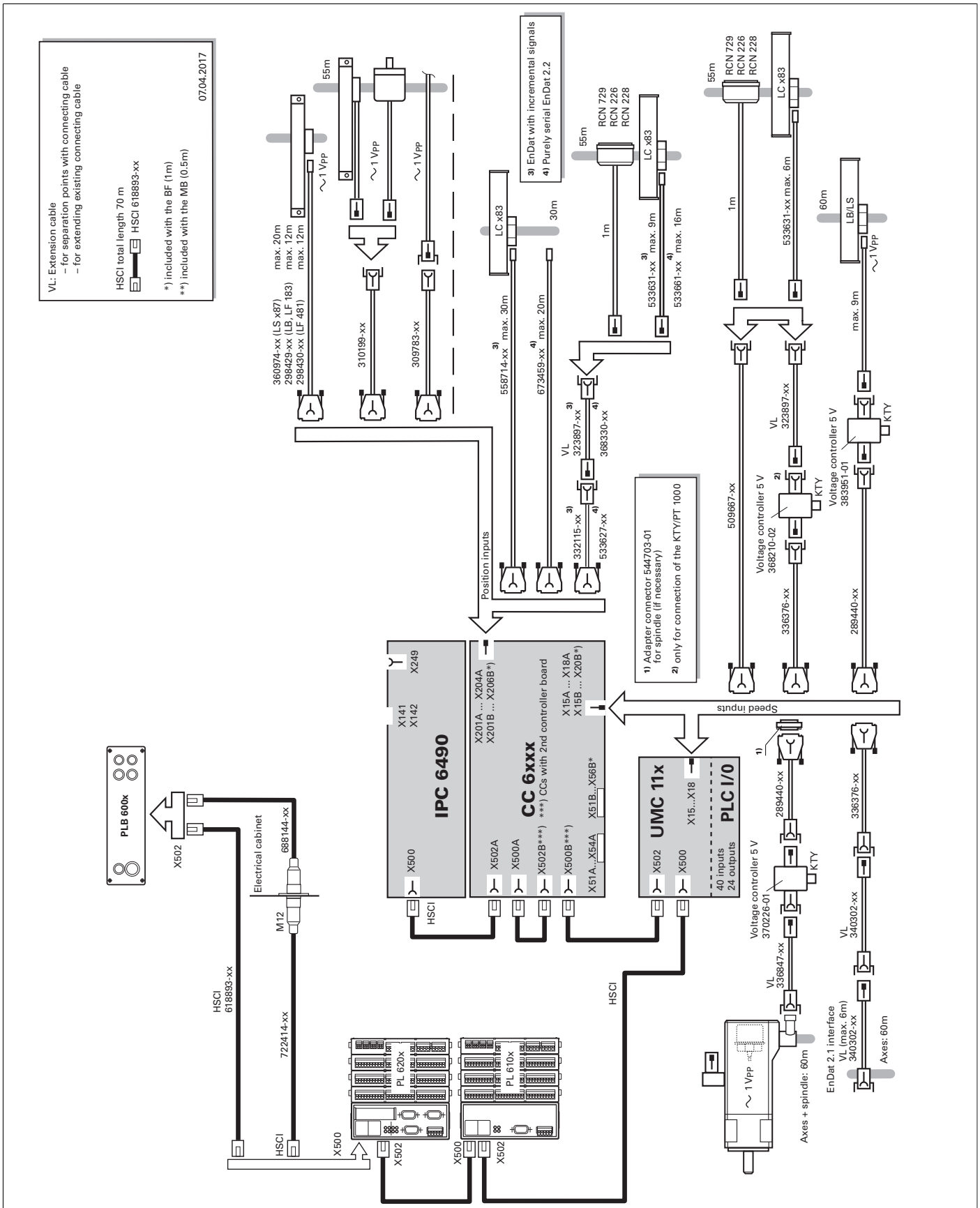
Encoders


06.07.2016
UEC 1xx
UMC 1xx
CC 6xxx
*) CCs with 2nd controller board
X502A
X500A
X502B*)
X500B*)
X15A ... X18A
X15B ... X20B*)
X201A ... X204A
X201B ... X206B*)
Position inputs
Speed inputs
360974-xx (LS x87, LF x85) max. 20m
298429-xx (LB) max. 12m
~ 1 VPP
55m
max. 9m
310128-xx (LB, LF 183)
310123-xx (LF 481)
360645-xx (LS x87)
310199-xx
309783-xx
LC 211
LC x15 / EnDat 22
673459-xx
max. 25m
533661-xx max. 6m
533627-xx
max. 55m
LC 281
LC x85 / EnDat 02
558714-xx
max. 30m
533631-xx max. 9m
332115-xx
RCN xx10 / EnDat 22
735987-xx
679671-xx max. 6m
RCN xx80 / EnDat 02
727658-xx
643450-xx max. 20m
641926-xx
1083369-xx
LC x15 / EnDat 22
558727-xx
509667-xx
533631-xx max. 9m
Voltage controller 5 V
368210-02
LC x85 / EnDat 02
adapter KTY/PT 1000
367770-02
735994-xx
679671-xx max. 6m
RCN xx10 / EnDat 22
735961-xx
643450-xx max. 20m
RCN xx80 / EnDat 02

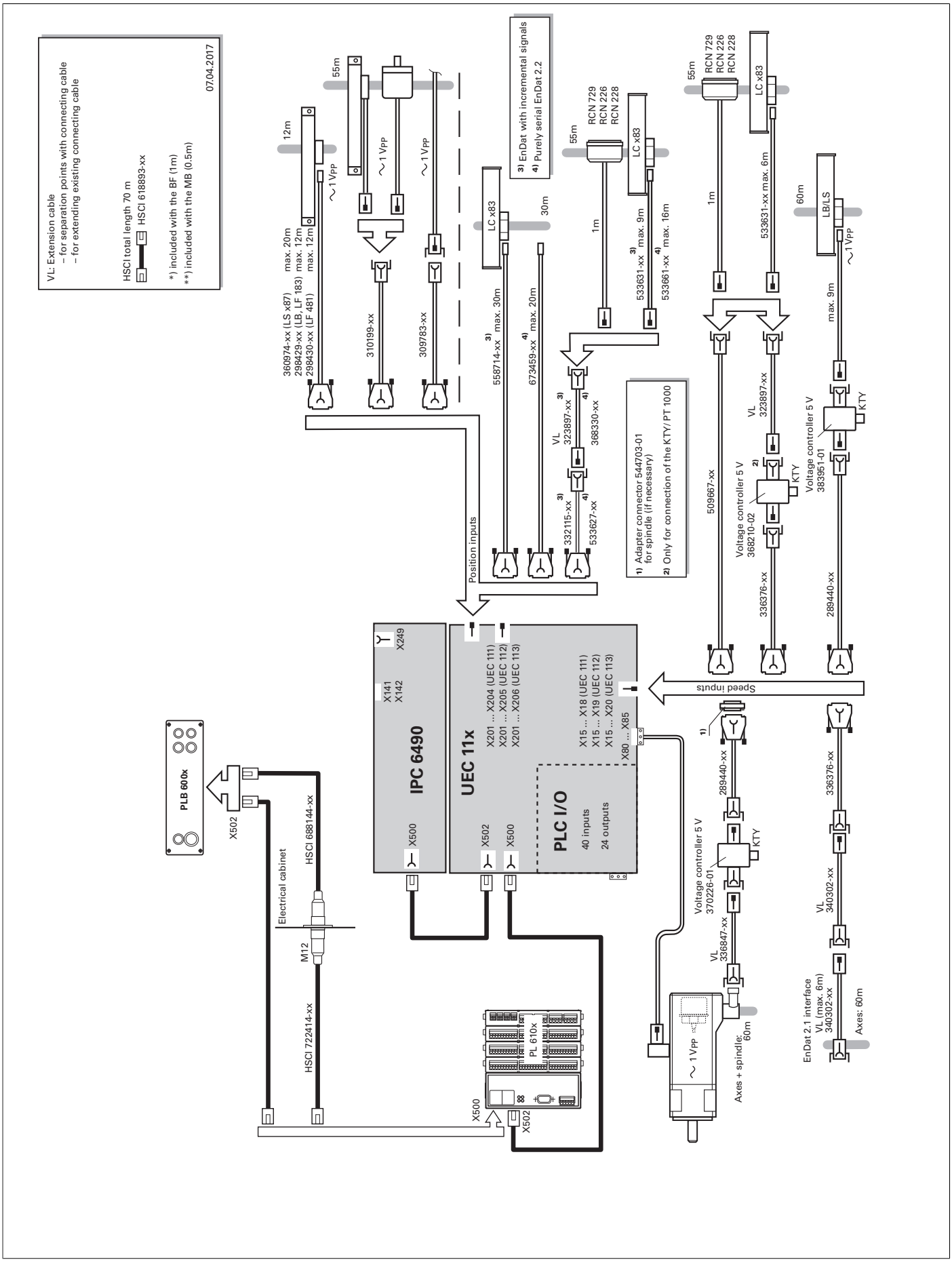
Accessories



PNC 610 with CC



PNC 610 with UEC



Technical description
Digital control design

Uniformly digital

In the HEIDENHAIN uniformly digital control solution, all components are connected over purely digital interfaces: the control components over **HSCI** (HEIDENHAIN Serial Controller Interface), the new HEIDENHAIN real-time protocol for Fast Ethernet and the encoders over **EnDat 2.2**, the bidirectional interface from HEIDENHAIN. This achieves a high degree of availability for the entire system. It can be diagnosed and is immune to noise—from the main computer to the encoder. The outstanding characteristics of the uniformly digital solution from HEIDENHAIN guarantee very high accuracy and surface definition together with high traversing speeds. Please refer to the *Uniformly Digital* Technical Information sheet for more detailed information.

HSCI

HSCI, the HEIDENHAIN Serial Controller Interface, connects the main computer, controller(s) and other control components. The connection between two HSCI components is also referred to as an HSCI segment. HSCI is based on 100BaseT Ethernet hardware. A special interface component developed by HEIDENHAIN makes short cycle times for data transfer possible.

Main advantages of the control design with HSCI:
- Hardware platform for a flexible and scalable control system (e.g. decentralized axis systems)
- High noise immunity due to digital communication between components
- Hardware basis for implementing "functional safety"
- Simple wiring (commissioning, configuration)
- Inverters connected via proven PWM interface
- Large cable lengths in the entire system (HSCI segment up to max. 70 m)
- High number of possible control loops
- High number of PLC inputs/outputs
- Controller units can be installed elsewhere

CC or UEC controller units, up to nine PL 6000 input/output modules, and an MB machine operating panel (e.g. MB 721 from HEIDENHAIN) can be connected to the serial HSCI bus of the MC main computer. The HR handwheel is connected directly to the machine operating panel. The combination of visual display unit and main computer is especially advantageous if the computer is housed in the operating panel. All that is required then is the power supply and an HSCI line to the controller in the electrical cabinet.

Maximum cable length for HSCI:
- For one HSCI segment: 70 m
- For up to 12 HSCI slaves: 290 m (total of HSCI segments)
- For up to 13 HSCI slaves (maximum configuration): 180 m (total of HSCI segments)

The maximum permissible number of individual HSCI participants is listed below.

HSCI components		**Maximum number**	
MC/IPC	HSCI master	1 in the system	
CC, UEC, UMC	HSCI slave	4 controller motherboards (distributed to CC, UEC, UMC as desired)	
MB, PLB 600x	HSCI slave	2 in the system	
PLB 61xx, PLB 62xx	HSCI slave	7 in the system	
HR	On MB and/or PLB 600x	5 in the system	
PLD-H-xx-xx-xx FS	In PLB 6xxx FS	10 in the system	Total maximum of 1000 inputs/outputs
PLD-H-xx-xx-xx, PLA-H-xx-xx-xx	In PLB 6xxx	25 in the system	

Functional safety

Basic principle

Controls with functional safety from HEIDENHAIN fulfill the safety integrated level 2 (SIL 2) as per EN 61 508 and the performance level "d" category 3 as per EN ISO 13 849-1 (successor to EN 954-1). These standards describe the assessment of safety-oriented systems, for example based on the failure probabilities of integrated components and subsystems. The modular approach helps manufacturers of safety-related systems to implement their systems, because they can begin with prequalified subsystems. Safety-related position encoders, the TNC 640 control and functional safety accommodate this concept. The basis for the controls with functional safety are two redundant, mutually independent safety channels. All safety-relevant signals are captured, processed and output via two channels. Errors are detected by mutual comparison of the states and data in the two channels. The occurrence of a single error in the control therefore does not result in a loss of the safety function.

Structure

The safety-related controls from HEIDENHAIN have a dual-channel design with mutual monitoring. The software processes SPLC (safety-related PLC program) and SKERN (safety kernel software) are the basis of the two redundant systems. The two software processes run on the MC main computer (CPU) and CC controller unit components. The dual-channel structure through MC and CC is continued in the PLB 6xxx FS and MB 720 FS input/output systems. This means that all safety-relevant signals (e. g. permissive buttons and keys, door contacts, emergency stop button) are captured via two channels, and are evaluated independently of each other by the MC and CC. The MC and CC use separate channels to also address the power modules, and to stop the drives in case of an error.

Components

In systems with functional safety, certain hardware components assume safety-relevant tasks. Systems with FS must consist of only those safety-relevant components, including their variants, which HEIDENHAIN has approved for use!

Control components with functional safety are recognizable by the suffix FS after the model designation, e.g. MB 720 FS.

MB and TE

An MB machine operating panel with FS is indispensable for systems with functional safety. Only on such a machine operating panel do all keys have a dual-channel design. Axes can be moved without additional permissive keys.

PLB

In systems with functional safety, a combination of hardware (FS and standard) is possible, but a PLB 62xx FS is essential.

HR

FS handwheels are required in systems with functional safety because only they have the required cross-circuit-proof permissive buttons.

For a current list of components approved for FS, see the *Functional Safety FS* Technical Manual.

Safety functions

The following safety functions are integrated in the hardware and software:

- Safe stop reactions (SS0, SS1, and SS2)
- Safe torque off (STO)
- Safe operating stop (SOS)
- Safely limited speed (SLS)
- Safely limited position (SLP)
- Safe brake control (SBC)
- Safe operating modes
  - Operating mode 1: Automated or production mode
  - Operating mode 2: Set-up mode
  - Operating mode 3: Manual intervention
  - Operating mode 4: Advanced manual intervention, process monitoring

Please note:
The complete feature content is not yet available for all machine types with functional safety. Before planning a machine with functional safety, please inform yourself of whether the current scope of features suffices for your machine design.

Activation of functional safety

If the control identifies a PLB 62xx FS in the system during booting, functional safety is activated.

In this case, it is essential that the following prerequisites be fulfilled:

- Functional safety versions of safety-related control components (e.g. TE 745 FS, HR 550 FS)
- Safety-related SPLC program
- Configuration of safe machine parameters
- Wiring of the machine for systems with functional safety

Functional safety cannot be activated or deactivated by parameter.

For more information

For more information on the topic of functional safety, refer to the Technical Information documents *Safety-Related Control Technology for Machine Tools* and *Safety-Related Position Encoders*.

For details, see the *Functional Safety FS* Technical Manual. Your contact person at HEIDENHAIN will be glad to answer any questions concerning controls with functional safety.

Operating system

HEROS 5

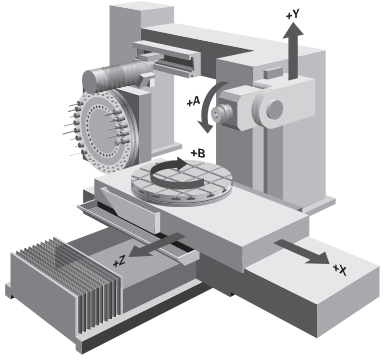
The TNC 640 and the PNC 610 operates with the Real-time Operating System (HEROS 5) from HEIDENHAIN. This future-focused operating system features powerful functions:

- **PDF files**, drawings, work instructions, etc. can be opened directly on the control.
- Direct Internet access from the TNC 640 thanks to the **integrated browser**. The browser can be run in a **Sandbox** to increase data security.
- Plays **audio and video files** (ogg)
- You can open various **file formats** directly on the TNC 640 and also edit some of them with the appropriate editors:
  - Text files (txt, ini)
  - Graphic files (gif, bmp, jpg, png)
  - Tables (xls, csv)
  - Internet (html)
- Standardized **display format** for operating system dialogs
- Setting up a firewall for additional **data security**
- Managing printers
- Backup function for backing up and restoring control data

Axes

Linear axes

The TNC 640 can control linear axes with any axis designation (X, Y, Z, U, V, W ...).



Display and programming

–99 999.9999 to +99 999.9999 [mm]
–99 999.99999 to +99 999.99999 [mm] with option 23

Feed rate in mm/min relative to the workpiece contour, or mm per spindle revolution

Feed rate override: 0 % to 150 %

Traverse range

–99 999.9999 to +99 999.9999 [mm]
–99 999.99999 to +99 999.99999 [mm] with option 23

The machine tool builder defines the traverse range. The user can set additional limits to the traverse range if he wishes to reduce the working space. Three different traverse ranges can be defined (selection by PLC).

Rotary axes

The TNC 640 can control rotary axes with any axis designation (A, B, C, U ...). Special parameters and PLC functions are available for rotary axes with Hirth coupling.

Display and programming

0° to 360° or
–99 999.9999 to +99 999.9999 [°]
–99 999.99999 to +99 999.99999 [°] with option 23

Feed rate in degrees per minute [°/min]

Traverse range

–99 999.9999 to +99 999.9999 [°]
–99 999.99999 to +99 999.99999 [°] with option 23

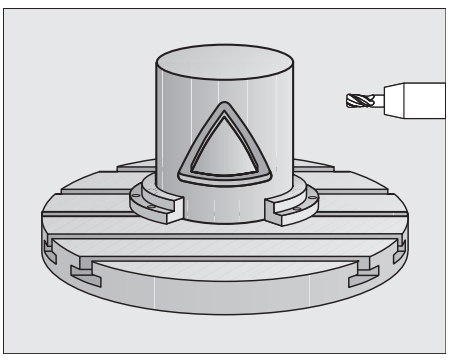
The machine tool builder defines the traverse range. The user can set additional limits to the traverse range if he wishes to reduce the working space. Various traverse ranges can be defined per axis using parameter sets (selection by PLC).

Free rotation

For milling-turning operations, the rotary axis can be started via the PLC with a defined feed rate. For functions specific to milling/turning machines, see *Turning operations*.

Cylinder surface interpolation (option 8)

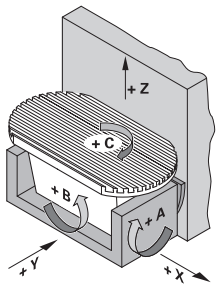
A contour defined in the working plane is machined on a cylindrical surface.



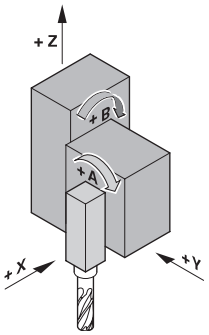
Tilting the working plane (option 8)

The TNC 640 has special coordinate transformation cycles for controlling swivel heads and tilting tables. The offset of the tilting axes and the tool lengths are compensated by the TNC.

The TNC can manage more than one machine configuration (e. g. different swivel heads).



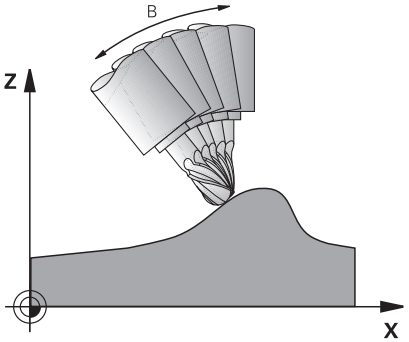
Tilting table



Swivel head

5-axis machining (option 9)

Tool Center Point Management (TCPM)
The offset of the tilting axes is compensated so that the tool tip remains on the contour. Handwheel commands can also be superimposed during machining without moving the tool tip from the programmed contour.

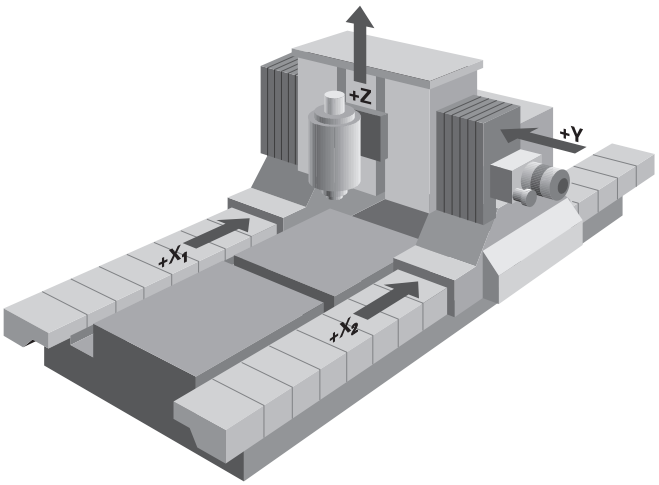


Synchronized axes (option 24)

Synchronized axes move in synchronism and are programmed with the same axis designation.

With HEIDENHAIN controls, parallel axis systems (gantry axes) such as on portal-type machines or tilting tables can be moved synchronously to each other through high-accuracy and dynamic position control.

With **gantry axes** more than one slave axis can be assigned to one master gantry axis. They may also be distributed to several controller units.

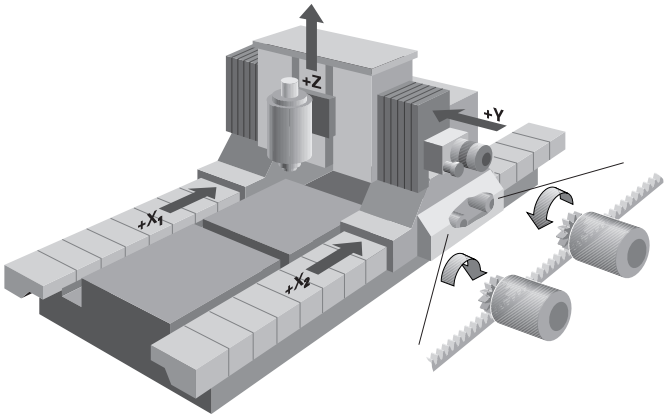


Torque control

Torque control is used on machines with mechanically coupled motors for which

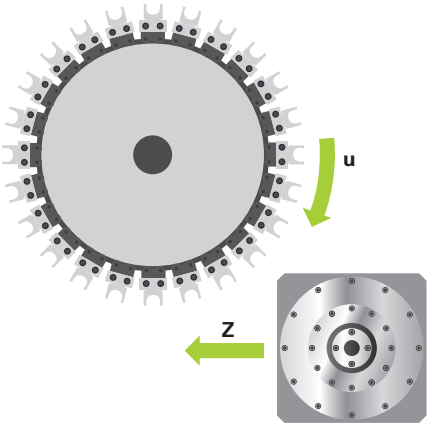
- a defined distribution of drive torque is desired,
  or
- parts of the controlled system show a backlash effect that can be eliminated by "tensioning" the servo drives. (e.g. toothed racks).

For torque control, the master and slave must be on the same motherboard. Depending on the controller unit being used, up to five slave axes can be configured for each master in this manner.



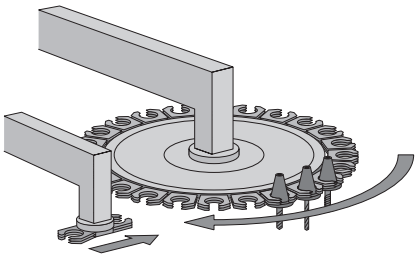
Real-time coupling function (option 135)

The real-time coupling function (synchronizing functions) allows the cyclic calculation of a position offset for an axis from the actual and nominal values of any other axes in the system. This enables you to realize complex simultaneous movements of several NC or PLC axes. The mutual dependence of the axes is defined in mathematical formulas.



PLC axes

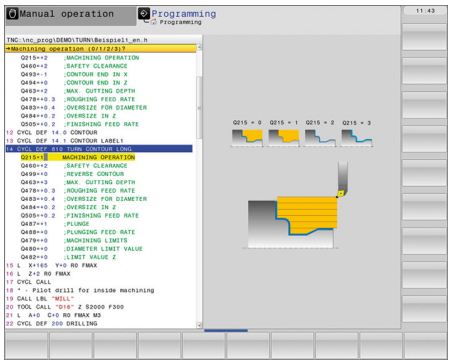
Axes can be controlled by the PLC. They are programmed through M functions or OEM cycles. The PLC axes are positioned independently of the NC axes and are therefore designated as asynchronous axes.



Turning

Performing turning operations (option 50)

The TNC 640 supports machines that can perform a combination of milling and turning operations in a single setup. It offers the operator a comprehensive package of cycles for both types of operations, which are programmed in HEIDENHAIN's workshop-oriented conversational format. Rotationally symmetric contours are produced during turning operations. The preset must be in the center of the lathe spindle for this.

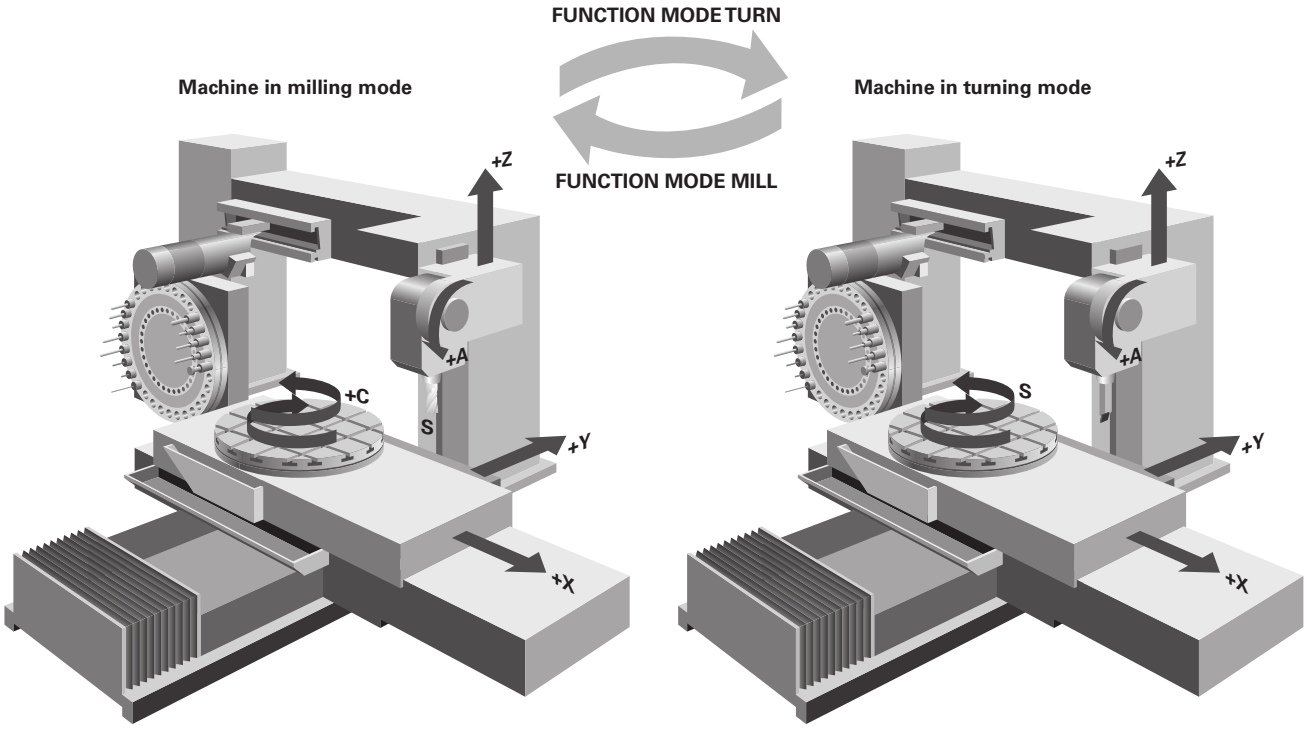


In turning mode, the rotary table serves as the lathe spindle, while the milling spindle with the tool remains stationary. Machines for milling and turning must fulfill special demands. A basic prerequisite is a machine designed with high rigidity, in order to ensure a low oscillation tendency even when the machine table (acting as lathe spindle) is turning at high speeds.

Toggling between milling and turning modes

When switching between turning and milling modes, the TNC switches the diameter programming on or off, respectively, selects the XZ plane as working plane for turning, and shows whether it is in milling or turning mode in the status display.

The machine operator uses the NC commands FUNCTION MODE TURN and FUNCTION MODE MILL to toggle between milling and turning modes. The machine-specific procedures necessary here are realized via OEM macros. In these macros the machine tool builder specifies, for example, which kinematics model is active for the milling or turning mode, and which axis and spindle parameters are in effect. Since the FUNCTION MODE TURN and FUNCTION MODE MILL commands are independent of the type of machine, NC programs can be exchanged between different types of machines.



Measuring the unbalance – Balancing

An important and basic prerequisite for turning operations is that the radial runout of the workpiece has been balanced. Both the machine (rotary table) and the workpiece must be balanced before machining. If the clamped workpiece has an unbalance, undesirable centrifugal forces can result, influencing the accuracy of the runout.

An unbalance of the rotary table can endanger the machine operator, as well as lower the quality of the workpiece and reduce the machine's lifetime.

The TNC 640 can determine an unbalance of the rotary table by measuring the effects of the centrifugal forces on neighboring linear axes. A rotary table positioned via a linear axis would be ideal for this. For other machine designs, measurement of the unbalance via external sensors is appropriate.

The TNC 640 features the following functions:

- **Calibration of the unbalance**
  A calibration cycle ascertains the unbalance behavior of the rotary table. This unbalance calibration is generally performed by the machine tool builder before he ships the machine. During execution of the calibration cycle, the TNC generates a table describing the unbalance behavior of the rotary table.
- **Balancing**
  After the workpiece blank to be turned has been clamped, the machine operator can use a measuring cycle to determine the current unbalance. During balancing, the TNC assists the machine operator by indicating the mass and position of the balancing weights.
- **Unbalance monitoring**
  The TNC constantly monitors the momentary unbalance during machining. An NC stop is triggered if a specified limit value is exceeded.

Spindle

Overview

The TNC 640 contouring control is used in connection with the HEIDENHAIN inverter systems with field-oriented control. As an alternative, an analog nominal speed value can be output.

Controller unit

With the CC controller units and the UEC/UMC inverters, a fundamental PWM frequency can be set for each controller assembly, e.g. 4 kHz. Possible fundamental frequencies are 3.33 kHz, 4 kHz or 5 kHz. The **double speed** option (option 49) can double this frequency for high-speed spindles (e.g. 8 kHz for HF spindles). See the *Technical Manual.*

Controller groups

For example with CC 6106
1: X51 + X52
2: X53 + X54
3: X55 + X56

Maximum spindle speed

The maximum spindle speed is calculated as follows:

$$n_{max} = \frac{f_{PWM} \cdot 60000\ rpm}{NPP \cdot 5000\ Hz}$$

f_{PWM} = PWM frequency in Hz
NPP = Number of pole pairs

Operating mode switchover

For controlling the spindle, different parameter sets can be saved for closed-loop control (e.g. for wye or delta connections). You can switch between the parameter sets in the PLC.

Position-controlled spindle

The position of the spindle is monitored by the control.

Encoder

HEIDENHAIN rotary encoder with sinusoidal voltage signals (1 V_{PP}) or EnDat interface.

Tapping

There are special cycles for tapping with or without floating tap holder. For tapping without floating tap holder, the spindle must be operated under position control.

Oriented spindle stop

With a position-controlled spindle, the spindle can be positioned exactly to 0.1°.

Spindle override

0 to 150 %

Gear ranges

A separate nominal speed is defined for each gear range. The gear code is output via the PLC.

Multiple main spindles

Up to 4 spindles can be controlled alternately. The spindles are switched by the PLC. One control loop is required for each active spindle.

Spindle synchronism- (option 131)

The spindle synchronization option synchronizes the shaft speeds of two or more spindles. Spindle synchronization is also possible with an transmission ratio or a defined offset.

Encoders

Overview

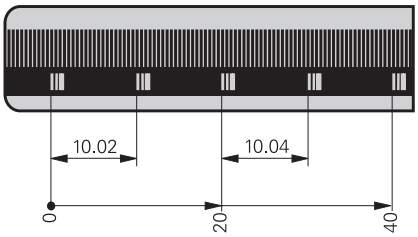
For speed and position control of the axes and spindle, HEIDENHAIN offers both incremental and absolute encoders.

Incremental encoders

Incremental encoders have as measuring standard a grating consisting of alternate lines and spaces. Relative movement between the scanning head and the scale causes output of sinusoidal scanning signals. The measured value is calculated by counting the signals.

Reference mark

When the machine is switched on, the machine axes need to traverse a reference mark for an accurate reference to be established between measured value and machine position. For encoders with distance-coded reference marks, the maximum travel until automatic reference mark evaluation for linear encoders is only 20 mm or 80 mm, depending on the model, or 10° or 20° for angle encoders.



Evaluation of reference marks

The routine for traversing the reference marks can also be started for specific axes via the PLC during operation (reactivation of parked axes).

Output signals

Incremental encoders with sinusoidal output signals with ~ 1 V_{PP} levels are suitable for connection to HEIDENHAIN numerical controls.

Absolute encoders

With absolute encoders, the position information is contained in several coded tracks. Thus, an absolute reference is available immediately after switch-on. Reference-mark traverse is not necessary. Additional incremental signals are output for highly dynamic control loops.

EnDat interface

The TNC 640 features the serial EnDat 2.2 interface (includes EnDat 2.1) for the connection of absolute encoders.

Note: The EnDat interface on HEIDENHAIN encoders differs in its pin assignment from the interface on Siemens motors with integrated absolute ECN/EQN rotary encoders. Special adapter cables are available.

Encoder inputs

Incremental and absolute linear, angle or rotary encoders from HEIDENHAIN can be connected to all **position encoder** inputs of the controller unit.

Incremental and absolute rotary encoders from HEIDENHAIN can be connected to all **speed encoder** inputs of the controller unit.

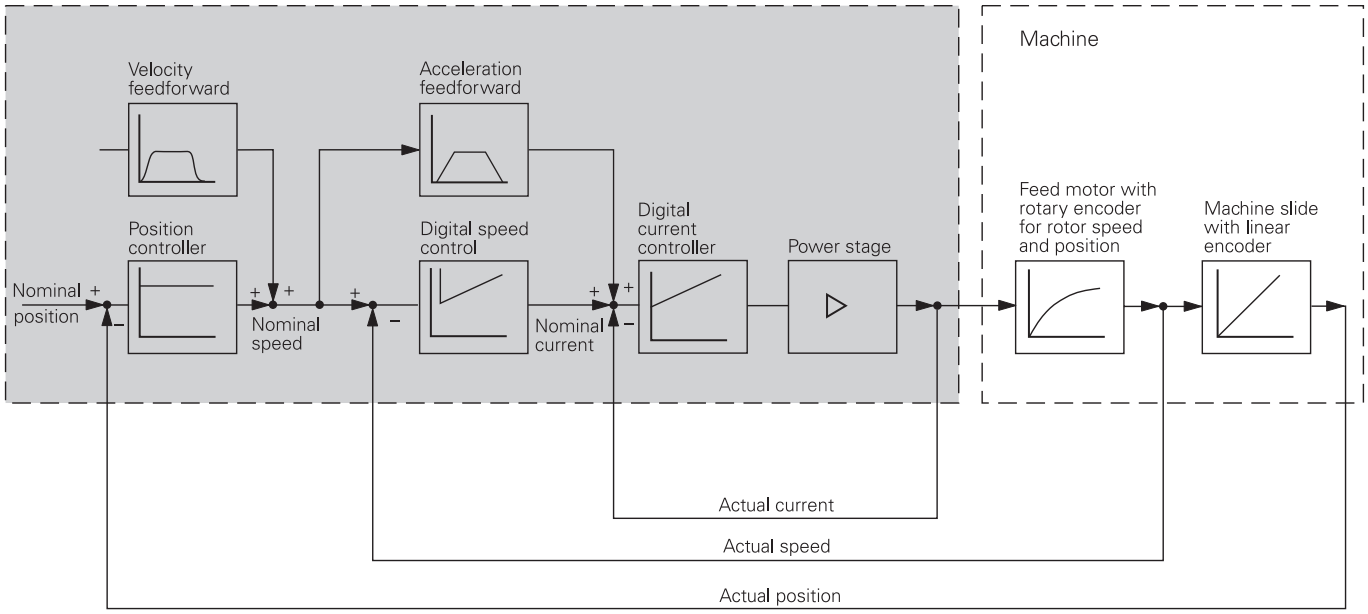
Channel inputs	**Signal level/ Interface**[1]	**Input frequency**[1]	
		Position	**Speed**
Incremental signals	~1 V_{PP}	33 kHz/350 kHz	350 kHz
Absolute position values Incremental signals	EnDat 2.2[2]/02 ~1 V_{PP}	– 33 kHz/350 kHz	– 350 kHz
Absolute position values	EnDat 2.2[2]/22	–	–

[1] Switchable
[2] Includes EnDat 2.1

Digital servo control

Integrated inverter

Position controllers, speed controllers, current controllers and inverters are integrated in the TNC 640. HEIDENHAIN synchronous or asynchronous motors are connected to the TNC 640.



Axis feedback control

The TNC 640 can be operated with following error or feedforward control. During roughing operations at high speeds, for example, you can switch to velocity semi-feedforward control via an OEM cycle in order to machine faster at reduced accuracy.

Operation with following error

The term "following error" denotes the distance between the momentary nominal position and the actual position of the axis. The velocity is calculated as follows:

$v = k_v \cdot s_a$

v = Velocity
k_v = Position loop gain
s_a = Following error

Operation with feedforward control

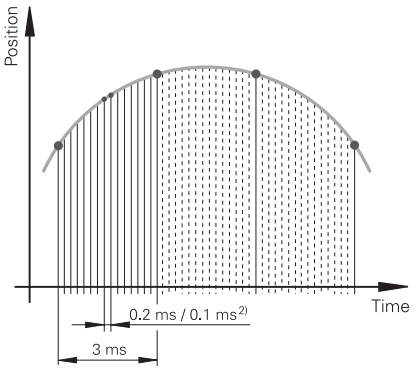
Feedforward means that the speed and the acceleration are adjusted to fit the machine. Together with the values calculated from the following error, it forms the nominal value. This greatly reduces the following error (to within a few µm).

Compensation of torque ripples

The torque of synchronous, torque and linear motors is subject to periodic oscillations, one cause of which can be permanent magnets. The amplitude of this torque ripple depends on the motor design, and under certain circumstances can have an effect on the workpiece surface. After the axes have been commissioned with the TNCopt software, the Torque Ripple Compensation (TRC) of the CC 61xx or UEC 11x can be used to compensate it.

Control loop cycle times

The cycle time for **path interpolation** is defined as the time interval during which interpolation points on the path are calculated. The cycle time for **fine interpolation** is defined as the time interval during which interpolation points are calculated that lie within the interpolation points calculated for path interpolation. The cycle time for the **position controller** is defined as the time interval during which the actual position value is compared to the calculated nominal position value. The **speed controller cycle time** is the time interval in which the actual speed value is compared to the calculated nominal speed value. The **cycle time for the current controller** is defined as the time interval during which the actual current value is compared to the calculated nominal current value.



	CC/UEC/UMC
Path interpolation	3 ms
Fine interpolation	0.2 ms/0.1 ms[1)] at f_{PWM} = 5000 Hz
Position controller	0.2 ms/0.1 ms at f_{PWM} = 5000 Hz
Speed controller	0.2 ms/0.1 ms[1)] at f_{PWM} = 5000 Hz
Current controller	0.1 ms at f_{PWM} = 5000 Hz

[1)] Double speed (with option 49)

Axis clamping

The control loop can be opened through the PLC in order to clamp specific axes.

Double-speed control loops (option 49)

Double-speed control loops permit higher PWM frequencies as well as shorter cycle times of the speed controller. This makes improved current control for spindles possible, and also higher control performance for linear and torque motors.

Crossover Position Filter (CPF)

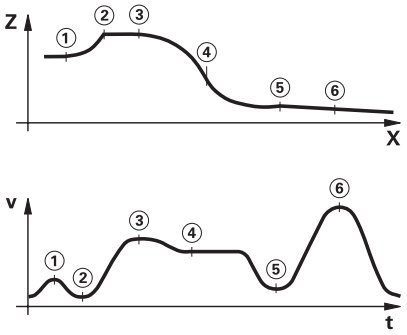
To increase the stability of the position control loop in systems with resonances, the position signal from the position encoder, which is filtered through a low-pass filter, is combined with the position signal from the motor speed encoder, which is filtered through a high-pass filter. This signal combination is made available to the position controller as actual position value. The possible position controller gain (k_V factor) is increased significantly by this. The filter separation frequency is set specifically for each axis via machine parameters. The CPF can be used only in dual-encoder systems, i.e. on drive motors with speed encoder and position encoder.

Fast contour milling

Short block processing time

The TNC 640 provides the following important features for fast contour machining:

The block processing time of the MC 6xxx is 0.5 ms. This means that the TNC 640 is able to run long programs from the hard disk, even with contours approximated with linear segments as small as 0.2 mm, at a feed rate of up to 24 m/min.



Look-ahead

The TNC 640 calculates the geometry ahead of time in order to adjust the feed rate (max. 5000 blocks). In this way directional changes are detected in time to accelerate or decelerate the appropriate NC axes.

Jerk

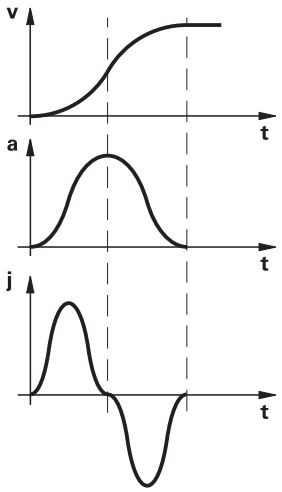
The derivative of acceleration is referred to as jerk. A linear change in acceleration causes a jerk step. Such motion sequences may cause the machine to oscillate.

Jerk limiting

To prevent machine oscillations, the jerk is limited to attain optimum path control.

Smoothed jerk

The jerk is smoothed by nominal position value filters. The TNC 640 therefore mills smooth surfaces at the highest possible feed rate and yet keeps the contour accurate. The operator programs the permissible tolerance in a cycle. Special filters for HSC machining (HSC filters) can specifically suppress the natural frequencies of an individual machine. The desired accuracy and a very high surface quality are attained.



Advanced Dynamic Prediction (ADP)

The Advanced Dynamic Prediction feature (ADP) expands the conventional look-ahead of the permissible maximum feed rate profile and makes optimized motion control possible to produce clean surfaces and perfect contours. ADP shows its strengths for example during bidirectional finish milling through symmetrical feed behavior on the forward and reverse paths as well as through particularly smooth feed rate curves on parallel milling paths. NC programs that are generated on CAM systems negatively influence the machining process through various factors such as short step-like contours, coarse chord tolerances and heavily rounded end-point coordinates. Through an improved reaction to such influence quantities and the exact fulfillment of dynamic machine parameters, ADP not only improves the surface quality of the workpiece, it also optimizes the machining time.

Dynamic Efficiency

Overview

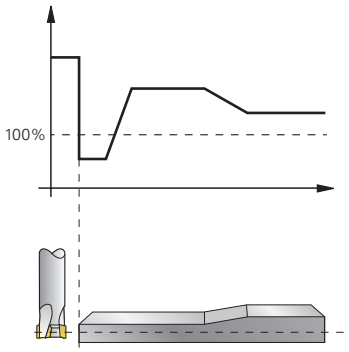
With the concept of Dynamic Efficiency, HEIDENHAIN offers innovative TNC functions that help the user to make heavy machining and roughing more efficient while also enhancing its process reliability. Dynamic Efficiency permits higher removal rates and therefore increases productivity. At the same time, it prevents any tool overloading and the concomitant premature cutter wear.

Dynamic Efficiency comprises three software functions:
- **Active Chatter Control** (ACC): This option reduces chatter tendencies and permits greater feed rates and infeeds
- **Adaptive Feed Control** (AFC): The AFC option controls the feed rate depending on the machining situation
- **Trochoidal milling**: A function for the roughing of slots and pockets that eases the load on the tool

Each solution in itself offers decisive advantages in the machining process. But the combination of these TNC features, in particular, exploits the potential of the machine and tool and at the same time reduces the mechanical load.

Adaptive Feed Control (AFC) (option 45)

With Adaptive Feed Control (AFC), the contouring feed rate is controlled depending on the respective spindle power in percent.

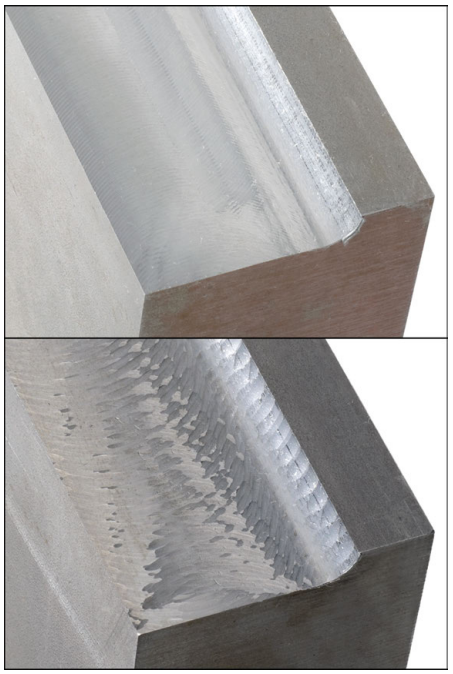


Benefits of adaptive feed control:
- Optimization and reduction of machining time
- Prevention of subsequent damage through tool monitoring
- Automatic insertion of a replacement tool when the tool is worn (machine-dependent function)
- Protection of the machine mechanics
- Documentation by capturing and saving the learning and process data
- Integrated NC function, and therefore an alternative to external software solutions

Restrictions:
AFC cannot be used for analog spindles or in volts-per-hertz control mode.

Active Chatter Control (ACC) (option 145)

Strong milling forces come into play during heavy machining—roughing at high cutting speed. Depending on the tool spindle speed, the resonances in the machine tool and the chip volume (metal-removal rate during milling), the tool can sometimes begin to "chatter." This chattering places heavy strain on the machine, and causes ugly marks on the workpiece surface. The tool, too, is subject to heavy and irregular wear from chattering. In extreme cases it can result in tool breakage. To reduce the inclination to chattering, HEIDENHAIN now offers an effective antidote with its Active Chatter Control (ACC) option. The use of this option is particularly advantageous during heavy cutting. ACC makes substantially higher metal removal rates possible—depending on the machine model the metal removal rate increases by 25 % and more. You reduce the mechanical load on the machine and increase the life of your tools at the same time.



Top figure: Part milled with ACC
Bottom figure: Part milled without ACC

Dynamic Precision

Overview

The hypernym Dynamic Precision stands for a number of HEIDENHAIN solutions for milling that dramatically improve the dynamic accuracy of a machine tool. The dynamic accuracy of machine tools can be seen in position errors at the tool center point (TCP), which depend on motion quantities such as velocity and acceleration (also jerk), and are caused, in part, by vibrations of machine components. All the deviations are together responsible for dimensional errors and faults in the workpiece surface. They therefore have a decisive influence on quality and, when poor-quality parts are scrapped, also on productivity.

Because the stiffness of machine tools is limited for reasons of design and economy, problems such as compliance and vibration within the machine design are very difficult to avoid. Dynamic Precision counteracts these problems with intelligent control technology to enable designers to further improve the quality and dynamic performance of machine tools. That saves time and money in production.

The machine tool builder can use the options comprised by Dynamic Precision either individually or in combination:

- **CTC** – Compensates acceleration-dependent position errors at the tool center point, thereby increasing accuracy during acceleration phases
- **AVD** – Active vibration damping improves surfaces
- **PAC** – Position-dependent adaptation of control parameters
- **LAC** – Load-dependent adaptation of control parameters enhances accuracy regardless of load and aging
- **MAC** – Motion-dependent adaptation of control parameters

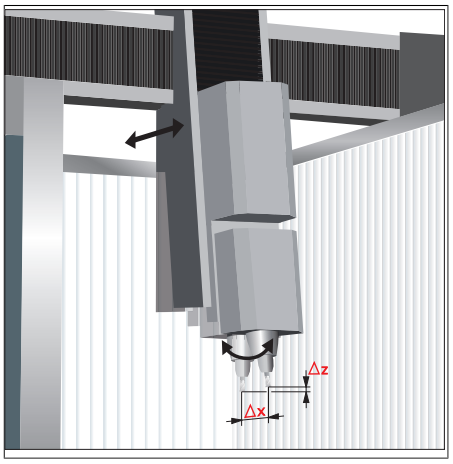
Cross Talk Compensation (CTC) (option 141)

CTC (option 141) makes it possible to compensate dynamic position errors that are caused by acceleration forces.

To increase productivity, machine tool users are asking for ever higher feed rates and acceleration values, while at the same time they need to maintain the highest possible surface quality and accuracy, placing very special requirements on path control.

Highly dynamic acceleration processes introduce forces to the structure of a machine tool. They can deform parts of the machine and thereby lead to deviations at the tool center point (TCP). Besides deformation in axis direction, the dynamic acceleration of an axis due to mechanical axis coupling can also result in deformation of axes that are perpendicular to the direction of acceleration. The resulting position error at the TCP in the direction of the accelerated axis and lateral axes is proportional to the amount of acceleration.

If the dynamic position error as a function of the axis acceleration is known, this acceleration-dependent error can be compensated with the CTC option (Cross Talk Compensation) in order to prevent negative effects on the surface quality and accuracy of the workpiece. Often, the resulting error at the TCP depends not only on the acceleration but also on the position of the axes in the working space. This can also be compensated by CTC.



Active Vibration Damping (AVD)(option 146)

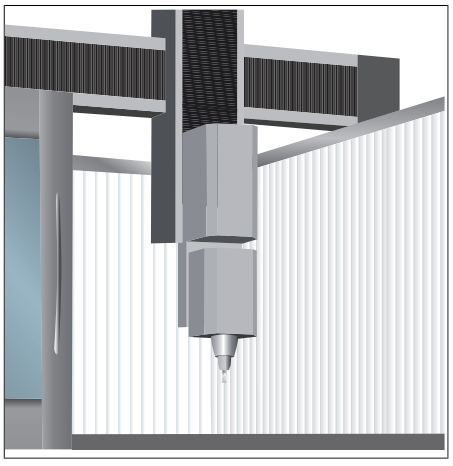
The high dynamics of modern machine tools lead to deformations in the machine base, frame and drive train during acceleration and deceleration of the feed drives. This results in vibrations, such as machine setup vibrations, that may reduce the attainable accuracy and surface quality of the workpieces. The Active Vibration Damping (AVD) controller function dampens the especially critical low-frequency oscillations and optimizes the control behavior of the affected axis at the same time so that high-accuracy workpieces with increased surface quality can also be produced at high feed rates. The improved rigidity attained can be used to increase the dynamic limit values (e. g. jerk), and therefore makes reduced machining times possible.

Position Adaptive Control (PAC) (option 142)

Option 142, PAC, permits a dynamic and position-dependent adaptation of controller parameters depending on the position of the tool in space.

The specifics of a machine's kinematics cause a unique position of the axes' center of gravity in the working space. This results in a variable dynamic behavior of the machine, which can negatively influence the control's stability depending on the axis positions.

To exploit the machine's dynamic possibilities, you can use the PAC option (Position Adaptive Control) to change machine parameters depending on position. This makes it possible to assign respectively optimal loop gain to defined interpolation points. Additional position-dependent filter parameters can be defined in order to further increase control loop stability.



Load Adaptive Control (LAC) (option 143)

LAC (option 143) enables you to adapt controller parameters dynamically depending on the load or friction.

The dynamic behavior of machines with rotary tables can vary depending on the mass moment of inertia of the fixed workpiece. The LAC (Load Adaptive Control) option enables the control to automatically ascertain the current workpiece mass moment of inertia as well as current frictional forces.

In order to optimize changed control behavior at differing loads, adaptive feedforward controls can exploit data on acceleration, holding torque, static friction and friction at high shaft speeds.

Motion Adaptive Control (MAC) (option 144)

In addition to the position-dependent adjustment of machine parameters by the PAC option, the MAC option (Motion Adaptive Control) also provides a way to change machine parameter values depending on other input quantities such as velocity, following error or acceleration of a drive. Through this motion-dependent adaptation of the control parameters it is possible, for example, to realize a velocity-dependent adaptation of the k_V factor on motors whose stability changes through the various traversing velocities.

Monitoring functions

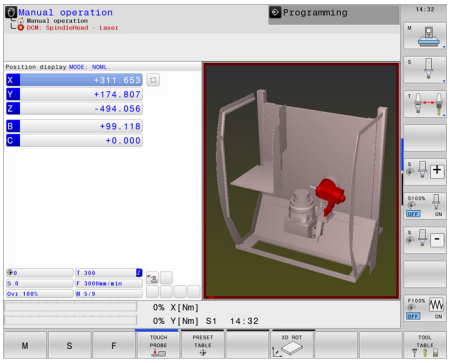
Description

During operation the control monitors the following:
- Amplitude of the encoder signals
- Edge separation of the encoder signals
- Absolute position from encoders with distance-coded reference marks
- Current position (following error monitoring)
- Actual path traversed (movement monitoring)
- Position deviation at standstill
- Nominal speed value
- Checksum of safety-related functions
- Supply voltage
- Buffer battery voltage
- Operating temperature of the MC and CPU
- Run time of the PLC program
- Motor current and temperature
- Temperature of the power module
- DC-link voltage

With EnDat 2.2 encoders:
- The CRC checksum of the position value
- EnDat alarm Error1→ EnDat status alarm register (0xEE)
- EnDat alarm Error2
- Edge speed of 5 µs
- Transmission of the absolute position value on the time grid

In the event of hazardous errors, an EMERGENCY STOP message is sent to the external electronics via the control-is-ready output, and the axes are brought to a stop. The correct connection of the TNC 640 in the machine's EMERGENCY STOP loop is checked when the control system is switched on. In the event of an error, the control displays a message in plain language.

Dynamic Collision Monitoring (DCM) (option 40)



The TNC features a Dynamic Collision Monitoring (DCM) software option for cyclically monitoring the working space of the machine for possible collisions with machine components. The machine manufacturer must define three-dimensional collision objects within the working space of the machine that are to be monitored by the TNC during all machine motions, including those made by swivel heads and tilting tables. If two objects monitored for collision come within a defined distance of each other, the TNC outputs an error message. At the same time, the machine components concerned are shown in red color in the machine display. Dynamic collision monitoring is active in both the manual operating modes as well as the machine operating modes, and is indicated by a symbol in the operating mode display.

Please note:
- Only the machine manufacturer can define collision objects (including clamping fixtures).
- Collisions between machine components (such as swivel heads) and the workpiece cannot be detected.
- Collision objects are not transformed automatically into rotationally symmetric objects in turning mode.
- In operation with following error (no feedforward), DCM is inactive.
- Checking for collision is not possible in the Test Run mode.

Collision monitoring also protects fixtures and tool carriers from collisions.

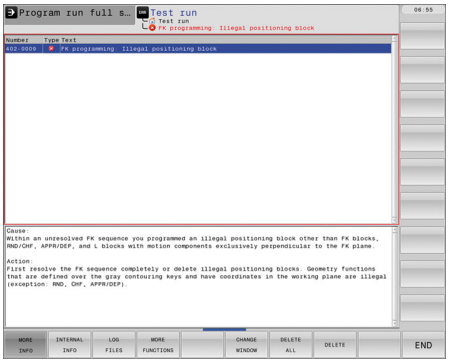
The 3-D collision objects are configured with the commissioning software KinematicsDesign.

With the TNC 640, collision bodies can also be transferred in M3D format from standard CAD models (e.g. STL) to the control.

Advantages of the M3D format:
- Simple data transfer from already available CAD models
- Fully detailed illustration of machine components
- Greater exploitation of the working space

Context-sensitive help

The HELP and ERR keys provide the user with context-sensitive help. This means that in the event of an error message, the control displays information on the cause of the error and proposes solutions. The machine tool builder can also use this function for PLC error messages.



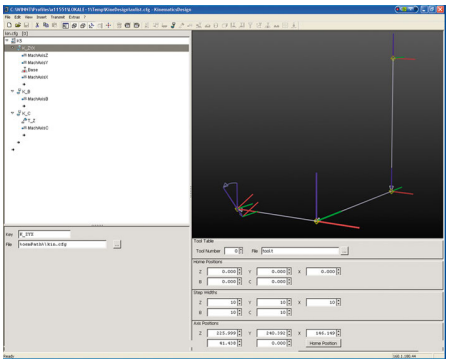
KinematicsDesign (accessory)

KinematicsDesign is a PC program for creating adaptable kinematic configurations. It supports:
- Complete kinematic configurations
- Transfer of configuration files between control and PC
- Description of tool-carrier kinematics

Kinematics descriptions developed for the iTNC 530 can also be converted to kinematics descriptions for the TNC 640/620/320/128.

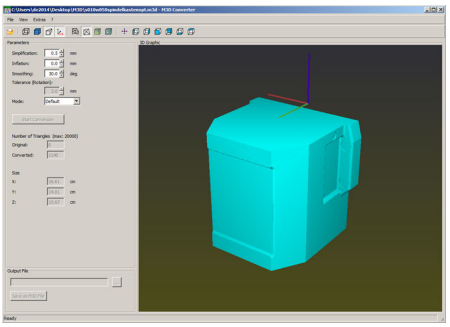
If KinematicsDesign is connected to a control online (operation is also possible with the programming station software), then machine movements can be simulated and the axes are moved. Together with the TNC 640, KinematicsDesign simulates the working space when DCM is active, and collisions that occur, or machine components in danger of collision, are displayed in a color that you define.

The comprehensive displaying possibilities range from a pure listing of the transformation chain to a wire model to the depiction of the entire work envelope on the TNC 640 and iTNC 530.



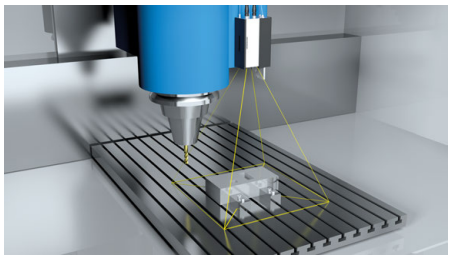
M3D Converter

With the TNC 640, you can transfer collision objects out of a CAD file and integrate them into the machine kinematics using the M3D format. The M3D data format from HEIDENHAIN permits an especially finely detailed depiction of high-resolution collision objects. The M3D converter that is capable of performing tasks such as checking, repairing, simplifying, merging and optimizing the CAD data of collision objects is used to generate the M3D data. As an independent PC tool, the M3D converter is part of the KinematicsDesign installation package (as of version 3.1). The M3D converter requires a software release module (ID 1124969-01.



VSC – Camera-based working-spacemonitoring (option 136)

With the Visual Setup Control option (VSC), the TNC can automatically monitor the current setup or machining situation during program run. With this option, reference photos are taken by the VS 101 camera system for the first parts of a series, which are then compared with the photos of the subsequent parts. User friendly cycles enable you to specify several places in the NC program at which the control conducts an optical comparison of the actual with the desired condition. If an error is detected, the TNC reacts as previously chosen by the user.



Error compensation

Overview

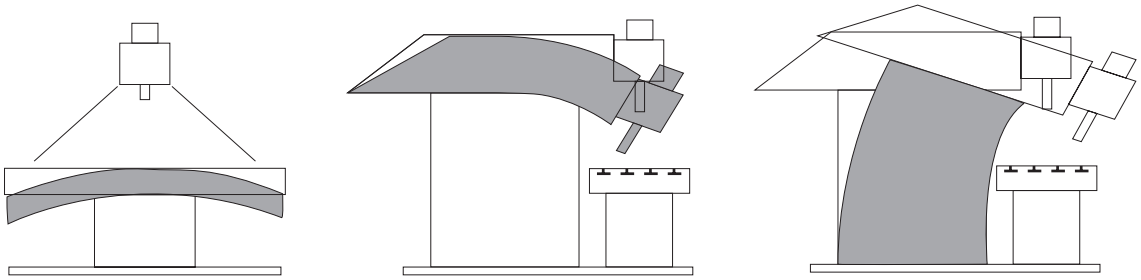
The TNC 640 automatically compensates mechanical errors of the machine.

Linear error

Linear error can be compensated over the entire travel range for each axis.

Nonlinear error

The TNC 640 can compensate for ball-screw pitch errors and sag errors simultaneously. The compensation values are stored in a table. Nonlinear axis-error compensation also makes it possible to compensate for position-dependent backlash.



Backlash

The play between table movement and rotary encoder movement on direction changes can be compensated in length measurements by spindle and rotary encoder. This backlash is outside the controlled system.

Hysteresis

The hysteresis between table movement and motor movement is also compensated in direct length measurements. In this case the hysteresis is within the controlled system.

Reversal spikes

In circular movements, reversal spikes can occur at quadrant transitions due to mechanical influences. The TNC 640 can compensate for these reversal spikes.

Static friction

At very low feed rates, high static friction can cause the slide to stop and start repeatedly for short periods. This is commonly known as stick-slip. The TNC 640 can compensate for this problem condition.

Sliding friction

Sliding friction is compensated by the speed controller of the TNC 640.

Thermal expansion

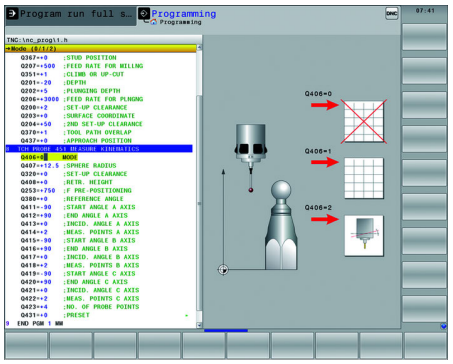
To compensate thermal expansion, the machine's expansion behavior must be known.

The temperature can be recorded via thermistors connected to the analog inputs of the TNC 640. The PLC evaluates the temperature information and transfers the compensation value to the NC.

KinematicsOpt (option 48)

Using the KinematicsOpt function, machine tool builders or end users can check the accuracy of rotary or swivel axes, and compensate for possible displacements of the center of rotation of these axes. The deviations are automatically transferred to the kinematics description and can be taken into account in the kinematics calculation.

In order to measure the rotary axes, you must attach a calibration sphere (e.g. KKH 100 or KKH 250 from HEIDENHAIN) at any position on the machine table. A HEIDENHAIN touch probe uses a special cycle to probe this calibration sphere, and measures the rotary axes of the machine fully automatically. But first you define the resolution of the measurement and define for each rotary axis the range that you want to measure. The results of measurement are the same regardless of whether the axis is a rotary table, a tilting table or a swivel head.



Calibration sphere (accessory)

HEIDENHAIN offers calibration spheres as accessories for the measurement of rotary axes with KinematicsOpt:

KKH 100	Height: 100 mm	ID 655475-02
KKH 250	Height: 250 mm	ID 655475-01

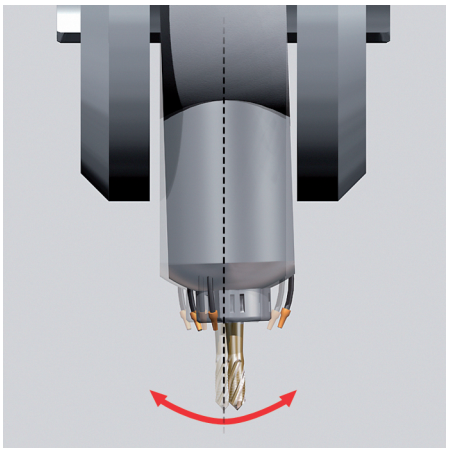
KinematicsComp (option 52)

Increasingly stringent requirements on workpiece tolerances constantly increase demands placed on a the precision of a machine tool. However, components of the machine tool inevitably show imperfections that are for example caused by manufacturing or installation or result from elastic deformation. This is the reason why the commanded tool position and orientation are not always reached exactly everywhere in the working space. The more axes a machine has, the more sources of errors there are. The use of mechanical means to cope with these problems requires considerable effort, particularly in the field of 5-axis machining, or if large machines with parallel axes are involved.

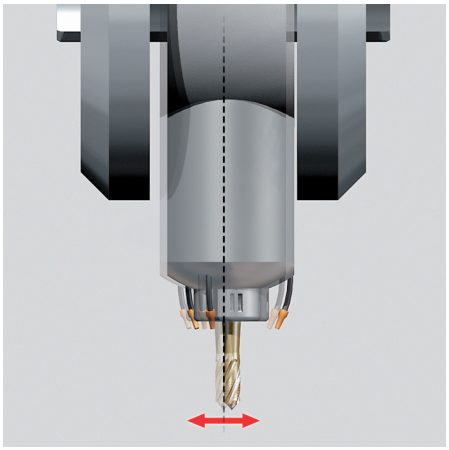
The new KinematicsComp software option enables the machine manufacturer to save a comprehensive description of the machine errors in the control. KinematicsComp then automatically compensates position error that results from static error of the physical machine axes (volumetric compensation). The positions of all rotary and linear axes as well as the current tool length are included in the calculation. As always, KinematicsComp can be used to define position-dependent temperature compensation. The required data is supplied by several sensors located at relevant points on the machine.

For example, the spatial errors of the tool tip can be measured with a laser tracer or laser interferometer. However, multidimensional tables for component errors make it possible to use measured data directly for compensation without building a model. PLC variables as initial values for formulas and multidimensional tables make it easy to enter parameters for powerful compensation, for example, for various thermal conditions or load situations.

The KinematicsComp option cannot be enabled for the export versions.



Fault characteristics according to ISO 230-1: EBA



Fault characteristics according to ISO 230-1: EXA

3D-ToolComp (option 92)

3D-ToolComp is a three-dimensional tool radius compensation depending on the tool's contact angle for compensating tool form errors. A compensation-value table is used to define angle-dependent delta values. These delta values define the deviation of a tool from its ideal circular form or any deviation in a touch probe's switching behavior. For use with a tool, this function requires surface normal vectors in the NC program, for which the software option Advanced Function Set 2 must be enabled. These compensation values will only be taken into account during probing with a touch probe if new probing cycles (e.g. Cycle 444) are used, which have been prepared for this purpose.

Commissioning and diagnostic aids

Overview

The TNC 640 provides comprehensive internal commissioning and diagnostic aids. It also includes highly effective PC software for diagnosis, optimization and remote control.

ConfigDesign (accessory)

PC software for configuring the machine parameters

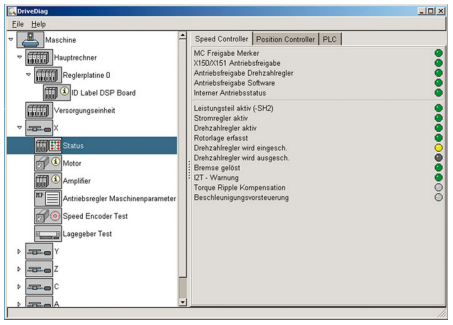
- Machine-parameter editor for the control; all support information; additional data and input limits are shown for each parameter
- Configuration of machine parameters
- Comparison of parameters from different controls
- Importing of service files: easy testing of machine parameters in the field
- Rule-based creation and management of machine configurations for multiple controls (together with PLCdesign)

DriveDiag

DriveDiag permits quick and easy troubleshooting of the drives. The following diagnostic functions are available:

- Reading and displaying the electronic ID labels of QSY motors with EQN 13xx or ECN 13xx as well as the inverter modules UVR 1xxD and UM 1xxD
- Displaying and evaluating the internal control conditions and the status signals of the inverter components
- Displaying the analog values available to the drive controller
- Automatic test for proper function of motors and inverters, of position encoders and speed encoders

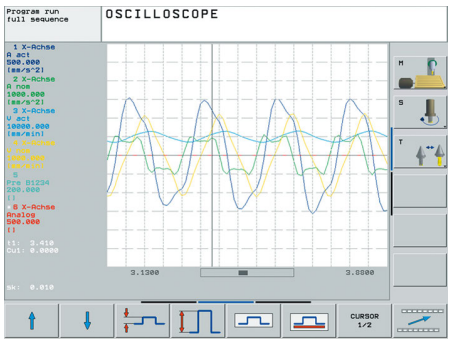
DriveDiag can be called immediately at the control through the diagnostics soft key. End users have read-access, whereas the code number for the machine tool builder gives access to comprehensive testing possibilities with DriveDiag.



Oscilloscope

The TNC 640 features an integrated oscilloscope. Both X/t and X/Y graphs are possible. The following characteristic curves can be recorded and stored in six channels:

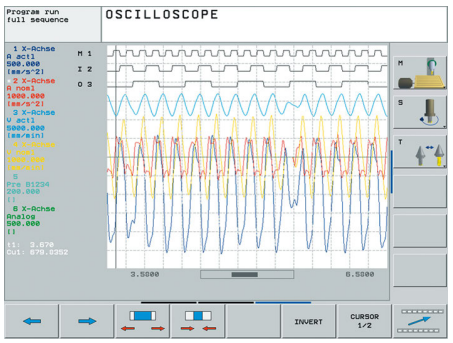
- Actual value and nominal value of the axis feed rate
- Contouring feed rate
- Nominal and actual position
- Following error of the position controller
- Nominal and actual values for speed, acceleration and jerk
- Content of PLC operands
- Encoder signal (0° – A) and (90° – B)
- Difference between position and speed encoder
- Nominal velocity value
- Integral-action component of the nominal current value
- Torque-determining nominal current value



Logic signals

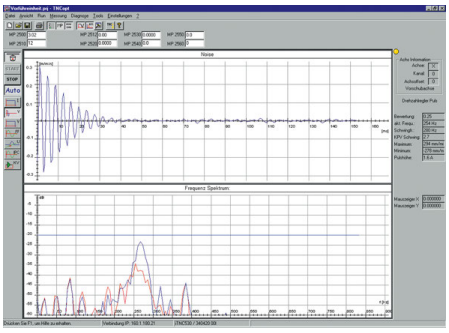
Simultaneous graphic representation of the logic states of up to 16 operands (markers, words, inputs, outputs, counters, timers)

- Marker (M)
- Input (I)
- Output (O)
- Timers (T)
- Counter (C)
- IpoLogik (X)



TNCopt (accessory)

PC software for commissioning digital control loops.
Functions (among others):
- Commissioning the current controller
- Commissioning the velocity controller (automatic)
- Optimization of sliding-friction compensation (automatic)
- Optimization of the reversal-spike compensation (automatic)
- Optimization of the k_V factor (automatic)
- Circular interpolation test, contour test



Online Monitor (OLM)

The online monitor is a component part of the TNC 640 and is called over a code number. It supports commissioning and diagnosis of control components by:
- Display of control-internal variables for axes and channels
- Display of controller-internal variables (if a CC is present)
- Display of hardware signal states
- Various trace functions
- Activation of spindle commands
- Enabling control-internal debug outputs

TNCscope (accessory)

PC software for transferring the oscilloscope files to a PC. With TNCscope you can record and save up to 16 channels simultaneously.
Note: The trace files are saved in the TNCscope data format.

API DATA

The API DATA function enables the control to display the states or contents of the symbolic API markers and API double words. This function requires that your PLC program use the symbolic memory interface.
Note: The API DATA function does not provide usable display values with the iTNC 530-compatible memory interface (API 1.0)

Table function

The current conditions of the markers, words, inputs, outputs, counters and timers are displayed in tables. The conditions can be changed through the keyboard.

Trace function

The current content of the operands and the accumulators is shown in the statement list in each line in hexadecimal or decimal code. The active lines of the statement list are marked.

Log

For the purposes of error diagnostics, all error messages and keystrokes are recorded in a log. The entries can be read using the **PLCdesign** or **TNCremo** software for PCs.

TeleService (accessory)

PC software for remote diagnostics, remote monitoring and remote operation of the control. For more information, please ask for the *Remote Diagnosis with TeleService* Technical Information sheet.

Single station license		ID 340449-xx
Network license	For 14 workstations	ID 340454-xx
	For 20 workstations	ID 340455-xx

Bus diagnosis

In Diagnosis mode, the structure of the connected bus systems as well as the details of the connected components can be displayed in a clearly laid out screen.

TNCtest

Acceptance tests on machine tools with external or integrated Functional Safety (FS) must be conducted reproducibly and verifiably.

The program packages TNCtest and TestDesign programs can be used to plan and perform acceptance tests for machine tools with HEIDENHAIN controls. The acceptance tests are planned with TestDesign and run with TNCtest.

The TNCtest programs are designed to provide support during acceptance testing, provide required information, perform automatic configurations, record data and evaluate them semiautomatically. Whether a test case passes or fails must be evaluated manually by the tester.

TNCanalyzer

The TNCanalyzer application from HEIDENHAIN provides for simple and intuitive evaluation of service files and log files.

Function
- Loading of log and service files
- Analysis of temporal sequences and static states
- Filters and search functions
- Data export (HELogger, CSV and JSON formats)
- Definition of application-specific analysis profiles
- Preconfigured analysis profiles
- Graphic display of signals via TNCscope
- Interaction with other tools that are intended for the display of special sections of the service file

Integrated PLC

Overview

The PLC program is created by the machine manufacturer either at the control or with the PLC development software **PLCdesign** (accessory). Machine-specific functions are activated and monitored via the PLC inputs/outputs. The number of PLC inputs/outputs required depends on the complexity of the machine.

PLC inputs/ outputs

PLC inputs and outputs are available via the external PL 6000 PLC input/output systems or the UEC 11x. The PLC inputs/outputs and the PROFIBUS-DP-capable I/O system must be configured with the IOconfig PC software.

PLC programming

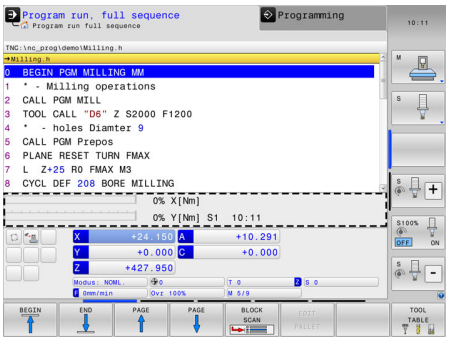
Format	Statement list
Memory	Min. 1 GB
Cycle time	9 ms to 30 ms (adjustable)
Command set	• Bit, byte and word commands • Logical operations • Arithmetic commands • Comparisons • Nested calculations (parentheses) • Jump commands • Subprograms • Stack operations • Submit programs • Timers • Counter • Comments • PLC modules • Strings

PLC window

PLC error messages can be displayed by the TNC in the dialog line during operation.

Small PLC window

The TNC can show additional PLC messages and bar diagrams in the small PLC window.

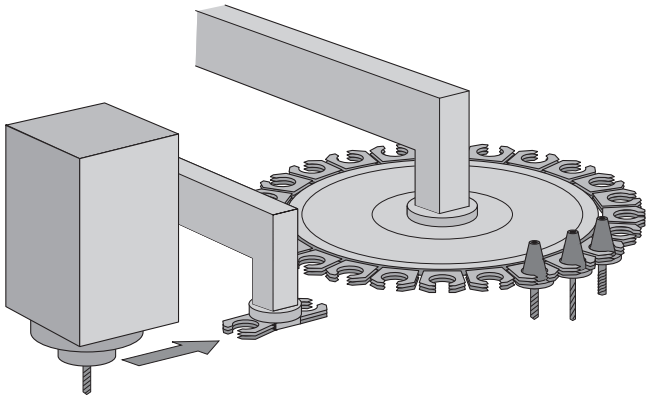


PLC soft keys

The machine manufacturer can display his own PLC soft keys in the vertical soft-key row on the screen.

PLC positioning

All closed-loop axes can be also positioned via the PLC. PLC positioning of the NC axes cannot be superimposed on NC positioning.



PLC axes

Axes can be controlled by the PLC. They are programmed by M functions or OEM cycles. The PLC axes are positioned independently of the NC axes.

PLCdesign (accessory)

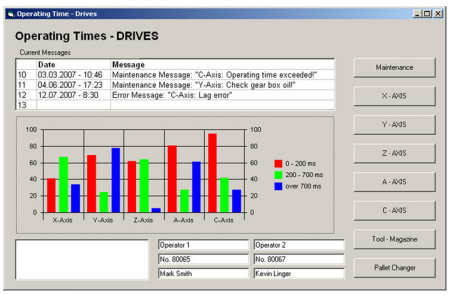
PC software for PLC program development.
The PC program **PLCdesign** can be used for easy creation of PLC programs. Comprehensive examples of PLC programs are included with the product.

Functions:

- Easy-to-use text editor
- Menu-guided operation
- Programming of symbolic operands
- Modular programming method
- "Compiling" and "linking" of PLC source files
- Operand commenting, creation of the documentation file
- Comprehensive help system
- Data transfer between the PC and control
- Creation of PLC soft keys

Python OEM process (option 46)

The Python OEM Process option is an effective tool for the machine tool builder to use an object-oriented high-level programming language in the control (PLC). Python is an easy-to-learn script language that supports the use of all necessary high-level language elements.



Python OEM Process can be used universally for machine functions and complex calculations, as well as to display special user interfaces. User-specific or machine-specific solutions can be efficiently implemented. Numerous libraries on the basis of Python and GTK are available, regardless of whether you want to create special algorithms for special functions, or separate solutions such as an interface for machine maintenance software.

The applications you create can be included via the PLC in the familiar PLC windows, or they can be displayed in separate free windows that can be expanded to the control's full screen size.

Simple Python scripts (e.g. for display masks) can also be executed without enabling the Python OEM Process (option 46) software option. 10 MB of dedicated memory are reserved for this function. For more information, refer to the *Python in HEIDENHAIN Controls* Technical Manual.

PLC basic program

The PLC basic program serves as a basis for adapting the control to the requirements of the respective machine. It can be downloaded from the Internet.

These essential functions are covered by the PLC basic program:

- Controlling all axes
- Clamped axes
- Homing the axes; reference end positions
- Positioning the axes after reference run
- Compensating the axis temperature
- Assigning the C axis as lathe spindle
- Feed rate control
- Spindle control and orientation
- Activating tool-specific torque monitoring
- Tool changer
- Pallet changer (translational, rotatory, setup functions)
- Vertical PLC soft-key row
- Support for 19" screens
- Displaying and managing PLC error messages
- Status display in the small PLC window
- Hydraulic control
- Control of the coolant system (internal, external, air)
- M functions
- Lubrication
- Chip conveyor
- Operation of the second spindle alternately with the first
- Wye/delta connection switchover (static, dynamic)
- S-coded spindle
- 3-D head with C-axis operation
- Positioning the spindle as an axis
- Operation with clamped axes
- Axes with central drive
- Axes with Hirth grid
- Indexing fixture
- PLC log
- Touch probes
- PLC support for handwheels
- Control of doors

Interfacing to the machine

OEM cycles

The machine tool builder can create and store his own cycles for recurring machining tasks. These OEM cycles are used in the same way as standard HEIDENHAIN cycles.

CycleDesign (accessory)

The soft-key structure for the cycles is managed using the **CycleDesign** PC program. In addition, CycleDesign can be used to store help graphics and soft keys in BMP format in the TNC. Graphic files can be compressed to ZIP format to reduce the amount of memory used.

Tool management

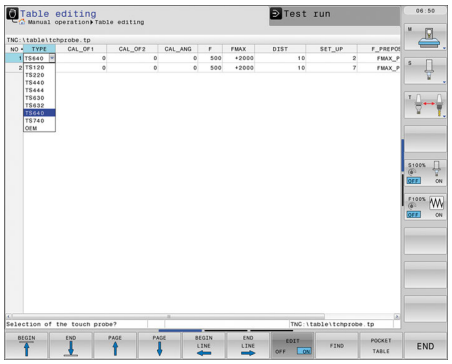
With integral PLC, the tool changer is moved either via proximity switch or as a controlled axis. Tool management including tool life monitoring and replacement tool monitoring is carried out by the TNC 640.

Tool calibration

Tools can be measured and checked using the **TT** or **TL** tool touch probes (accessory). The control features standard cycles for automatic tool measurement. The control calculates the probing feed rate and the optimal spindle speed. The measured data is stored in a tool table.

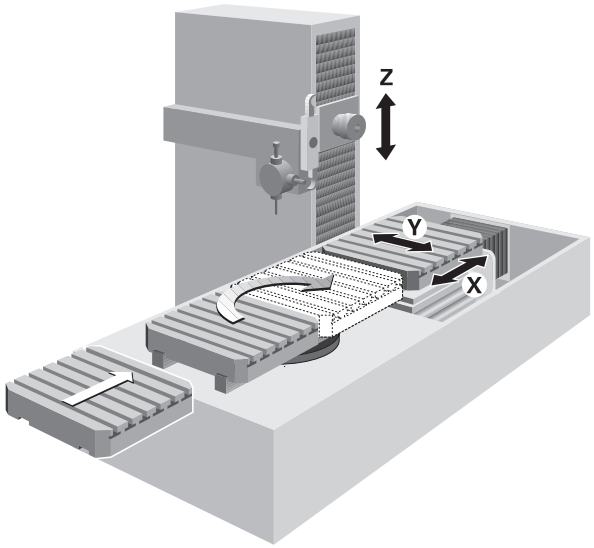
Touch probe configuration

All touch-probe data can be configured conveniently through a table. All HEIDENHAIN touch probe systems are preconfigured and can be selected through a drop-down menu.



Pallet management

Pallet movement can be controlled via PLC axes. The order of movement, as well as pallet and workpiece datums, must be defined in the pallet table by the user. The pallet tables are freely configurable, which means that any information can be stored in the tables and called up later via the PLC.



Data transfer and communication
Data interfaces

Overview
The TNC 640 is connected to PCs, networks and other data storage devices via data interfaces.

Ethernet
The TNC 640 can be interconnected via the Ethernet interface. For connection to the data network, the control features a 1000BASE-T (twisted pair Ethernet) connection.

Maximum transmission distance:
Unshielded 100 m
Shielded 400 m

Protocol
The TNC 640 communicates using the TCP/IP protocol.

Network connection
- NFS file server
- Windows networks (SMB)

Data transfer speed
Approx. 400 to 800 Mbps (depending on file type and network utilization)

RS-232-C/V.24
Data interface according to DIN 66 020 or EIA standard RS-232-C. Maximum transmission distance: 20 m

Data transfer rate
115 200; 57 600; 38 400; 19 200; 9600; 4800; 2400; 1200; 600; 300; 150; 110 bps

Protocols
The TNC 640 can transfer data using various protocols.

Standard data transfer
The data is transferred character by character. The number of data bits, stop bits, the handshake and character parity must be set by the user.

Blockwise data transfer
The data is transferred blockwise. For data backup, a so-called block check character (BCC) is used. This method improves data security.

LSV2
Bidirectional transfer of commands and data as per DIN 66 019. The data is divided into telegrams (blocks) and transmitted.

Adapter block
For connecting the interface to the electrical cabinet or operating panel.

RS-232-C adapter	9-pin	ID 363987-xx
	25-pin	ID 310085-xx

USB
The TNC 640 features USB ports for the connection of standard USB devices, such as a mouse, drives, etc. On the back panel of the MC 7xxx there are 4 USB 3.0 ports. The MC 6xxx has four USB 3.0 ports. One of them is led to the BF or TE. More USB 2.0 ports are in the integrated USB hub on the rear of the BF. One easily accessible USB 2.0 port is on the front of the unit. A cover cap protects it from contamination. The USB ports are rated for a maximum of 0.5 A.

USB cables

Cable length up to 5 m	ID 354770-xx
Cable length 6 m to 30 m with integrated amplifier; USB 1.1.	ID 624775-xx

USB hub

If you need further USB ports or if the supply current is not sufficient, a USB hub is required. The USB hub from HEIDENHAIN offers four free USB 2.0 ports.

USB hub ID 582884-xx
Voltage supply: DC 24 V/max. 300 mA

Cover

The USB hub can be installed in the operating panel in such a way that two USB ports can be accessed from the outside. An optionally available cover cap can be used to protect the ports from contamination.

Cover ID 508921-xx

Software for data transfer

We recommend using HEIDENHAIN software to transfer files between the TNC 640 and a PC.

TNCremo (accessory)

This PC software package helps the user to transfer data from the PC to the control. The software transfers data blockwise with block check characters (BCC).

Functions:
- Data transfer (also blockwise)
- Remote control (only serial)
- File management and data backup of the control
- Reading out the log
- Print-out of screen contents
- Text editor
- Managing more than one machine

TNCremoPlus (accessory)

In addition to the features you are already familiar with from TNCremo,TNCremoPlus can also transfer the current content of the control's screen to the PC (live screen). This makes it very simple to monitor the machine.

Additional functions:
- Request of DNC data (NC up time, Machine up time, Machine running time, Spindle running time, pending errors, data from the data servers, e.g. symbolic PLC operands)
- Targeted overwriting of tool data using the values of a tool presetter

TNCremoPlus ID 340447-xx

Connected Machining

Overview

Connected Machining makes uniformly digital order management possible in networked manufacturing. You also profit from:

- Easy data usage
- Time-saving procedures
- Transparent processes

Remote Desktop Manager (option 133)

Remote control and display of external computers over Ethernet connection (e.g. Windows PC). The information is displayed on the control's screen. The Remote Desktop Manager allows you to access important applications, such as CAD/CAM applications or order management, from the control.

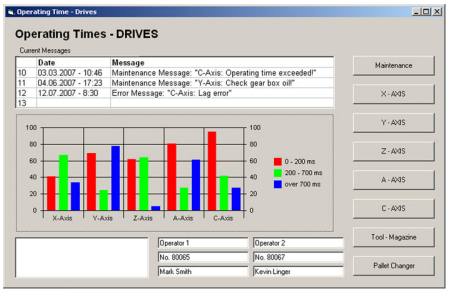
Remote desktop manager ID 894423-xx

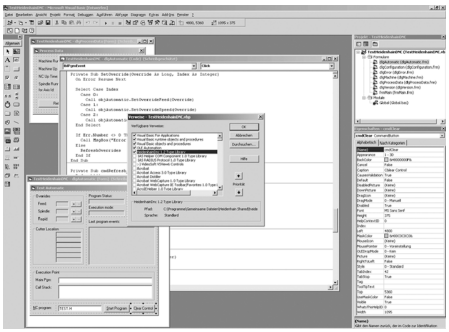
HEIDENHAIN DNC (option 18)

The development environments on Windows operating systems are particularly well suited as flexible platforms for application development in order to come to terms with the increasingly complex requirements of the machine's environment.

The flexibility of the PC software and the large selection of ready-to-use software components and standard tools in the development environment enable you to develop PC applications of great use to your customers in a very short time, for example:

- Error reporting systems that, for example, send the customer a text message to his cell phone reporting problems on the currently running machining process
- Standard or customer-specific PC software that decidedly increases process reliability and equipment availability
- Software solutions controlling the processes of manufacturing systems
- Information exchange with job management software





The HEIDENHAIN DNC software interface is an attractive communication platform for this purpose. It provides all the data and configuration capabilities needed for these processes so that an external PC application can evaluate data from the control and, if required, influence the manufacturing process.

RemoTools SDK (accessory)

To enable you to use HEIDENHAIN DNC effectively, HEIDENHAIN offers the RemoTools SDK development package. It contains the COM component and the ActiveX control for integration of the DNC functions in development environments.

RemoTools SDK		ID 340442-xx

For more information, refer to the *HEIDENHAIN DNC* brochure.

virtualTNC (accessory)

The **virtualTNC** control software is a control component for virtual machines for machine simulations, and is available via the HEIDENHAIN DNC interface.

Single station license		ID 1113933-02
Network license	For one work station	ID 1122145-02
	For 14 workstations	ID 1113935-02
	For 20 workstations	ID 1113936-02

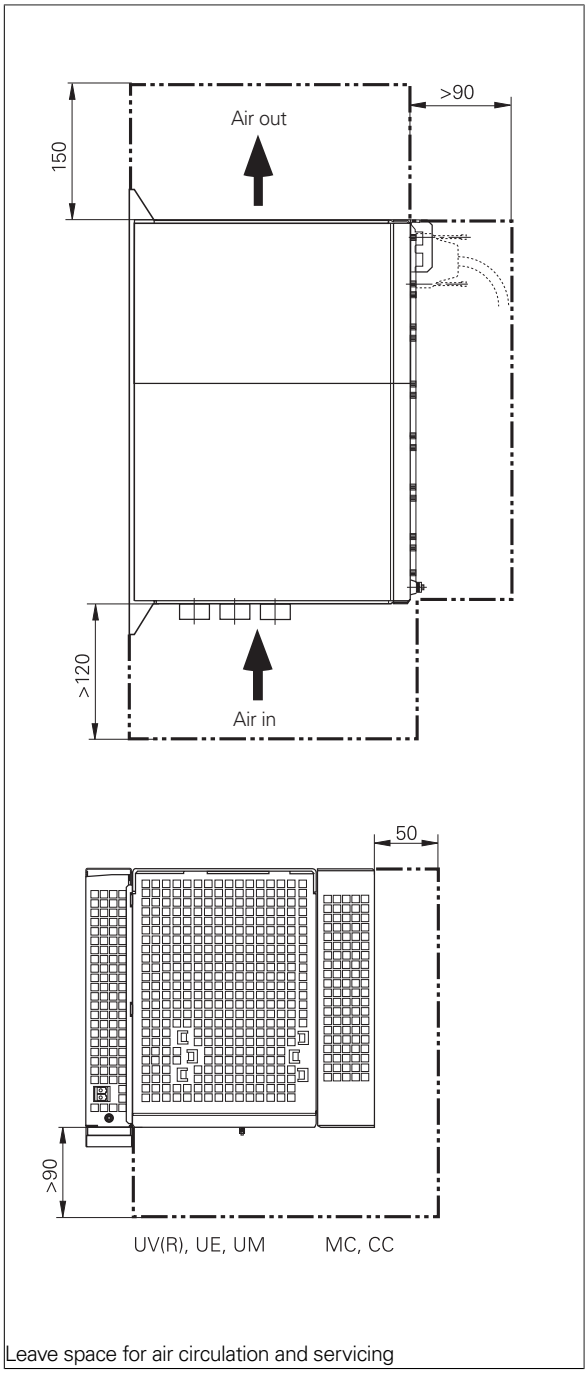
For more information, refer to the *HEIDENHAIN DNC* brochure.

Mounting information
Clearances and mounting

Proper minimum clearance

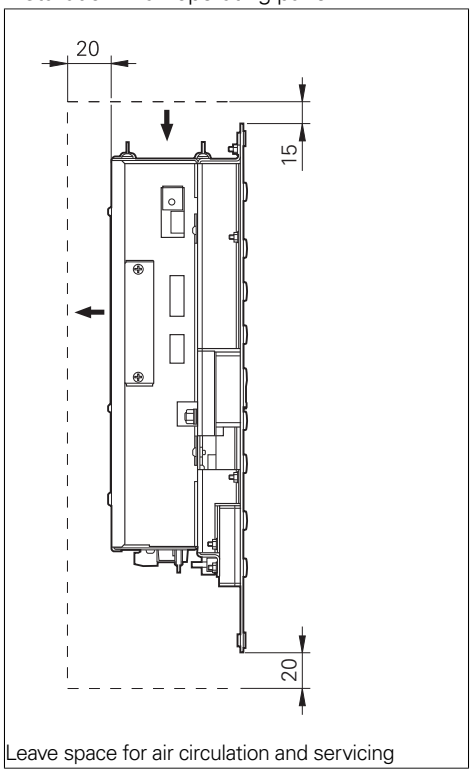
When mounting the control components, please observe proper minimum clearances, space requirements, length and position of the connecting cables.

Installation in an electrical cabinet



Leave space for air circulation and servicing

Installation in an operating panel



Leave space for air circulation and servicing

Mounting and electrical installation

Observe the following points during mounting and electrical connection:
- National regulations for low-voltage installations at the operating site of the machine or components
- National regulations regarding interference and noise immunity at the operating site of the machine or components
- National regulations regarding electrical safety and operating conditions at the operating site of the machine or components
- Specifications for the installation position
- Specifications of the Technical Manual

Degrees of protection

The following components fulfill the requirements for IP54 (dust protection and splash-proof protection):
- Display unit (installed)
- Keyboard unit (installed)
- Machine operating panel (installed)
- Handwheel

All electric and electronic control components must be installed in an environment (e.g. electrical cabinet, housing) that fulfills the requirements of protection class IP54 (dust and splash-proof protection) in order to fulfill the requirements of pollution degree 2. All components of the OEM operating panel must also comply with protection class IP54, just like the HEIDENHAIN operating panel components.

Electromagnetic compatibility

Protect your equipment from interference by observing the rules and recommendations specified in the Technical Manual.

Intended place of operation

This unit fulfills the requirements for EN 50370-1 and is intended for operation in industrially zoned areas.

Likely sources of interference

Interference is produced by capacitive and inductive coupling into electrical conductors or into device connections, caused by e.g.:
- 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, CC and its leads to devices that carry interference signals
- Keep a minimum distance of 10 cm from the MC, CC 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 equipotential bonding lines according to the grounding plan. Please refer to the Technical Manual of your control.
- Use only genuine HEIDENHAIN cables and connecting elements

Installation elevation

The maximum altitude for installation of HEIDENHAIN control components (MC, CC, PLB, MB, TE, BF, IPC, etc.) is 3000 m above sea level.

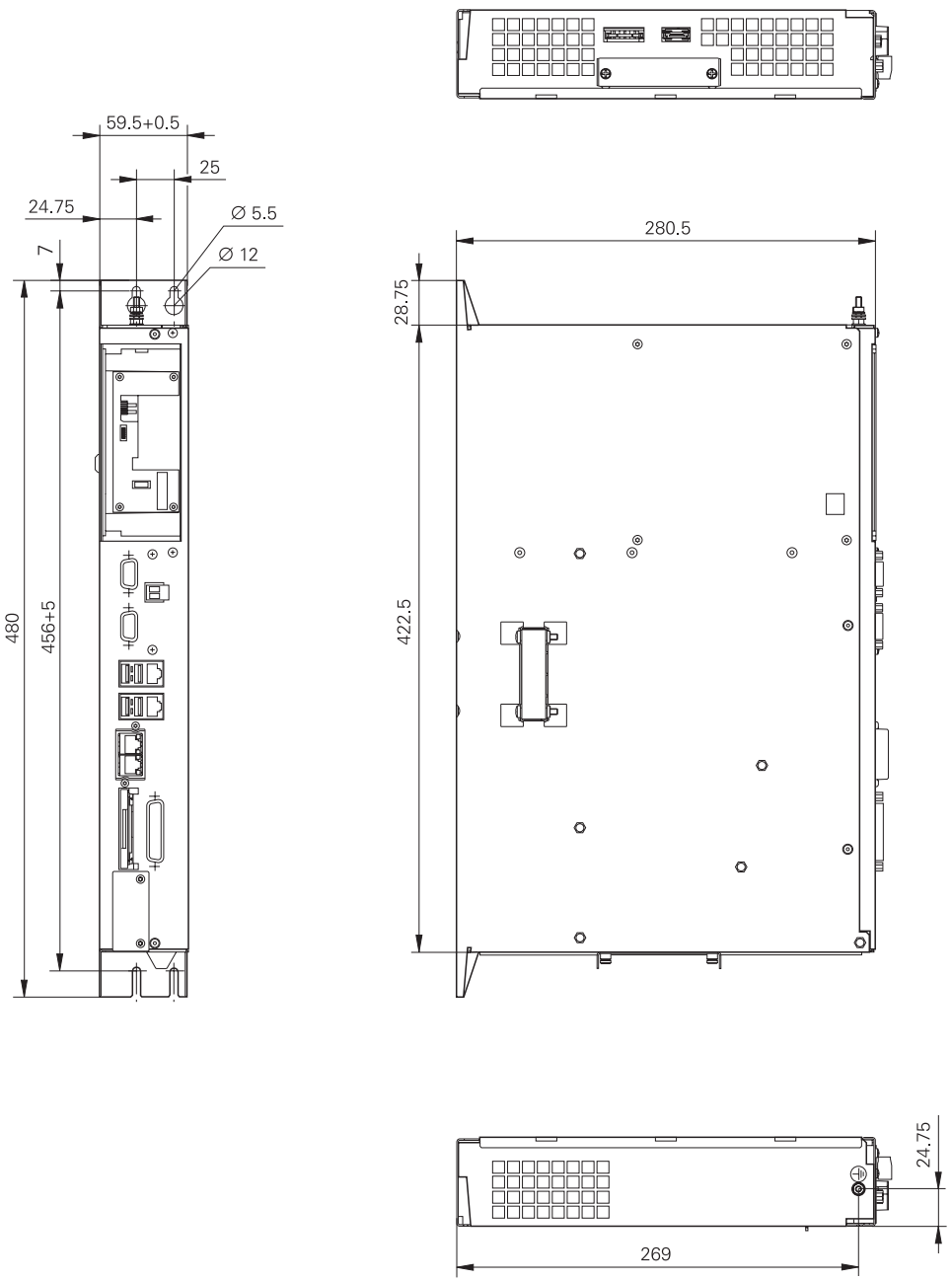
Overall dimensions

Main computer

MC 6541, MC 6641, IPC 6641

mm

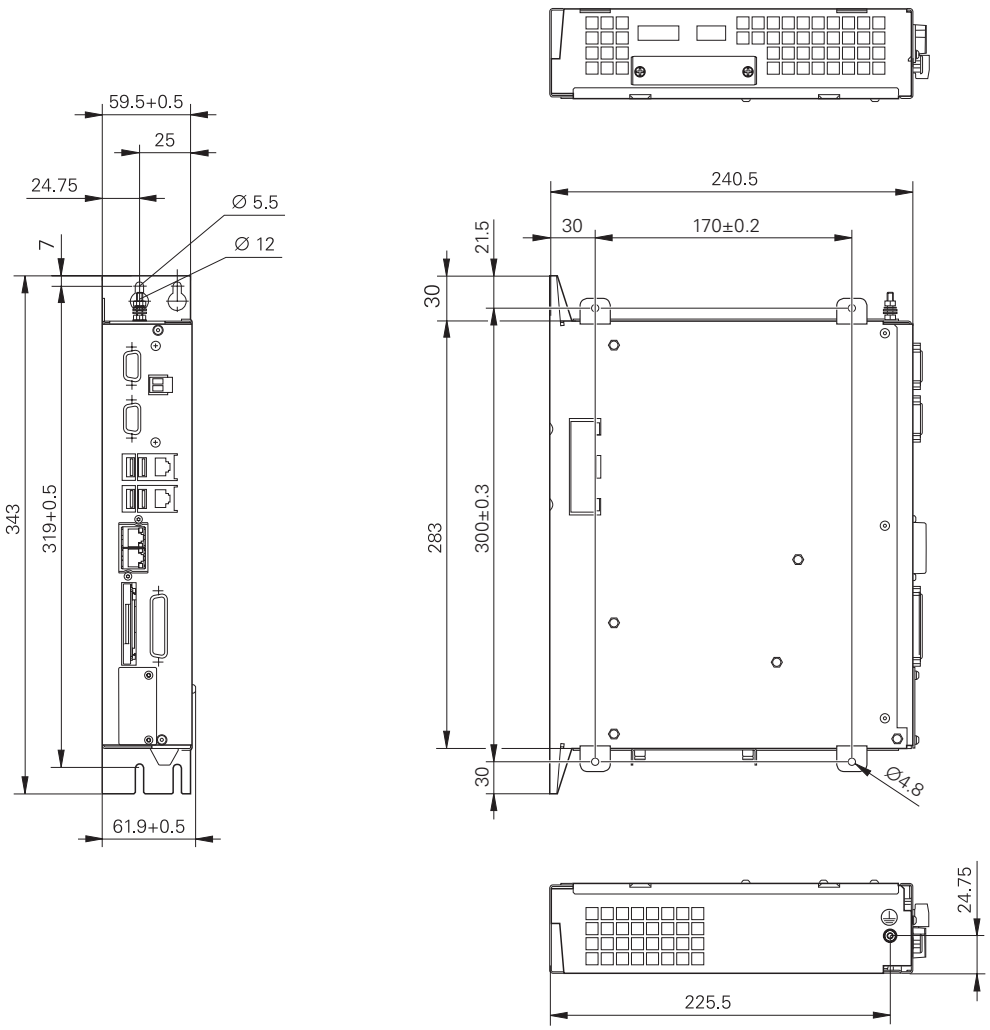
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



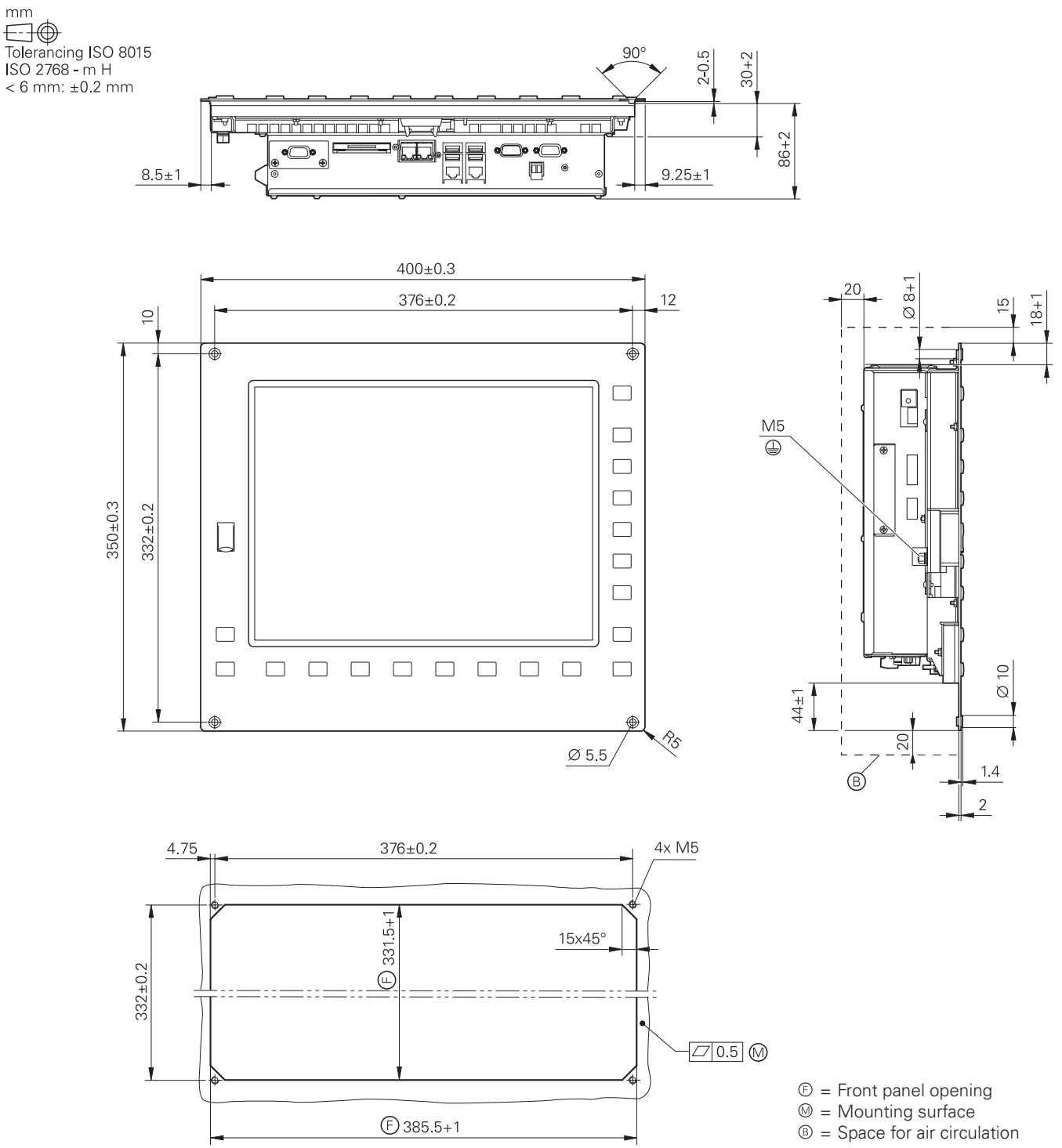
MC 6542/IPC 6490

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



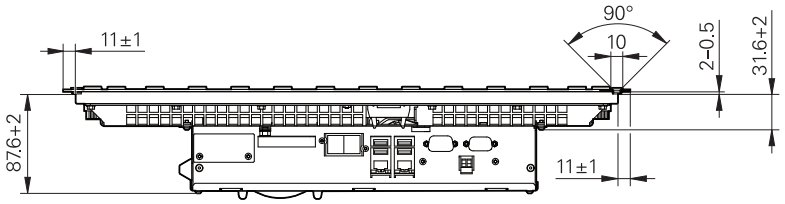
MC 7522

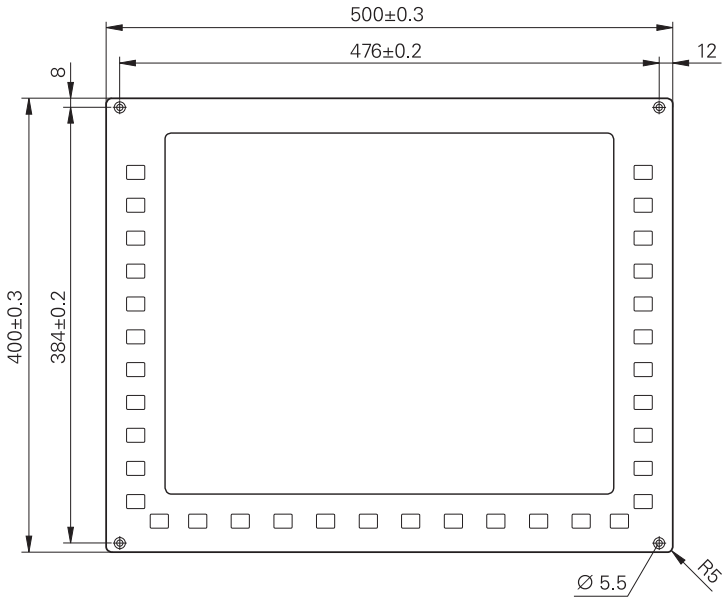

mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm
90°
2-0.5
30+2
86+2
8.5±1
9.25±1
400±0.3
376±0.2
12
10
350±0.3
332±0.2
Ø 5.5
R5
20
Ø 8+1
15
18+1
M5
44±1
Ø 10
20
1.4
2
4.75
376±0.2
4x M5
332±0.2
331.5+1
15x45°
0.5 M
385.5+1
Ⓕ = Front panel opening
Ⓜ = Mounting surface
Ⓑ = Space for air circulation

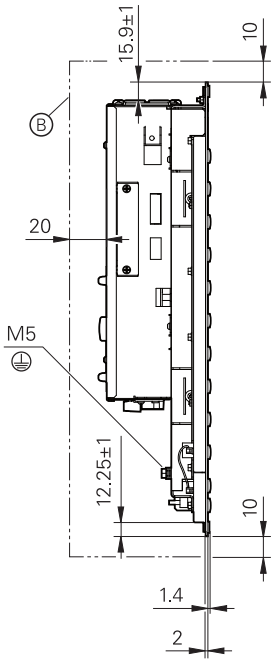
MC 7532

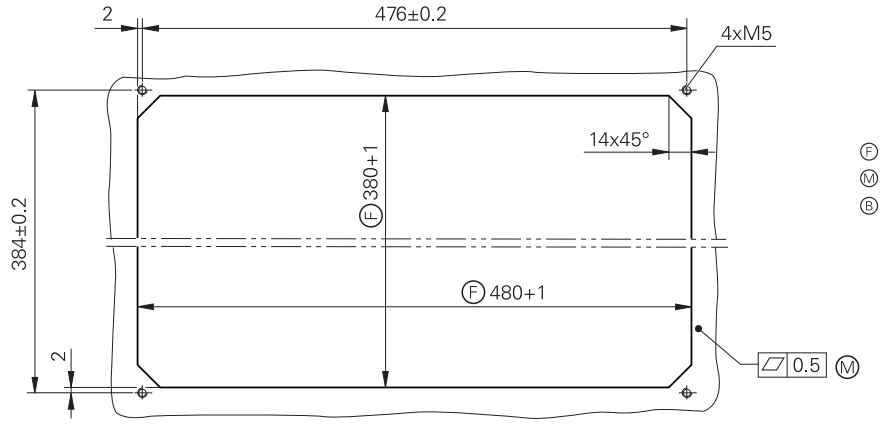
mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm







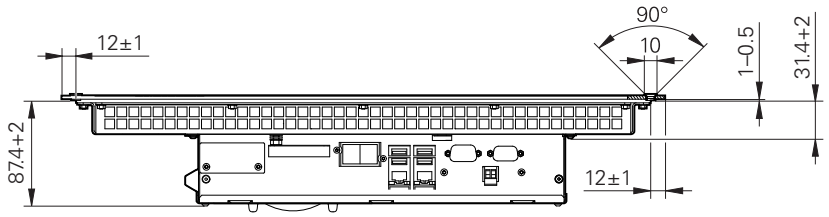


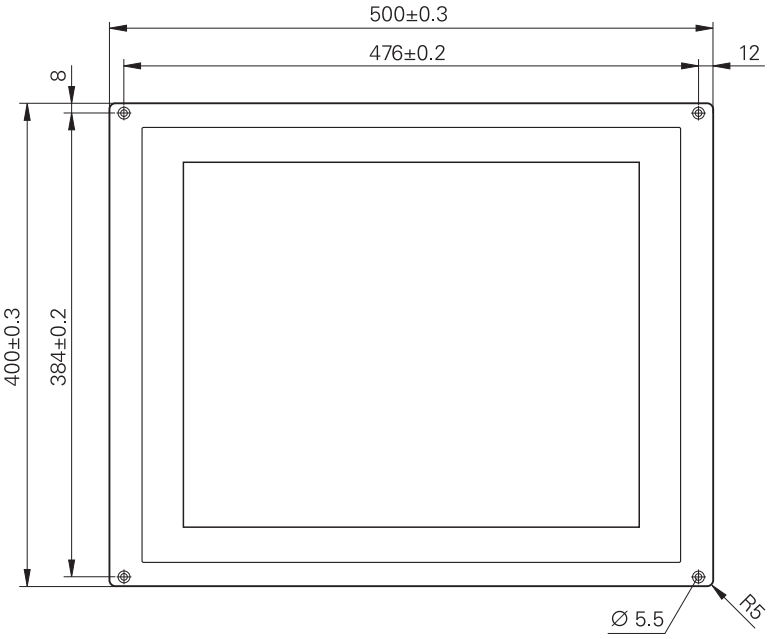
Ⓕ = Front panel opening
Ⓜ = Mounting surface
Ⓑ = Space for air circulation

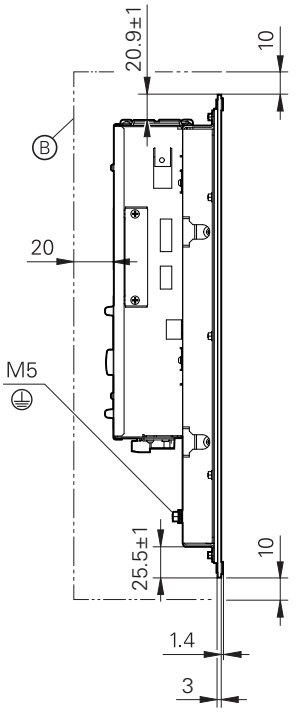
MC 8532

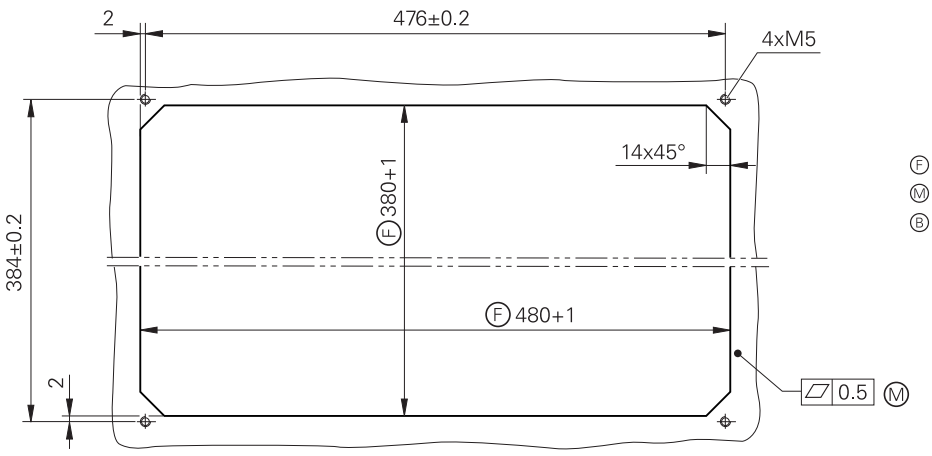
mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm









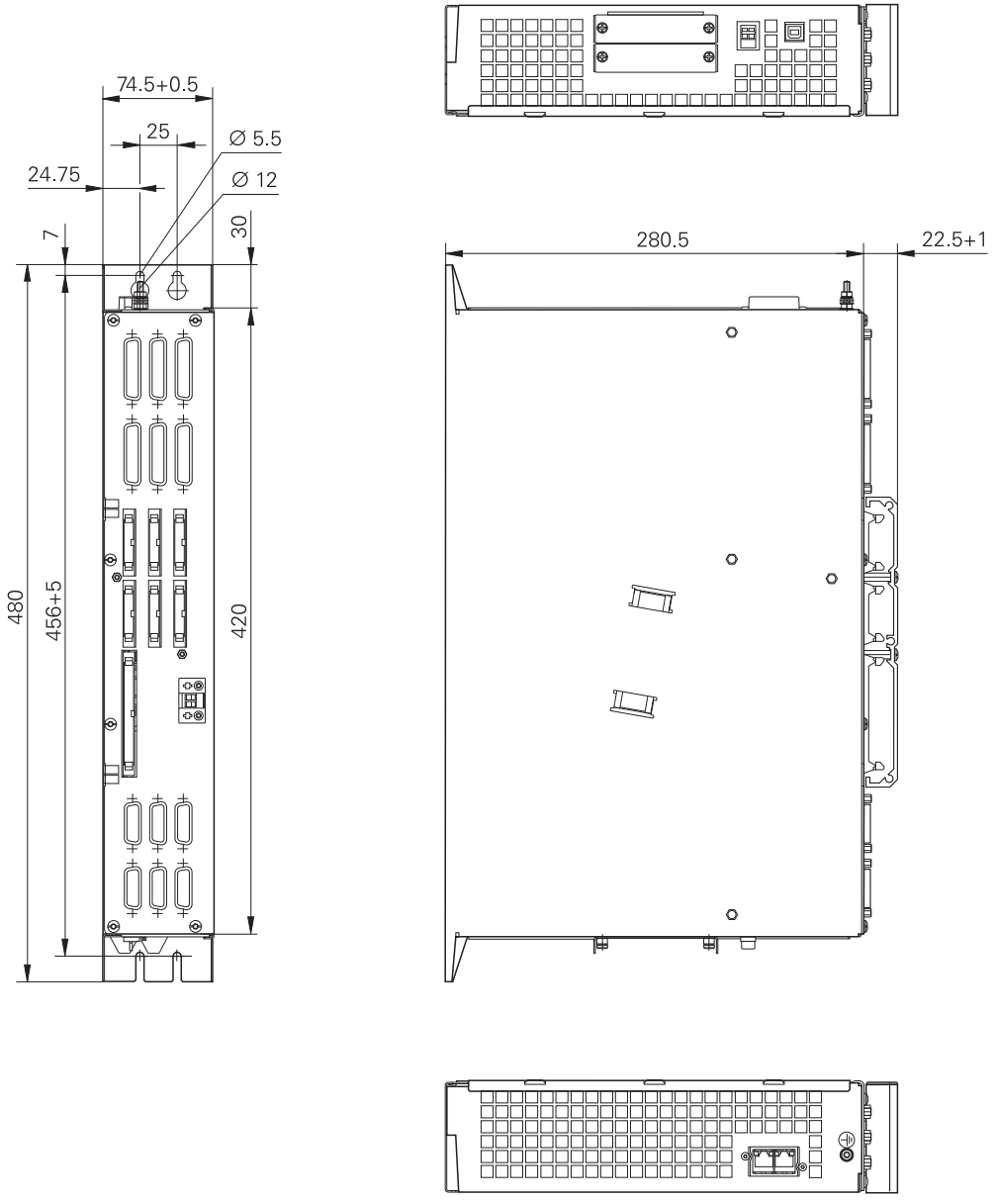
Ⓕ = Front panel opening
Ⓜ = Mounting surface
Ⓑ = Space for air circulation

Controller unit

CC 6106

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

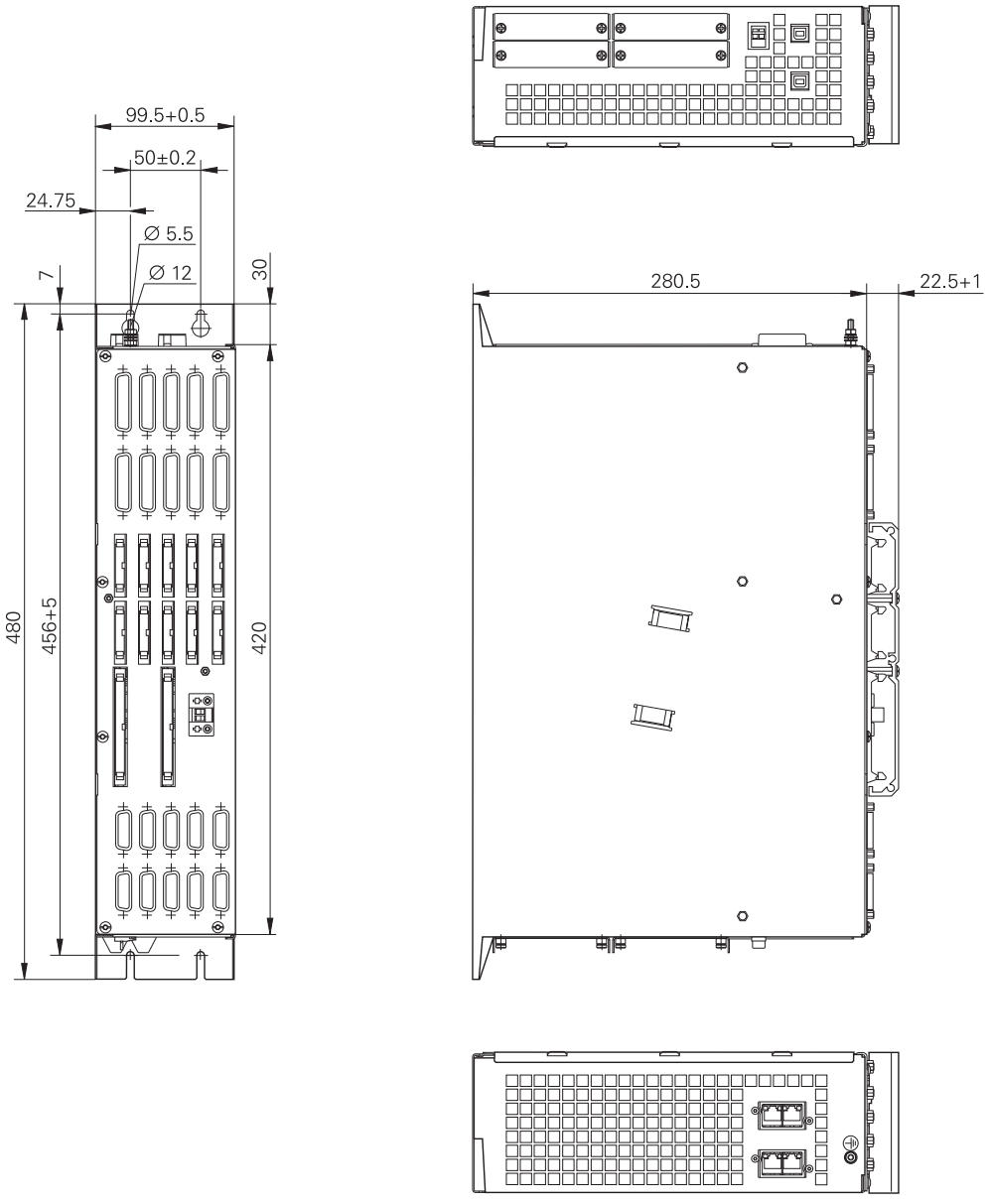


CC 6108, CC 6110

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

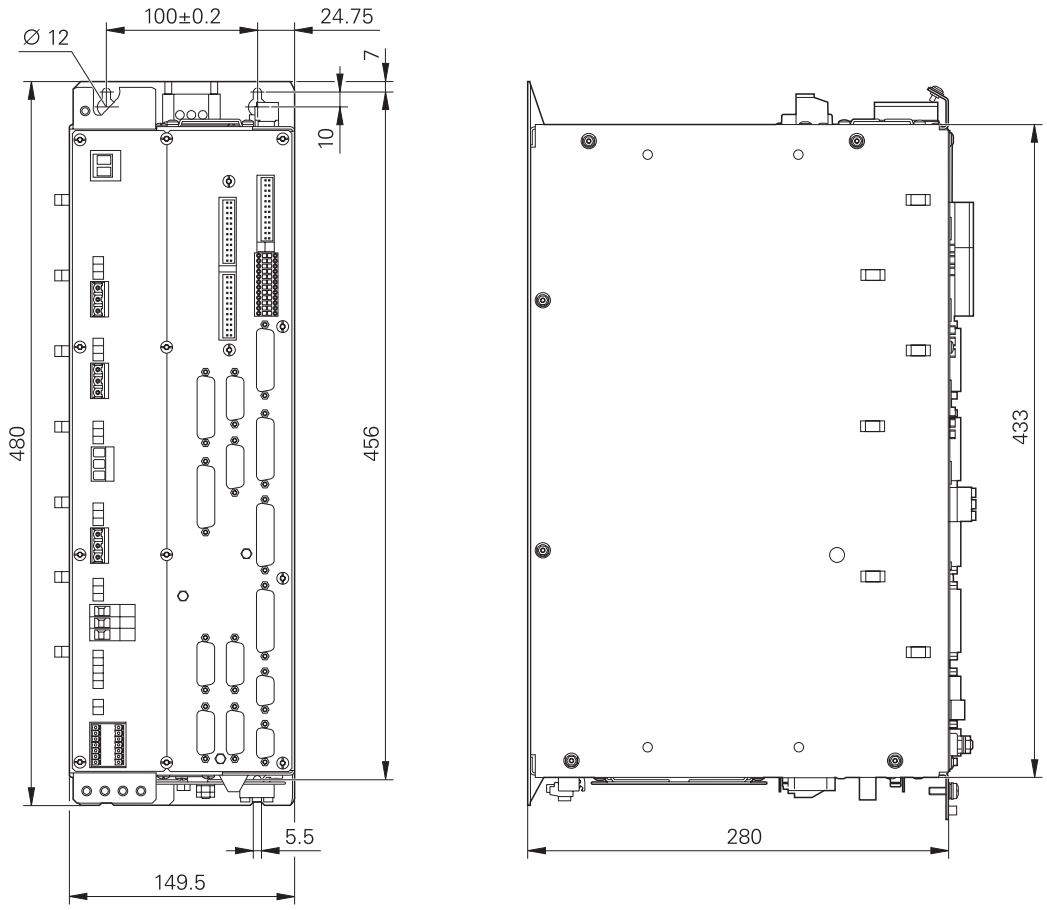
CC 6108: 8 control loops
CC 6110: 10 control loops



UEC 111, UEC 112, UEC 113

mm

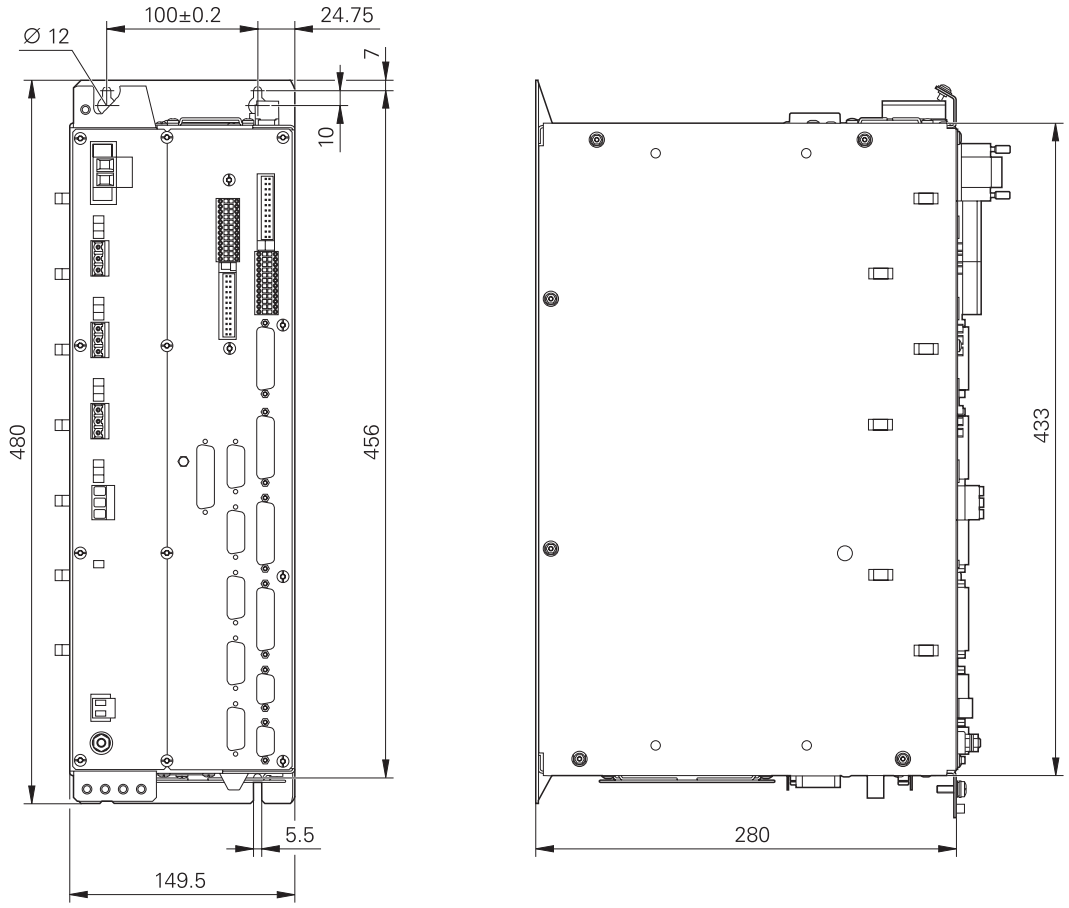
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



UMC 111 FS

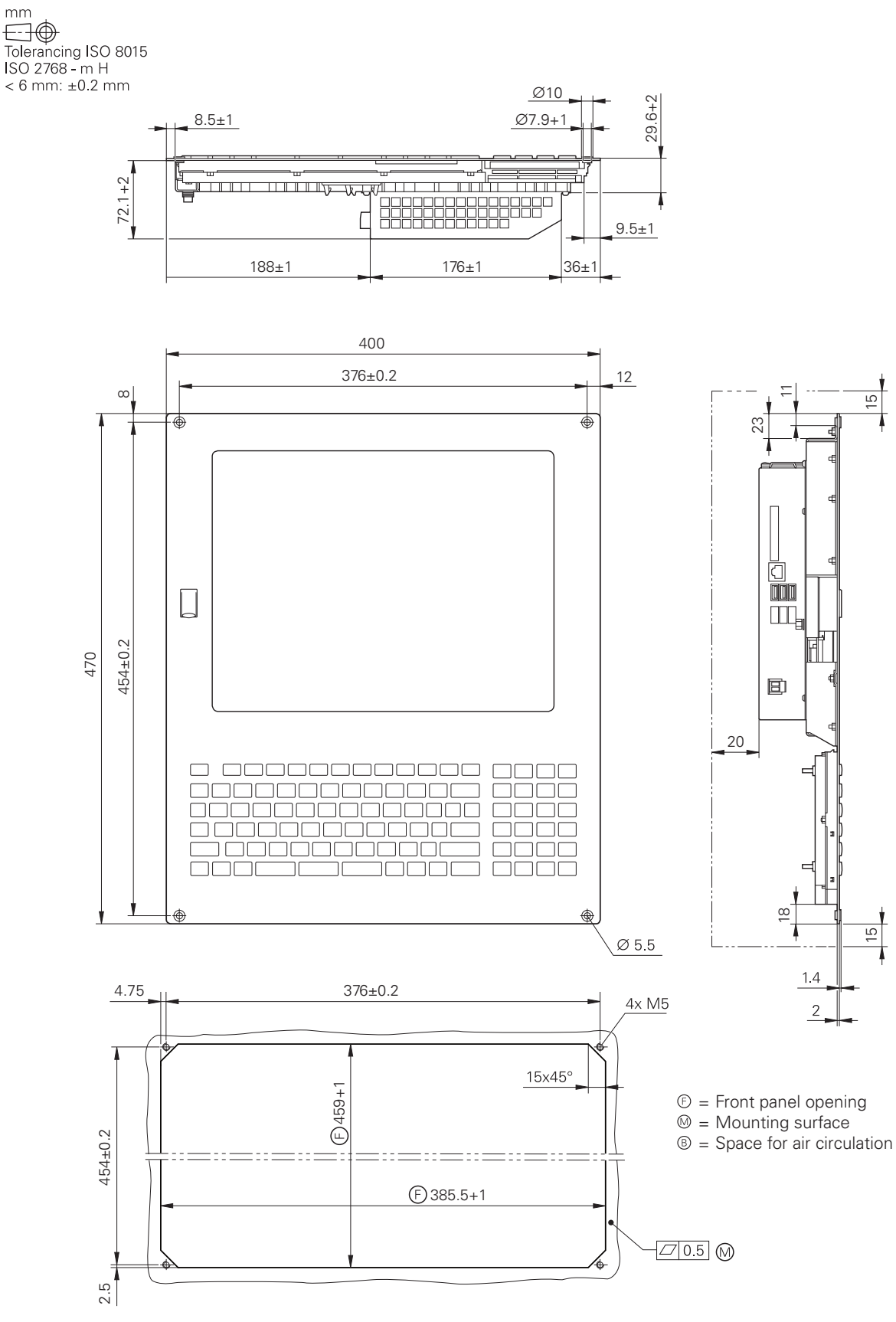
mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



Operating panel, screen and keyboard

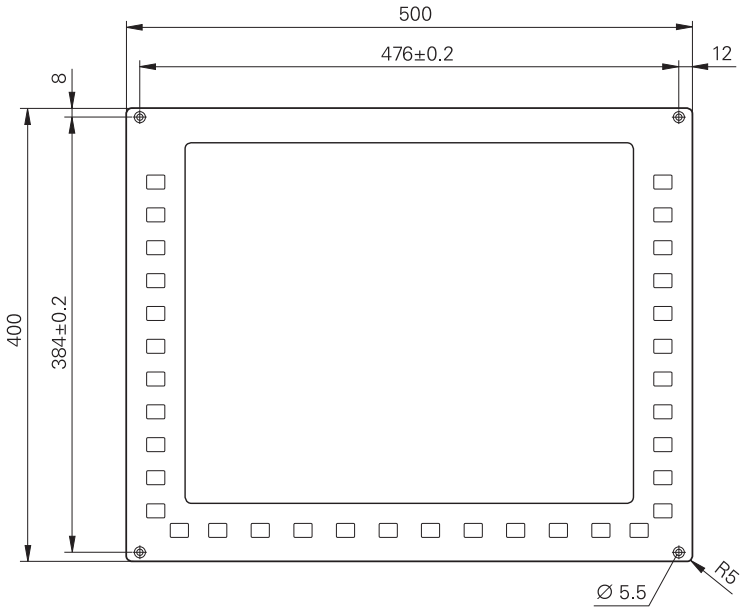
ITC 755

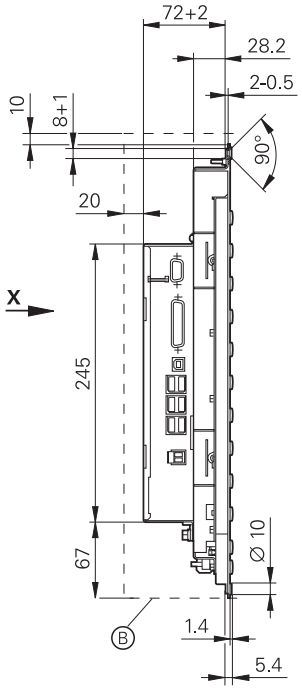


BF 760, ITC 760

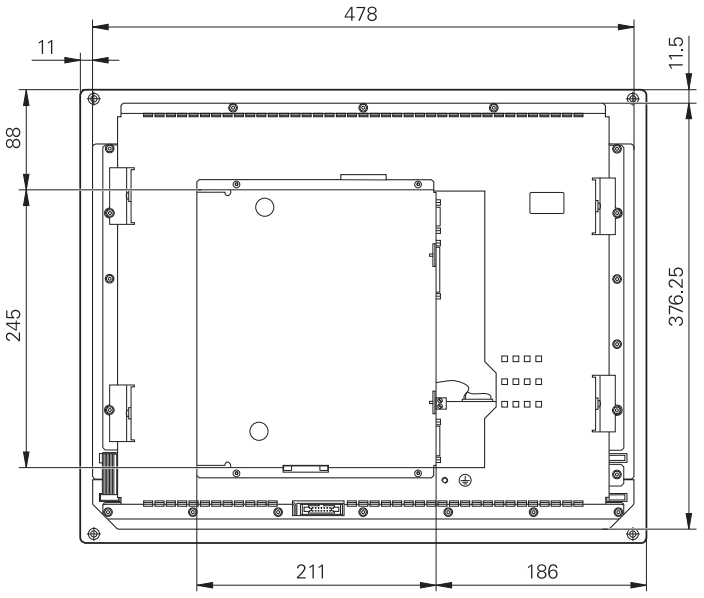
mm

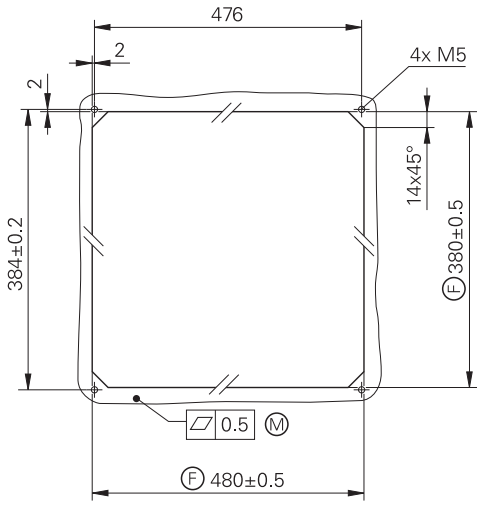
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm





X



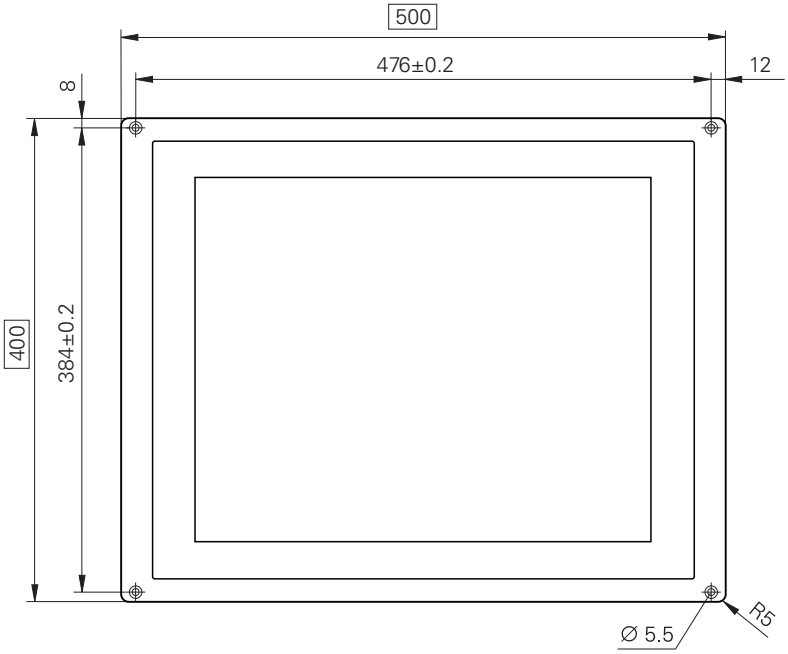


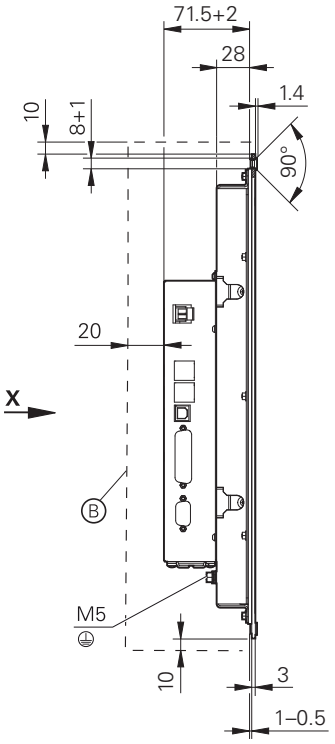
Ⓕ = Front panel opening
Ⓜ = Mounting surface
Ⓑ = Space for air circulation

BF 860, ITC 860

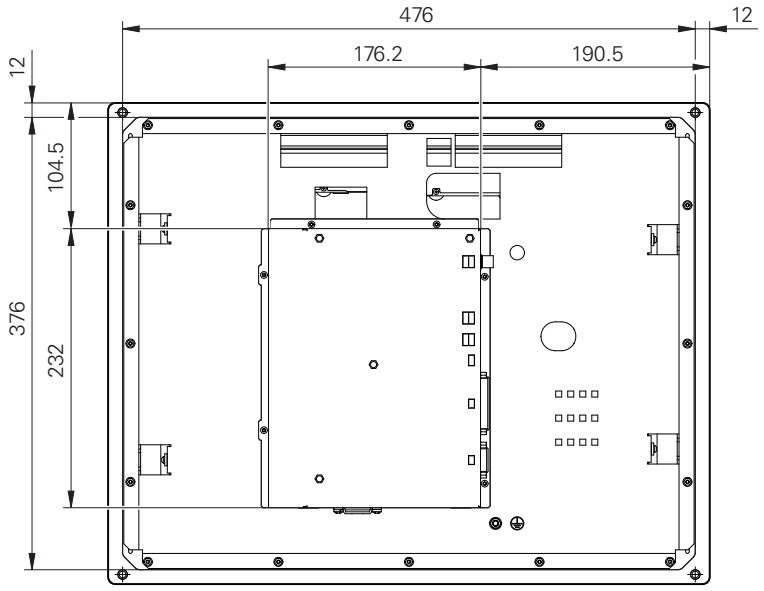
mm

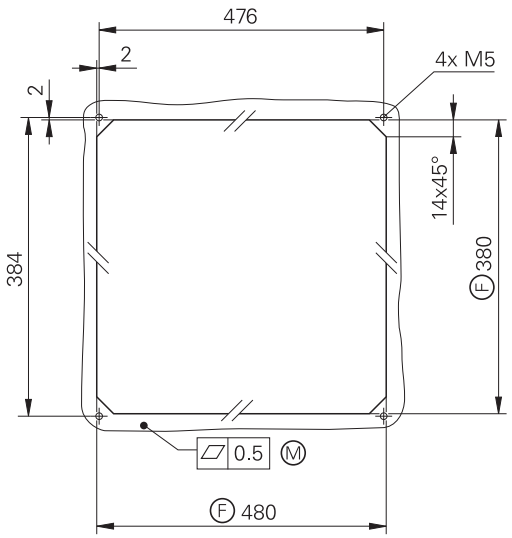
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm





X



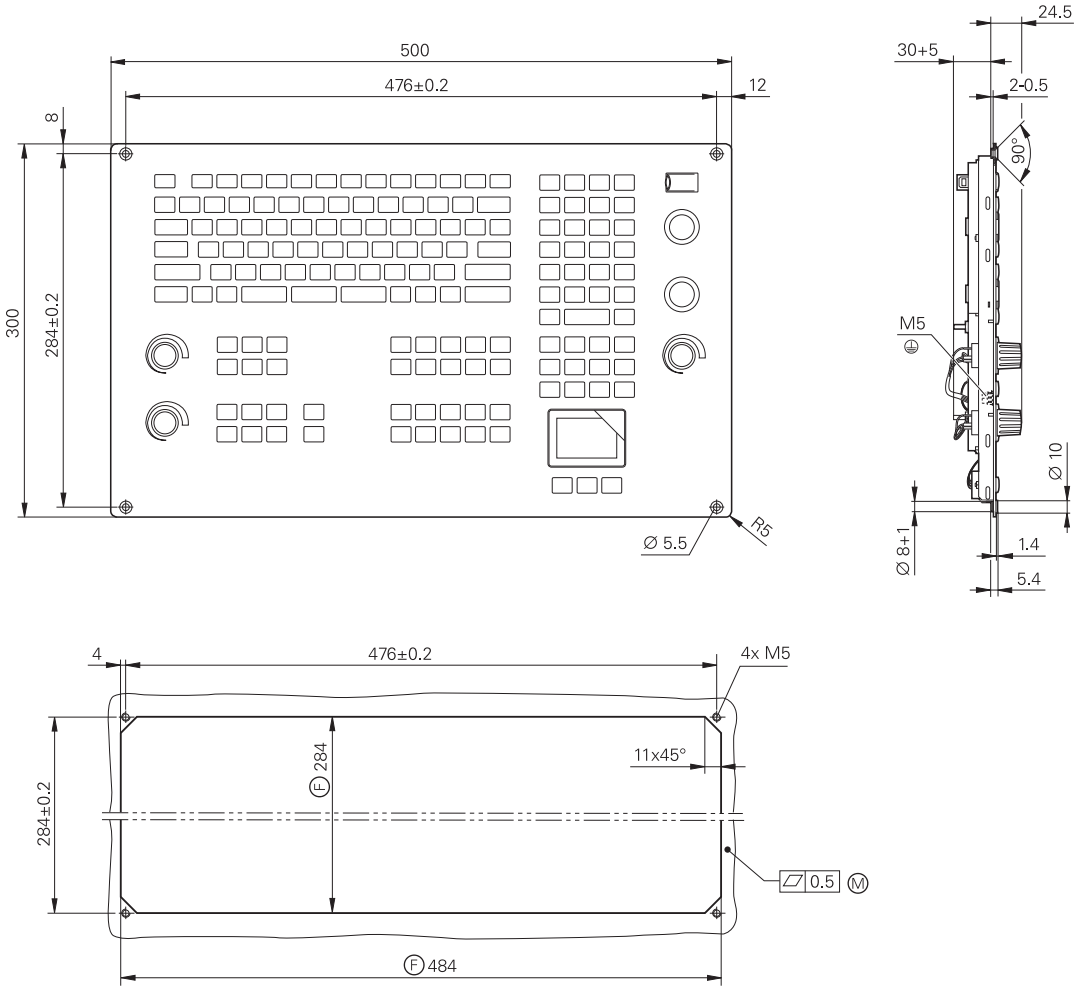


Ⓕ = Front panel opening
Ⓜ = Mounting surface
Ⓑ = Space for air circulation

TE 740

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

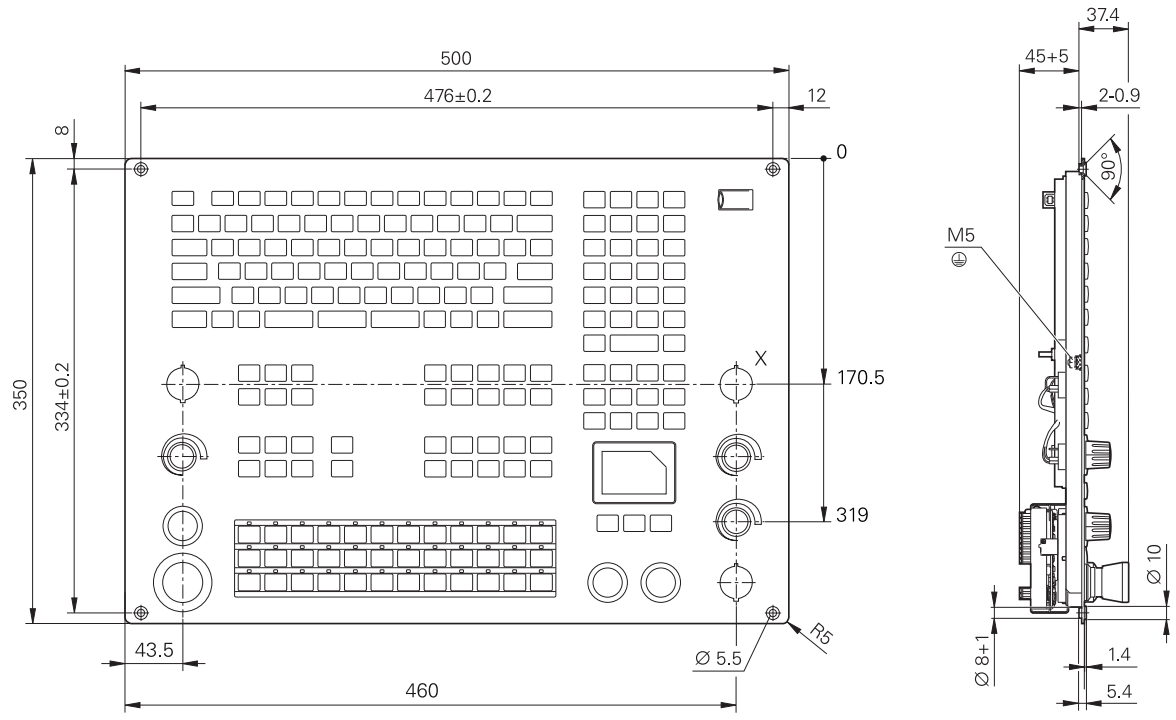


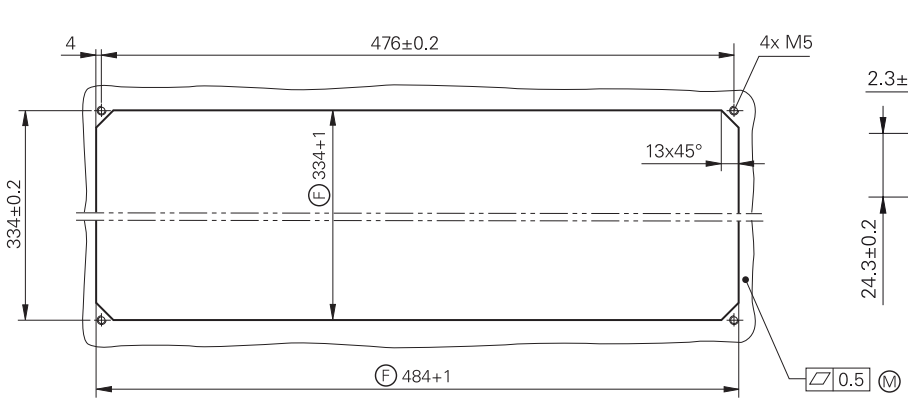
Ⓕ = Front panel opening
Ⓜ = Mounting surface

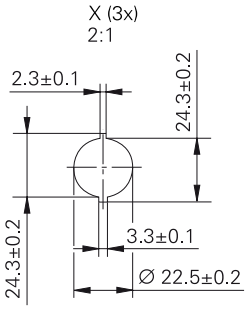
TE 745

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm





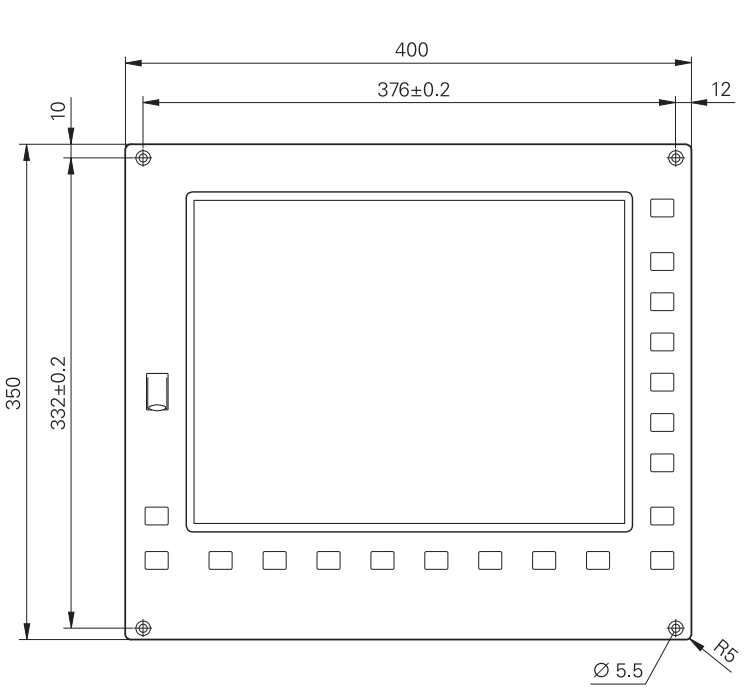


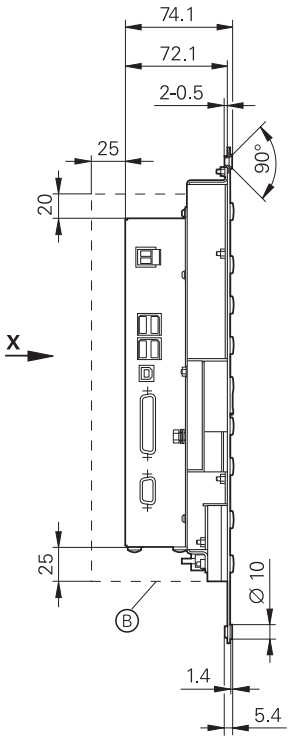
Ⓕ = Front panel opening
Ⓜ = Mounting surface

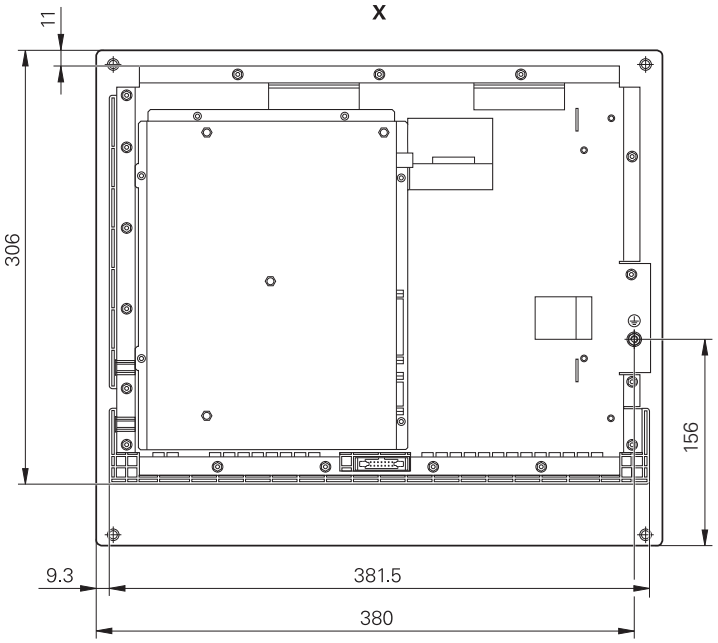
BF 750, ITC 750

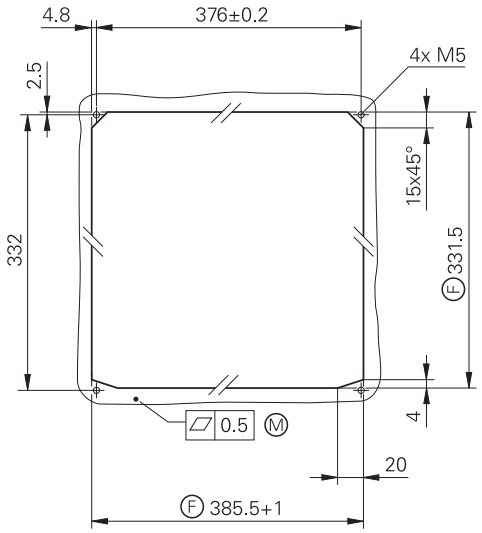
mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm









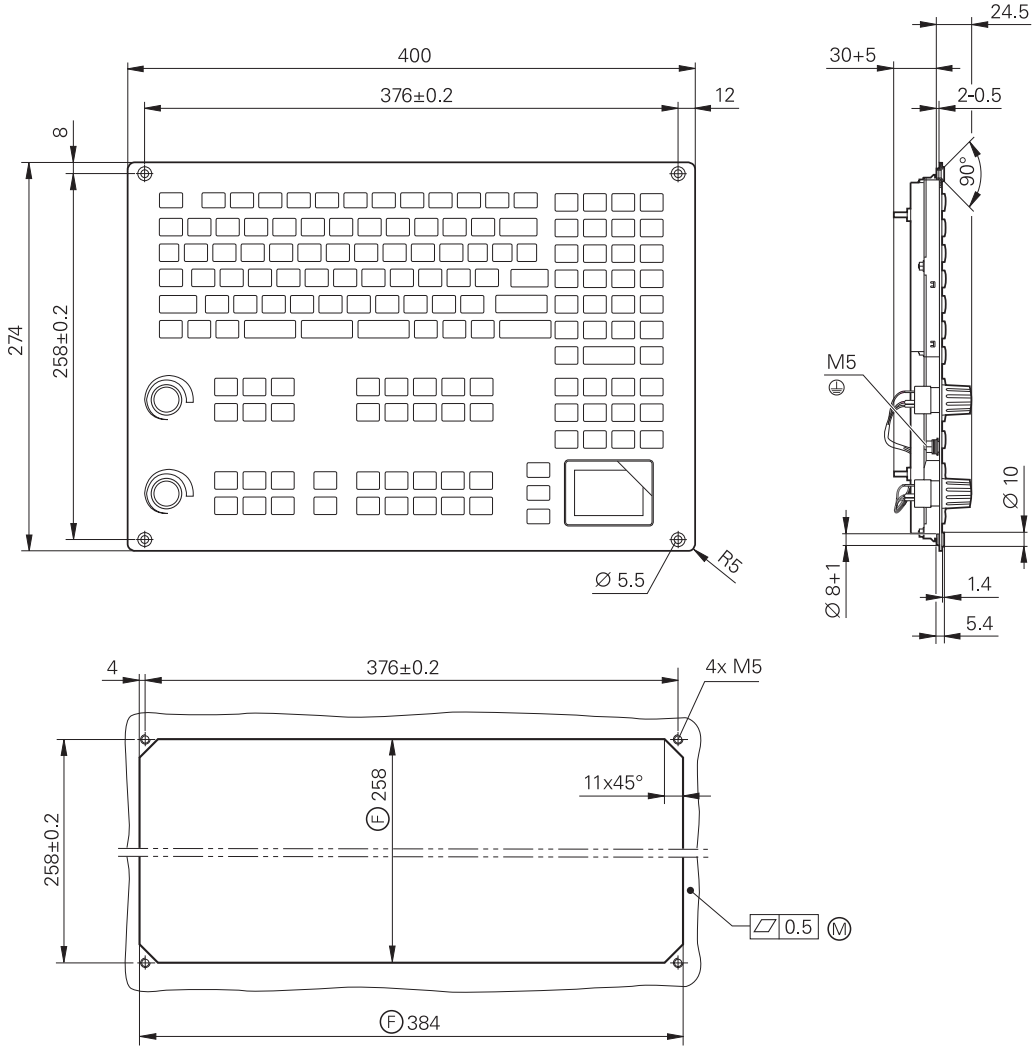
Ⓕ = Front panel opening
Ⓜ = Mounting surface
Ⓑ = Space for air circulation

TE 720, TE 730

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

TE 720 B: Without touchpad
TE 730 B: With touchpad

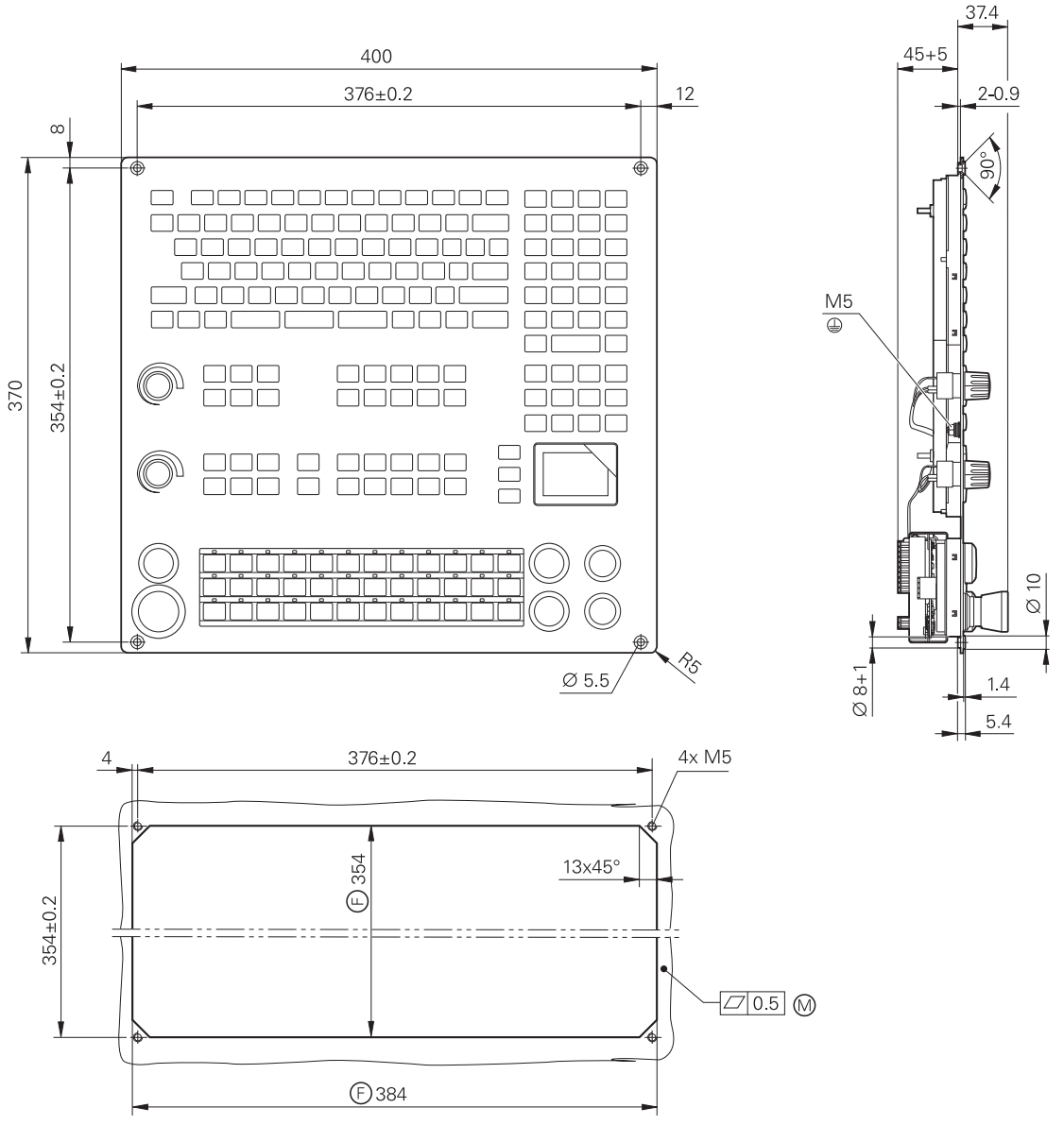


Ⓕ = Front panel opening
Ⓜ = Mounting surface

TE 735

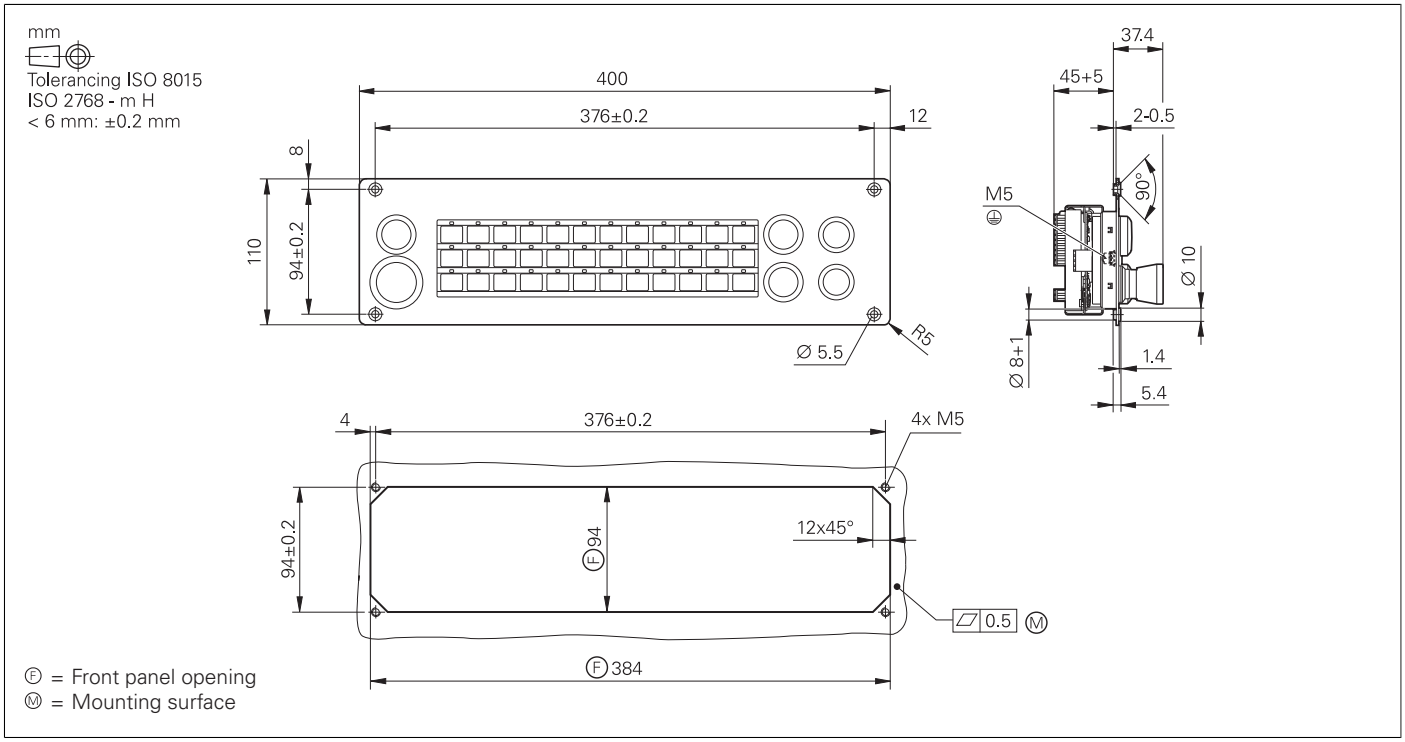
mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

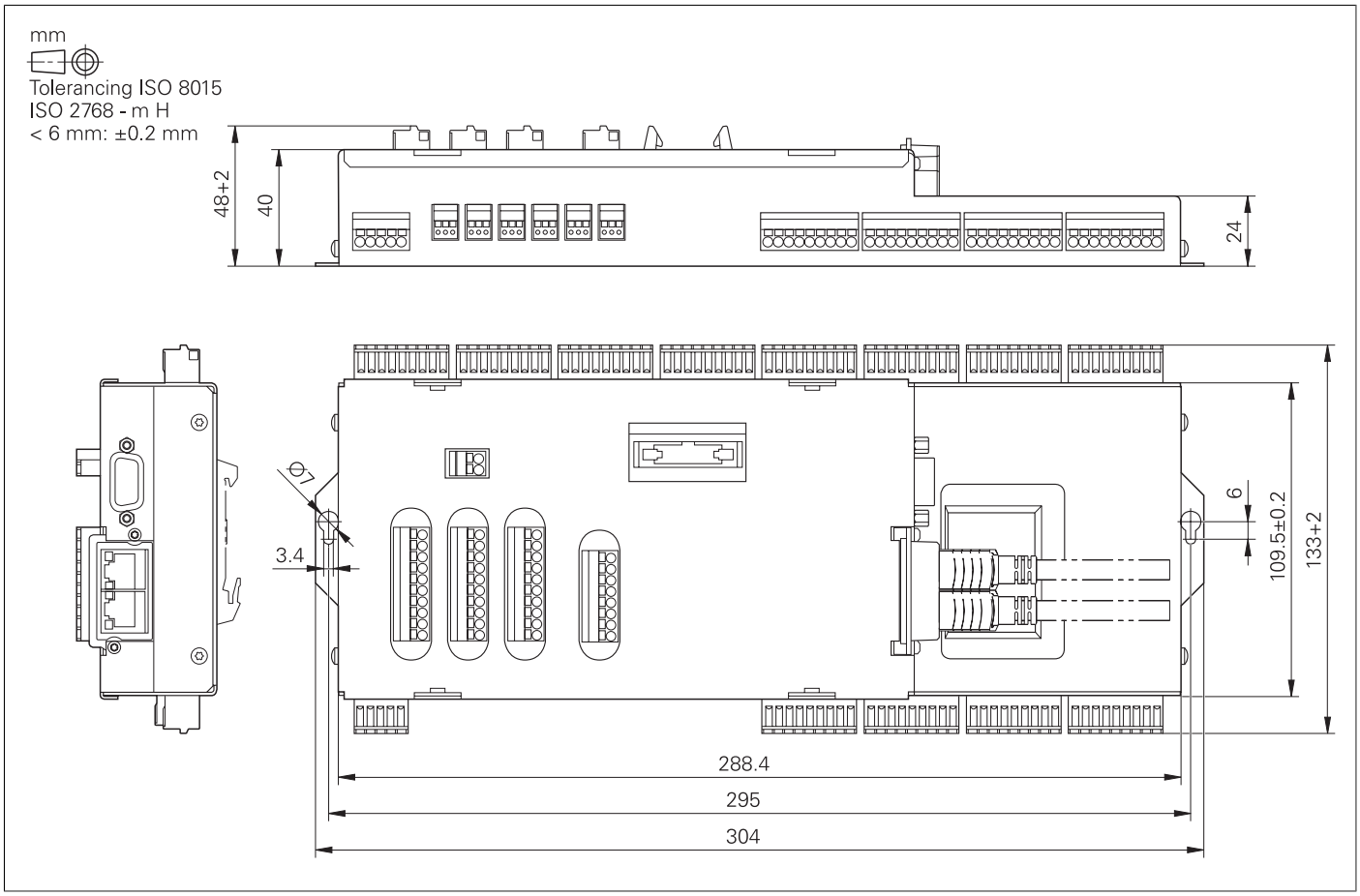


Ⓕ = Front panel opening
Ⓜ = Mounting surface

MB 720

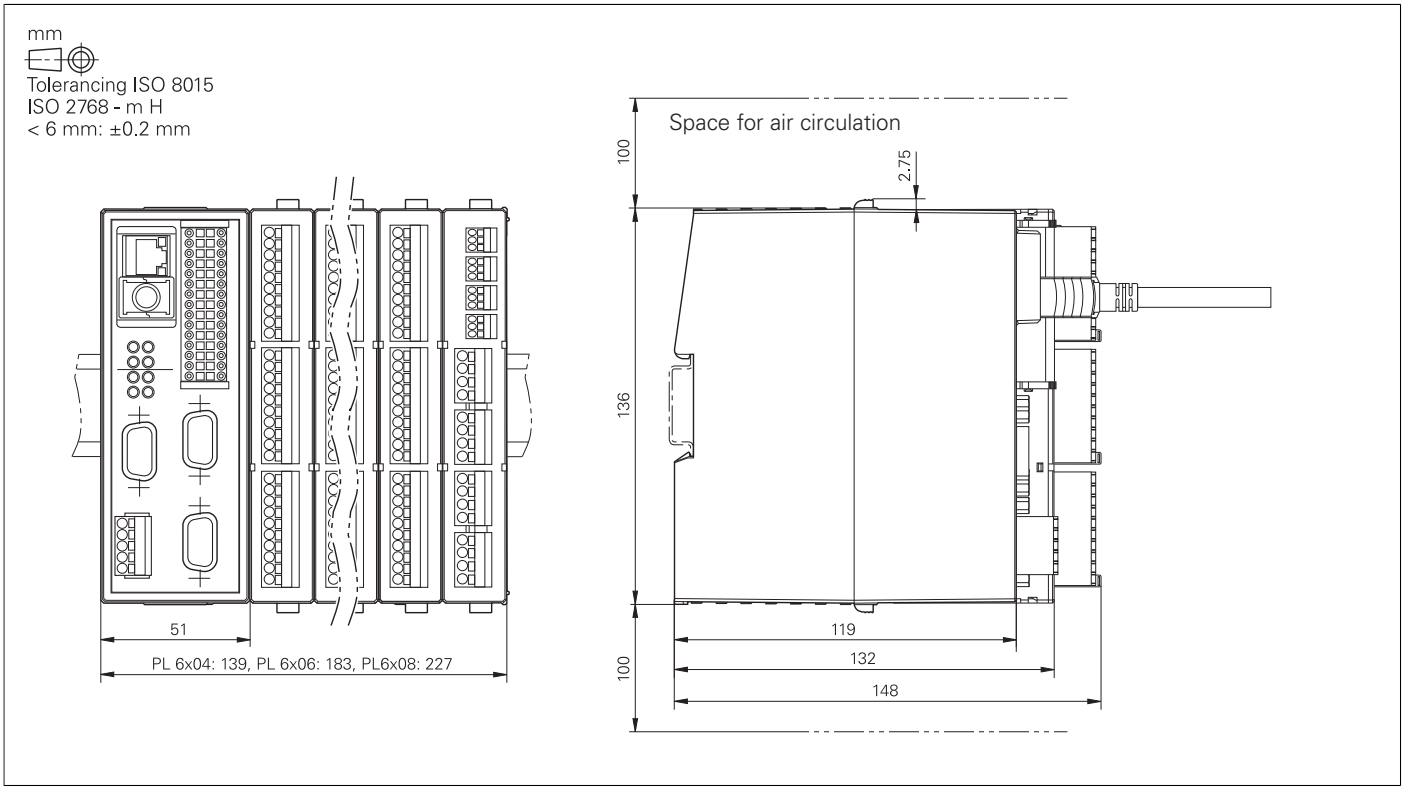


PLB 600x



PLC inputs and outputs

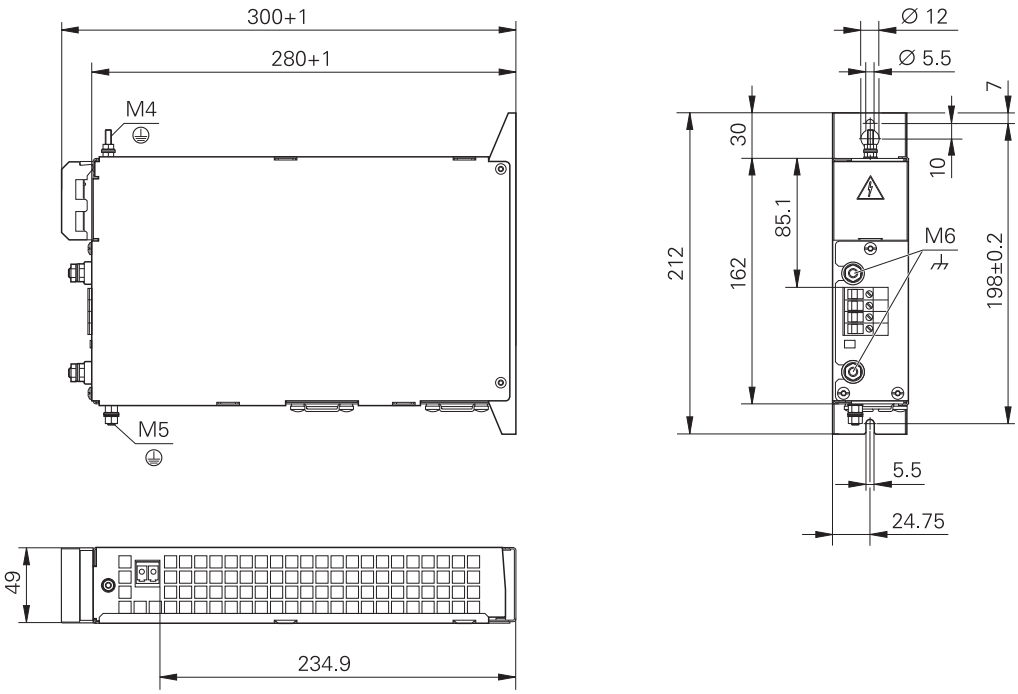
PL 6000 (PLB 62xx, PLB 61xx)



Power supply units

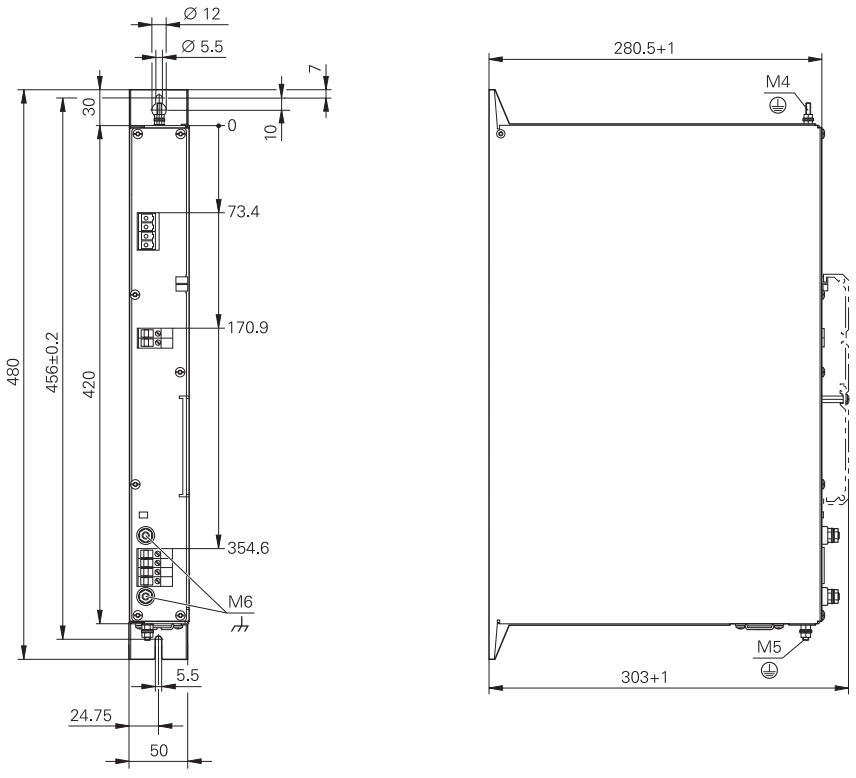
PSL 130

mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



PSL 135

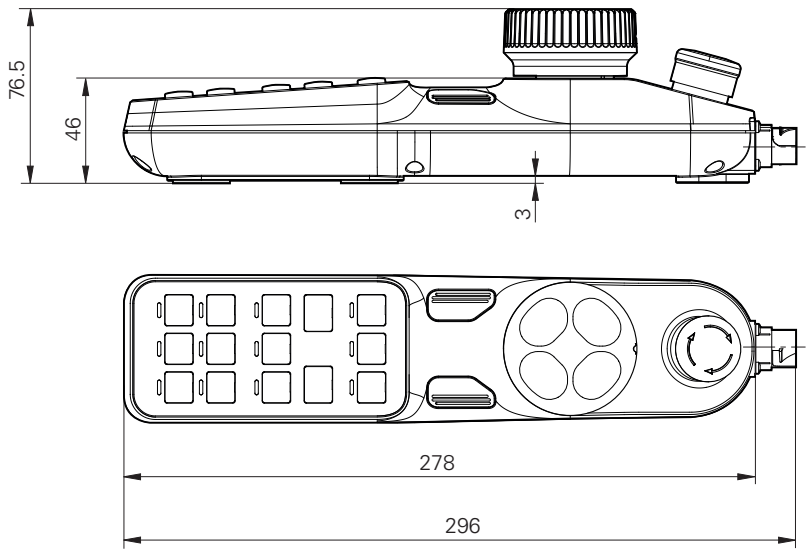
mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



Electronic handwheels

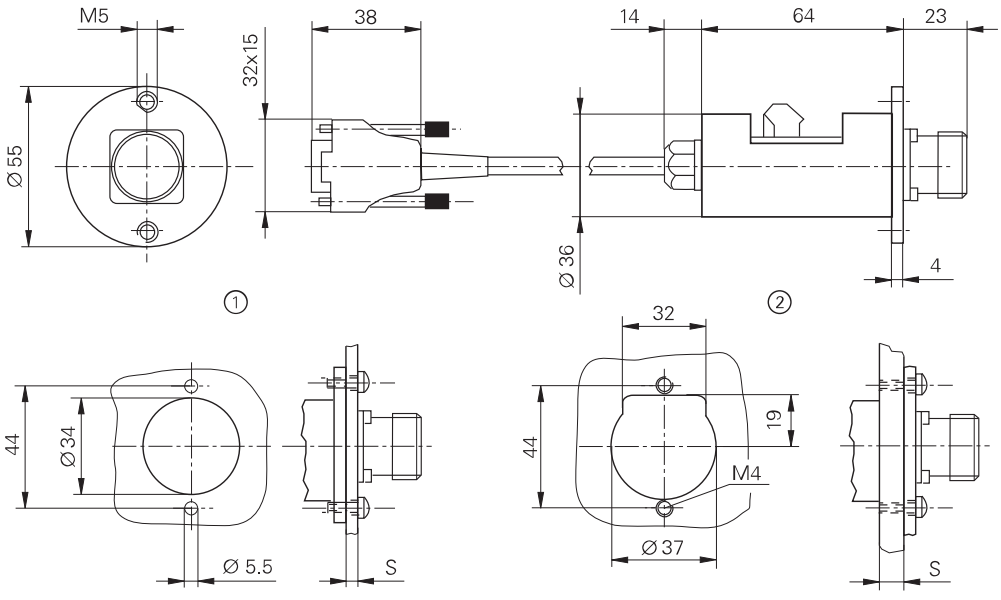
HR 510

mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



Adapter cable for HR 510 and HR 520

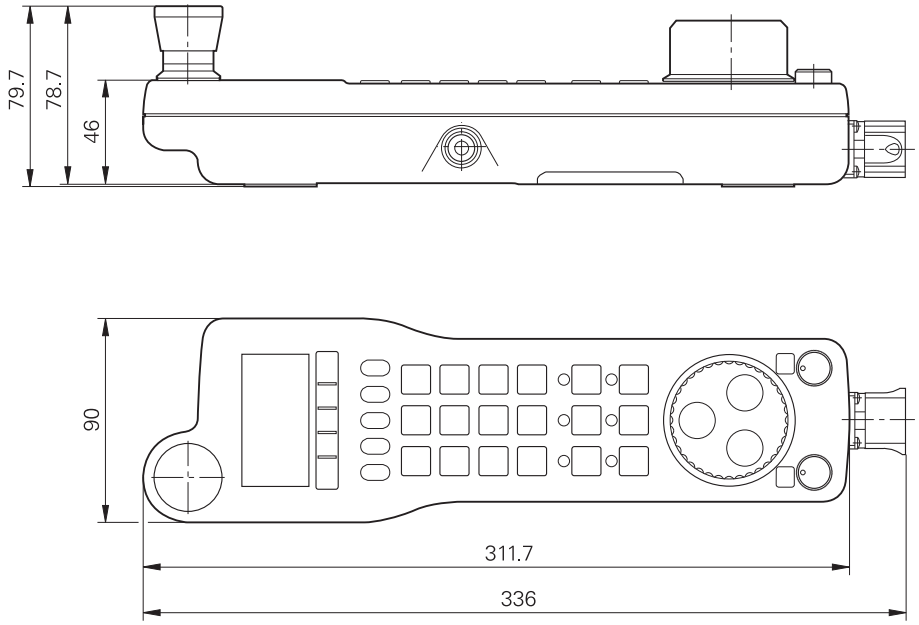
mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



① Mounting opening for wall thickness S = 4 or more
② Mounting opening up to wall thickness S = 4

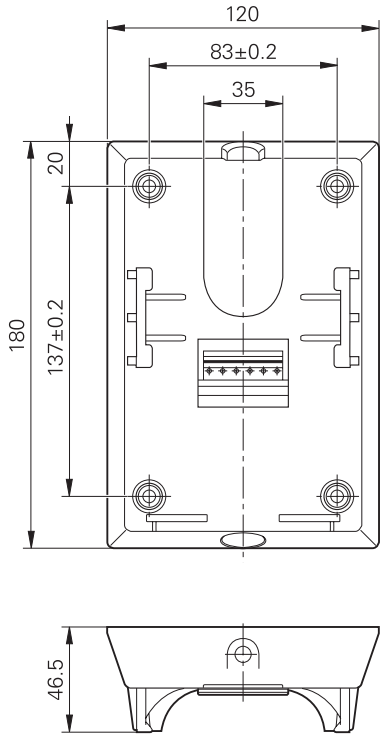
HR 520

mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



Mount for HR 520

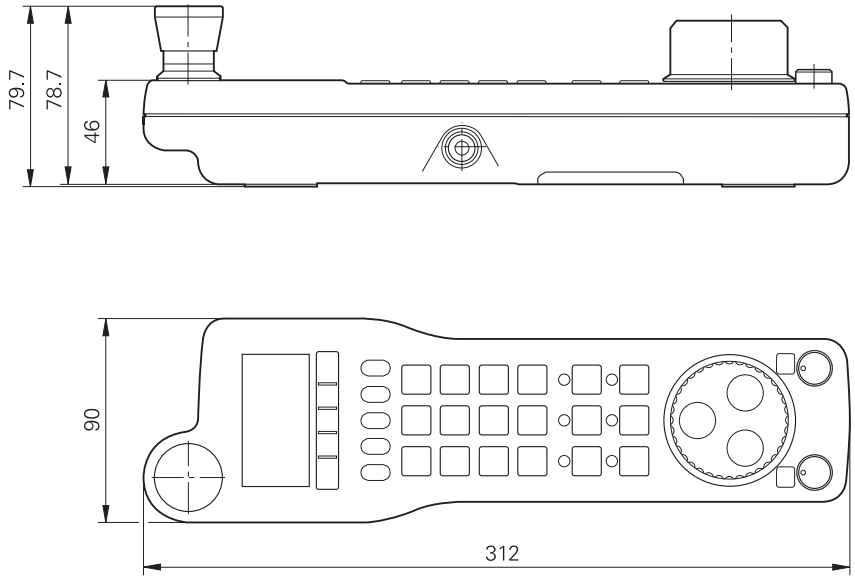
mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



HR 550 FS

mm

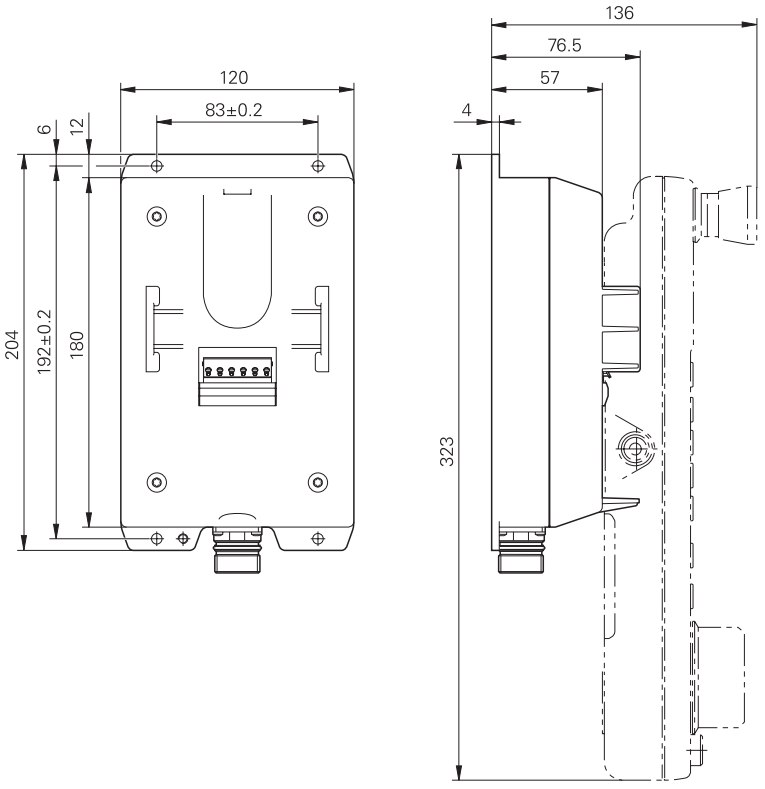
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



HRA 551 FS

mm

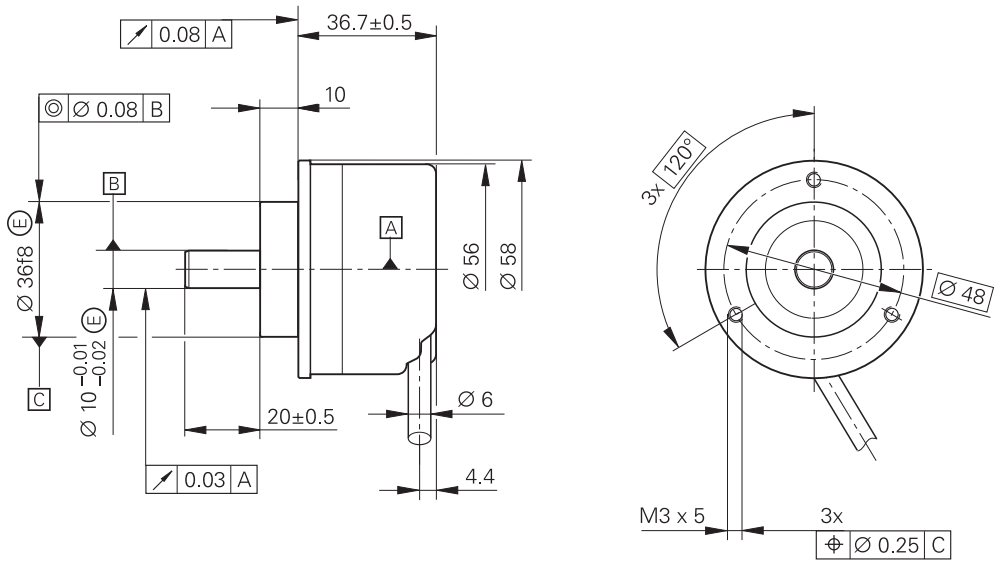
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

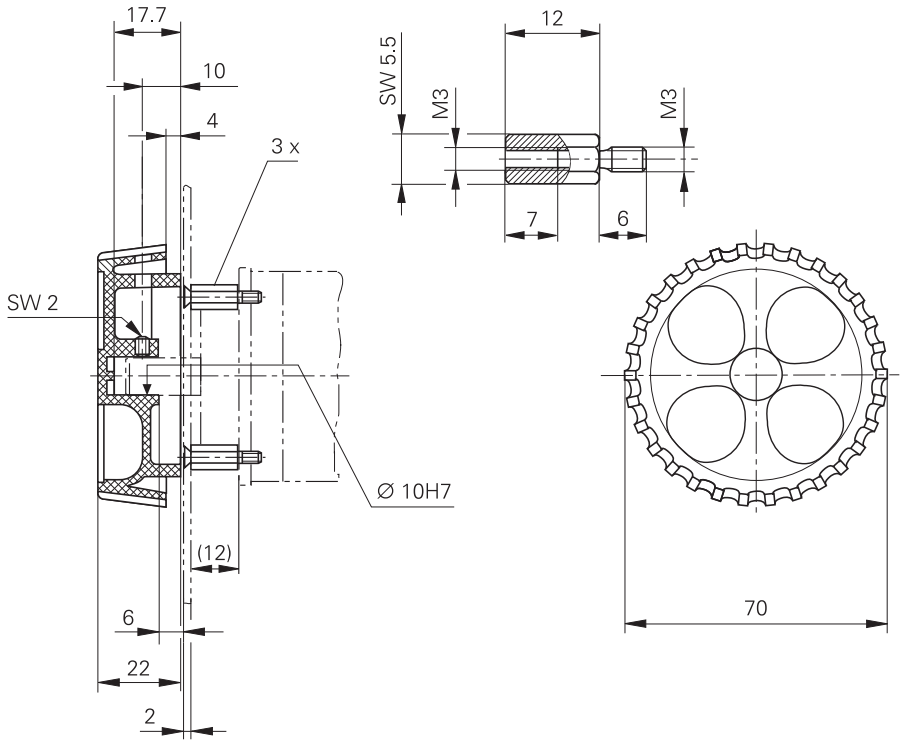


HR 130, HR 150 with control knob

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

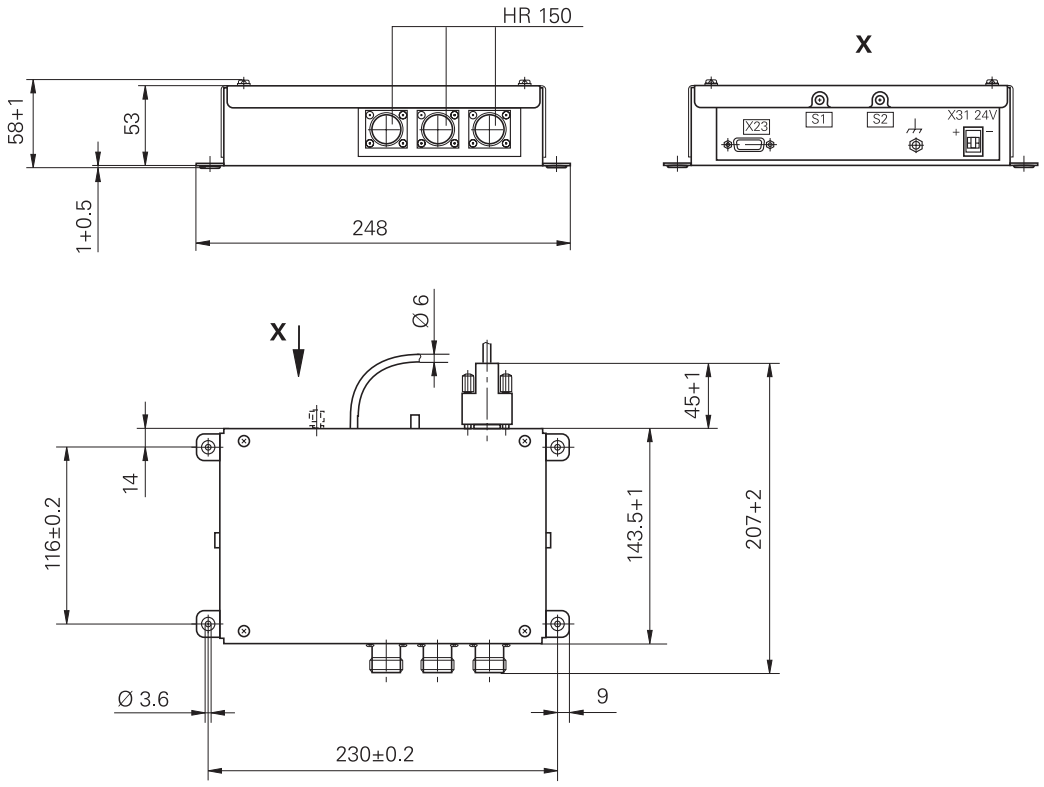




HRA 110

mm

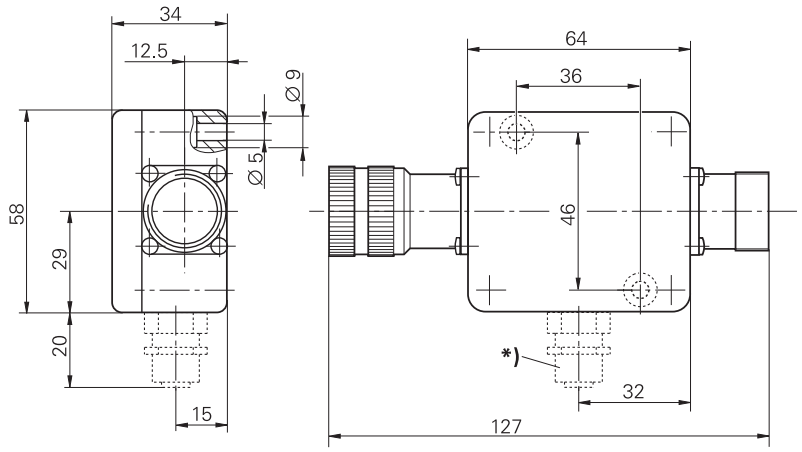
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



Interface accessories

Line-drop compensator for encoders with EnDat interface

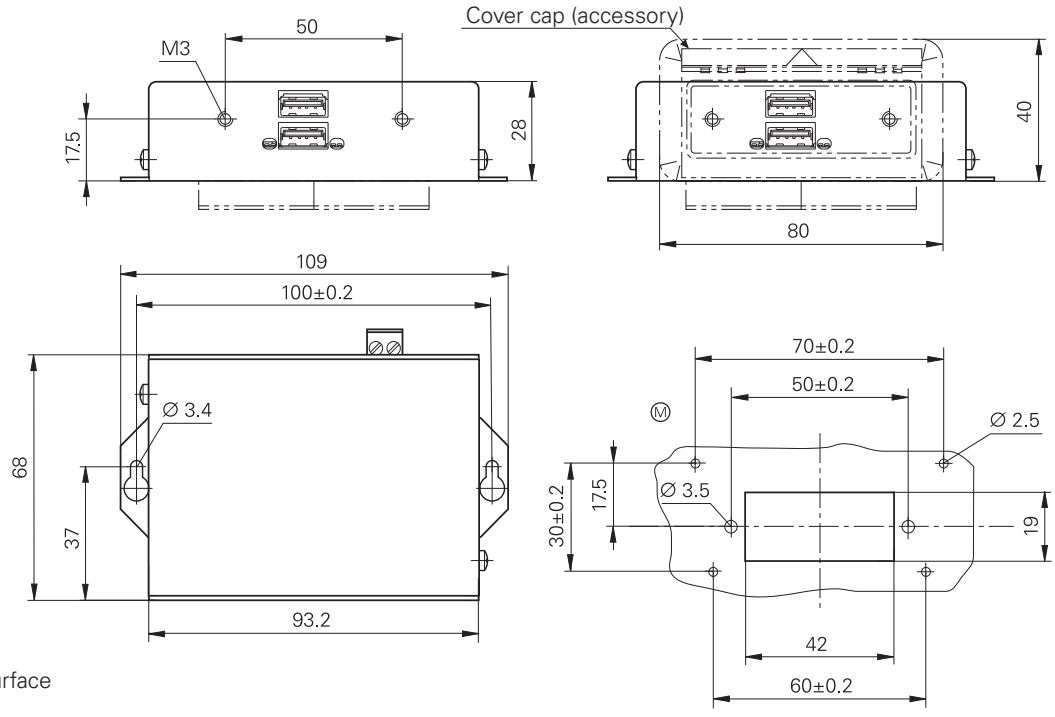
mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



*) Connection to KTY

USB hub

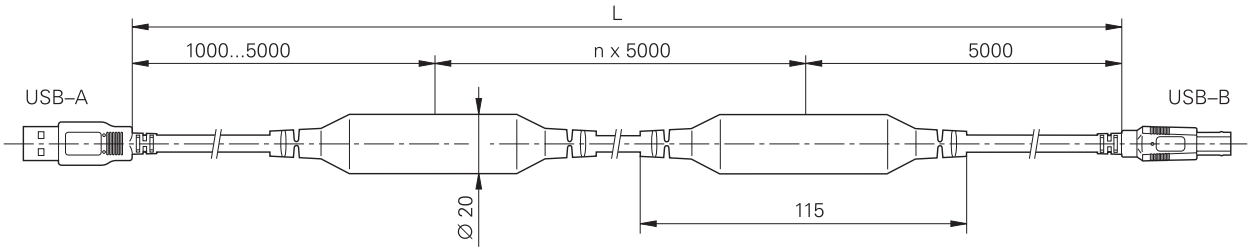
mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



Ⓜ = Mounting surface

USB extension cable with hubs

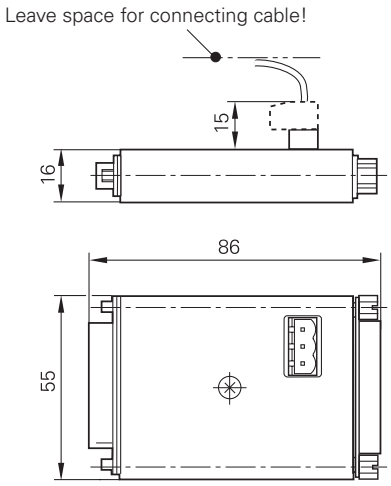
mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



n = 0 ... 4
L = Ordering length

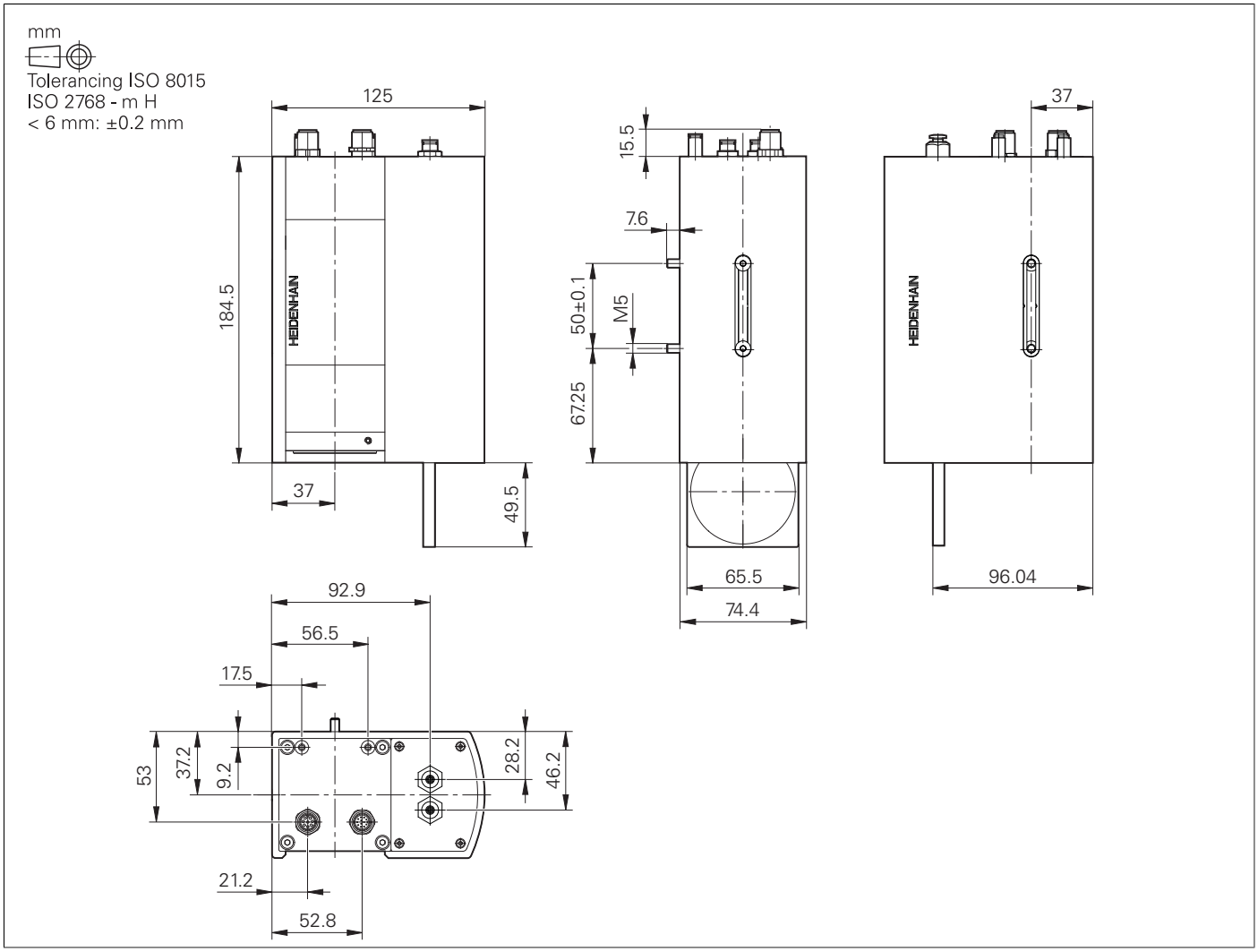
KTY adapter connector

mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



Camera system

VS 101



General information
Documentation

Technical documentation	• **TNC 640** Technical Manual	ID 892899-xx; in PDF format on HESIS-Web including Filebase
	• **PNC 610** Technical Manual	ID 1191125-xx; in PDF format on HESIS-Web including Filebase
	• **Inverter Systems and Motors** Technical Manual	ID 208962-xx
	• **Functional Safety FS** Technical Manual	ID 749363-xx
	• **TS 260** Mounting Instructions	ID 808652-9x
	• **TS 460** Mounting Instructions	ID 808653-9x
	• **TS 444** Mounting Instructions	ID 632757-9x
	• **TS 642** Mounting Instructions	ID 666024-9x
	• **TS 740** Mounting Instructions	ID 632761-9x
	• **TT 160** Mounting Instructions	ID 808654-xx
	• **TT 460** Mounting Instructions	ID 808655-xx
User - documentation	**TNC 640**	
	• **HEIDENHAIN Conversational Programming** User's Manual	ID 892903-xx
	• **Cycle Programming** User's Manual	ID 892905-xx
	• **DIN/ISO Programming** User's Manual	ID 892909-xx
	Miscellaneous	
	• **TNCremo** User's Manual	As integrated help
	• **TNCremoPlus** User's Manual	As integrated help
	• **PLCdesign** User's Manual	As integrated help
	• **CycleDesign** User's Manual	As integrated help
	• **IOconfig** User's Manual	As integrated help
	• **KinematicsDesign** User's Manual	As integrated help
	• **M3D Converter** User's Manual	As integrated help
Other documentation	• **TNC 640** brochure	ID 892916-xx
	• **Functions of the TNC 640** Brochure	ID 1110731-xx
	• **Touch Probes** brochure	ID 1113984-xx
	• **Inverter Systems** brochure	ID 622420-xx
	• **Motors** brochure	ID 208893-xx
	• **HEIDENHAIN DNC** brochure	ID 628968-xx
	• **Remote Diagnosis with TeleService** Product Overview	ID 348236-xx
	• **Touch Probes** CD-ROM	ID 344353-xx
	• **TNC 640 Programming Station Demo Version** CD-ROM	ID 825164-xx
	• **HR 550FS** Product Information	PDF
	• Technical Information: **Safety-Related Control Technology**	PDF
	• Technical Information: **Safety-Related Position Measuring Systems**	PDF
	• Technical Information: **Uniformly Digital**	PDF
Safety parameters	For HEIDENHAIN products (such as control components, encoders or motors), the safety characteristics (such as failure rates, statements on fault exclusion) are available on product-specific request from your HEIDENHAIN contact person.	

Service and training

Technical support

HEIDENHAIN offers the machine manufacturer technical support to optimize the adaptation of the TNC to the machine, including on-site support.

Exchange control system

In the event of a fault, HEIDENHAIN guarantees the rapid supply of a replacement control system (usually within 24 hours in Europe).

Helpline

Our service engineers are naturally at your disposal by telephone if you have any questions on the interfacing of the control or in the event of faults:

NC support	+49 8669 31-3101 E-mail: service.nc-support@heidenhain.de
PLC programming	+49 8669 31-3102 E-mail: service.plc@heidenhain.de
NC programming	+49 8669 31-3103 E-mail: service.nc-pgm@heidenhain.de
Encoders / machine calibration	+49 8669 31-3104 E-mail: service.ms-support@heidenhain.de
APP programming	+49 8669 31-3106 E-mail: service.app@heidenhain.de

If you have questions about repairs, spare parts or exchange units, please contact our Service Department:

Service, national	+49 8669 31-3121 E-mail: service.order@heidenhain.de
Customer service, international	+49 8669 31-3123 E-mail: service.order@heidenhain.de

Machine calibration

On request, HEIDENHAIN engineers will calibrate your machine's geometry, e.g. with a KGM grid encoder.

Technical courses

HEIDENHAIN provides technical customer training in the following subjects:

- NC programming
- PLC programming
- TNC optimization
- TNC service
- Encoder service
- Special training for specific customers

For more information on dates, registration, etc. call in Germany:
+49 8669 31-2293 or 31-1695
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E-mail: mtt@heidenhain.de
training.heidenhain.de

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