HEIDENHAIN

TNC 320

The Compact Contouring Control for Milling, Drilling and Boring Machines

Information for the Machine Tool Builder

TNC contouring control from HEIDENHAIN
General information

TNC 320

- Compact contouring control for **milling, drilling and boring machines**
- Axes: 6 control loops, of which up to 2 are configurable as spindles
- Analog nominal-value interface to the drives (± 10 V)
- Compact design: Screen, keyboard and main computer all in one unit
- Dimensions: 400 mm x 470 mm x 105 mm
- Integrated 15-inch TFT color flat-panel display
- Storage medium for NC programs: CompactFlash memory card
- Programming in HEIDENHAIN conversational format
- Standard milling, drilling and boring cycles
- Touch probe cycles
- Short block processing time

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:
- 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 320 with NC software version
771851-04 (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.

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Accessories

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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	20
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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	19
PLC input/output system	For additional internal PLC inputs and outputs **PL 510** consisting of PLB 51x basic module and I/O modules	17
USB hub	✓	46
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]
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[1] New generation of touch probes
[2] For more information, refer to the *TNC Programming Station* brochure.

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[1] Available to registered customers for downloading from the Internet
[2] Available to all customers (without registration) for downloading from the Internet

Specifications

Specifications	TNC 320	Page
Axes	6 control loops, of which up to 2 are configurable as spindles	30
PLC axes	✓	30
Central drive	✓	30
Open-loop axes	✓	30
Spindle	*Milling:* Max. 2; second spindle can be controlled by PLC alternately with the first	
Analog nominal speed value	Up to 100 000 rpm	32
Digital control over PLC outputs	✓	
Position-controlled spindle	✓	32
Oriented spindle stop	✓	32
Gear shifting	✓	32
NC program memory	1.8 GB	
Input resolution and display step		
Linear axes	0.1 µm	30
Rotary axes	0.0001°	30
Interpolation		
Straight line	4 of 5 axes	
Circular	2 of 5 axes	
Helical	✓	
Axis feedback control	Analog speed command interface ± 10 V (X8)	34
With following error	✓	
With feedforward	✓	
Cycle times		
Block processing	3 ms	34
Path interpolation	3 ms	
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	

Interfacing to the machine

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Error compensation	✓	37
Linear axis error	✓	37
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Backlash	✓	37
Hysteresis	✓	37
Thermal expansion	✓	37
Static friction	✓	37
Sliding friction	✓	37
Integrated PLC	✓	41
Program format	Statement list	41
Program input at the control	By external USB keyboard	41
Program input by PC	✓	41
Symbolic PLC-NC interface	✓	41
PLC memory	350 MB	41
PLC cycle time	9 ms to 30 ms (adjustable)	41
PLC inputs, DC 24 V[1]	31 (expandable via PL); additional 25 on the machine operating panel	17
PLC outputs, DC 24 V[1]	31 (expandable by PL)	17
Inputs for PT 100 thermistors	Via PL	17
PLC functions	✓	41
Small PLC window	✓	41
PLC soft keys	✓	41
PLC positioning	✓	42
PLC basic program	✓	43
Integration of applications		42
High-level language programming	Python programming language used in combination with the PLC (option 46)	42
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.	42

[1] Further PLC inputs/outputs over PL 510 for connection to MC

Interfacing to the machine	TNC 320	Page
Commissioning and diagnostic aids		38
ConfigDesign	Software for creating the machine configuration	38
Integrated oscilloscope	✓	38
Trace function	✓	39
API DATA function	✓	39
Table function	✓	39
OLM (online monitor)	✓	39
Log	✓	39
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Data interfaces	✓	
Ethernet	1000BASE-T	45
USB	*Rear:* 2 x USB 3.0 *Front:* USB 2.0	45
RS-232-C	✓	45
Protocols		45
Standard data transfer	✓	45
Blockwise data transfer	✓	45
LSV2	✓	45
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Position	4 (optional: 6)	33
Incremental	1 V_{PP}	33
Absolute	EnDat 2.1	33

[1] Further PLC inputs/outputs over PL 510 for connection to MC

User functions

User function	Standard	Option	TNC 320
Short description	✓	0 1	Basic version: 3 axes plus closed-loop spindle 1st additional axis for 4 axes plus closed-loop or open-loop spindle 2nd additional axis for 5 axes plus closed-loop or open-loop spindle
Program entry	✓ ✓		HEIDENHAIN conversational DIN/ISO via soft keys or via external USB keyboard
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)
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
Rotary table machining		8 8	Programming of cylindrical contours as if in two axes Feed rate in distance per minute
Contour elements	✓ ✓ ✓ ✓ ✓ ✓ ✓		Straight line Chamfer Circular path Circle center Circle radius Tangentially connecting circular arc Corner rounding
Contour approach and departure	✓ ✓		Via straight line: tangential or perpendicular Via circular arc
FK free contour programming	✓		FK free contour programming in HEIDENHAIN conversational format with graphic support for workpiece drawings not dimensioned for NC
Fixed cycles	✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓		Drilling, conventional and rigid tapping Rectangular and circular pockets Face milling Peck drilling, reaming, boring, counterboring, centering Milling internal and external threads Clearing level and oblique surfaces Multi-operation machining of straight and circular slots Multioperation machining of rectangular and circular pockets, and rectangular and circular studs Cartesian and polar point patterns Contour train, contour pocket Engraving cycle: Engrave text or numbers in a straight line or on an arc OEM cycles (special cycles developed by the machine tool builder) can be integrated

User function	Standard	Option	TNC 320
Program jumps	✓ ✓ ✓		Subprograms Program section repeats Calling any program as a subprogram
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, angle α of sin α and cos α, 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
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 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 / 3-D line graphics Magnification of details
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	✓		For saving any reference points
Datum tables	✓		Several datum tables for storing workpiece-related datums
Touch probe cycles	✓ ✓ ✓ ✓		Calibrating the touch probe Compensation of workpiece misalignment, manual or automatic Reference-point setting, manual or automatic Automatic tool and workpiece measurement
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
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 771851-	ID	Remark	Page
0	Additional axis 1	01	ID 354540-01	Additional control loop 1	14
1	Additional axis 2	01	ID 353904-01	Additional control loop 2	14
8	Advanced function set 1	01	ID 536164-01	**Rotary table machining** • Programming of cylindrical contours as if in two axes • Feed rate in distance per minute	30
				Coordinate transformation • Tilting the working plane, PLANE function	31
				Interpolation • Circular in 3 axes with tilted working plane	
18	HEIDENHAIN DNC	01	ID 526451-01	Communication with external PC applications over COM component	
24	Gantry axes	01	ID 634621-01	Gantry axes in master-slave torque control	31
42	DXF converter	01	ID 526450-01	Load and convert DXF contours	
46	Python OEM process	01	ID 579650-01	Execute Python applications	42
93	Extended tool management	02	ID 676938-01	Extended tool management	
133	Remote Desktop Manager	04	ID 894423-01	Display and remote operation of external computer units (e.g. a Windows PC)	47

Control components

Main computer

TNC 320

The standard version of the TNC 320 features four inputs for position encoders. It can be enhanced with options.

The TNC 320 includes the MC 321 main computer with:
- Intel Celeron 1047 processor (1.4 GHz, dual-core)
- 2 GB SDRAM main memory
- 15-inch TFT color flat-panel display; resolution 1024 x 768 pixels
- TNC keyboard
- PLC
- Interface to handwheel and touch probes
- Further interfaces (PLC expansion, Ethernet, USB 2.0 on front, 2 x USB 3.0 on rear, RS-232-C/V.24

To be ordered separately, and installed in the main computer by the OEM:
- **CFR** CompactFlash memory card with the NC software
- The **System Identification Key component**(SIK) for enabling control loops and options
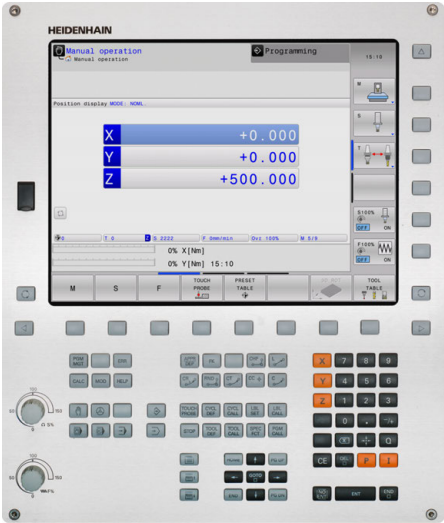
MC 321	Position inputs	4 x 1 V_{PP} or EnDat
		(optional 5 x 1 V_{PP} or EnDat)
	Mass	8 kg
		ID 824012-xx

| Power supply | Supply voltage[1] | 24 V DC |
| | Power consumption | 60 W |

[1] PELV according to EN 61800-5-1 for low voltage electrical separation

Memory medium

The storage medium is a CFR (= CompactFlash Removable) compact flash memory card. It contains the NC software and is used to store NC and PLC programs. The storage medium is removable and must be ordered separately from the main computer.

Please note: These CFRs use the fast SATA protocol (CFast) for significantly shorter access times.

CFR CompactFlash 8 GB
Free capacity for NC programs	1.8 GB
Free capacity for PLC programs	350 MB
No export license required	ID 1097497-54

CFR CompactFlash

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 loopscan 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.
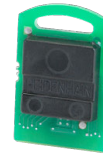
SIK component

| Master keyword (General Key) | For commissioning the TNC 320, 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.
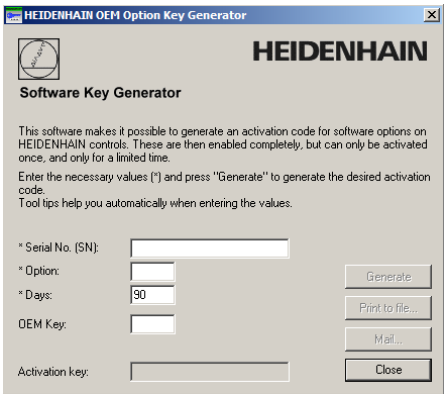
NC software license

SIK with software license and enabling for

| **4 control loops** (3 axes plus closed-loop spindle) | ID 533093-51 |
| **5 control loops** (4 axes plus closed-loop spindle) | ID 533093-52 |

Axis options

With the NC software license for three axes, two additional control loops can be enabled later:

| **1st additional axis** | ID 354540-01 |
| **2nd additional axis** | ID 353904-01 |

Encoder input board

An additional encoder input board is required for axis configurations with four or more axes plus closed-loop spindle.

| **Encoder input board** | ID 554296-xx |
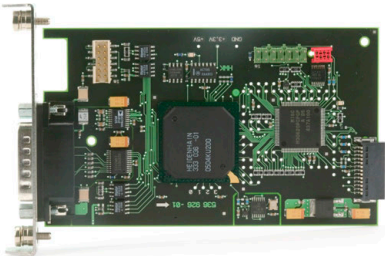
Possible configurations	Closed-loop axes	Spindle[1]	NC software license for	Necessary options
	3	Closed loop	4 control loops	–
	4	Open loop	4 control loops	1st additional axis
			5 control loops	–
	4	Closed loop	4 control loops	1st additional axis Encoder input board
			5 control loops	Encoder input board
	5	Open loop	4 control loops	1st additional axis 2nd additional axis Encoder input board
			5 control loops	2nd additional axis Encoder input board
	5	Closed loop	4 control loops	1st additional axis 2nd additional axis 2 encoder input boards
			5 control loops	2nd additional axis 2 encoder input boards

[1] For the *open-loop spindle,* the TNC specifies the spindle speed as analog nominal speed value. For the *closed-loop spindle*, position feedback is provided, for example for oriented spindle stop.

Options

The capabilities of the TNC 320 can also be adapted retroactively with options to meet new requirements. These options are described on page 11. 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.

TNC keyboard

The keys for the Z axis, axis IV and V are designed as snap-on keys and can be replaced by keys with other symbols (see Snap-on keys).

Export license

An **export license** is generally **not** required for the TNC 320 because the NC software limits the number of interpolatable axes to four. The 5th axis can be used for the spindle or as an auxiliary axis.

Machine operating panel

MB 521 machine operating panel

- 36 exchangeable snap-on keys, freely definable via PLC
- Operating elements
  12 axis keys, 18 function keys, NC start[1], NC stop[1], spindle start, spindle stop (snap-on)
  emergency stop, control voltage On[1]
  2 holes for additional keys or keylock switches
- Additional connections:
  Terminals for 7 PLC inputs and 8 PLC outputs

[1] Keys illuminated, addressable via PLC

MB 521	ID 823882-xx
Mass	≈ 1 kg

MB 521

PL 510 PLC input/output system

PL 510

If the PLC inputs/outputs of the control do not suffice, you can connect additional PL 51x PLC input/output systems. These external modular I/O systems consist of a PLB 51x basic module and one or more PLD 16-8 and PLA 4-4 input/output modules.

PL 510

Basic modules

Basic modules feature slots 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   ≈ 20 W
Mass   0.36 kg (bare)

Basic modules with HEIDENHAIN PLC interface
PLB 510   Slots for 4 I/O modules   ID 358849-01
PLB 511   Slots for 6 I/O modules   ID 556941-01
PLB 512   Slots for 8 I/O modules   ID 557125-01

Up to four PLB 510 modules, and up to two PLB 511 or PLB 512 modules can be connected to the control. The maximum cable length to the last PLB 51x is 30 m.

I/O modules

The I/O modules consist of one module with digital inputs/outputs and one analog module. For partially occupied basic modules, the unused slots must be occupied by an empty housing.

PLD 16-8   ID 360916-11
I/O module for PL 5x0 with
16 digital inputs and
8 digital outputs.
The maximum power output per module is 200 W. A load of up to 2 A can be placed on each output. No more than four outputs may be loaded with 2 A at any given time.
Mass   0.2 kg

PLA 4-4   ID 366423-01
Analog module for PL 5x0 with
4 analog inputs for PT 100 thermistors
4 analog inputs for ± 10 V
Mass   0.2 kg

Empty housing   For unused slots   ID 383022-xx

Accessories
Touch probes

Overview

Before the TNC 320 leaves the factory, it is already prepared for the use of touch probes for workpiece or tool measurement. 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 19 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 19 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 320 has standard routines for measuring the length and diameter of the tool as well as the individual teeth. The TNC 320 automatically saves the results of measurement in a tool table. It is also possible to measure tool wear between two machining steps. The TNC 320 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 320.

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 320 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 320
- **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**

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. |

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

[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

	HR 510	HR 510 FS	HR 520	HR 520 FS	HR 550 FS with HRA 551 FS	
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 27.

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

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		Red ID 330816-47		ID 330816-48
	Green ID 330816-09		ID 330816-41		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		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 I	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

Symbol	ID	Symbol	ID	Symbol	ID	Symbol	ID
	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

Symbol	ID	Symbol	ID	Symbol	ID	Symbol	ID
	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	ENT	ID 679843-F5
	ID 679843-36		ID 679843-66		Black ID 679843-D2	PRT SC	ID 679843-F6
	ID 679843-37		ID 679843-75		ID 679843-D5		
△	ID 679843-38	NC I	Green ID 679843-90	NC 0	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
TNC 320

VL: Extension cable
 – for separation points with connecting cable
 – for extending existing connecting cable

Housing must be mounted

07.05.2014

60m

9m

~1Vpp

~1Vpp

~1Vpp

RCN 729
RCN 226
RCN 228

LC x83

60m

Transfer unit
251250-01

40m

298429-xx
298430-xx

310199-xx

309783-xx

LC x83

30m

1m

533631-xx max. 6m

Terminal box
251249 01

37-pin male connector
315650-07

635877-xx

635876-xx

557714-xx

15-pin male connector
315650-03

20m

290110-xx

290109-xx

VL
323897-xx

MB 521
823882-01

40m

X10

629633-xx

635876-xx

VL
635878-xx

635877-xx

X3

Analog output

PLC I/O

Position inputs

TNC 320

X46

X8

X41/X42

X1 ... X4

*) X5

X6

*) Input PCB for encoders
554296-02

27

Accessories

Technical description

Operating system

HEROS 5

The TNC 320 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 320 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 320 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 320 can control linear axes with any axis designation (X, Y, Z, U, V, W ...).
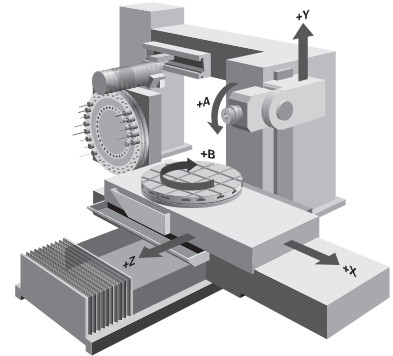
Display and programming	–99 999.9999 to +99 999.9999 [mm]
	Feed rate in mm/min relative to the workpiece contour, or mm per spindle revolution
	Feed rate override: 0 % to 150 %

Traverse range   –99 999.9999 to +99 999.9999 [mm]

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 320 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 [°]

Feed rate in degrees per minute [°/min]

Traverse range   –99 999.9999 to +99 999.9999 [°]

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).

Cylinder surface interpolation (option 8)

A contour defined in the working plane is machined on a cylindrical surface.
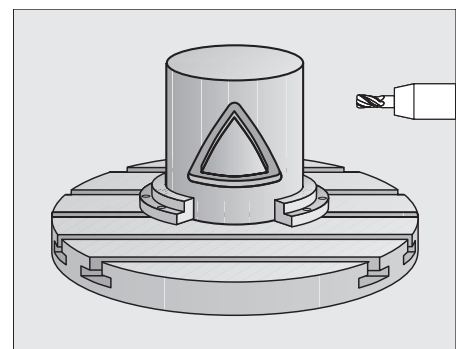
Tilting the working plane (option 8)

The TNC 320 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).
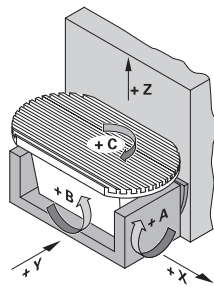
Tilting table
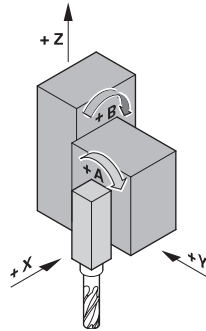
Swivel head

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.
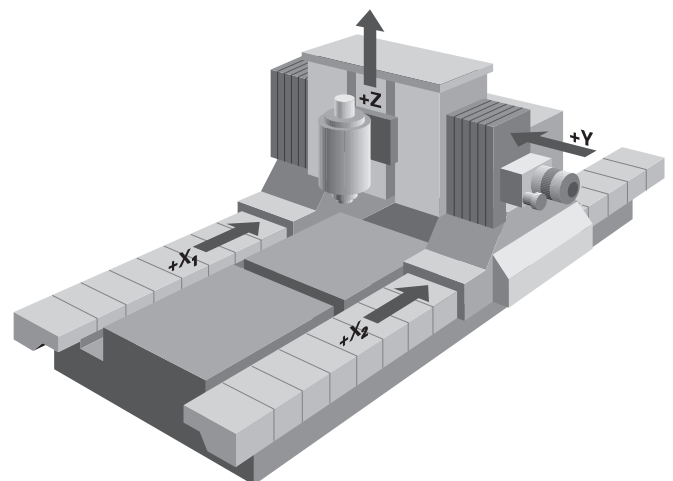
PLC axes

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.
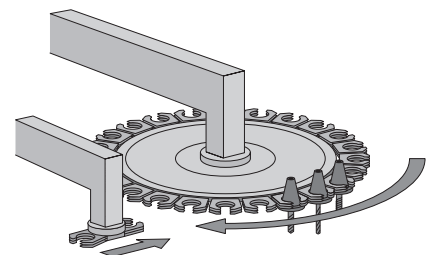
Spindle

Analog nominal speed value	Up to 100 000 rpm
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 stages are controlled by the PLC.
Multiple main spindles	Up to 2 spindles can be controlled alternately. The spindles are switched by the PLC. One control loop is required for each active spindle.

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 320 features the serial EnDat 2.1 interface 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 for position control

Incremental and absolute linear, angular or rotary encoders from HEIDENHAIN can be connected to encoder inputs of the TNC 320.
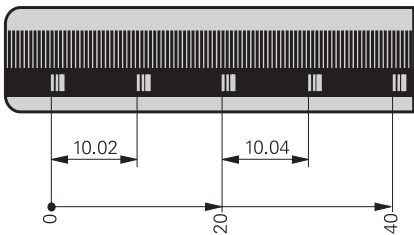
Channel inputs	Signal level/Interface[1]	Input frequency[1]
Incremental	~1 V_{PP}	33 kHz/350 kHz
Absolute	EnDat 2.1 ~1 V_{PP}	– 33 kHz/350 kHz

[1] Switchable

Servo control

Analog speed command interface

The position controller is integrated in the TNC 320. The motor speed controller and the current controller are located in the servo amplifier. The nominal speed command signal (= velocity) is sent by the TNC to the servo amplifier through an analog ±10 V interface (connection X8).
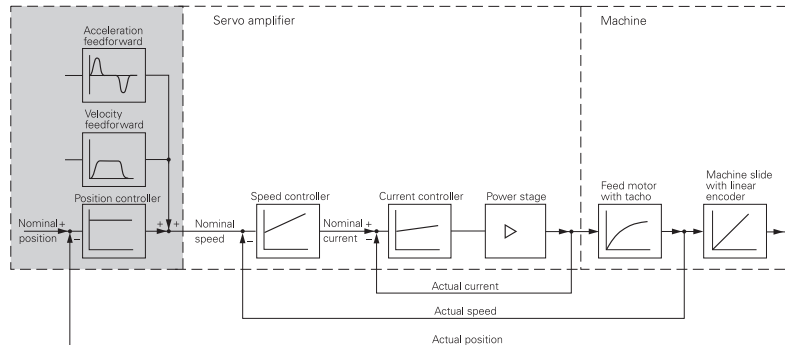
Axis feedback control

The TNC 320 can be operated with following error or feedforward control.

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). The feedforward is adjustable from 0 to 100 % via a machine parameter.

Central drive

It is possible to use one common drive for several or all machine axes. The NC software allows the user to use the same nominal position value output for more than one axis.

The most important basic requirements for realizing a machine with central drive:
- Common drive package with an analog nominal position value input for all axes
- The PLC must handle the machine axes as clamping axes
- The PLC monitors the drive regarding movement in multiple axes and outputs an error message if necessary

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 control-loop cycle time of the TNC 320 is 3 ms.

3 ms

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

Block processing time   When running long programs from the internal memory, the TNC has a short block processing time of only 3 ms. This means that the TNC can even mill contours made of 0.25 mm line segments at feed rates as high as 5 m/min.

Look-ahead   The TNC calculates the geometry ahead of time in order to adjust the feed rate. In this way, directional changes are detected in time to accelerate or decelerate the appropriate NC axes.

Open-loop axes   One or more axes can be defined as open-loop axes (manual axes, counter axes). They have position encoders for determining and displaying the current position value, but no nominal-value outputs. The target position is reached manually (e.g. through mechanical handwheels). If an NC block is reached with the non-controlled axis, a dialog window prompts the machine operator to move the axis to the nominal coordinates.

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
- Checksum of safety-related functions
- Supply voltage
- Buffer battery voltage
- Operating temperature of the MC and CPU
- Run time of the PLC program

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 320 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.

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.
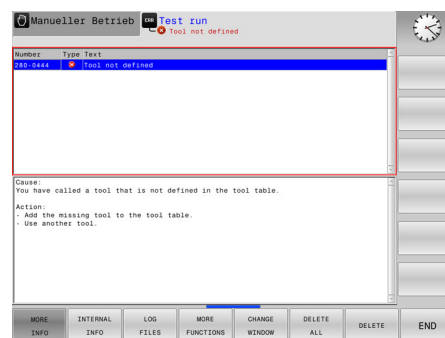
KinematicsDesign (accessory)

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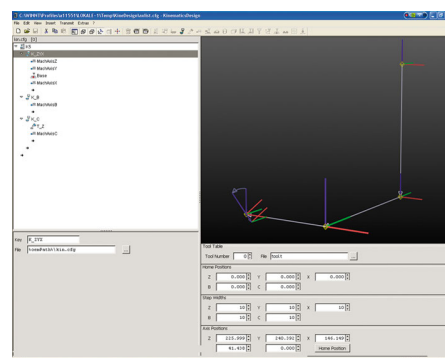
The comprehensive displaying possibilities range from a pure listing of the transformation chain to a wire model to the depiction of the entire work envelope on the TNC 640 and iTNC 530.

Error compensation

Overview　The TNC 320 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 320 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.
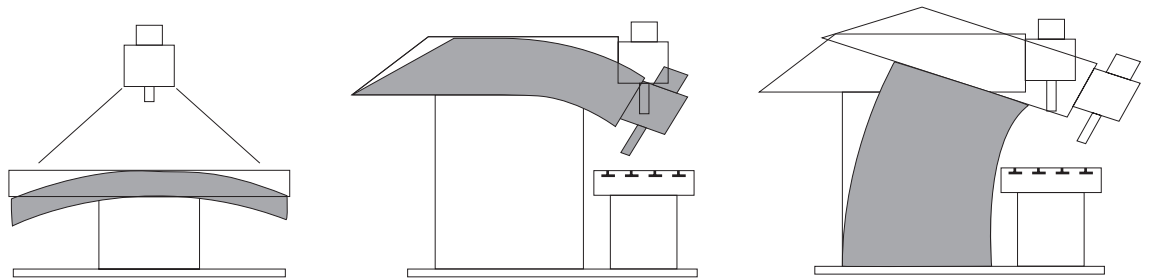
Backlash　The play between table movement and rotary encoder movement on direction changes can be compensated in length measurements by spindle and rotary encoder. This backlash is outside the controlled system.

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 320 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 320 can compensate for this problem condition.

Sliding friction　Sliding friction is compensated by the speed controller of the TNC 320.

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 320. The PLC evaluates the temperature information and transfers the compensation value to the NC.

Commissioning and diagnostic aids

Overview

The TNC 320 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)

Oscilloscope

The TNC 320 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 values for speed, acceleration and jerk
- Actual values for acceleration and jerk
- Nominal value of analog output
- Content of PLC operands
- Encoder signal (0° – A) and (90° – B)
- Nominal velocity value
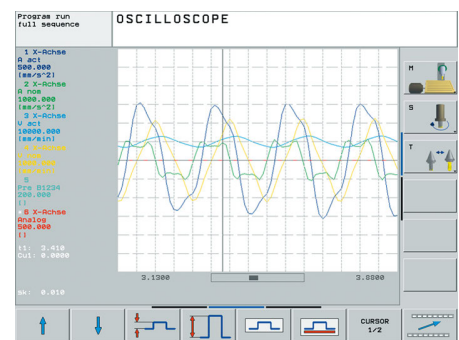
Logic signals

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)
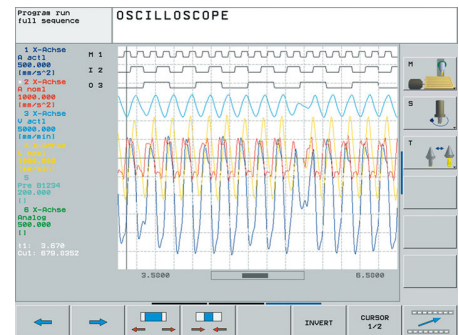
Commissioning wizard

In order to simplify the adaptation of the axes and spindle, the Commissioning Wizard for analog axes guides you step-by-step through the commissioning of any axis parameter set. You can define the following machine parameters with the aid of the commissioning wizard:
- Ascertain the algebraic sign of the axis
- Ascertain the axis traverse direction
- Ascertain the velocity with 9 V analog voltage
- Ascertain the maximum acceleration of the axis
- Ascertain the k_v factor of the axis
- Ascertain acceleration feedforward control for the axis

Online Monitor (OLM)	The online monitor is a component part of the TNC 320 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

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 (through an external PC keyboard with USB connection) 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 expansion
If the PLC inputs/outputs of the TNC 320 do not suffice, you can connect the external PLC input/output system PL 510.

Rated operating current
MC main computer: 0.15 A per output
PL 510: see *PL 510 PLC input/output systems*

PLC programming

Format	Statement list
Memory	350 MB
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.
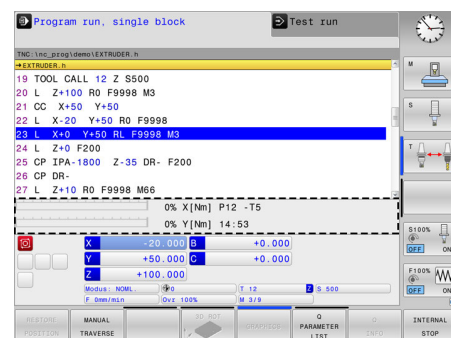
Small PLC window

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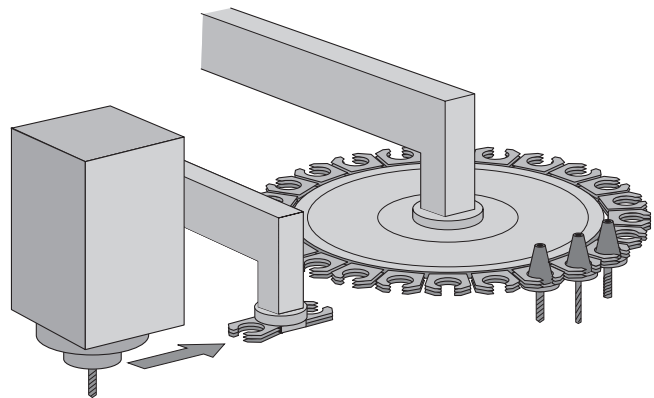
PLC axes   Axes can be controlled by the PLC. They are programmed by M functions or OEM cycles. The PLC axes are positioned independently of the NC axes.

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.
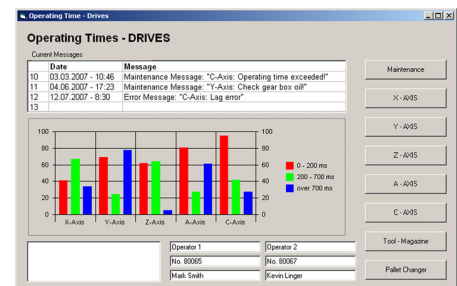
PLC basic program

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
- Feed rate control
- Spindle control and orientation
- Tool changer
- Vertical PLC soft-key row
- 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
- S-coded spindle
- 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 320.

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.
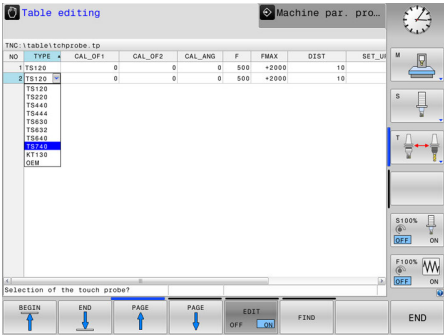
Data transfer and communication
Data interfaces

Overview	The TNC 320 is connected to PCs, networks and other data storage devices via data interfaces.
Ethernet	The TNC 320 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 320 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 320 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 320 features USB ports for the connection of standard USB devices, such as a mouse, drives, etc. On the back panel of the MC 321 there are 2 USB 3.0 ports. 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 320 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

connected
+machining

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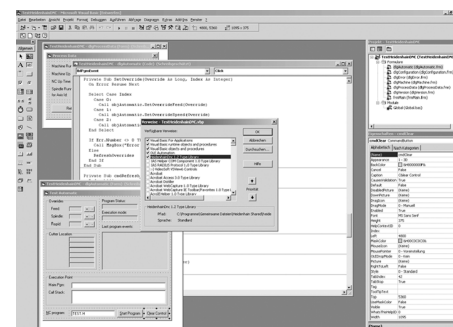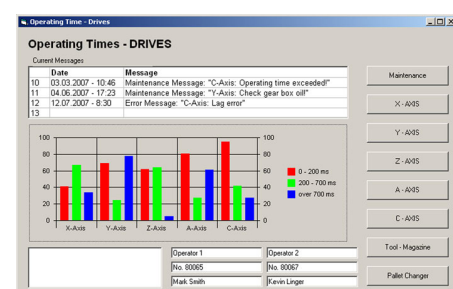
The HEIDENHAIN DNC software interface is an attractive communication platform for this purpose. It provides all the data and configuration capabilities needed for these processes so that an external PC application can evaluate data from the control and, if required, influence the manufacturing process.

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.

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.

20

Air in

15

Air out

15

Leave space for air circulation and servicing
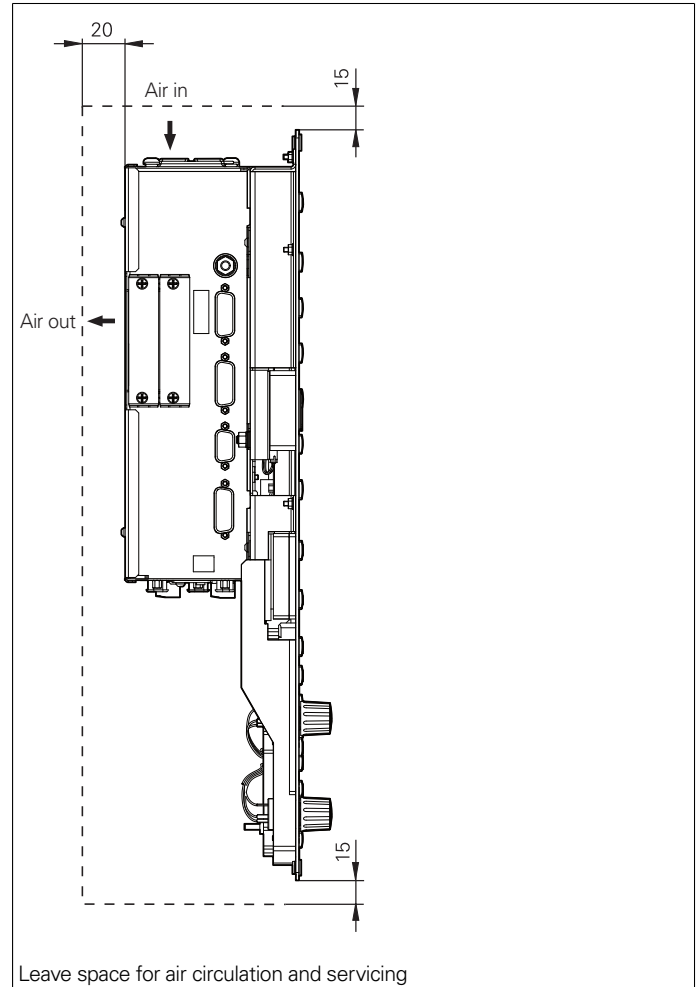
Mounting and electrical installation

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):
- TNC 320 (installed)
- Machine operating panel (installed)
- Handwheel

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 321

mm

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

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

Keyboard

MB 521

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

400

376±0.2

12

8

110

94±0.2

Ø 5.5

X

42

78

0   26

319.5   359.5

R5

1.4

5.4

M5

90°

Ø 10

Ø 8+1

55+5

2-0.5

30+5

4

376±0.2

4x M5

94±0.2

Ⓕ 94+1

12x45°

Ⓕ 384+1

0.5   Ⓜ

X (2x)
2:1

2.3±0.1

24.3±0.2

24.3±0.2

3.3±0.1

Ø 22.5±0.2

Ⓕ = Front panel opening
Ⓜ = Mounting surface

PLC inputs and outputs

PL 510

mm

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

PL 510/550: 139, PL 511: 183, PL 512: 227

51

X2

X1

POWER
ON

X3

148

132

95

100

135

100

3.25

78

Space for air circulation

Electronic handwheels

HR 510

mm

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

76.5
46
3
278
296
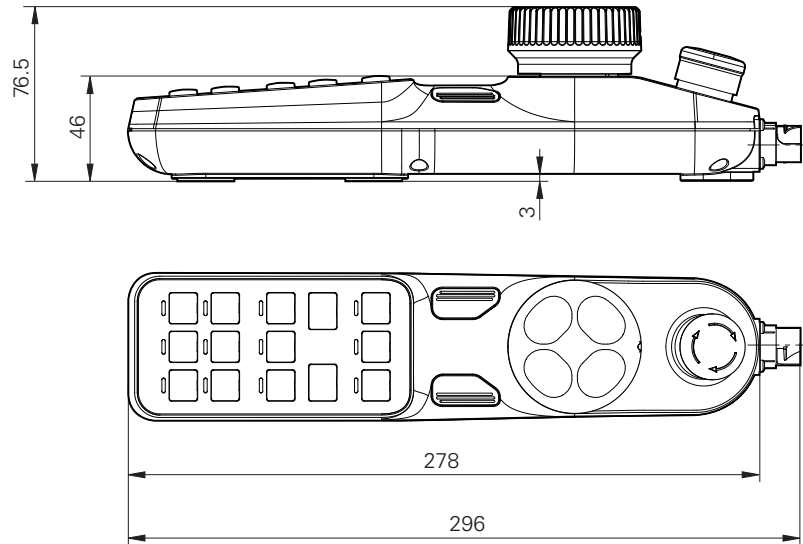
Adapter cable for HR 510 and HR 520

mm

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

M5
38
14
64
23
32×15
Ø 55
Ø 36
4
①
②
44
Ø 34
32
19
M4
44
Ø 5.5
S
Ø 37
S
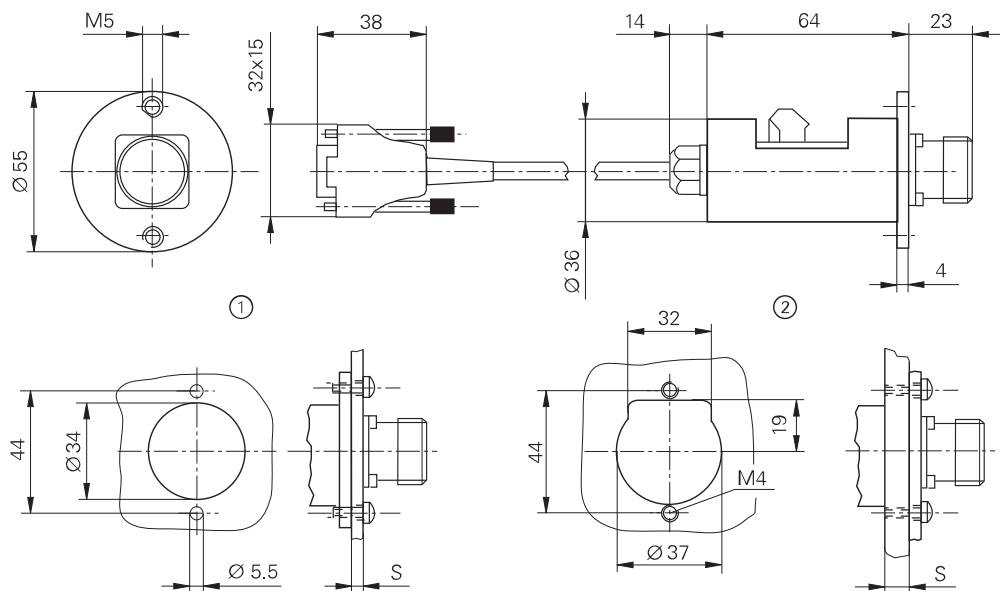
① Mounting opening for wall thickness S = 4 or more

② Mounting opening up to wall thickness S = 4

HR 520

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

79.7
78.7
46

90

311.7

336

Mount for HR 520

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

120
83±0.2
35
20
180
137±0.2

46.5
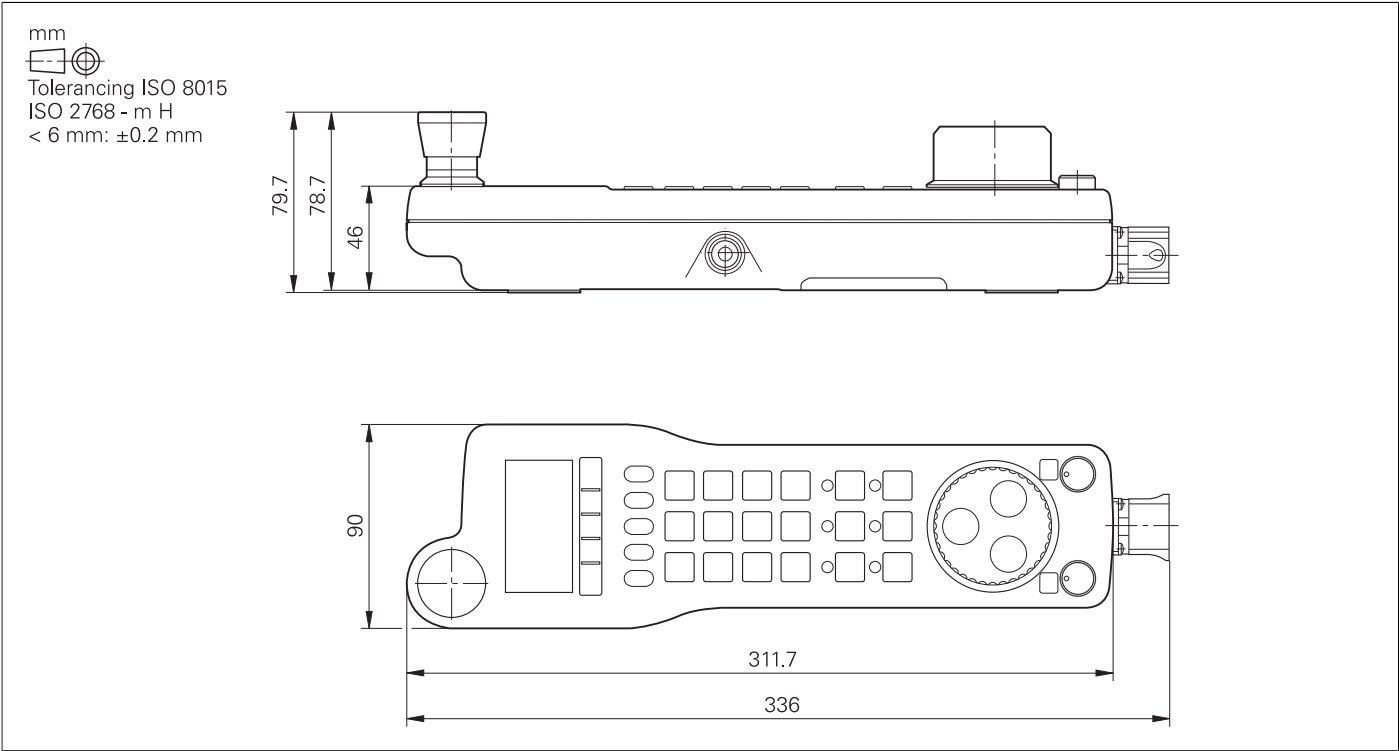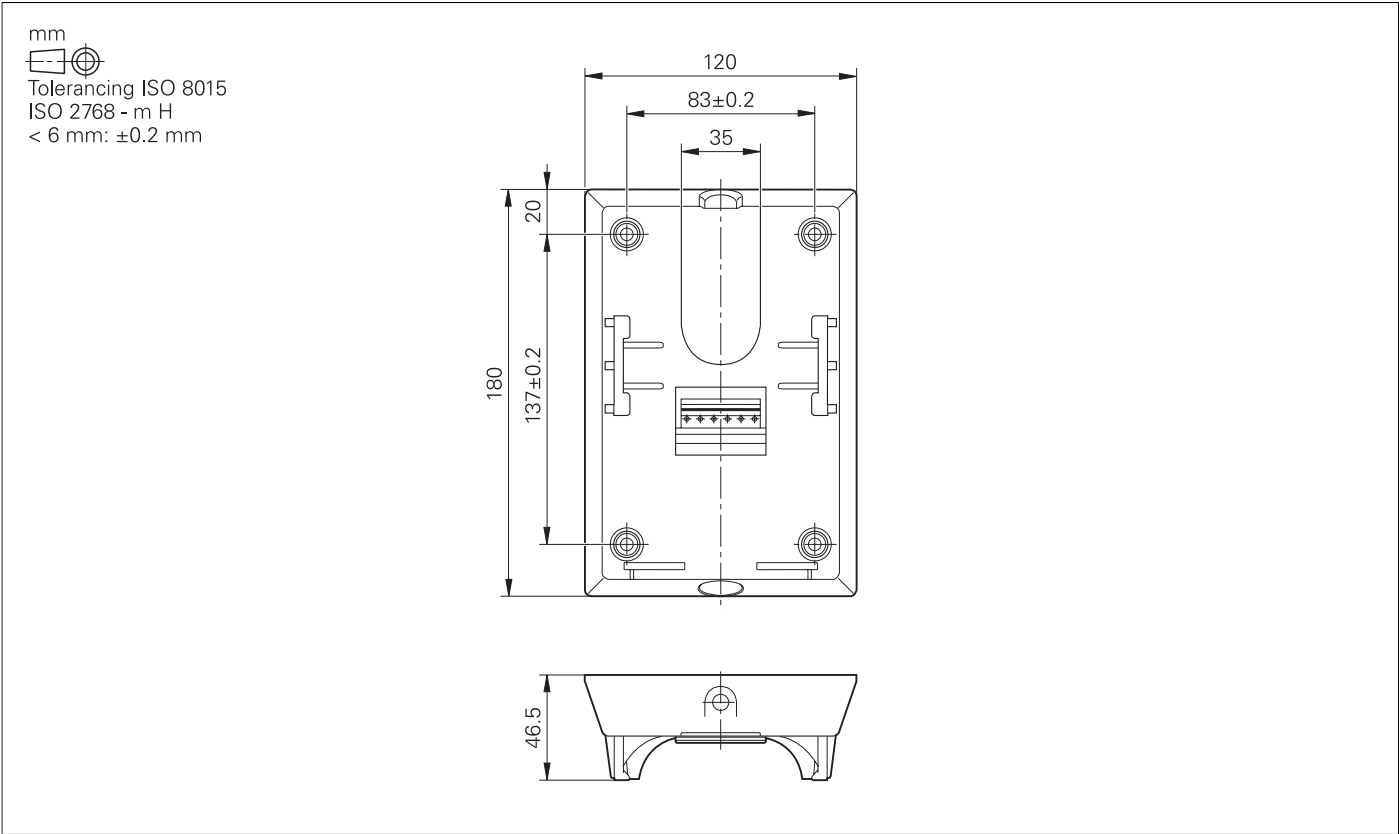
HR 550 FS

mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm
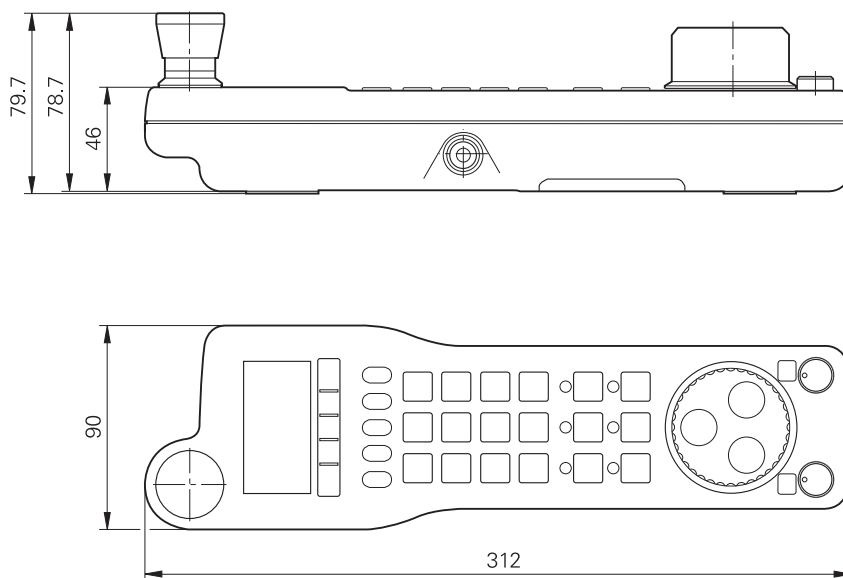
HRA 551 FS

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

⌀ 56
⌀ 58
⌀ 36f8
⌀ 10 −0.01 / −0.02
⌀ 6
⌀ 48

0.08 A
⌀ 0.08 B
0.03 A
⌀ 0.25 C

36.7±0.5
10
20±0.5
4.4

3x 120°
M3 x 5
3x

17.7
10
4
SW 2
(12)
6
22
2

⌀ 10H7

SW 5.5
M3
M3
12
7
6

70

3 x

HRA 110

mm

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

HR 150

X

58+1

53

X23 S1 S2 X31 24V
+ −

1+0.5

248

Ø 6

X

45+1

14

116±0.2

143.5+1

207+2

Ø 3.6

9

230±0.2
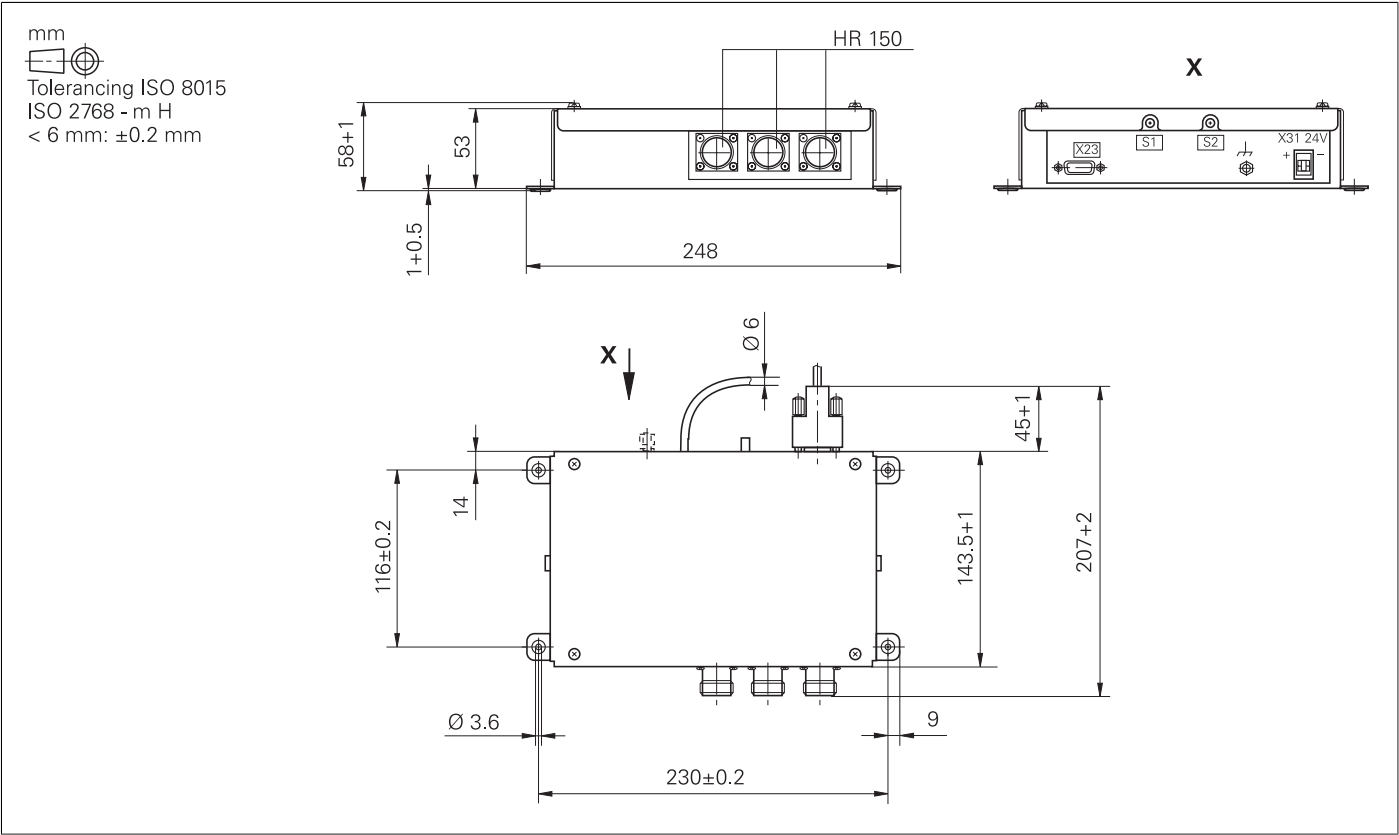
Interface accessories

Line-drop compensator for encoders with EnDat interface

mm

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

34

12.5

Ø 9

Ø 5

58

29

20

15

64

36

46

*)

32

127

*) Connection to KTY

USB hub

mm

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

Cover cap (accessory)

M3

50

17.5

28

40

80

109

100±0.2

68

Ø 3.4

37

93.2

Ⓜ

70±0.2

50±0.2

Ø 2.5

30±0.2

17.5

Ø 3.5

19

42

60±0.2

Ⓜ = Mounting surface
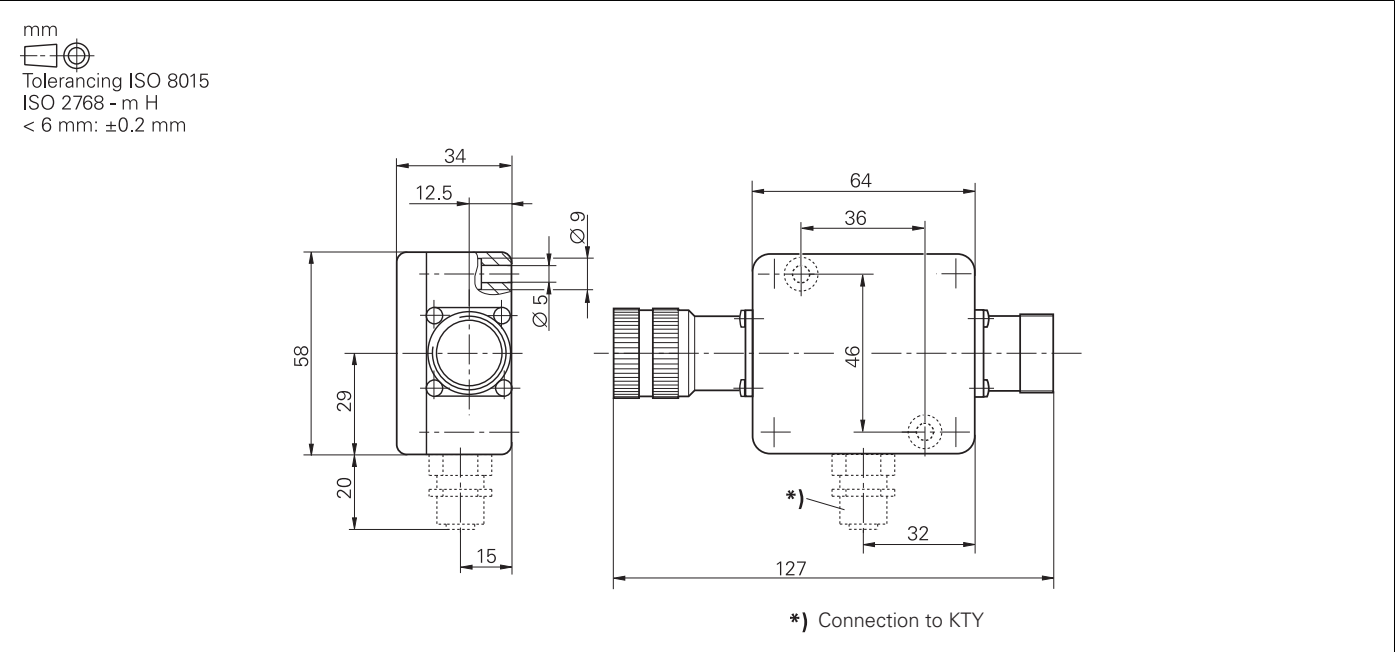
USB extension cable with hubs
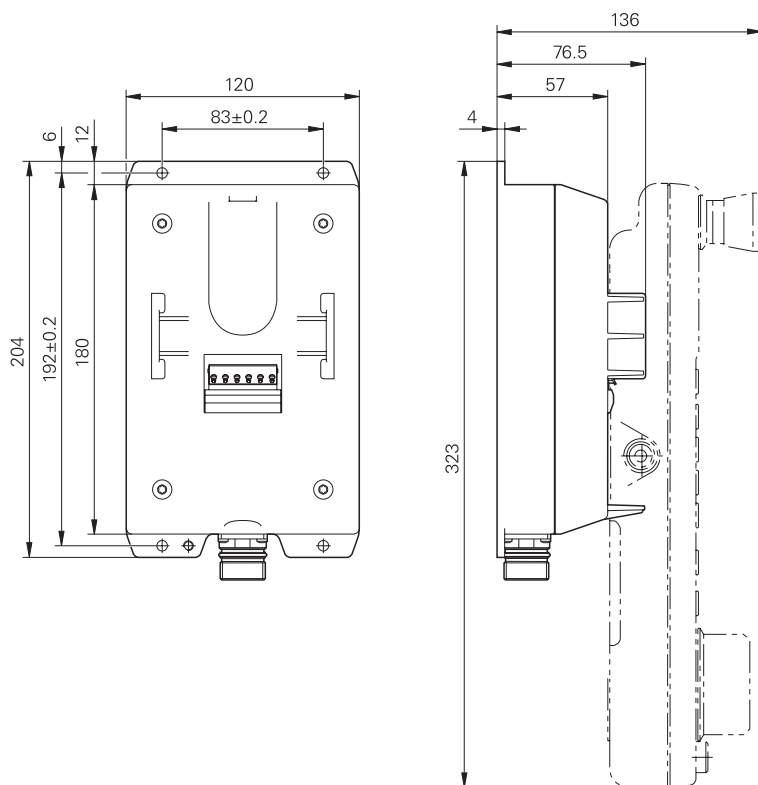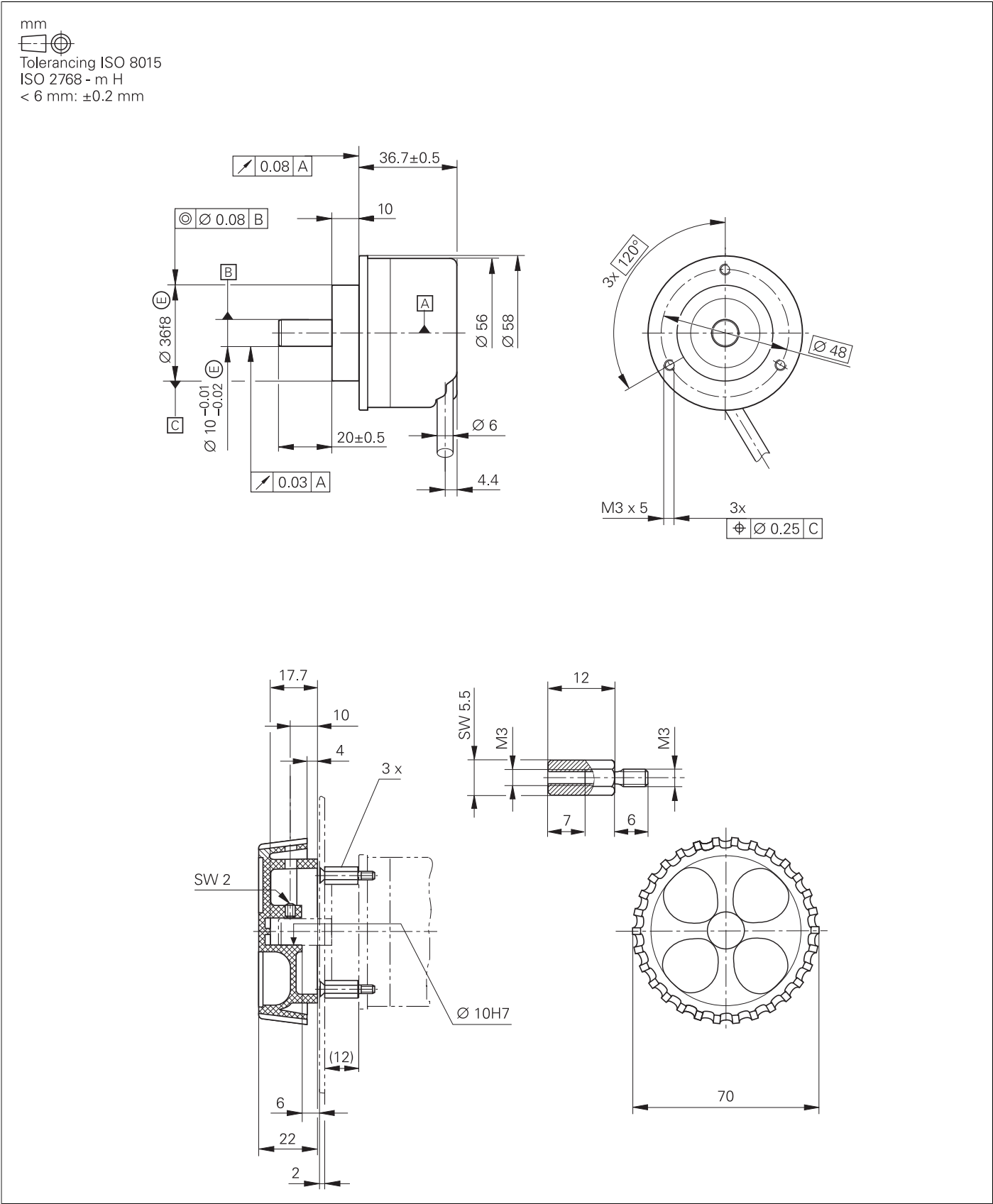
mm

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

L

1000...5000   n x 5000   5000

USB–A   USB–B

Ø 20

115
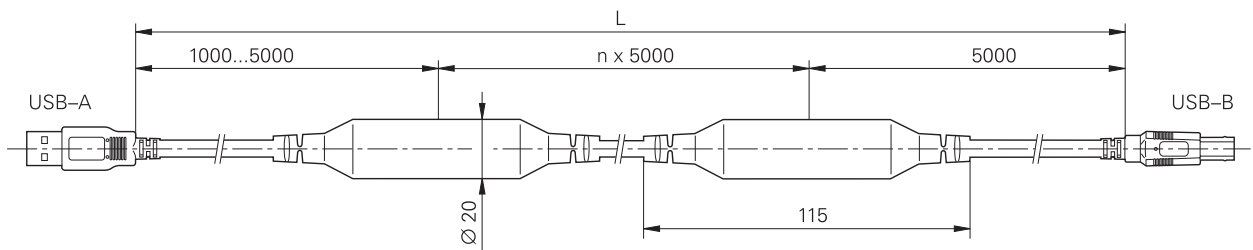
n = 0 ... 4
L = Ordering length

General information

Documentation

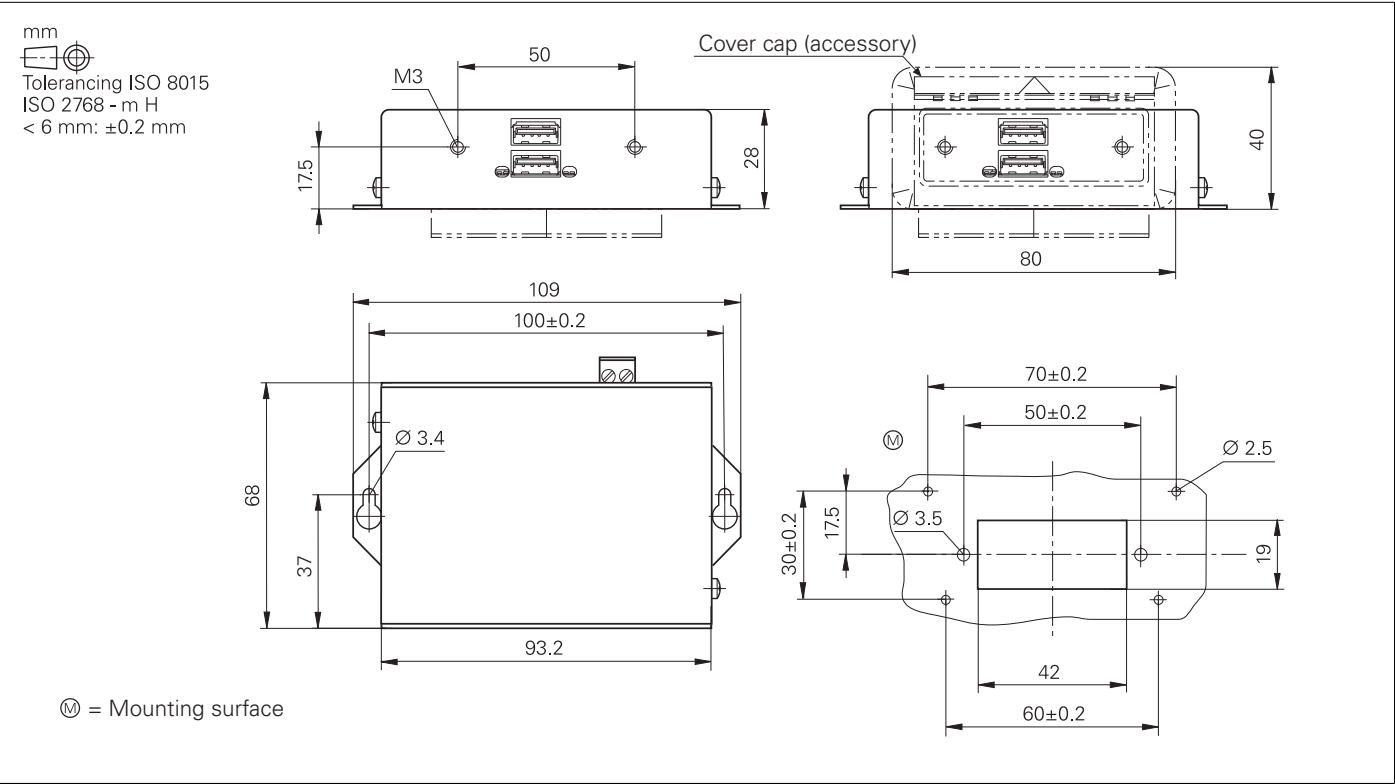|		
Technical documentation	• **TNC 320** Technical Manual	ID 1109226-xx; in PDF format on HESIS-Web including Filebase
	• **TS 260** Mounting Instructions	ID 808652-9x
	• **TS 460** Mounting Instructions	ID 808653-9x
	• **TS 444** Mounting Instructions	ID 632757-9x
	• **TS 642** Mounting Instructions	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 320**	
	• **HEIDENHAIN Conversational Programming** User's Manual	ID 1096950-xx
	• **Cycle Programming** User's Manual	ID 1096959-xx
	• **DIN/ISO Programming** User's Manual	ID 1096983-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
	• **KinematicsDesign** User's Manual	As integrated help
Other documentation	• **TNC 320** brochure	ID 1113511-xx
	• **Touch Probes** brochure	ID 1113984-xx
	• **HEIDENHAIN DNC** brochure	ID 628968-xx
	• **Remote Diagnosis with TeleService** Product Overview	ID 348236-xx
	• **Touch Probes** CD-ROM	ID 344353-xx
	• **TNC 320, TNC 620 Programming Station Demo Version** CD-ROM	ID 741708-xx
	• **HR 550 FS** Product Information	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
+49 8669 31-1999
E-mail: mtt@heidenhain.de
training.heidenhain.de

Other HEIDENHAIN controls
Examples

TNC 620

Information:
TNC 620 *brochure*

- Compact contouring control for **milling, drilling and boring machines**
- Axes: 6 control loops, of which up to 2 are configurable as spindles
- For operation with HEIDENHAIN inverter systems and preferably HEIDENHAIN motors
- Uniformly digital with HSCI interface and EnDat interface
- Compact size
- Storage medium for NC programs: CompactFlash memory card
- Programming in HEIDENHAIN conversational format or according to DIN/ISO
- Standard milling, drilling and boring cycles
- Touch probe cycles
- Short block processing time (1.5 ms)

Version with touchscreen:
- 19″ screen (vertical), keyboard and main computer in one unit (MC 8410)
- Integration of the keyboard in the lower screen area
- Multi-touch operation
- MC 8410 is compatible in its installation dimensions with the MC 7410
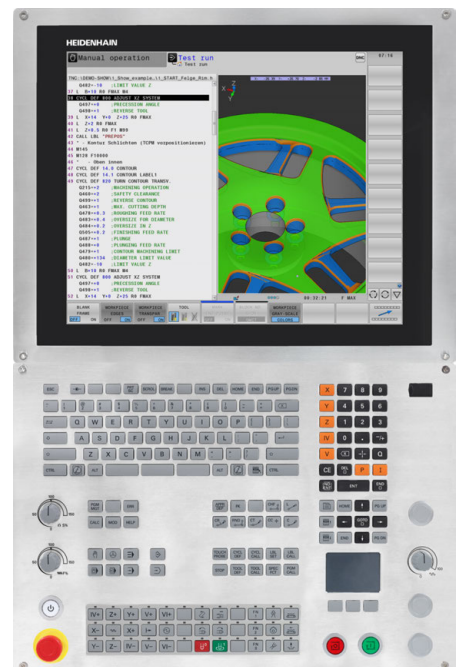
Version with operating keys:
- 15″ screen, keyboard and main computer in one unit (MC 7410)
- Screen and main computer in one unit (MC 7420) and separate keyboard with integrated ASCII keys

TNC 640

Information:
TNC 640 brochure

- 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)

Subject index

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www.tp-gruppen.dk

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