HEIDENHAIN

MANUALplus 4110

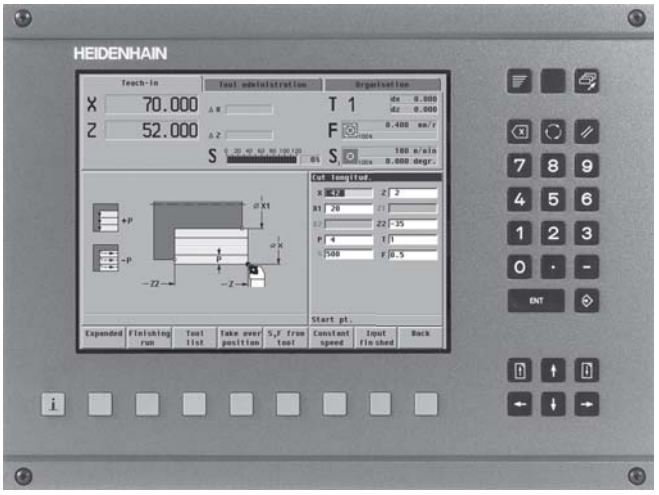
The Versatile Contouring Control for Lathes

Information for the Machine Manufacturer

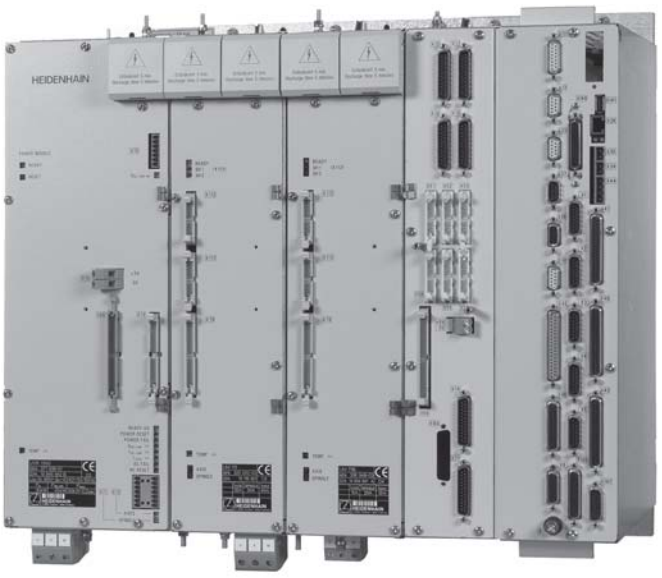
April 2007

MANUALplus 4110
Contouring Control with Inverter

MANUALplus 4110
- Contouring control for lathes with 2 axes, controlled spindle, C axis and driven tools
- HEIDENHAIN inverter systems and motors
- TFT color flat-panel display
- Hard disk
- Cycle programming for turning, drilling and milling operations
- Free ICP contour programming for turning and milling contours
- DIN programming for turning, drilling and milling operations



BFT 121 G control panel



MC 420, CC 422
with modular inverter

System tests

Controls, motors and encoders from HEIDENHAIN are usually 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.

Contents

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

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

MANUALplus 4110 with NC software version V 6.4
(as of ID 526488-07)

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.

This catalog supersedes all previous editions, which thereby become invalid.

Subject to change without notice

Specifications

Specifications	MANUALplus 4110	Page
Control systems		**9**
Main computer	MC 420	**10**
Controller unit	CC 422	**12**
Operating panel	BFT 121 G • TFT color flat-panel display • NC keyboard	**13**
Inverter systems	• Compact inverters • Modular inverters	*
Axes and spindles	• 2 closed-loop axes • Closed-loop spindle, switchable to C-axis operation • Driven tool – option	**20**
Program memory	At least 5 GB on hard disk	
Input resolution and display step	• To 0.001 mm on linear axes • To 0.001° on the C axis	**20**
Position loop resolution	• To 0.0001 mm on linear axes • To 0.0001° on the C axis	
Interpolation Straight line Circle C axis	• In 2 axes (max. ± 10 m) • In 2 axes (circle radius max. ± 100 m) • Interpolation of X and Z linear axes with the C axis	
Axis feedback control	• With following error • With feedforward • With jerk limiting	**21, 22, 23**
Feed rate	• mm/min or mm/revolution • Constant cutting speed • Feed rate with chip breaking • Maximum feed rate: $\frac{60000\ \text{rpm}}{\text{No. of pole pairs of the motor}} \cdot \text{screw pitch [mm]}$	
Block processing time	• 3 ms	
Cycle time for path interpolation	• 3 ms	
Servo drive control	• Digital drive control for synchronous and asynchronous motors	**21**
Position loop resolution	• Signal period of the position encoder/1 024	
Cycle times	• Position controller: 3 ms • Speed controller: 0.6 ms • Current controller at f_{PWM} / T_{INT} 3333 Hz / 150 µs 4166 Hz / 120 µs 5000 Hz / 100 µs 6666 Hz / 75 µs 8333 Hz / 60 µs 10000 Hz / 50 µs	22
Maximum speed	60000 rpm for motors with two pole pairs	20

* For more information, see *Inverter Systems* brochure

Specifications	MANUALplus 4110	Page
Monitoring functions	During operation the control monitors the: • Amplitude of the encoder signals • Actual position • Actual path traversed (movement monitoring) • Actual speed • Supply voltage • Motor current • Motor temperature • DC-link voltage • Supply voltage of the logic unit • Temperature of the power module	**29**
Data interfaces Protocols	• One RS-232-C/V.24 with max. 38.4 kbps • One RS-422-C/V.11 with max. 38.4 kbps • 100 BaseT Fast Ethernet interface • Two USB interfaces • Windows-supported network protocols (including TCP/IP)	**29**
Power supply	• 3 x 400 Vac for inverter with logic unit • 24 Vdc for color flat-panel display and PLC	
Operating temperature **Storage temperature**	0 °C to 40 °C –35 °C to 65 °C	

Machine Interfacing	MANUALplus 4110	Page
Compensation	• Screw pitch error • Backlash • Slope angle / misalignment compensation • Tool nose (cutting) radius • Milling tool radius	**26**
Integral PLC PLC program RAM process memory RAM data memory PLC cycle time PLC inputs, 24 Vdc PLC outputs, 24 Vdc Analog inputs ±10 V Analog outputs ±10 V Inputs for thermistors	 • On hard disk • 512 KB • 124 KB • 18 ms • 56 (expandable by PL) • 31 (expandable by PL) • 3 (expandable by PL) • 6 • 3 (expandable by PL)	**27**
Additional inputs/outputs (option)	Maximum four PL 510 external input/output systems	**14**
Commissioning aids	• External in the PLC programming system • PLC window on the screen • Integrated oscilloscope for checking traversed distances and the dynamic adjustment of the drives • Logic Analyzer for chronological representation of digital inputs/outputs and PLC interface signals • TNCopt, PC software for commissioning digital control loops • TNCdiag, PC software for diagnostics of digital drive systems	**28**

User Functions

User Functions	MANUALplus 4110	Page
Modes of operation		*
Manual operation	• Manual slide movement through intermediate switch or electronic handwheel • Graphic support for entering and running cycles without saving the machining steps in alteration with manual machine operation • Thread repair (thread reworking in a second workpiece setup)	
Teach-in	• Sequential linking of fixed cycles, where each cycle is run immediately after input, or is graphically simulated and subsequently saved.	
Program run	• Cycle programs or DIN programs in single block or full sequence	
Setup functions	• Workpiece datum setting • Definition of tool-change position • Definition of protection zone	
Programming		*
Cycle programming	• Area clearance cycles for simple and complex contours, as well as contours described with Interactive Contour Programming (ICP) • Recessing cycles for simple, complex and ICP contours (with repetitions) • Recess turning cycles for simple and complex contours, as well as contours described with Interactive Contour Programming (ICP) • Undercut and parting cycles • Threading cycles for single or multi-start longitudinal, taper or API threads • Axial and radial drilling, peck drilling and tapping cycles • Thread milling • Axial and radial milling cycles for grooves, figures, single sides and polygons as well as complex ICP contours • Helical slot milling • Linear and circular patterns for milling, drilling and boring • Use of DIN macros in cycle programs • Conversion of cycle programs to DIN programs • Workpiece blank definition as rod/pipe and contour • Support graphics can be switched for inside and outside machining	
Interactive Contour Programming (ICP)	• Contour definition with linear and circular contour elements • Immediate display of entered contour elements • Calculation of missing coordinates, intersections, etc. • For multiple solutions: graphic display of all solutions • Chamfers, rounding arcs and form elements can be entered along with the contour or added later. • Downloading of DXF files (option)	
G-code programming	• NC programming as per ISO 6983 • Creation of DIN programs or DIN macros • Programming with area clearance, recessing, recess turning, drilling and milling cycles • Simplified geometry programming (calculation of missing data) • Programming with variables • Subprograms	

* See the "MANUALplus 4110" brochure

User Functions	MANUALplus 4110	Page
Tool programming Tool management	• Table for 99 tools with tool descriptions • Transfer of cutting data (feed rate, shaft speed) from the tool description • Tool monitoring for lifetime of the insert (tool tip) or the number of workpieces produced	*
Tool measurement	• By touching the workpiece • With a triggering touch probe (option) • By using an optical gauge (option)	
Tool compensation	• Automatic tool-tip and cutter radius compensation • Automatic tool-tip position recognition (in left, right, inward or outward direction of motion) • Compensation of tool-tip position in the X/Z plane • High-precision correction via handwheel, capturing compensation values in the tool table	
Program verification graphics	Graphic simulation of the cycle process, or of the cycle or ISO program: • Wire-frame or cutting-path graphics • Motion simulation (“erasing graphics”) – The blank is displayed as a white surface which is machined during the simulation. • Side or face view, or 2-D view of cylindrical surface • Display of programmed contours • Shifting and magnifying functions	*
Machining time analysis	• Calculation of machining and idle machine time • Consideration of switching commands triggered by the CNC • Representation of single times per cycle or per tool change with DIN programs	*
Conversational languages	German, English, French, Italian, Spanish, Dutch, Danish, Swedish, Czech, Polish, Hungarian, Finnish, Russian	*

* See the “MANUALplus 4110” brochure

Accessory

Accessory	MANUALplus 4110	Page
Electronic handwheels	• Connection of two **HR 150** panel-mounted handwheels for moving the slide on a manual machine. As a complement, the **HR 410** portable handwheel can be connected. *or* • Connection of one **HR 130** panel-mounted handwheel. The PLC assigns the handwheel to an axis.	**15**
PLC input/output system	Modular external **PL 510** I/O system consisting of • Basic module with HEIDENHAIN PLC interface **PLB 510:** for 4 I/O modules **PLB 511:** for 6 I/O modules **PLB 512:** for 8 I/O modules • **PLD 16-8:** I/O module with 16 digital inputs and 8 digital outputs • **PLA 4-4:** Analog module with 4 analog inputs for ±10 V and inputs for PT 100 thermistors	**14**
PC software **PLCdesignNT**	PLC development software with PLC basic program	**27**
TNCopt	Software for commissioning digital control loops	**28**
TNCdiag	Software for drive diagnosis (contained in TNCopt)	28, *
KonfigPilot	Configuration tool • Configuration of the parameters • Adjustment of M numbers	
DataPilot 4110	Control software on PCs for: • Programming and test runs • Program management • Operating resources management • Data backup • Training	**

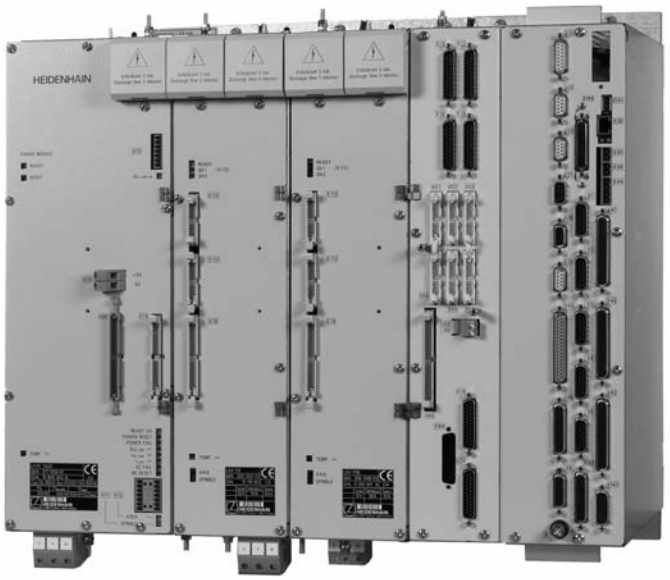
* See the "Remote diagnosis with Teleservice" Product Overview
** See the "DataPilot 4110" CD

HEIDENHAIN Control Systems

The MANUALplus 4110 lathe machine control from HEIDENHAIN includes various components, which can be selected and combined to fit the application.

		Model	Page
MANUALplus 4110	Main computer	**MC 420**	**10**
	Controller unit	**CC 422**	**12**
	Operating panel	**BFT 121 G**	**13**
	Connecting cables		**16**
Accessories	PLC inputs/outputs	**PL 510**	**14**
	Electronic handwheels	**HR 410, HR 150** or **HR 130**	**15**

MC 420, CC 422
with compact inverter



MC 420, CC 422
with modular inverter

Main Computer

Main computer

The **MC 420** main computer includes:
- Processor (Celeron, 400 MHz)
- RAM memory: 128 MB
- PLC
- Interface to the CC controller unit
- Interface to the control panel
- Interface to the handwheel
- Further interfaces (PLC expansion, Ethernet, USB, RS-232-C/V.24, RS-422/V.11)

To be ordered separately:
- **HDR** hard disk with the NC software
- **SIK component** (System Identification Key) for enabling the control loops and software options

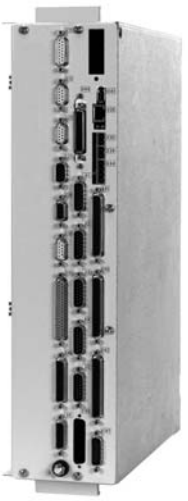
Power supply

The main computer is powered over the CC controller unit.

MC 420

The MC 420 main computer is available in versions with 5 position encoder inputs. It offers up to 5 control loops.

Position inputs	5 x 1 V_{PP} or EnDat
Controller unit	CC 422 with 6 shaft-speed inputs
Weight	4.2 kg
ID	515927-xx

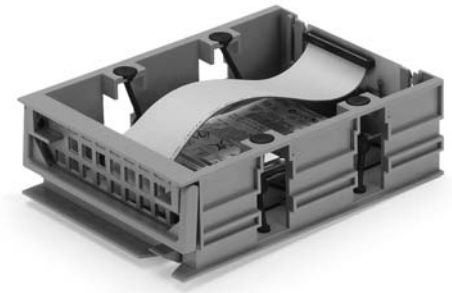


MC 420
with 5 position encoder inputs

HDR Hard Disk, SIK Component

HDR hard disk

The HDR hard disk is removable. It contains the NC software and a slot for the SIK component.



HDR hard disk

HDR for	MANUALplus 4110
MC 420	586040-51

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 HDR.

Additional control loops 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.

SIK component

Master keyword

For commissioning the MANUALplus 4110, a master keyword can be used that will unlock all control loop options for a duration of two weeks. After this period, the control loop options will be active only through the correct keyword.
Should service become necessary, the SIK component must be inserted in the replacement control to enable all required options.

NC software license for MC 420	SIK with software license and enabling for	MANUALplus 4110
	3 control loops for CC with max. 6 control loops	573208-51
Auxiliary axes	1st additional axis (4th)	354139-01
	2nd additional axis (5th)	354140-01

Software options

With software options, the features of the MC 420 can also be adapted retroactively to meet new requirements. 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 software options.

DXF import	526460-01
Tool measurement	534615-01

Controller Unit

Controller unit

The **CC 422** controller unit includes:
- Speed controller
- Current controller
- Interfaces to the UM 1xx, UR 2xx, and UE 2xx power modules (PWM outputs)
- Interfaces to the shaft speed encoders
- Interfaces for power supply for controller unit and main computer (supply via UVR 1xxD, UE 2xxD, UR 2xx)

CC 422

CC 422

The CC 422 is available with max. 6 digital control loops.
The MANUALplus 4110 software supports max. 5 control loops.

The number of enabled control loops is saved in the SIK (see *Main Computer*).

The CC 422 controller unit is combined with the MC 420 main computer. The position controllers and position encoder inputs are located on the MC 420 main computer (version with 5 position encoder inputs).

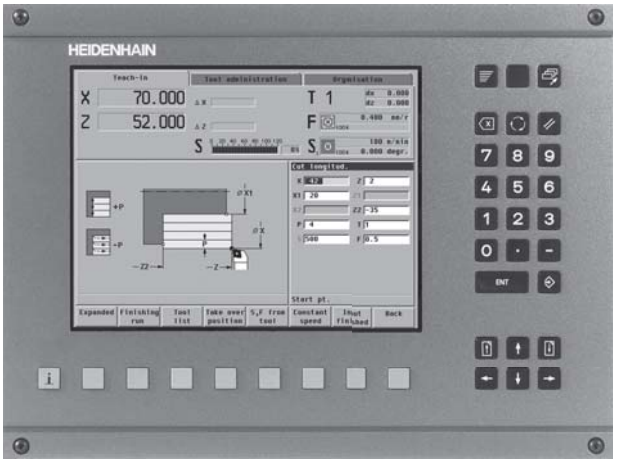
CC 422	Max. 6 digital control loops
Shaft speed inputs	6 x 1 V_{PP} or EnDat
PWM outputs	6
Weight	4.0 kg
ID	359651-xx

Control Panel

BFT 121 G operating panel

ID	326206-05
Weight	approx. 3 kg

- 10.4-inch flat-panel color display
- Soft keys
- Numeric keypad
- Editing keys

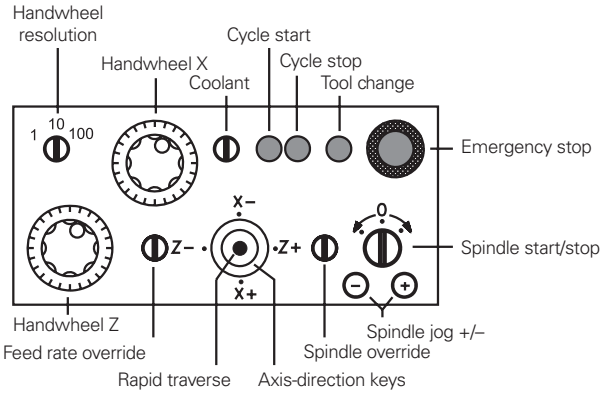


BFT 121 G

Machine operating panel

The machine tool builder designs the machine operating panel. It should contain the following components:

- Handwheels
- Axis-direction buttons or joystick
- Emergency-stop button
- Feed rate override
- Spindle override
- Cycle keys
- Spindle keys



Proposal for a machine operating panel

Accessories

PLC Inputs/Outputs

If the PLC inputs/outputs of the MC are insufficient, additional PL 510 input/output units can be connected. These external modular I/O systems consist of a basic module and one or more input/output modules.

PL 510

Basic module

Basic modules for 4, 6 or 8 I/O modules are available. They are mounted on standard NS 35 rails (DIN 46227 or EN 50022)

Supply voltage	24 Vdc
Power consumption	approx. 20 W
Weight	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, and up to two PLB 511 or PLB 512 can be connected to the control. The maximum cable length to the last PLB 51x is 30 meters.

I/O modules

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

PLD 16-8

I/O module with 16 digital inputs and 8 digital outputs

Total current	Outputs 0 to 7:	≤ 4 A
	Outputs 0 to 3, or 4 to 7:	≤ 2 A
Simultaneity factor:	2 outputs:	2 A each
	4 outputs:	1 A each
	8 outputs:	0,5 A each
Weight	0.2 kg	
ID	360916-01	

PLA 4-4

Analog module with
4 analog inputs for PT 100 thermistors
4 analog inputs for ±10 V

Weight	0.2 kg
ID	366423-01

Empty housing

For unused slots

ID	383022-01

Electronic Handwheels

The standard MANUALplus 4110 supports the use of electronic handwheels.

The following handwheels can be installed:
- Two **HR 150** panel-mounted handwheels, and one **HR 410** portable handwheel
  or
- One **HR 130** panel-mounted handwheel

Function

- Moving the machine slide in selectable increments via PLC:
  1 µm/10 µm/100 µm per increment
  Max. velocity 9.999 mm/min
- Positioning the slide to the starting position of MANUALplus cycles
- Fine adjustment of tool position

HR 150

Panel-mounted handwheel with ergonomic control knob.

ID	257061-09
Weight	approx. 0.7 kg

HR 410

Portable electronic handwheel with
- Keys for the selection of 5 axes
- Keys for traverse direction
- Keys for three preset feed rates
- Key for actual-position capture
- Three keys with machine functions (see below)
- Two permissive buttons (24 V)
- Emergency Stop button (24 V)
- Magnetic holding pads
- Weight approx. 1 kg

All keys are designed as snap-on keys and can be replaced by keys with other symbols.

HR 410 (NC start/stop, spindle start; for PLC basic program)	
Without detent	ID 296469-55
With detent	ID 535220-05
HR 410 (spindle right/left/stop)	
Without detent	ID 296469-54
Connecting cable (spiral cable)	
to HR 410 (3 m)	ID 312879-01
HR 410 / MC 422 adapter cable	ID 296466-xx
Dummy plug for emergency stop circuit	ID 271958-03

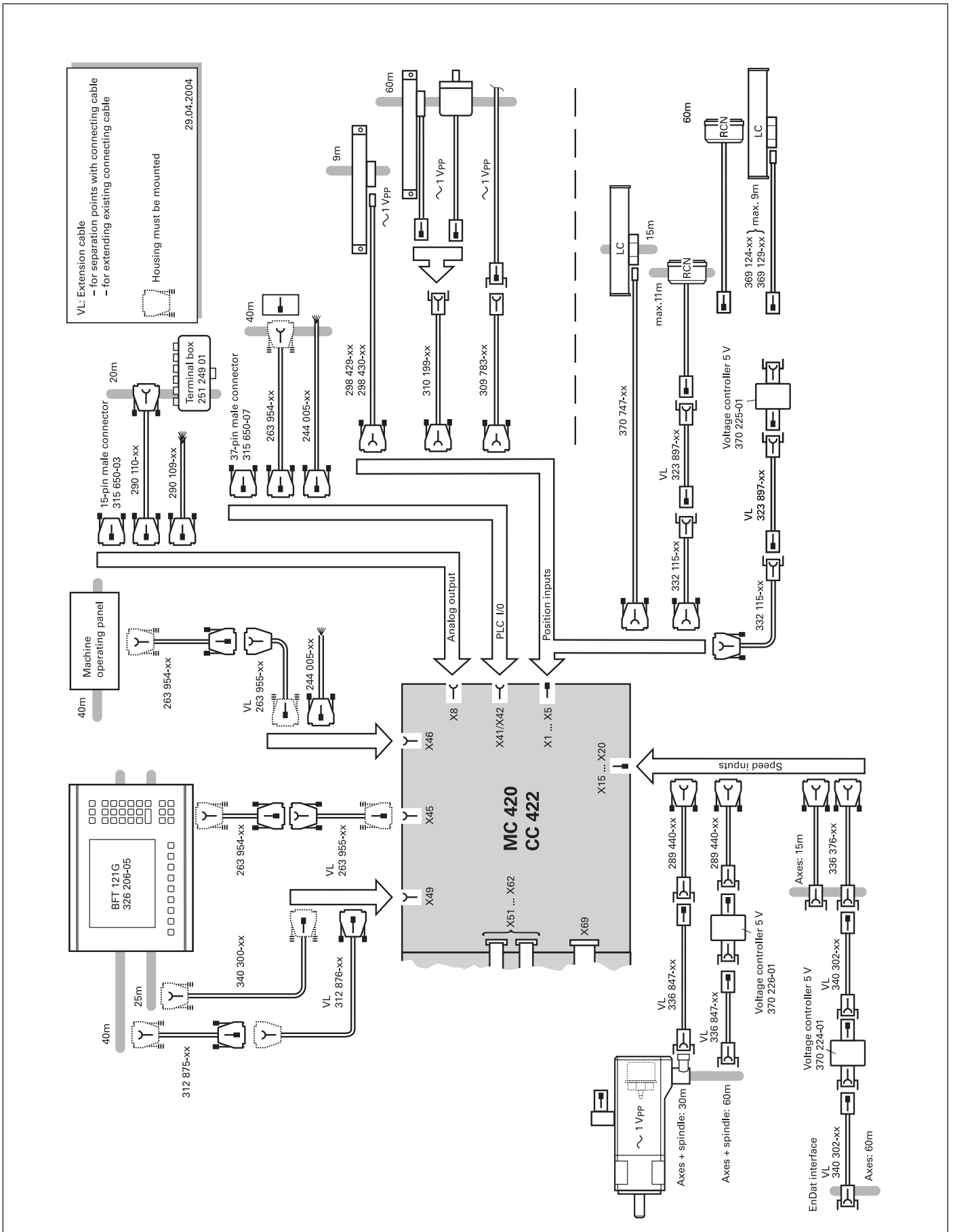
HR 130

Panel-mounted handwheel with ergonomic control knob.
It is connected to the logic unit directly or via extension cable.

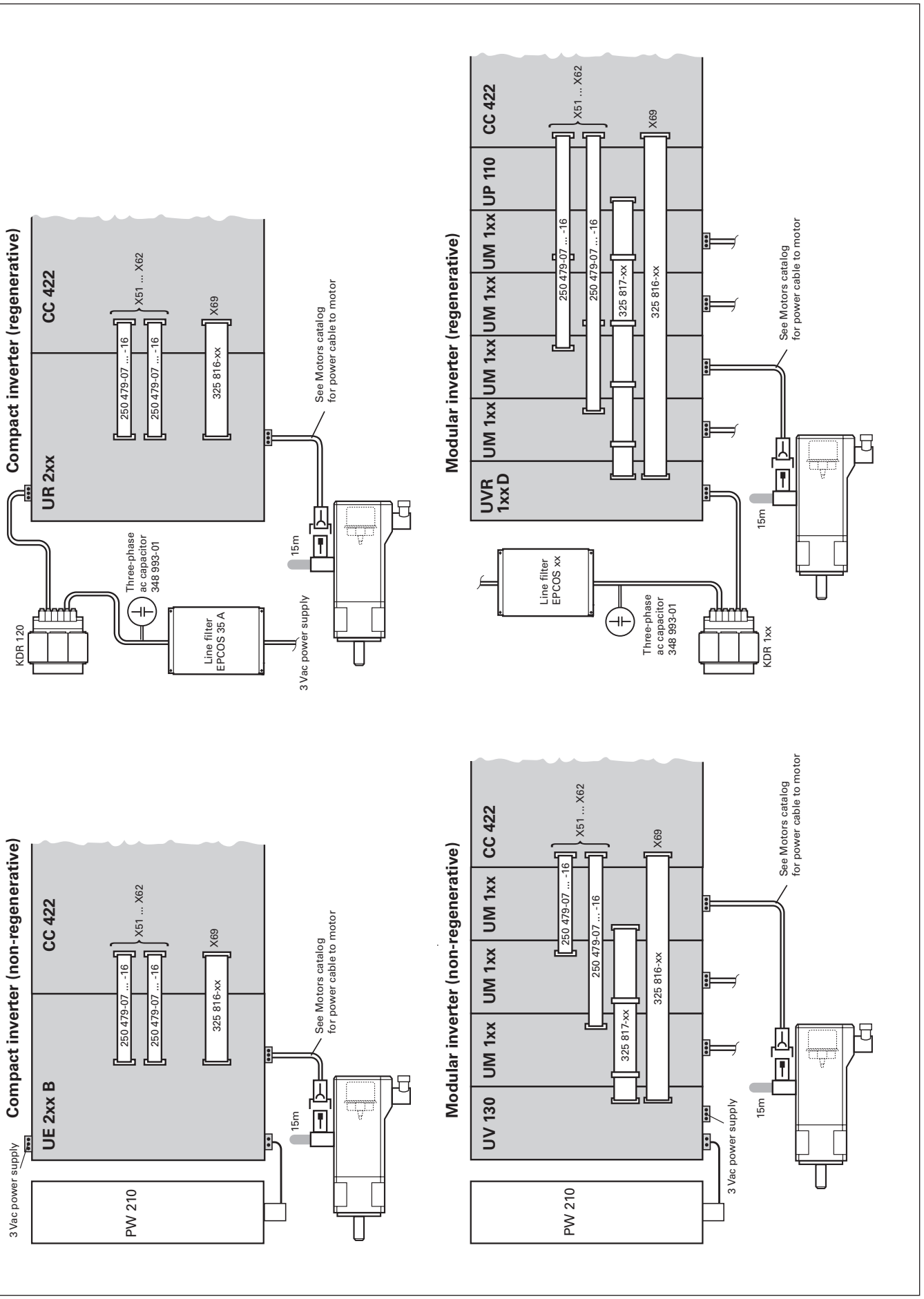
Weight	approx. 0.7 kg
HR 130 without detent	ID 254040-05
HR 130 with detent	ID 540940-01

Cable Overview

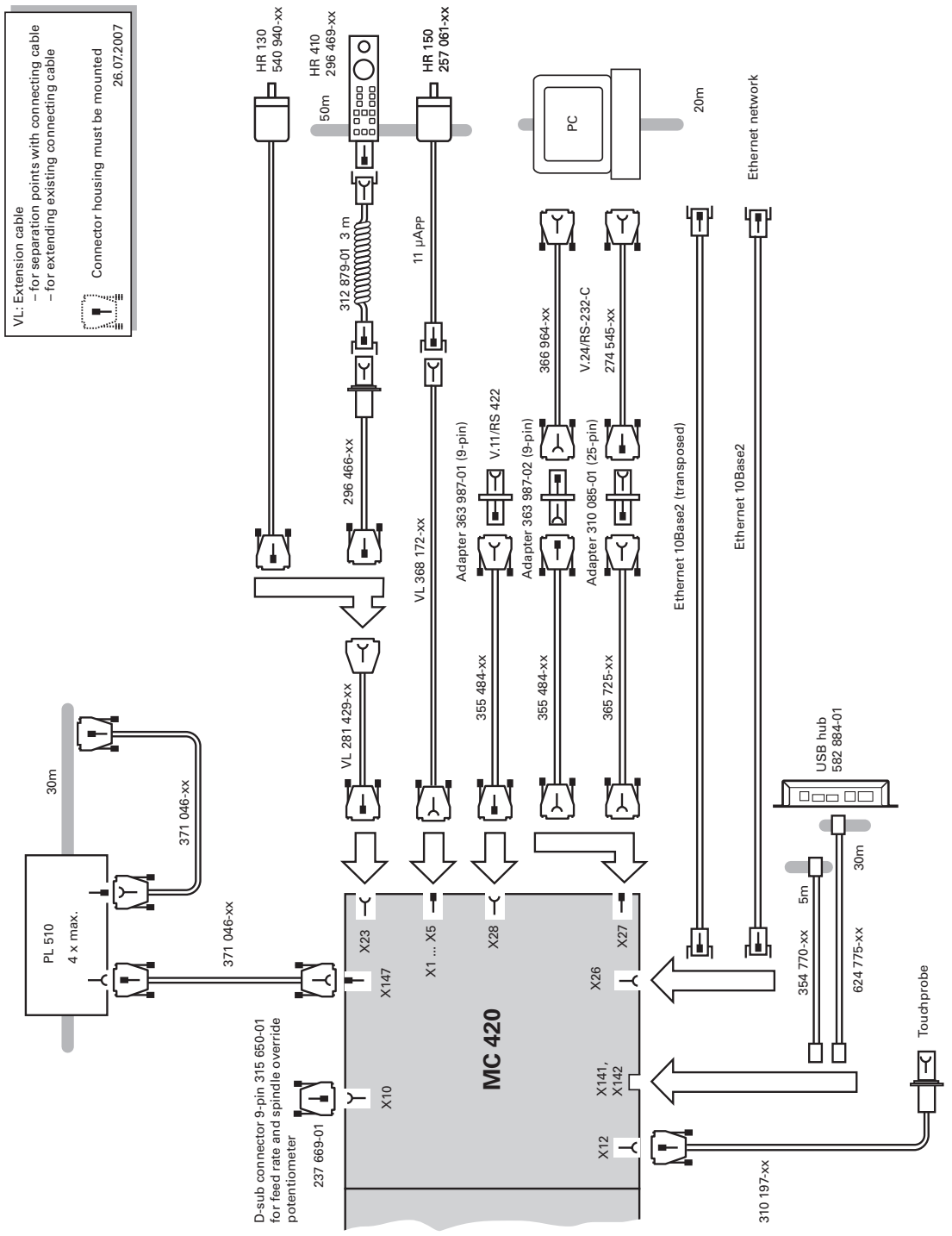
Control Systems



Inverter Systems



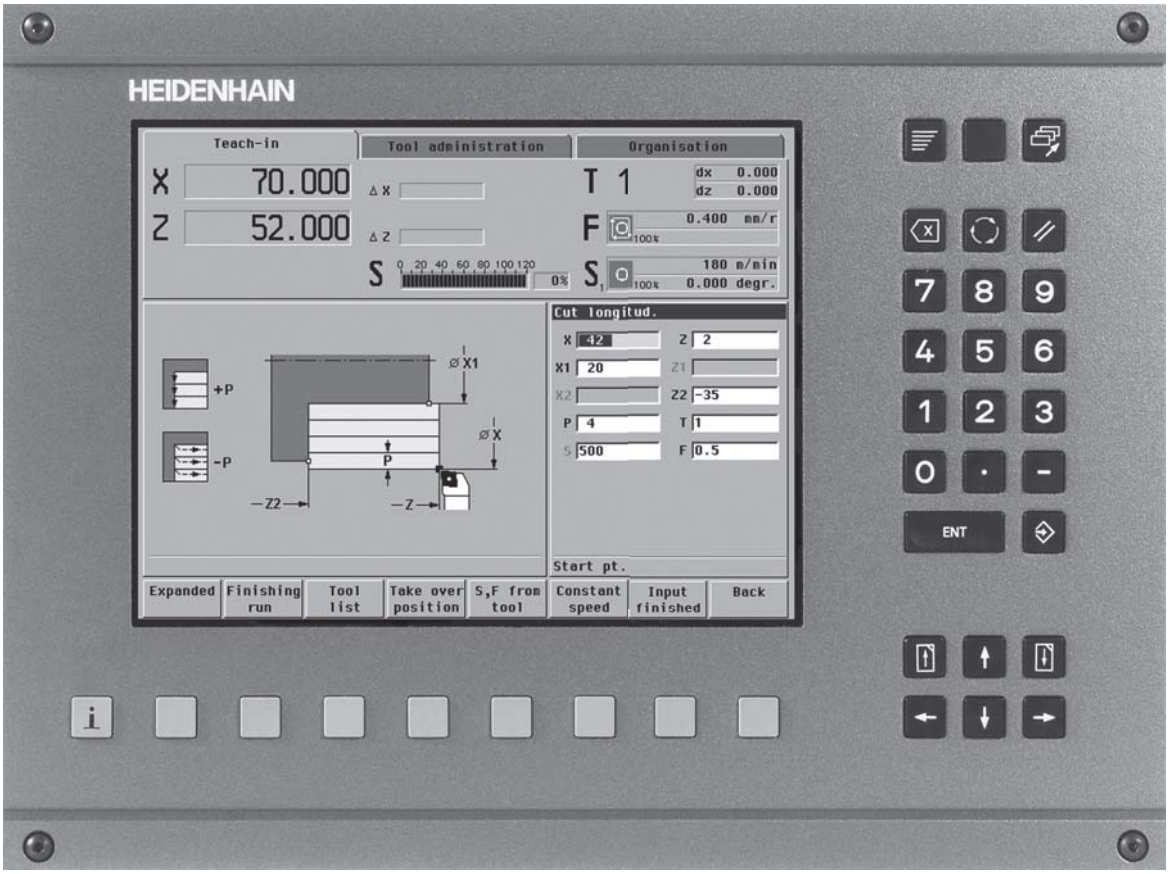
Accessories



MANUALplus 4110
The Versatile Contouring Control for Lathes

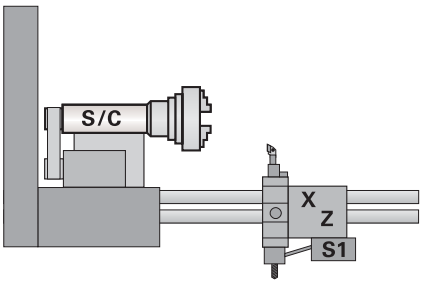
The MANUALplus 4110 is versatile:
- Conceived for single parts and short production runs
- Supports action-oriented machining
- Made for the machinist
- Quickly learned—requires minimum training time
- For new parts, rework and repair of workpieces
- Features a wide machining spectrum, from simple turned parts to complex CNC workpieces
- Supports milling operations on the end face and lateral surface
- Maximizes machine utilization rates
- Minimizes unit costs

The MANUALplus 4110 is suited for many different lathes:
- Complete lathe setup: spindle, one slide (X and Z axis), C axis or positionable spindle and driven tool
- Cycle-controlled lathes
- Lathes with simple tool holders
- Lathes with multiple tool carriers (e.g. turret)
- Lathes with driven tools and positionable spindle
- Lathes with driven tools and C axis
- Lathes with "turning in front of the workpiece" and "turning behind the workpiece"
- Vertical boring and turning lathes



Technical Description

Axes



The MANUALplus 4110 is a contouring control for manual lathes with one spindle and a compound rest (X and Z) for tool movement.

Programming and display

Feed rate in

- mm/min
- mm/revolution
- Feed rate with chip breaking
- Feed rate override: 0 to 150%
- Maximum feed rate at f_{PWM} = 5000 Hz:

$$\frac{60000 \text{ rpm}}{\text{No. of pole pairs of the motor}} \cdot \text{screw pitch [mm]}$$

Traverse range

–9999.9999 to +9999.9999 [mm]
The machine tool builder defines the traverse range. It is also possible for the operator to limit the traverse range if he wishes to reduce the working space (with software limit switches).
A protection zone for the spindle (Z–) can also be specified.

Spindle

For machines featuring a higher level of automation, you can switch the spindle to C-axis operation for machining with driven tools.

Programming and display

Spindle speed:
- Constant shaft speed: 1 to 19999 rpm
- Constant cutting speed: 1 to 2000 m/min

Spindle override

50 to 150%

Maximum speed

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

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

Speed limiting

- The MANUALplus monitors the actual speed.
- Speed limiting can be adjusted via parameter and in the feedrate/spindle/tool menu.

Gear stages

A separate nominal speed is defined for each of the 4 gear ranges. The gear code is output via the PLC.

C-axis operation

The spindle is switched to C-axis operation for milling, drilling and boring cycles. A separate servo drive for the C axis is activated.

Input resolution and display step: 0.001°

Driven Tool

The driven tool is used for drilling and tapping holes as well as for milling in M19 or C-axis operation. Programs for the driven tool can be input manually, via cycles or in the DIN editor.

Programming and display

Speed of the driven tool:
- Constant shaft speed: 1 to 19999 rpm
- Constant cutting speed: 1 to 2000 m/min

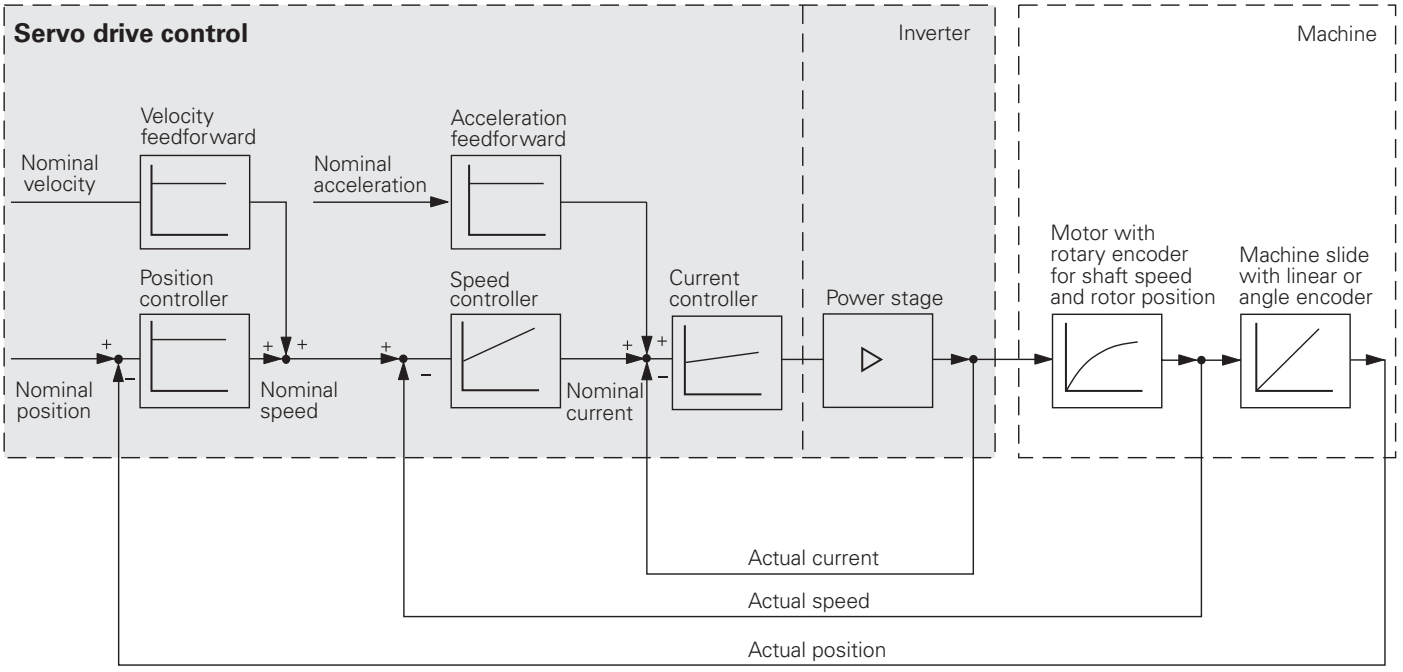
Speed limiting

- The MANUALplus monitors the actual speed.
- Speed limiting can be adjusted via parameter and in the feedrate/spindle/tool menu.

Digital Control

Integrated inverter

Position controllers, speed controllers, current controllers and inverters are integrated in the control. HEIDENHAIN synchronous and asynchronous motors are connected to the MANUALplus 4110 .



Axis feedback control

In the standard turning cycles, the MANUALplus 4110 operates with feedforward control. Feedforward control is turned off during certain threading cycles.

Servo control 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 = loop gain
s_a = following error

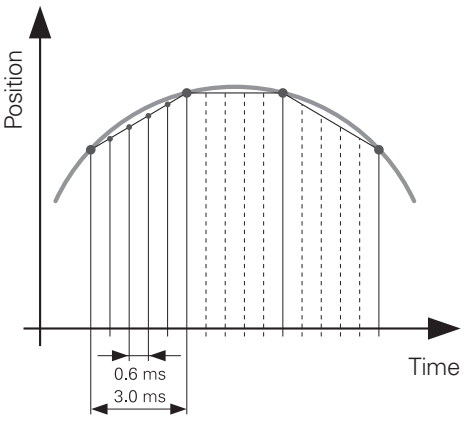
Servo control with velocity feedforward

Feedforward control means that the speed and the acceleration feedforward control are preset according to the machine, while taking the jerk limiting into account. Together with the values calculated from the following error, it forms the nominal value. In this way, the following error becomes very small (in the range of a few µm).

Control loop cycle times

The cycle time for the **position controller** is defined as the time interval during which interpolation points on the path are calculated. 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.

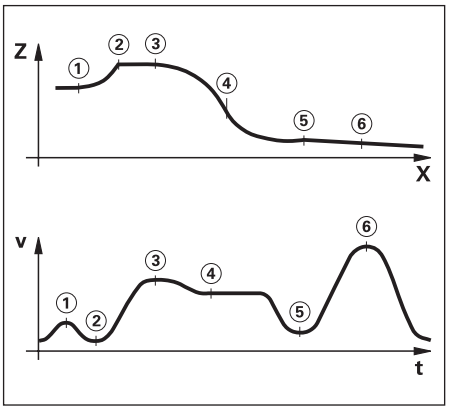
	Position controller	Speed controller	Current controller
MC 420 CC 422	3 ms	0.6 ms	0.1 ms



Fast Machining

Look-ahead

The MANUALplus 4110 calculates the geometry ahead of time in order to adjust the feed rate (20 blocks). In this way directional changes are detected in time to accelerate or decelerate the appropriate NC axes.



Jerk Limiting

Jerk

The derivative of acceleration is referred to as jerk.
A linear change in acceleration causes a jerk step. This jerk causes oscillations, and leads to contour damage.

Smoother jerk

To prevent machine oscillations, the jerk is limited to attain optimum path control. The MANUALplus 4110 machines smooth surfaces at the highest possible feed rate, and yet keeps the contour accurate. The user sets the permissible tolerance via parameter.

Encoders

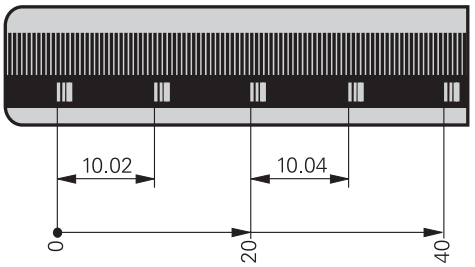
For speed and position control of the axes and spindle, HEIDENHAIN offers both incremental as well as absolute measuring systems.

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 from these 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.



Reference mark evaluation

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 levels $\sim$ 1 V_{PP} 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 MANUALplus 4110 is fitted with the serial EnDat 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 all position encoder inputs of the MC 420.

Inputs	Signal level/ Interface[1)]	Input frequency[1)]
Incremental	∿ 1 V_{PP}	33 kHz/350 kHz
Absolute	EnDat ∿ 1 V_{PP}	– 33 kHz/350 kHz

[1)] Switchable

Encoder inputs for speed control

Incremental and absolute rotary encoders from HEIDENHAIN can be connected to all speed encoder inputs of the CC 420.

Inputs	Signal level/ Interface[1)]	Input frequency
Incremental	∿ 1 V_{PP}	350 kHz
Absolute	EnDat ∿ 1 V_{PP}	– 350 kHz

[1)] Switchable

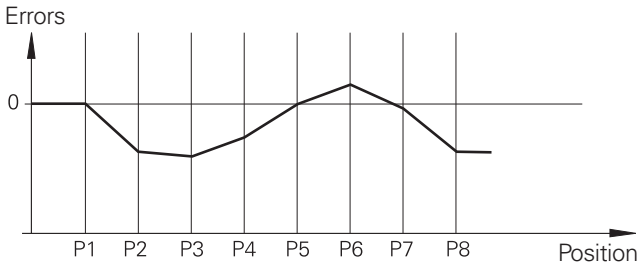
Compensation

The MANUALplus 4110 electronically compensates mechanical errors of the machine.

Axis error

The MANUALplus 4110 compensates axis error in the linear axes X and Z in a linear manner. Compensation of backlash is also possible. The compensation values must be determined by the machine tool builder and entered in the parameter list.

Up to 100 compensation points can be defined with the corresponding compensation values for multipoint error compensation. The error compensation is interpolated linearly between these points.



Backlash

For length measurements via spindle and rotary encoders, the play between the table movement and the rotary encoder movement on direction changes can be compensated. This backlash is outside the controlled system.

Reversal error

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

Misalignment compensation

Misalignment compensation counteracts nonparallelism in the compensation axes of a slide. The compensation path for this axis is calculated per 100 mm traverse of the neighboring axis.

Thermal expansion

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

The temperature can be recorded via temperature measurement thermistors connected to the analog inputs of the MANUALplus 4110. The PLC evaluates the temperature information and transfers the compensation value to the NC.

Integrated PLC

The machine tool builder provides the PLC software. Machine-specific functions are activated and monitored via PLC inputs/outputs. The number of PLC inputs/outputs required depends on the complexity of the machine.

PLC inputs
PLC outputs
56 freely assignable inputs (24 V)
31 freely assignable outputs (24 V / 100 mA)
and 1 "control-is-ready" output

PLC expansion
If the PLC inputs/outputs of the logic unit are insufficient, you can add PL 510 input/output units.

Rated operating current per output
Logic unit: 0.1 A
PL 510: 1.2 A

Memory
- PLC program: on hard disk
- Process memory: 512 KB RAM
- Data memory: 124 KB RAM

Cycle time
18 ms

PLC programming
The PC program **PLCdesignNT** (accessory) can be used for easy creation of PLC programs. Comprehensive examples of PLC programs are included.

Hardware requirements
- Standard PC with Windows operating system: 95/98/NT/2000/ME/XP
- At least 32 MB RAM

Features
- Menu-guided operation
- Modular programming method
- "Compiling" and "linking" of PLC source files
- Operand comments
- Comprehensive help system
- Data transmission to the control
- Compilation of the software file for the machine

Command set
- Bit, byte and word commands
- Logical operations
- Arithmetic commands
- Comparisons
- Parenthetic calculations
- Jump commands
- Subprograms
- 200 timers
- 48 counters
- Transfer commands

Format
Statement list

PLC test functions

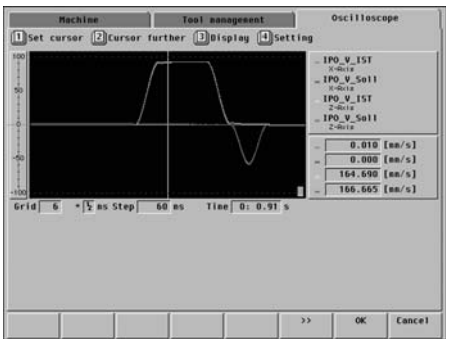
Logic Analyzer
Simultaneous representation of the logic states of up to 16 operands (markers, inputs, outputs, counters, timers)

Commissioning Aids

Oscilloscope

The MANUALplus 4110 features an integrated oscilloscope. The following characteristic curves can be recorded and stored in four channels:

- Actual position value
- Nominal position value
- Following error
- Actual velocity value
- Nominal velocity value
- Actual acceleration value
- Nominal acceleration value
- Performance
- Torque
- Actual value of shaft speed
- Nominal value of shaft speed
- Integral current (motor speed controller)
- Torque-determining current



Nominal and actual position

Logic diagram

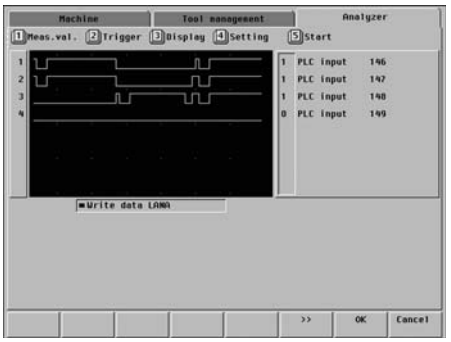
Simultaneous graphic representation of the logic states of up to 16 operands (markers, words, inputs, outputs,)

Table function

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

Log

For the purposes of error diagnosis, there is a log for all error messages.



Logic diagram

TNCopt (accessory)

PC software for commissioning digital control loops

Functions:
- Commissioning of current controller
- (Automatic) commissioning of speed controller
- (Automatic) optimization of sliding-friction compensation
- (Automatic) optimization of reversal-spike compensation
- (Automatic) optimization of k_V factor

Requirements:
- Windows 95/98 or NT 4.0 or 2000 operating system
- At least VGA, XGA recommended
- At least 16 MB RAM
- At least 15 MB free hard-disk space
- Serial or Ethernet interface

TNCdiag (accessory)

The TNCdiag software for PCs enables the service technician to make a simple and fast diagnosis of the drives. It also permits the display and evaluation of the electronic ID labels. TNCdiag works with the MANUALplus 4110 as of software version 526488-04.

The following diagnostic functions are available:
- Reading and displaying the electronic ID labels of QSY motors with EQN 1325 or ECN 1313
- Reading and displaying the electronic ID labels of the UVR 1xxD and UM 1xxD inverter modules
- 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
- Automatic test of position and speed encoders

Monitoring Functions

During operation, the MANUALplus 4110 monitors:

- Amplitude of the encoder signals
- Actual position
- Actual path traversed (movement monitoring)
- Actual speed
- Supply voltage
- Motor current
- Motor temperature
- DC-link voltage
- Supply voltage of the logic unit
- Temperature of the power module

In case of an error, the MANUALplus 4110 reports this error. If a hazardous error occurs, an EMERGENCY STOP message is sent to the external electronics via the control-is-ready output.

Data Interfaces

The MANUALplus 4110 is connected to other EDP systems (such as PCs, programming stations, etc.) or integrated in networks via data interfaces.

Ethernet

- 100 BaseT Fast Ethernet interface
- The MANUALplus 4110 supports various Windows networks protocols (TCP/IP among others).

RS-232-C / V.24

Data interface according to DIN 66020 or EIA standard RS-232-C.
Maximum transmission distance: 20 m

RS-422 / V.11

Data interface according to EIA standard RS-422.
Maximum transmission distance: 1 km

Data transfer rate

38400; 19200; 9600; 7200; 4800; 3600; 2400; 1200; 600; 300 baud

Data transfer

The data is transferred character by character. The number of data bits, stop bits, the character parity and the software or hardware handshake (Xon/Xoff, RTS/CTS) must be set by the user.

Adapter block

For connecting the interface to the electrical cabinet or operating panel

RS-232-C / V.24 adapter	9-pin	ID 363987-02
	25-pin	ID 310085-01
RS-422 / V.11 adapter	9-pin	ID 363987-01

USB

The two USB interfaces are available for connecting standard storage media. They must not be loaded with a total supply current greater than 0.5 A. The maximum cable length for external USB units is 6 m without amplifiers. For lengths from 7 m, USB connecting cables with an integrated amplifier are required.

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 ports.

Power supply:	24 Vdc / max. 300 mA
ID	582884-01

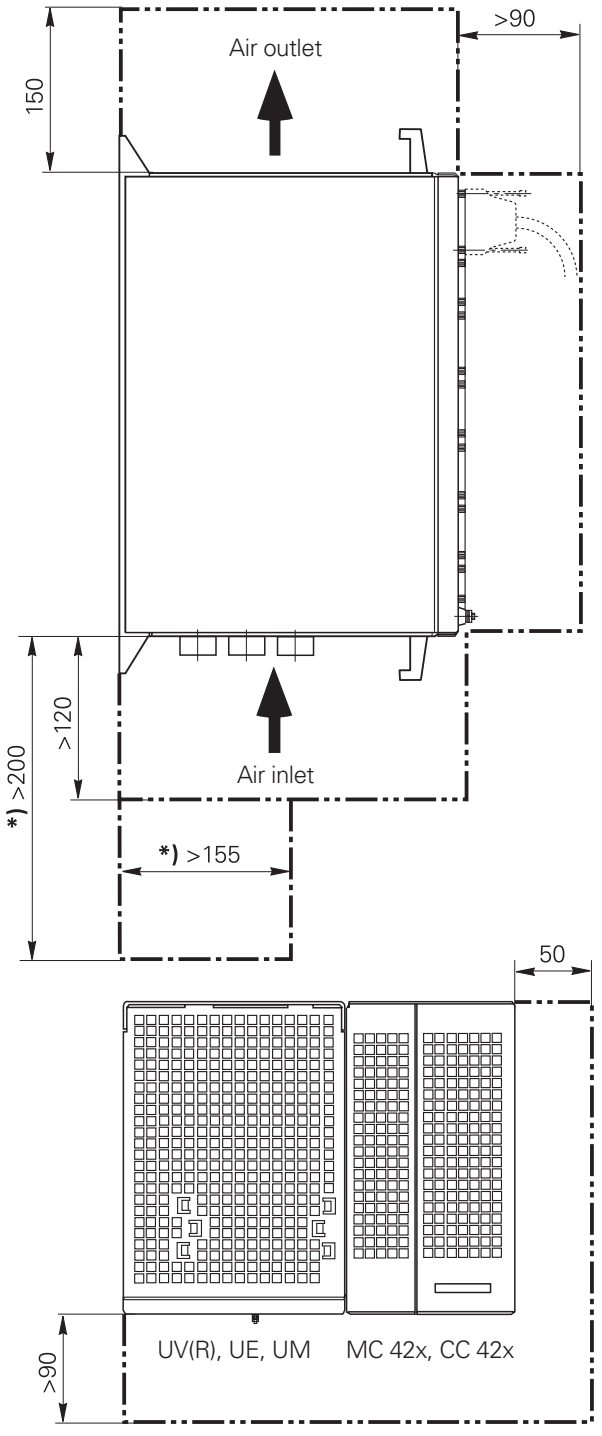
Cover

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 can be used to protect the ports from contamination.

ID 508921-21

Mounting Instructions

Mounting attitude When installing the **MC 420, CC 422, UV(R) 1xx, UM xxx, UE 2xx B** take note of the minimum spacing, space needed for servicing, and the appropriate length and location of the connecting cables.



Leave space for air circulation! Temperatures of > 150 °C may occur with the UE 21x B with integrated braking resistor; do not mount any temperature-sensitive parts!

Leave space for servicing!

Leave space for air circulation and servicing!

*) Leave space for exchanging the HDR hard disk

Leave space for servicing and connecting cables!

Mounting and electrical connection

Keep the following in mind during mounting and electrical connection:
- National regulations for power installations
- Interference and noise immunity
- Conditions of operation
- Mounting attitude

Degrees of protection

The following components fulfill the requirements for IP 54 (dust protection and splash-proof protection):
- Visual display unit (when properly installed)
- Keyboard unit (when properly installed)
- Handwheel

Electromagnetic compatibility

Intended area of application

The unit fulfills the requirements for a Class A device in accordance with the specifications in EN 55022, and is intended for use primarily in industrially-zoned areas.

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

Likely sources of interference

Noise is mainly produced by capacitive and inductive coupling from electrical conductors or from device inputs/outputs, such as:
- Strong magnetic fields from transformers or electric motors
- Relays, contactors and solenoid valves
- High-frequency equipment, pulse equipment and stray magnetic fields from switch-mode power supplies
- Power lines and leads to the above equipment

Protective measures

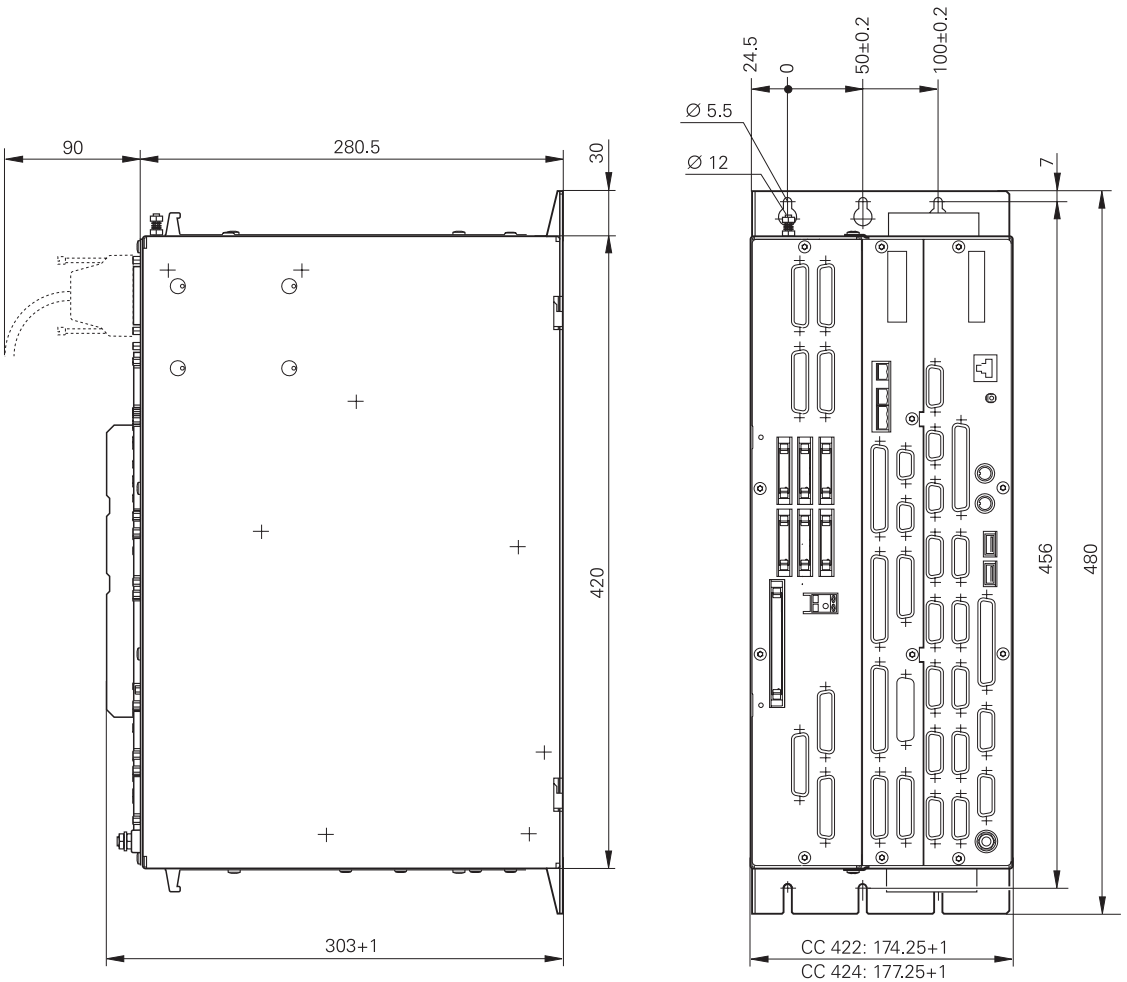
- Keep a minimum distance of 20 cm from the MC, CC and its leads to devices that carry interference signals.
- Keep a minimum distance of 10 cm from the MC, CC and its leads to cables that carry interference signals. For cables in metallic ducting, adequate decoupling can be achieved by using a grounded separation shield.
- Shielding according to EN 50178
- Use potential compensating lines with a cross section of 6 mm^2
- Use only original HEIDENHAIN cables, connectors and couplings.

Overall Dimensions

MC 420
CC 422

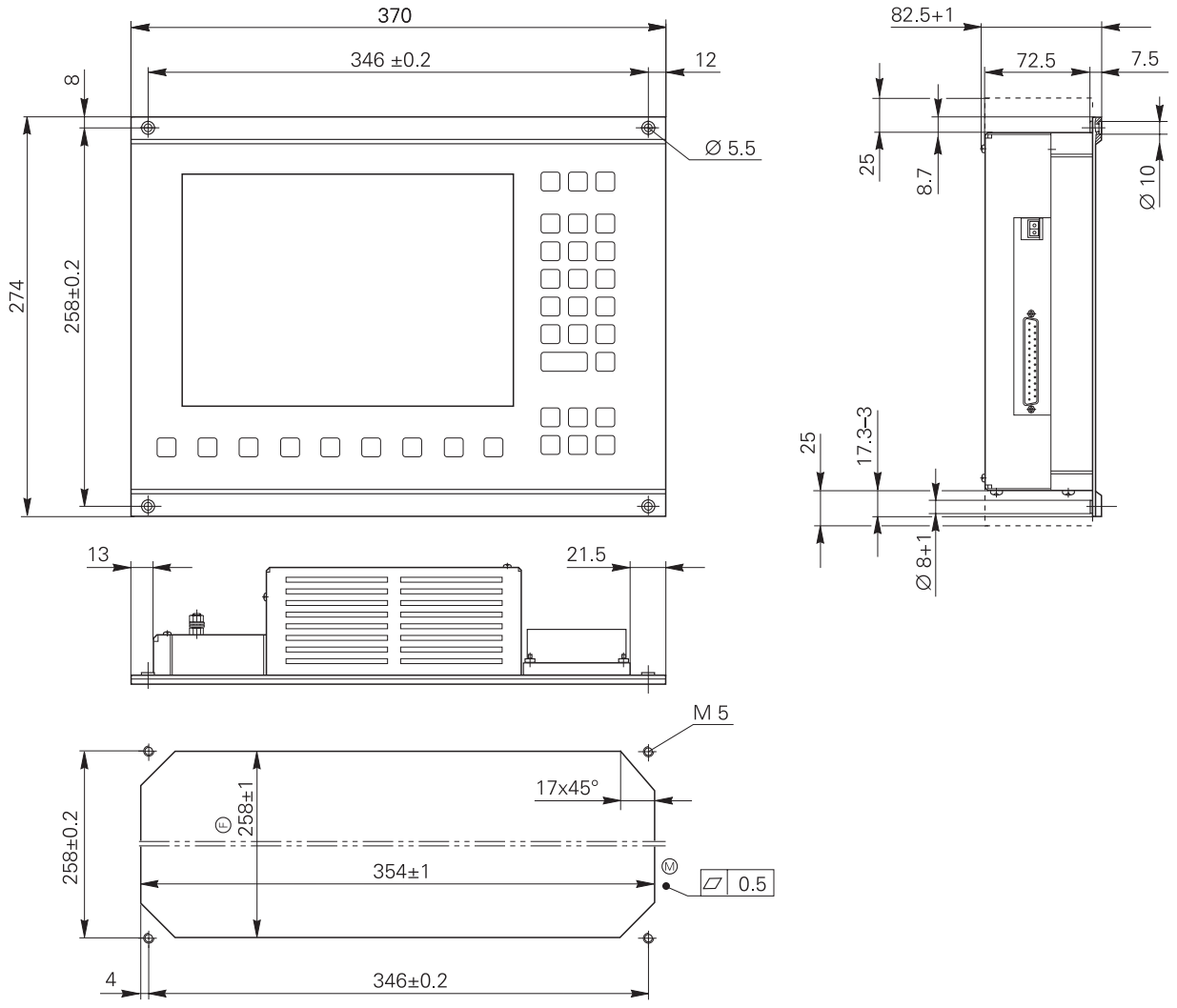
Dimensions in mm

MC 420 / 5 position encoder inputs
CC 422 / 6 control loops



BFT 121 G

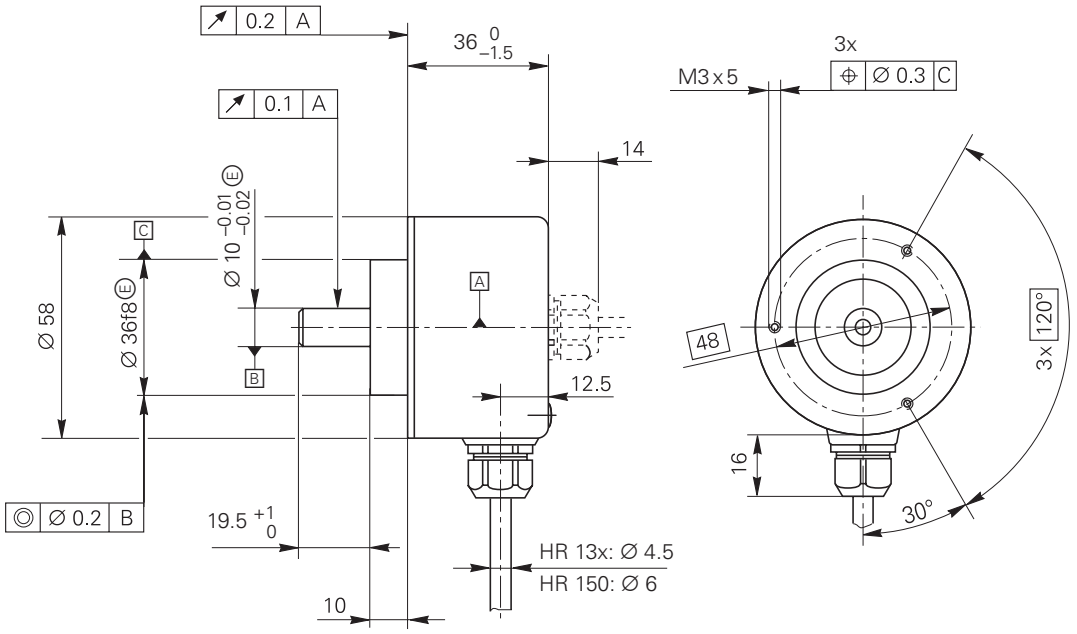
Dimensions
in mm



Ⓕ = Cutout in machine panel
Ⓜ = Mounting surface

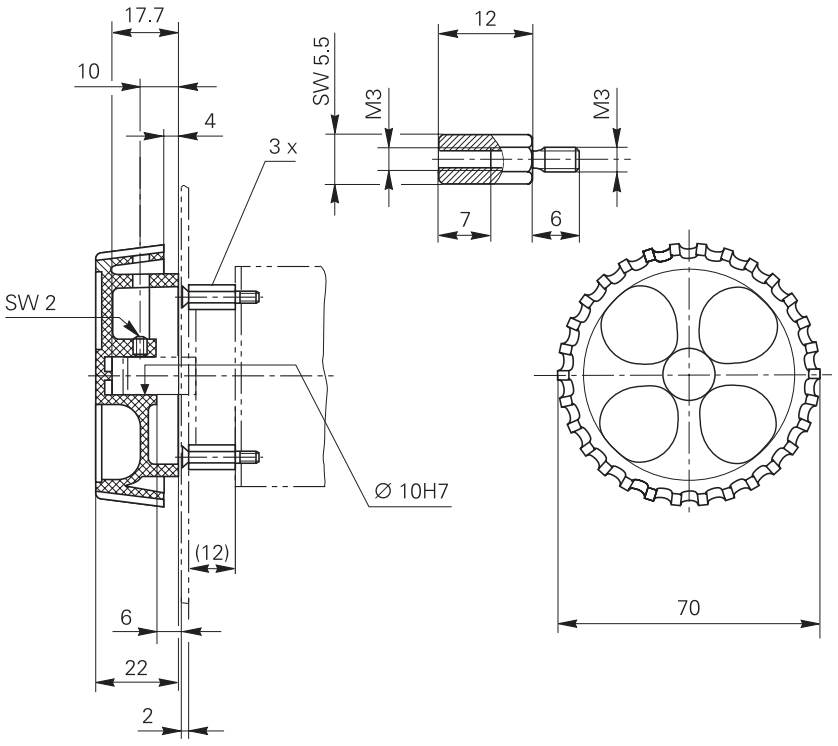
HR 130, HR 150

Dimensions
in mm



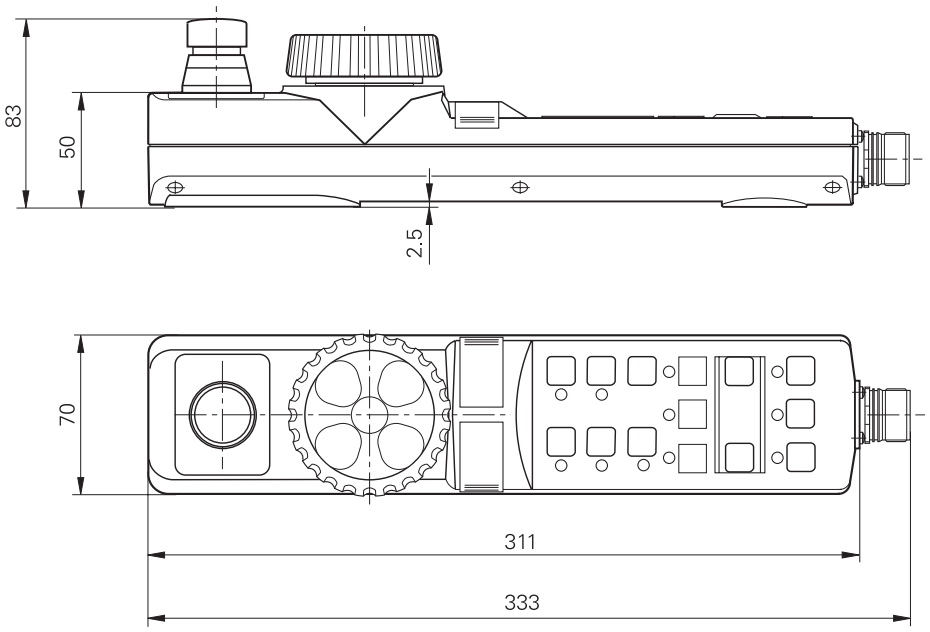
Control Knob for HR 130 and HR 150

Dimensions
in mm



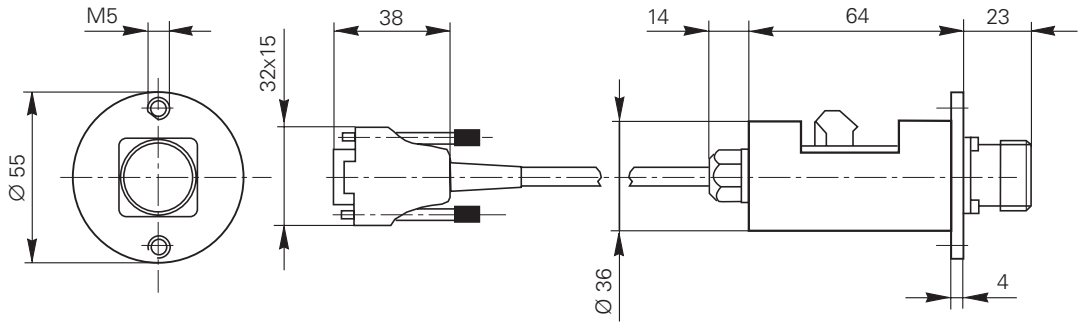
HR 410

Dimensions
in mm



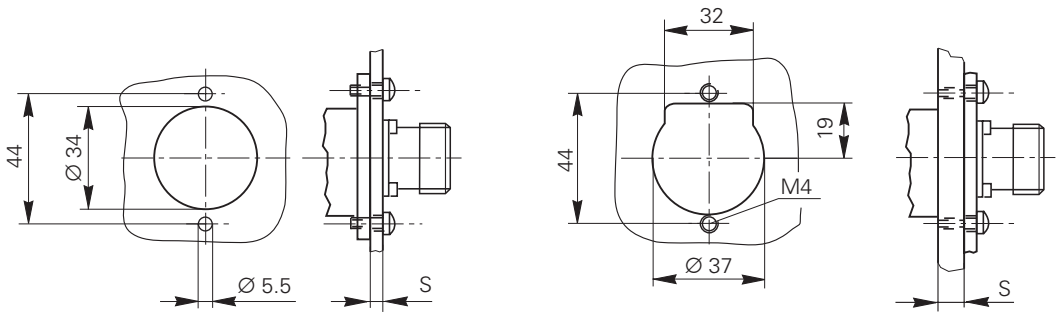
Adapter Cable for HR 410

Dimensions
in mm



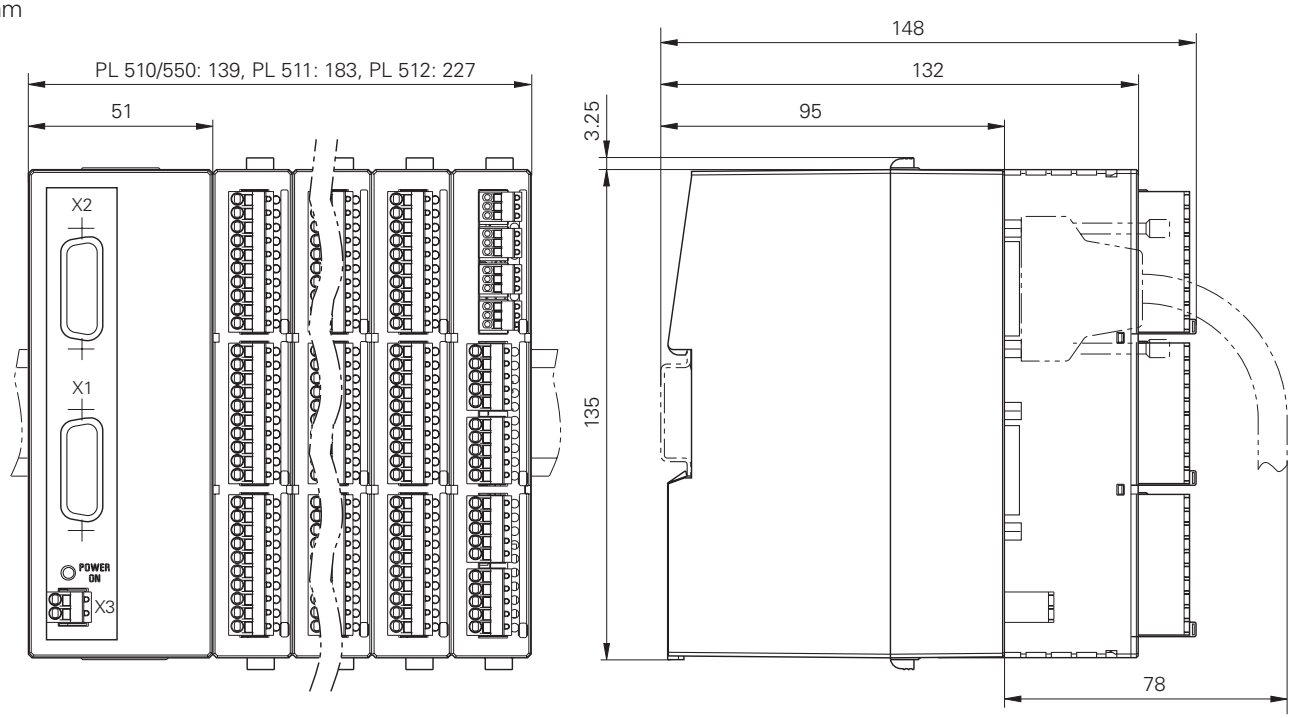
Mounting opening for wall thickness S≤4

Mounting opening for wall thickness S>4



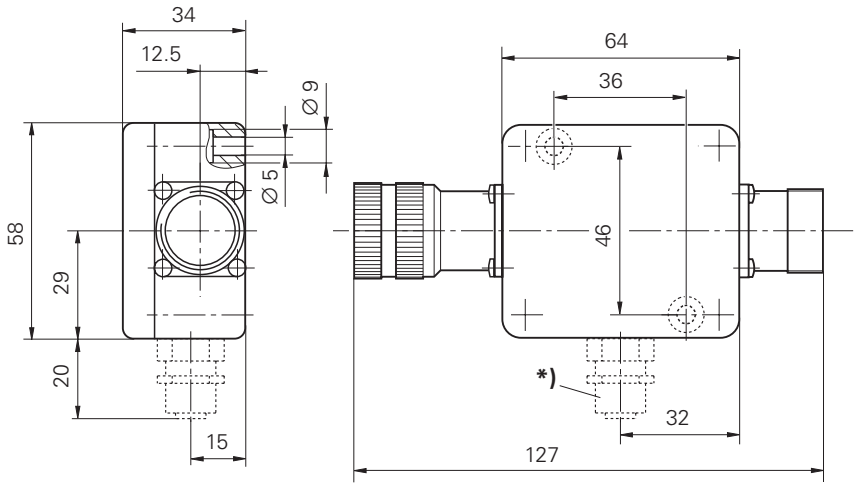
PL 510

Dimensions
in mm



Line Drop Compensator for EnDat Interface

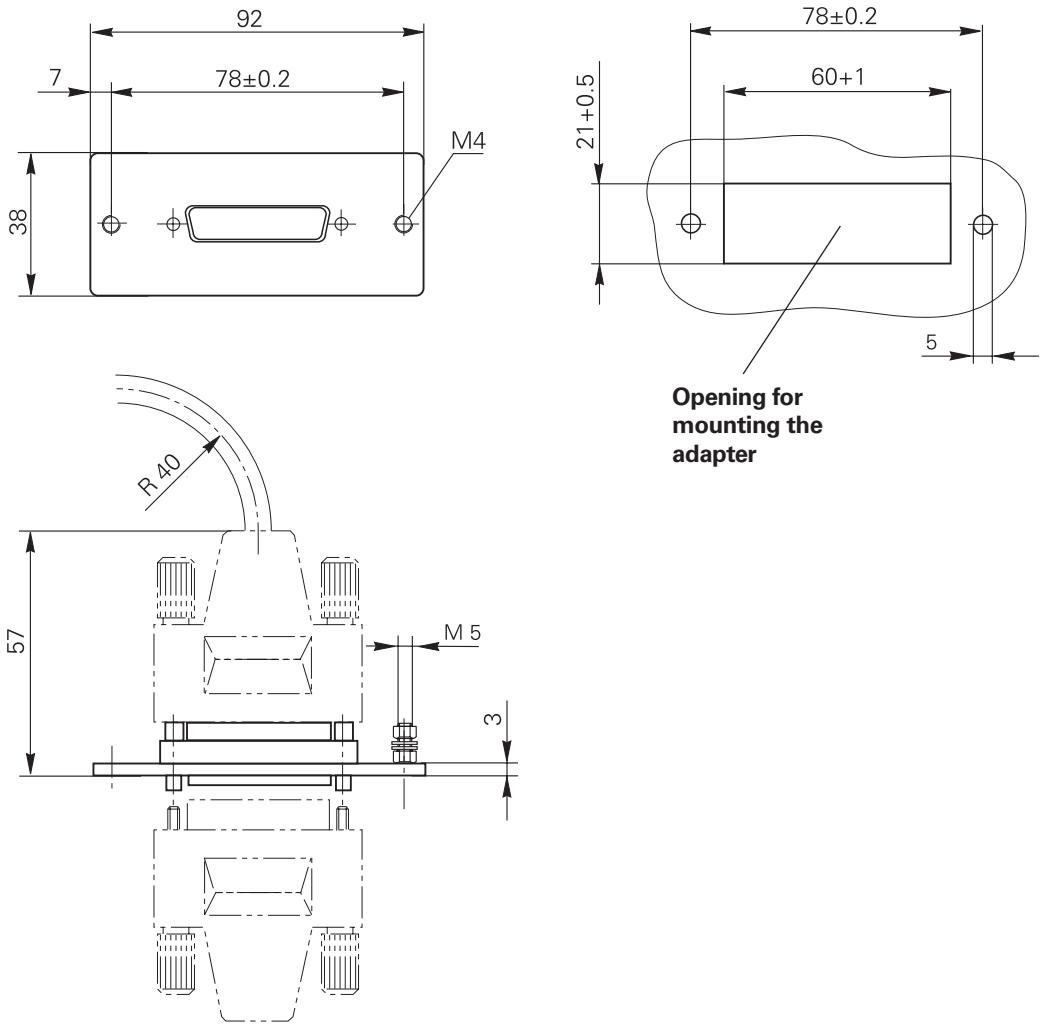
Dimensions
in mm



***)** Variant 03
Connection for temperature sensor

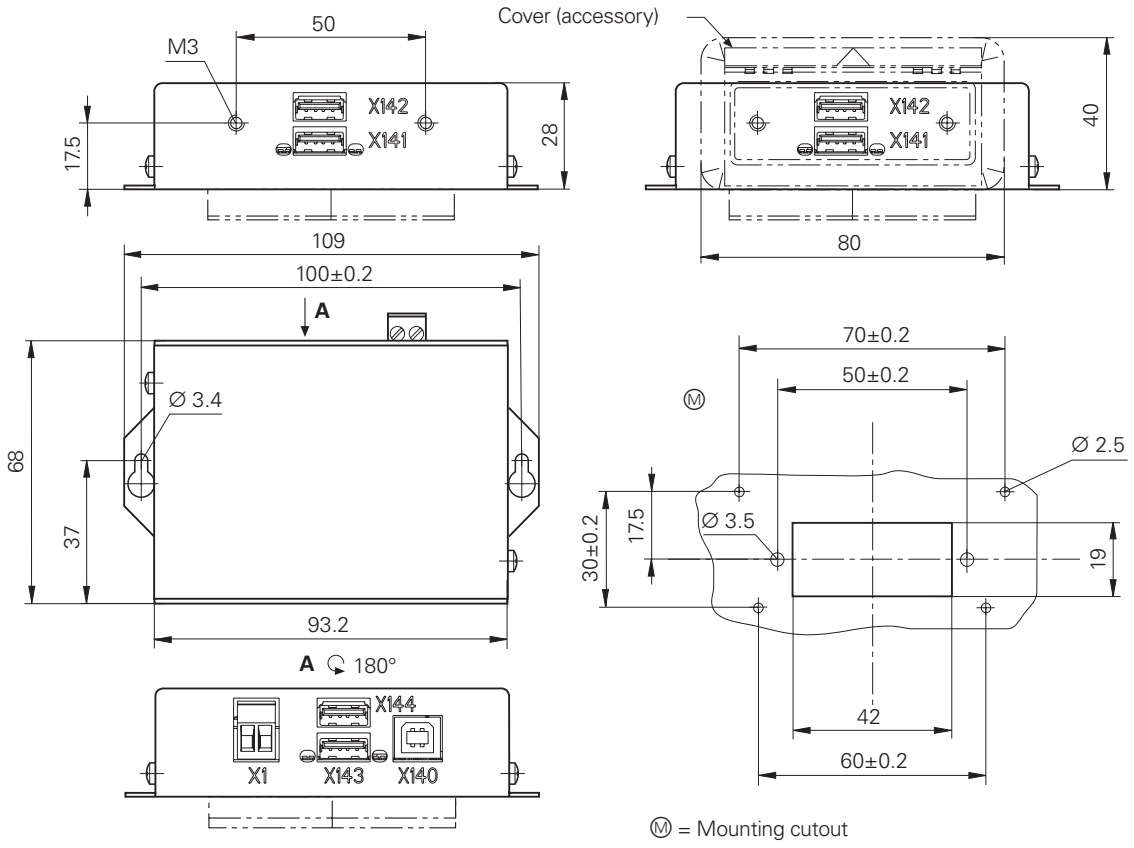
V.11/V.24 Adapter

Dimensions
in mm



USB Hub

Dimensions
in mm



Documentation

The following are supplied with a control system:
- 1 MANUALplus 4110 User's Manual
- 1 MANUALplus 4110 Pilot (brief programming guide)

This documentation must be ordered separately in the language required.
Further documentation is available from HEIDENHAIN.

Technical documentation	• HEIDENHAIN Technical Manual for **MANUALplus 4110** in English or German	ID 361406-xx
	• Technical Manual **for Inverter Systems and Motors**	ID 208962-xx
	The Technical Manuals are in loose-leaf format in a ring binder. Supplementary issues with update information and replacement sheets are sent when the software or hardware is updated.	
User documentation	• **MANUALplus 4110** User's Manual	ID 354267-xx
	• **MANUALplus 4110** Pilot – brief programming guide in German, English, French, Italian, Dutch, Spanish, Danish, Czech, Swedish, Polish, Finnish, Russian.	ID 354268-xx
Other documentation	• **Motors** brochure	ID 208893-xx
	• **MANUALplus 4110** brochure	ID 355830-xx
	• **DataPilot 4110** data sheet	ID 364321-xx
	• **DataPilot 4110** CD-ROM	ID 510703-xx
	• **Inverter Systems** brochure	ID 622420-xx
	• **Training documents** in German and English (also suitable for private study)	**DataPilot 4110** on CD-ROM

HEIDENHAIN Service

Technical support

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

Replacement control system

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

Hotline

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.

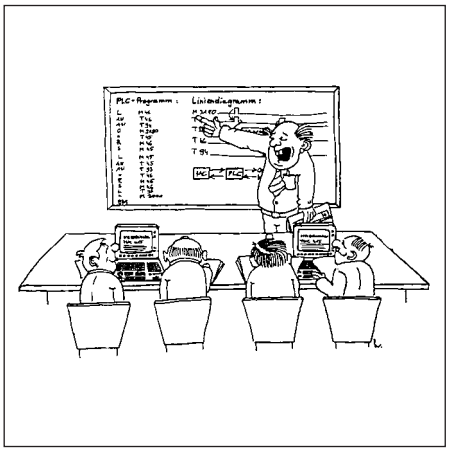
TNC support	☏ +49/8669/31-3101 E-mail: service.nc-support@heidenhain.de
PLC programming	☏ +49/8669/31-3102 E-mail: service.plc@heidenhain.de
NC programming	☏ +49/8669/31-3103 E-mail: service.nc-pgm@heidenhain.de
Measuring systems	☏ +49/8669/31-3104 E-mail: service.ms-support@heidenhain.de
Lathe controls	☏ +49/711/9528 03-0 E-mail: service.hsf@heidenhain.de

Seminars

HEIDENHAIN provides technical customer training in the following subjects:

- NC programming
- PLC programming
- MANUALplus 4110 mounting and commissioning
- MANUALplus 4110 service
- Encoder service
- Special training for specific customers

For more information on dates, registration, etc. call in Germany:
☏ (08669) 31-2293 or 31-1695
FAX (08669) 31-1999
E-mail: mtt@heidenhain.de
www.heidenhain.de

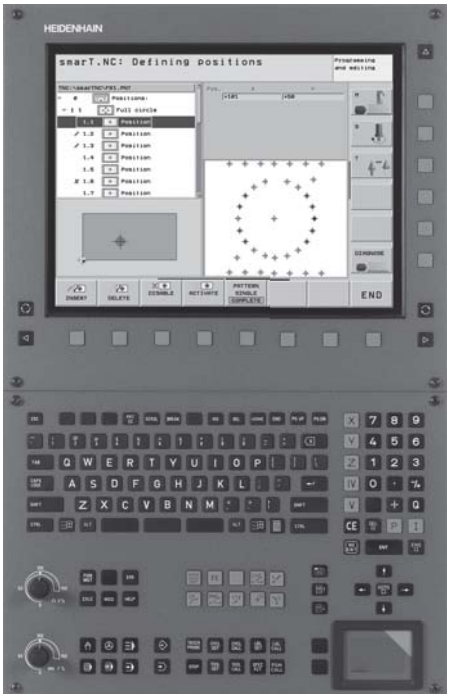


Other HEIDENHAIN Controls

iTNC 530
Contouring Control

Information:
iTNC 530
brochure

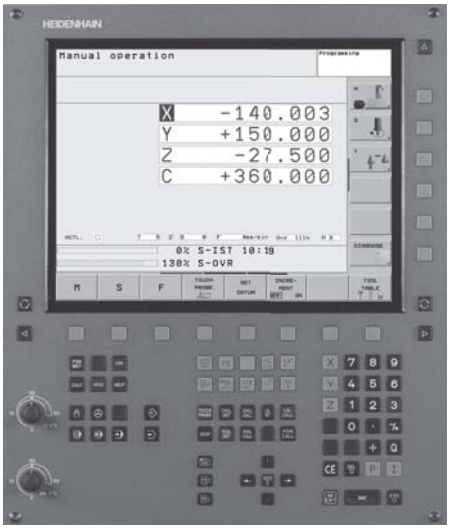
- Contouring control **for milling, drilling and boring machines, and machining centers**
- Max. 11 closed-loop **axes** and servo-controlled spindle
- For **digital drive control** with HEIDENHAIN inverter systems
- Flat-panel color display (15-inch)
- Keyboard unit with alphanumeric keys
- Program memory on integrated hard disk
- Program input with smarT.NC in HEIDENHAIN conversational format or according to ISO
- DXF file import
- External programming on CAD/CAM systems or programming stations
- FK free contour programming
- **User aids:** Programming graphics, verification graphics, program-run graphics
- **Programming aids:** Milling, drilling and boring cycles, parametric programming, coordinate transformation, subprogramming
- Five-axis machining with TCPM and 3-D tool compensation
- Tilted working plane with PLANE function and machining with a rotary table
- HSC machining
- Collision monitoring (optional)
- Tool, datum, preset and pallet tables
- Connection of HR electronic handwheels, TS workpiece touch probes and TT tool touch probes
- Data interfaces: Ethernet 100BaseT; RS-232-C / V.24; RS-422 / V.11; USB 1.1



TNC 320
Contouring Control

Information:
TNC 320
brochure

- Compact contouring control for **milling, drilling and boring machines**
- Three or optionally four closed-loop **axes** and one non-controlled spindle
- Analog speed command interface
- Integrated keyboard and flat-panel color display (15-inch)
- Program memory: 10 MB on Compact Flash memory card (CFR)
- Program input in HEIDENHAIN conversational language, execution of ISO programs
- FK free contour programming
- Subprogramming and fixed cycles
- **User aids:** Programming graphics, verification graphics, program-run graphics
- **Programming aids:** Milling, drilling and boring cycles, parametric programming, coordinate transformation, subprogramming
- Machining with rotary tables (option)
- Tool and reference-point tables
- Connection for one HR electronic handwheel and one TS workpiece touch probe
- Data interfaces: Ethernet 100BaseT, RS-232-C/V.24, USB 1.1



Subject Index

HEIDENHAIN

DR. JOHANNES HEIDENHAIN GmbH
Dr.-Johannes-Heidenhain-Straße 5
83301 Traunreut, Germany
☎ +49 (8669) 31-0
FAX +49 (8669) 5061
E-Mail: info@heidenhain.de

www.heidenhain.de

DE **HEIDENHAIN Technisches Büro Nord**
12681 Berlin, Deutschland
☎ (030) 54705-240
E-Mail: tbn@heidenhain.de

HEIDENHAIN Technisches Büro Mitte
08468 Heinsdorfergrund, Deutschland
☎ (03765) 69544
E-Mail: tbm@heidenhain.de

HEIDENHAIN Technisches Büro West
58093 Hagen, Deutschland
☎ (02331) 9579-0
E-Mail: tbw@heidenhain.de

HEIDENHAIN Technisches Büro Südwest
70771 Leinfelden-Echterdingen, Deutschland
☎ (0711) 993395-0
E-Mail: tbsw@heidenhain.de

HEIDENHAIN Technisches Büro Südost
83301 Traunreut, Deutschland
☎ (08669) 31-1345
E-Mail: tbso@heidenhain.de

AR **NAKASE SRL.**
B1653AOX Villa Ballester, Argentina
☎ +54 (11) 47684242
E-Mail: nakase@nakase.com

AT **HEIDENHAIN Techn. Büro Österreich**
83301 Traunreut, Germany
☎ +49 (8669) 31-1337
E-Mail: tba@heidenhain.de

AU **FCR Motion Technology Pty. Ltd**
Laverton North 3026, Australia
☎ +61 (3) 93626800
E-Mail: vicsales@fcrmotion.com

BE **HEIDENHAIN NV/SA**
1760 Roosdaal, Belgium
☎ +32 (54) 343158
E-Mail: sales@heidenhain.be

BG **ESD Bulgaria Ltd.**
Sofia 1172, Bulgaria
☎ +359 (2) 9632949
E-Mail: info@esd.bg

BR **DIADUR Indústria e Comércio Ltda.**
04763-070 – São Paulo – SP, Brazil
☎ +55 (11) 5696-6777
E-Mail: diadur@diadur.com.br

BY Belarus → **RU**

CA **HEIDENHAIN CORPORATION**
Mississauga, Ontario L5T 2N2, Canada
☎ +1 (905) 670-8900
E-Mail: info@heidenhain.com

CH **HEIDENHAIN (SCHWEIZ) AG**
8603 Schwerzenbach, Switzerland
☎ +41 (44) 8062727
E-Mail: verkauf@heidenhain.ch

CN **DR. JOHANNES HEIDENHAIN (CHINA) Co., Ltd.**
Beijing 101312, China
☎ +86 10-80420000
E-Mail: sales@heidenhain.com.cn

CS Serbia and Montenegro → **BG**

CZ **HEIDENHAIN s.r.o.**
106 00 Praha 10, Czech Republic
☎ +420 272658131
E-Mail: heidenhain@heidenhain.cz

DK **TP TEKNIK A/S**
2670 Greve, Denmark
☎ +45 (70) 100966
E-Mail: tp-gruppen@tp-gruppen.dk

ES **FARRESA ELECTRONICA S.A.**
08028 Barcelona, Spain
☎ +34 934092491
E-Mail: farresa@farresa.es

FI **HEIDENHAIN Scandinavia AB**
02770 Espoo, Finland
☎ +358 (9) 8676476
E-Mail: info@heidenhain.fi

FR **HEIDENHAIN FRANCE sarl**
92310 Sèvres, France
☎ +33 01 41 14 30 00
E-Mail: info@heidenhain.fr

GB **HEIDENHAIN (G.B.) Limited**
Burgess Hill RH15 9RD, United Kingdom
☎ +44 (1444) 247711
E-Mail: sales@heidenhain.co.uk

GR **MB Milionis Vassilis**
17341 Athens, Greece
☎ +30 (210) 9336607
E-Mail: bmilioni@otenet.gr

HK **HEIDENHAIN LTD**
Kowloon, Hong Kong
☎ +852 27591920
E-Mail: service@heidenhain.com.hk

HR Croatia → **SL**

HU **HEIDENHAIN Kereskedelmi Képviselet**
1239 Budapest, Hungary
☎ +36 (1) 4210952
E-Mail: info@heidenhain.hu

ID **PT Servitama Era Toolsindo**
Jakarta 13930, Indonesia
☎ +62 (21) 46834111
E-Mail: ptset@group.gts.co.id

IL **NEUMO VARGUS MARKETING LTD.**
Tel Aviv 61570, Israel
☎ +972 (3) 5373275
E-Mail: neumo@neumo-vargus.co.il

IN **ASHOK & LAL**
Chennai – 600 030, India
☎ +91 (44) 26151289
E-Mail: ashoklal@satyam.net.in

IT **HEIDENHAIN ITALIANA S.r.l.**
20128 Milano, Italy
☎ +39 0227075 1
E-Mail: info@heidenhain.it

JP **HEIDENHAIN K.K.**
Tokyo 102-0073, Japan
☎ +81 (3) 3234-7781
E-Mail: sales@heidenhain.co.jp

KR **HEIDENHAIN LTD.**
Suwon, South Korea, 443-810
☎ +82 (31) 2011511
E-Mail: info@heidenhain.co.kr

MK Macedonia → **BG**

MX **HEIDENHAIN CORPORATION MEXICO**
20235 Aguascalientes, Ags., Mexico
☎ +52 (449) 9130870
E-Mail: info@heidenhain.com

MY **ISOSERVE Sdn. Bhd**
56100 Kuala Lumpur, Malaysia
☎ +60 (3) 91320685
E-Mail: isoserve@po.jaring.my

NL **HEIDENHAIN NEDERLAND B.V.**
6716 BM Ede, Netherlands
☎ +31 (318) 581800
E-Mail: verkoop@heidenhain.nl

NO **HEIDENHAIN Scandinavia AB**
7300 Orkanger, Norway
☎ +47 72480048
E-Mail: info@heidenhain.no

PH **Machinebanks` Corporation**
Quezon City, Philippines 1113
☎ +63 (2) 7113751
E-Mail: info@machinebanks.com

PL **APS**
02-473 Warszawa, Poland
☎ +48 228639737
E-Mail: aps@apserwis.com.pl

PT **FARRESA ELECTRÓNICA, LDA.**
4470 - 177 Maia, Portugal
☎ +351 229478140
E-Mail: fep@farresa.pt

RO Romania → **HU**

RU **OOO HEIDENHAIN**
125315 Moscow, Russia
☎ +7 (495) 931-9646
E-Mail: info@heidenhain.ru

SE **HEIDENHAIN Scandinavia AB**
12739 Skärholmen, Sweden
☎ +46 (8) 53193350
E-Mail: sales@heidenhain.se

SG **HEIDENHAIN PACIFIC PTE LTD.**
Singapore 408593,
☎ +65 6749-3238
E-Mail: info@heidenhain.com.sg

SK Slovakia → **CZ**

SL **Posredništvo HEIDENHAIN SAŠO HÜBL s.p.**
2000 Maribor, Slovenia
☎ +386 (2) 4297216
E-Mail: hubl@siol.net

TH **HEIDENHAIN (THAILAND) LTD**
Bangkok 10250, Thailand
☎ +66 (2) 398-4147-8
E-Mail: info@heidenhain.co.th

TR **T&M Mühendislik Mümessillik**
34728 Erenköy-Istanbul, Turkey
☎ +90 (216) 3022345
E-Mail: info@tmmuhendislik.com.tr

TW **HEIDENHAIN Co., Ltd.**
Taichung 407, Taiwan
☎ +886 (4) 23588977
E-Mail: info@heidenhain.com.tw

UA Ukraine → **RU**

US **HEIDENHAIN CORPORATION**
Schaumburg, IL 60173-5337, USA
☎ +1 (847) 490-1191
E-Mail: info@heidenhain.com

VE **Maquinaria Diekmann S.A.**
Caracas, 1040-A, Venezuela
☎ +58 (212) 6325410
E-Mail: purchase@diekmann.com.ve

VN **AMS Advanced Manufacturing Solutions Pte Ltd**
HCM City, Viêt Nam
☎ +84 (8) 9123658 - 8352490
E-Mail: davidgoh@amsvn.com

ZA **MAFEMA SALES SERVICES C.C.**
Midrand 1685, South Africa
☎ +27 (11) 3144416
E-Mail: mailbox@mafema.co.za

Zum Abheften hier falzen! / Fold here for filing!

Vollständige Adressen siehe www.heidenhain.de
For complete addresses see www.heidenhain.de

364 189-24 · 5 · 4/2007 · E · Printed in Germany · Subject to change without notice