# HEIDENHAIN

## TNC 640 HSCI

For Gen 3 Drives

The Contouring Control for Milling Machines, Milling-Turning Machines, and Machining Centers

**Information for the Machine Tool Builder**

# TNC contouring control with drive system from HEIDENHAIN
## General information

**TNC 640**

- Contouring control for **milling machines, milling-turning machines, and machining centers**
- Axes: up to 24 control loops (22 control loops with functional safety (FS)), of which up to 4 can be configured as spindles
- For operation with HEIDENHAIN inverter systems and ideally HEIDENHAIN motors
- Uniformly digital with HSCI interface and EnDat interface
- Version with touchscreen for multitouch operation
- Solid state disk (SSDR)
- Programming in HEIDENHAIN Klartext or G-code (ISO)
- Comprehensive cycle package for milling and turning operations
- Constant surface speed for turning operations
- Tool radius compensation
- Touch probe cycles
- Free contour programming (FK)
- Special function for fast 3-D machining
- Short block processing time (0.5 ms)
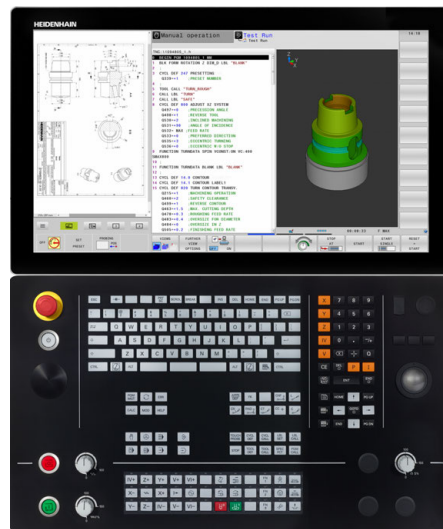
**System test**

Controls, power modules, motors, and encoders from HEIDENHAIN are usually integrated as components into complete systems. In such cases, comprehensive testing of the complete system is required, irrespective of the specifications of the individual devices.

**Parts subject to wear**

Controls from HEIDENHAIN contain parts subject to wear, such as a backup battery and fan.

**Standards**

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

**Note**

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**Validity**

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

**TNC 640 with NC software versions**
340590-10 (export license required)
340591-10 (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 also note that, for some functions, a special PLC program must be created by the manufacturer.

**Functional safety (FS)**

If no explicit distinction is made between standard and FS components (FS = functional safety), then the data and other information apply to both versions (e.g., TE 360, TE 360 FS).

**Use of this brochure**

The purpose of this brochure is to help you select suitable components from HEIDENHAIN. Further documents are required for project planning (see "Technical documentation", Page 106).

# Contents

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

# Overview tables
## Components

| Control systems | | 15-inch design | 19-inch design | 24-inch design | Page |
|---|---|---|---|---|---|
| **Main computer** | *For operating panel* | **MC 8512** (1024 x 1280 pixels) | **MC 8532** (1280 x 1024 pixels) | **MC 366** (1920 x 1080 pixels) | 16 |
| | *For electrical cabinet* | – | **MC 306** | | |
| Storage medium | *MC 85x2; MC 306* | **SSDR** solid-state disk | | | 18 |
| NC software license | | On **SIK component** | | | 18 |
| **Monitor** | | – | **BF 860** (1280 x 1024 pixels) | **BF 360** (1920 x 1024 pixels) | 22 |
| **Keyboard** | | – | **TE 745** | **TE 360** | |
| **Machine operating panel** | | MB 721 | Integrated in TE 745 | Integrated in TE 360 | 22 |
| | | **PLB 600x** (HSCI adapter for OEM machine operating panel) | | | 26 |
| **PLC inputs/ outputs**[1] | With HSCI interface | **PL 6000** consisting of PLB 62xx basic module (system PL) or PLB 61xx (expansion PL) and I/O modules | | | 24 |
| | | On UEC | | | |
| | | On UMC | | | |
| **Additional modules**[1] | | **CMA-H** for analog axes/spindles in the HSCI system | | | 27 |
| | | **Modules for fieldbus systems** | | | |
| **Inverter systems**[2] | | Compact inverters and modular inverters | | | |
| **Connecting cables** | | | | | 41 |

[1] May be necessary depending on the configuration
[2] For more information, refer to the *Gen 3 Drives* brochure.

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

# Accessories

| Accessory | TNC 640 | Page |
|---|---|---|
| **Electronic handwheels** | • **HR 510 FS** portable handwheel, or<br>• **HR 520 FS** portable handwheel with display, or<br>• **HR 550 FS** portable wireless handwheel with display, or<br>• **HR 130** panel-mounted handwheel | 28 |
| **Workpiece touch probes**[1] | • **TS 260** touch trigger probe with cable connection, or<br>• **TS 460** touch trigger probe with radio and infrared transmission, or<br>• **TS 740** touch trigger probe with infrared transmission | |
| **Tool touch probes**[1] | • **TT 160** touch trigger probe with cable connection, or<br>• **TT 460** touch trigger probe with radio and infrared transmission | |
| **Programming station**[2] | Control software for PCs for programming, archiving, and training<br>• Single-station license with original control keyboard<br>• Single-station license with virtual keyboard<br>• Network license with virtual keyboard<br>• Demo version with virtual keyboard or PC keyboard—free of charge | |
| **Auxiliary axis control** | **PNC 610** | 33 |
| **Industrial PC** | **ITC 860**: additional operating station and integrated screen keyboard<br>**IPC 306**: industrial PC for Windows<br>**IPC 6490/IPC 8420** – industrial PC for PNC 610 | 31 |
| **Camera system** | **VS 101** camera system for monitoring the working space | 36 |
| **Snap-on keys** | For controls and handwheels | 37 |

[1] For more information, refer to the *Touch Probes* brochure
[2] For more information, refer to the *Programming Station for TNC Controls* brochure

| Accessories / Software | TNC 640 | Page |
|---|---|---|
| **PLCdesign**[1] | PLC development software | 76 |
| **KinematicsDesign**[1] | Software for creation of kinematic models | 68 |
| **M3D converter**[4] | Software for creation of high-resolution collision objects in M3D format | 68 |
| **TNCremo**[2]**, TNCremoPlus**[2] | Data transfer software (TNCremoPlus with "live" screen) | 81 |
| **ConfigDesign**[1] | Software for configuring the machine parameters | 72 |
| **CycleDesign**[1] | Software for creating cycle structures | 79 |
| **TNCkeygen**[1] | Software for enabling SIK options for a limited time, and for single-day access to the OEM area | 18 |
| **TNCscope**[1] | Software for data recording | 73 |
| **TNCopt**[1] | Software for putting digital control loops into service | 73 |
| **IOconfig**[1] | Software for configuring PLC I/O and fieldbus components | 25 |
| **TeleService**[1][3] | Software for remote diagnostics, monitoring, and operation | 74 |
| **RemoTools SDK**[1] | Function library for developing customized applications for communication with HEIDENHAIN controls | 82 |
| **virtualTNC**[1][3] | Control component for virtual machines | 82 |
| **TNCtest**[1] | Software for creation and execution of an acceptance test | 74 |
| **TNCanalyzer**[1] | Software for the analysis and evaluation of service files | 74 |

[1] Available to registered customers for download from the Internet
[2] Available to all customers (without registration) for download from the Internet
[3] Software release module required
[4] Included in the KinematicsDesign installation package with version 3.1 or later (software release module required)

# Specifications

| Specifications | TNC 640 | Page |
|---|---|---|
| **Axes** | Max. of 24 control loops (22 control loops with functional safety (FS)), of which up to 4 can be configured as spindles | 51 |
| Rotary axes | Max. 3 | |
| Synchronized axes | ✓ | |
| PLC axes | ✓ | |
| **Main spindles** | *Milling:* max. 4; second, third, and fourth spindle can be controlled alternately with the first<br>*Turning:* max. 2<br>Milling spindle or lathe spindle activated via NC command | 57 |
| Speed | Max. 60 000 rpm (with software option 49, max. 120 000 rpm)[*] | 57 |
| Operating mode switchover | ✓ | 57 |
| Position-controlled spindle | ✓ | 57 |
| Oriented spindle stop | ✓ | 57 |
| Gear shifting | ✓ | 57 |
| **NC program memory** | ≈ 18 GB (with 32 GB SSDR)<br>≈ 189 GB (with 240 GB SSDR) | 16 |
| **Input resolution and display step** | | 51 |
| Linear axes | Down to 0.01 µm | |
| Rotary axes | Down to 0.000 01° | |
| **Functional safety (FS)** | With FS components, SPLC, and SKERN | 47 |
| For applications with up to | • SIL 2 as per EN 61508<br>• Category 3, PL d as per EN ISO 13849-1: 2008 | |
| **Interpolation** | | |
| Straight line | In 4 axes; in max. 6 axes with software option 9 | |
| Circular | In 2 axes; in 3 axes with software option 8 | |
| Helical | ✓ | |
| **Axis feedback control** | | 59 |
| With following error | ✓ | |
| With feedforward | ✓ | |
| Axis clamping | ✓ | 51 |
| Maximum feed rate | $\dfrac{60000\ \text{rpm}}{\text{No. of motor pole pairs}} \cdot \text{Screw pitch [mm]}$<br><br>at $f_{PWM} = 5000$ Hz | 51 |

[*] For motors with a single pole pair

| Specifications | TNC 640 | | Page |
|---|---|---|---|
| **Cycle times** of main computer | **MC** | | 60 |
| Block processing | 0.5 ms | | 61 |
| **Cycle times** of controller unit | **CC/UEC/UMC** | | 60 |
| Path interpolation | 3 ms | | 60 |
| Fine interpolation | *Single-speed:* 0.2 ms<br>*Double-speed:* 0.1 ms (software option 49) | | |
| Position controller | *Single-speed:* 0.2 ms<br>*Double-speed:* 0.1 ms (software option 49) | | |
| Speed controller | *Single-speed:* 0.2 ms<br>*Double-speed:* 0.1 ms (software option 49) | | |
| Current controller | $f_{PWM}$<br>3333 Hz<br>4000 Hz<br>5000 Hz<br>6666 Hz with software option 49<br>8 000 Hz with software option 49<br>10 000 Hz with software option 49<br>13 300 Hz with software option 49<br>16 000 Hz with software option 49 | $T_{INT}$<br>150 µs<br>125 µs<br>100 µs<br>75 µs with software option 49<br>62.5 µs with software option 49<br>50 µs with software option 49<br>37.5 µs with software option 49<br>30 µs with software option 49 | |
| **Permissible temperature range** | Operation:<br>In electrical cabinet: 5 °C to 40 °C<br>In operating panel: 0 °C to 50 °C<br>Storage: –20 °C to 60 °C | | |

# Interfacing to the machine

| Interfacing to the machine | TNC 640 | Page |
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| **Error compensation** | ✓ | 69 |
| Linear axis error | ✓ | 69 |
| Nonlinear axis error | ✓ | 69 |
| Backlash | ✓ | 69 |
| Reversal spikes during circular movement | ✓ | 69 |
| Hysteresis | ✓ | 69 |
| Thermal expansion | ✓ | 69 |
| Static friction | ✓ | 69 |
| Sliding friction | ✓ | 69 |
| **Integrated PLC** | ✓ | 75 |
| Program format | Statement list | 75 |
| Program input at the control | ✓ | 75 |
| Program input via PC | ✓ | 75 |
| Symbolic PLC-NC interface | ✓ | 75 |
| PLC memory | ≈ 1 GB (with 32 GB SSDR) ≈ 4 GB (with 240 GB SSDR) | 75 |
| PLC cycle time | 9 ms to 30 ms (adjustable) | 75 |
| **PLC inputs/outputs** | For the maximum configuration of the PLC system, see Page 46 | 24 |
| PLC inputs, DC 24 V | Via PL, UEC, UMC | 24 |
| PLC outputs, DC 24 V | Via PL, UEC, UMC | 24 |
| Analog inputs ±10 V | Via PL | 24 |
| Inputs for PT 100 thermistors | Via PL | 24 |
| Analog outputs ±10 V | Via PL | 24 |
| **PLC functions** | ✓ | 75 |
| Small PLC window | ✓ | 76 |
| PLC soft keys | ✓ | 76 |
| PLC positioning | ✓ | 76 |
| PLC basic program | ✓ | 78 |
| **Integration of applications** | | 77 |
| High-level language programming | Use of the Python programming language in conjunction with the PLC (software option 46) | 77 |
| User interfaces can be custom-designed | Creation of individualized user interfaces by the machine manufacturer with the Python programming language. Programs up to a memory limit of 10 MB are enabled in standard mode. More can be enabled via software option 46. | 77 |

| Interfacing to the machine | TNC 640 | Page |
|---|---|---|
| **Commissioning and diagnostic aids** | | 72 |
| TNCdiag | Software for the analysis of status and diagnostic information of digital drive systems | 72 |
| TNCopt | Software for putting digital control loops into service | 73 |
| ConfigDesign | Software for creating the machine configuration | 72 |
| KinematicsDesign | Software for creating the machine kinematics, initialization of DCM | 68 |
| Integrated oscilloscope | ✓ | 72 |
| Trace function | ✓ | 73 |
| API DATA function | ✓ | 73 |
| Table function | ✓ | 73 |
| OLM (online monitor) | ✓ | 73 |
| Log | ✓ | 73 |
| TNCscope | ✓ | 73 |
| Bus diagnostics | ✓ | 74 |
| **Data interfaces** | ✓ | |
| Ethernet | 2 x 1000BASE-T | 80 |
| USB | *Rear:* 4 x USB 3.0<br>*Front:* may vary based on the component description | 80 |
| **Protocols** | | 80 |
| Standard data transmission | ✓ | 80 |
| Blockwise data transfer | ✓ | 80 |
| LSV2 | ✓ | 80 |

# Functions for the user

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

| Function | Standard | Option | TNC 640 |
|---|---|---|---|
| **Contour approach and departure** | ✓<br>✓ | | Via straight line: tangential or perpendicular<br>Via circular arc |
| **Adaptive feed control** | | 45 | AFC: Adaptive Feed Control adjusts the contouring feed rate to the current spindle power |
| **Collision monitoring** | | 40<br>40<br>40 | Dynamic Collision Monitoring (DCM)<br>Graphic depiction of the active collision objects (high-resolution M3D format)<br>Tool carrier monitoring |
| **FK free contour programming** | ✓ | | FK free contour programming in HEIDENHAIN Klartext format with graphical support for workpiece drawings not dimensioned for NC |
| **Program jumps** | ✓<br>✓<br>✓ | | Subprograms<br>Program section repeat<br>Calling any program as a subprogram |
| **Fixed cycles** | ✓<br>✓<br><br><br><br>✓<br><br><br><br><br><br>✓<br>✓<br>✓<br>✓<br>✓<br>✓<br>✓<br>✓<br>✓ | <br><br>50<br>50<br>50<br><br>50<br>50+<br>135<br>96 | Drilling, tapping with a floating tap holder, rigid tapping<br>Peck drilling, reaming, boring, counterboring, centering<br>Area clearance cycles, longitudinal and transverse, paraxial and contour parallel<br>Recessing cycles, radial/axial<br>Radial/axial recess turning cycles (combined recessing and roughing motion)<br>Milling internal and external threads<br>Turning internal and external threads<br>Hobbing<br><br>Interpolation turning (not with functional safety (FS))<br>Clearing level and oblique surfaces<br>Multi-operation machining of straight and circular slots<br>Multi-operation machining of rectangular and circular pockets<br>Point patterns for circles, lines, and DataMatrix codes<br>Contour train, contour pocket<br>Contour slot with trochoidal milling<br>OEM cycles (special cycles developed by the machine tool builder) can be integrated<br>Engraving cycle: engrave text or numbers in a straight line or on an arc |
| **Coordinate transformations** | ✓ | <br>8<br>44 | Shifting, rotating, mirroring, scaling (axis specific)<br>Tilting the working plane, PLANE function<br>*Manually definable:* shifts, rotations, and handwheel superimpositioning can be manually defined via global program settings |
| **Q parameters Programming with variables** | ✓<br><br><br>✓<br>✓<br>✓<br><br>✓<br>✓ | | Mathematical functions =, +, −, *, /, sin $\alpha$, cos $\alpha$, tan $\alpha$, arc sin, arc cos, arc tan, $a^n$, $e^n$, ln, log, square root of $a$, square root of $(a^2 + b^2)$<br>Logical operations (=, = /, <, >)<br>Calculating with parentheses<br>Absolute value of a number, constant $\pi$, negation, truncation of digits before or after the decimal point<br>Functions for calculation of circles<br>Functions for text processing |
| **Programming aids** | ✓<br>✓<br>✓<br>✓<br><br>✓<br>✓ | | Calculator<br>Complete list of all current error messages<br>Context-sensitive help function for error messages<br>TNCguide: the integrated help system; user information is available directly on the TNC 640, with context-sensitive calling<br>Graphic support for programming cycles<br>Comment and structure blocks in the NC program |
| **CAD viewer** | ✓ | | Display of standardized CAD file formats on the TNC |

| Function | Standard | Option | TNC 640 |
|---|:---:|:---:|---|
| **Teach-In** | ✓ | | Actual positions can be transferred directly into the NC program |
| **Test graphics** **Depictions** | ✓ ✓ ✓ | | Graphical simulation before a program run, even while another program is running<br>Plan view / projection in 3 planes / 3-D view, also in tilted working plane<br>Detail zoom |
| **3-D line graphics** | ✓ | | For verification of programs created offline |
| **Programming graphics** | ✓ | | In the Programming and Editing mode, the contours of entered NC blocks are rendered (2-D pencil-trace graphics), even while another NC program is running |
| **Program-run graphics** **Display modes** | ✓ ✓ | | Graphic simulation during real-time machining<br>Plan view / projection in 3 planes / 3-D view |
| **Machining time** | ✓ ✓ | | Calculation of machining time in the Test Run operating mode<br>Display of the current machining time in the Program Run operating modes |
| **Returning to the contour** | ✓ ✓ | | Mid-program startup at any block in the program, and approach of the calculated nominal position for continued machining<br>Program interruption, contour departure and approach |
| **Preset management** | ✓ | | One table for storing presets |
| **Datum tables** | ✓ | | Multiple datum tables for storing workpiece-specific datums |
| **Pallet tables** | ✓ | | Workpiece-oriented execution of pallet tables (with any number of entries for the selection of pallets, NC program, and datums) |
| **Parallel secondary axes** | ✓ ✓ ✓ | | Compensation of movement in the secondary axes U, V, W through the principal axes X, Y, Z<br>Movements of parallel axes included in the position display of the associated principal axis (sum display)<br>Defining the principal and secondary axes in the NC program makes it possible to run programs on different machine configurations |
| **Touch probe cycles** | ✓ ✓ ✓ ✓ | 48 | Calibrating the touch probe<br>Compensation of workpiece misalignment, manual or automatic<br>Reference point setting, manual or automatic<br>Automatic tool and workpiece measurement<br>Automatic measurement and optimization of machine kinematics |
| **Conversational languages** | ✓ | | English, German, Czech, French, Italian, Spanish, Portuguese, Dutch, Swedish, Danish, Finnish, Norwegian, Slovenian, Slovak, Polish, Hungarian, Russian (Cyrillic), Romanian, Turkish, Chinese (traditional and simplified), Korean |

# Software options

| Software option number | Software option | With NC software 34059x- or later | ID | Comment | Page |
|---|---|---|---|---|---|
| **0** | Additional Axis 1 | 01 | 354540-01 | Additional control loop 1 | 20 |
| **1** | Additional Axis 2 | 01 | 353904-01 | Additional control loop 2 | 20 |
| **2** | Additional Axis 3 | 01 | 353905-01 | Additional control loop 3 | 20 |
| **3** | Additional Axis 4 | 01 | 367867-01 | Additional control loop 4 | 20 |
| **4** | Additional Axis 5 | 01 | 367868-01 | Additional control loop 5 | 20 |
| **5** | Additional Axis 6 | 01 | 370291-01 | Additional control loop 6 | 20 |
| **6** | Additional Axis 7 | 01 | 370292-01 | Additional control loop 7 | 20 |
| **7** | Additional Axis 8 | 01 | 370293-01 | Additional control loop 8 | 20 |
| **8** | Advanced Function Set 1 | 01 | 617920-01 | Rotary table machining<br>• Programming of cylindrical contours as if in two axes<br>• Feed rate in mm/min | 51 |
| | | | | Coordinate transformation<br>• Tilting the working plane, PLANE function | 52 |
| | | | | Interpolation<br>• Circular in 3 axes with tilted working plane | |
| **9** | Advanced Function Set 2 | 01 | 617921-01 | 3-D machining<br>• 3-D tool compensation via surface normal vectors<br>• Using the electronic handwheel to change the angle of the swivel head during program run without affecting the position of the tool point (TCPM = Tool Center Point Management)<br>• Keeping the tool normal to the contour<br>• Tool radius compensation normal to the tool direction<br>• Manual traverse in the active tool-axis system<br><br>Interpolation<br>• Linear in more than 4 axes (export license required) | 52 |
| **18** | HEIDENHAIN DNC | 01 | 526451-01 | Communication with external PC applications over COM component | 82 |
| **40** | DCM Collision | 01<br>02 | 526452-01 | Dynamic collision monitoring (DCM) | 67 |
| **42** | CAD Import | 08 | 526450-01 | Importing of contours from 2-D and 3-D models, e.g., STEP, IGES, DXF | |
| **44** | Global PGM Settings | 05 | 576057-01 | Global program settings | 53 |
| **45** | Adaptive Feed Control (AFC) | 02 | 579648-01 | Adaptive feed control | 62 |
| **46** | Python OEM Process | 01 | 579650-01 | Execute Python applications | 77 |
| **48** | KinematicsOpt | 01 | 630916-01 | Touch-probe cycles for the automated measurement of rotary axes | 70 |
| **49** | Double-Speed Axes | 01 | 632223-01 | Short control-loop cycle times for direct drive motors | 60 |

| Software option number | Software option | With NC software 34059x- or later | ID | Comment | Page |
|---|---|---|---|---|---|
| **50** | Turning | 01 | 634608-01 | Turning functions<br>• Tool management for turning<br>• Tool-tip radius compensation<br>• Switching between milling and turning modes of operation<br>• Lathe-specific contour elements<br>• Package of turning cycles | 54 |
| **52** | KinematicsComp | 05 | 661879-01 | Spatial compensation of errors in rotary and linear axes (export license required) | 71 |
| **56 - 61** | OPC UA NC Server 1 to 6 | 10 | 1291434-01 to 1291434-06 | Connection of an OPC UA application | 83 |
| **77** | 4 Additional Axes | 01 | 634613-01 | 4 additional control loops | 20 |
| **78** | 8 Additional Axes | 01 | 634614-01 | 8 additional control loops | 20 |
| **92** | 3D-ToolComp | 07 | 679678-01 | 3-D radius compensation based on the contact angle (only with the Advanced Function Set 2 software option) | 71 |
| **93** | Extended Tool Management | 01 | 676938-01 | Expanded tool management:<br>• Tooling list (list of all tools of the NC program)<br>• T usage sequence (sequence of all tools inserted during the program) | |
| **96** | Adv. Spindle Interp. | 05 | 751653-01 | Additional functions for an interpolated spindle<br>• Interpolation turning, coupling<br>• Interpolation turning, contour finishing | |
| **101 - 130** | OEM Software Option | 02 | 579651-01 to 579651-30 | Software options of the machine manufacturer | |
| **131** | Spindle Synchronism | 05 | 806270-01 | Synchronization of two or more spindles | 82 |
| **133** | Remote Desktop Manager | 01 | 894423-01 | Display and remote operation of external computer units (e.g., a Windows PC) | 82 |
| **135** | Synchronizing Functions | 04 | 1085731-01 | Expanded synchronization of axes and spindles | 53 |
| **136** | Visual Setup Control | 06 | 1099457-01 | VSC: camera-based monitoring of the setup situation | 53 |
| **137** | State Reporting | 09 | 1232242-01 | State Reporting Interface (SRI): provision of operating statuses | 74 |
| **141** | Cross Talk Comp. | 02 | 800542-01 | CTC: compensation of axis couplings | 65 |
| **142** | Pos. Adapt. Control | 02 | 800544-01 | PAC: position-dependent adaptation of control parameters | 65 |
| **143** | Load Adapt. Control | 02 | 800545-01 | LAC: load-dependent adaptation of control parameters | 64 |
| **144** | Motion Adapt. Control | 02 | 800546-01 | MAC: motion-dependent adaptation of control parameters | 64 |
| **145** | Active Chatter Control | 02 | 800547-01 | ACC: active suppression of chatter | 63 |

| Software option number | Software option | With NC software 34059x- or later | ID | Comment | Page |
|---|---|---|---|---|---|
| **146** | Active Vibration Damping | 04 | 800548-01 | AVD: active vibration damping | 65 |
| **154** | Batch Process Manager | 05 | 1219521-01 | Planning and executing multiple machining operations | 53 |
| **155** | Component Monitoring | 09 | 1226833-01 | Monitoring for component overloading and wear | 68 |
| **156** | Grinding | 10 | 1237232-01 | Grinding function<br>• Jig grinding<br>• Switching between normal operation and dressing mode<br>• Reciprocating stroke<br>• Grinding cycles<br>• Tool management for grinding and dressing | 56 |
| **157** | Gear Cutting | 09 | 1237235-01 | Functions for the machining of gear teeth | 55 |
| **158** | Advanced Function Set Turning | 09 | 1237237-01 | Extended turning cycles and functions | 55 |
| **160** | Integrated FS: Basic | 10 | 1249928-01 | Enables functional safety and four safe control loops | 47 |
| **161** | Integrated FS: Full | 10 | 1249929-01 | Enables functional safety and maximum number of safe control loops (≥ 10) | 47 |
| **162** | Add. FS Ctrl. Loop 1 | 10 | 1249930-01 | Additional control loop 1 | 47 |
| **163** | Add. FS Ctrl. Loop 2 | 10 | 1249931-01 | Additional control loop 2 | 47 |
| **164** | Add. FS Ctrl. Loop 3 | 10 | 1249932-01 | Additional control loop 3 | 47 |
| **165** | Add. FS Ctrl. Loop 4 | 10 | 1249933-01 | Additional control loop 4 | 47 |
| **166** | Add. FS Ctrl. Loop 5 | 10 | 1249934-01 | Additional control loop 5 | 47 |
| **167** | Optimized Contour Milling | 10 | 1289547-01 | OCM: optimized contour milling | 63 |

# HSCI control components

## Main computers

**Main computer**
The **MC 85xx** and **MC 366** main computer contain the following:
- Processor: Core i7/3, 1.7 GHz
- Main memory: 4 GB RAM
- Gbit HSCI interface to the controller unit and to other control components
- HDL2 interface to the BF monitor (with electrical cabinet versions)
- 4 x USB 3.0 ports (e.g., for the TE 7x5 operating panel)

To be ordered separately and installed in the main computer by the OEM:
- **SSDR** memory card with the NC software
- The **System Identification Key** (SIK) component for the enabling of control loops and software options

The following HSCI components are required for operation of the TNC 640:
- MC main computer
- Controller unit
- **PLB 62xx** PLC I/O unit (system PL; integrated in UxC)

Interfaces
For use by end users, the MC is equipped with the USB 3.0 and Ethernet interfaces. Connection to PROFIBUS DP or PROFINET IO is possible either via additional modules or by means of a combined PROFIBUS DP / PROFINET IO module.

Export version
Because the complete NC software is on the storage medium, no export version is required for the main computer itself. Only the easily replaceable storage medium and SIK component are available as export versions.

Gen 3 labels
The different Gen 3 labels identify how control components can be deployed.

Gen **3** ready
Gen 3 ready: These components can be used in systems with Gen 3 drives (UVR 3xx, UM 3xx, CC 3xx) and in systems with a 1xx inverter system (UVR 1xx, UE 2xx, UR 2xx, CC 61xx).

Gen **3** exclusive
Gen 3 exclusive: These components can be used only in systems with Gen 3 drives (UVR 3xx, UM 3xx, CC 3xx).

Versions

Various versions of the MC main computer are available:
- Installation in the **electrical cabinet**:
  The MC 306 are installed in the electrical cabinet. The operating panel requires HSCI, USB, and HDL2 cables as control lines
- Installation in the **operating panel**:
  The MC 85x2 and MC 366, together with the BF monitor, form a single unit that is installed directly into the operating panel. With the exception of the power supply line, only one HSCI connecting cable to the electrical cabinet is needed.



MC 8512 with main computer installed on the back



MC 8532 with main computer installed on the back
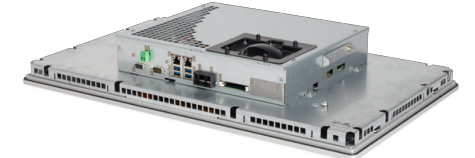


MC 366 with main computer installed on the back

Gen **3** ready

|  | Installation type | Storage medium | Processor | RAM | Power consumption*) | Mass | ID |
|---|---|---|---|---|---|---|---|
| **MC 306** | Electrical cabinet | SSDR | Intel Xeon E3, 2.1 GHz, quad-core | 8 GB | ≈ 65 W | ≈ 4.0 kg | 1180045-xx |
| **MC 8512** | Operating panel | SSDR | Intel Core i7/3, 1.7 GHz, dual-core | 4 GB | ≈ 75 W | ≈ 7.5 kg | 1243919-xx |
| **MC 8532** | Operating panel | SSDR | Intel Core i7/3, 1.7 GHz, dual-core | 4 GB | ≈ 75 W | ≈ 7.5 kg | 1189190-xx |
| **MC 366** | Operating panel | SSDR | Intel Core i7-3, 1.7 GHz, dual-core | 8 GB | ≈ 75 W | ≈ 7.5 kg | 1246689-xx |

*) Test conditions: Windows 7 (64-bit) operating system, 100 % processor loading, no load on interfaces, no fieldbus module



MC 306

**17**

**Software options**
Software options allow the performance of the TNC 640 to be adapted to one's actual needs at a later time. The software options are described on page 13. They are enabled by entering keywords based on the SIK number and are saved in the SIK component. Please provide the SIK number when ordering new options.

**Storage medium**
The storage medium is removable and must be ordered separately from the main computer. It contains NC software version 34059x-xx. The NC software is based on the HEIDENHAIN HEROS 5 operating system.

Gen**3** ready

**32 GB SSDR solid state disk for the operating panel**

| | |
|---|---|
| Free PLC memory space | ≈ 1 GB |
| Free NC memory space | ≈ 18 GB |
| For main computer | MC 85x2 and MC 366 |
| Export license required | ID 810288-10 |
| No export license required | ID 810288-60 |
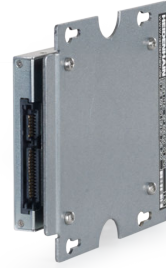
SSDR for operating panel

Gen**3** exclusive

**240 GB SSDR solid state disk for the electrical cabinet**

| | |
|---|---|
| Free PLC memory space | ≈ 4 GB |
| Free NC memory space | ≈ 189 GB |
| For main computer | MC 306 |
| Export license required | ID 1279027-10 |
| No export license required | ID 1279027-60 |

SSDR MC 306

**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 into a slot provided for it in the MC main computer.

The SIK component with the NC software license exists in different versions based on the enabled control loops and software options. Additional control loops can be enabled later by entering a keyword. HEIDENHAIN provides the keyword, which is based on the SIK number.

SIK component

When ordering, please provide the SIK number of your control. When the keywords are entered in the control, they are saved in the SIK component, thereby enabling and activating the software options. Should servicing become necessary, the SIK component must be inserted into the replacement control in order to enable all of the required software options.
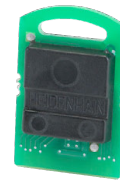
**Master keyword (general key)**
For putting the TNC 640 into service, there is a master keyword that enables all software options once for 90 days. After this period, the software options can be activated only with the correct keywords. The general key is activated via a soft key.

| | **TNCkeygen (accessory)** | TNCkeygen is a collection of PC software tools for generating enabling keys for HEIDENHAIN controls for a limited period of time. |
|---|---|---|

**TNCkeygen (accessory)**

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

With the **OEM Key Generator**, you can generate enabling keys for software options by entering the SIK number, the software option to be enabled, the enabling period, and an OEM-specific password. This activation is limited to a period of 10 to 90 days. Each software option can be enabled only once; this is performed independently of the master keyword.

The **OEM daily key generator** generates an enabling key for the protected OEM area, thus granting the user access on the day it is generated.

**HEIDENHAIN OEM Option Key Generator**

**HEIDENHAIN**

**Software Key Generator**

This software makes it possible to generate an activation code for software options on HEIDENHAIN controls. These are then enabled completely, but can only be activated once, and only for a limited time.

Enter the necessary values (*) and press "Generate" to generate the desired activation code.
Tool tips help you automatically when entering the values.

* Serial No. (SN):
* Option:
* Days: 90
OEM Key:

Activation key:

Generate | Print to file... | Mail... | Close

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

| | Recommended combinations | | | | | | NC software license | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Active control loops** | **CC 306** | **CC 308** | **CC 310** | **CC 310 + CC 302** | **CC 306 + CC 308** | **2 x CC 308** | **Without option** | **Incl. option 8** | **Incl. options 8 + 9** | **Incl. options 8 + 9 + 50** |
| | | | | | | | SIK | SIK | SIK | SIK |
| 4 | ✓ | | | | | | ID 674989-20 *ID 674989-70* | ID 674989-09 *ID 674989-59* | ID 674989-01 *ID 674989-51* | ID 674989-28 *ID 674989-78* |
| 5 | ✓ | | | | | | ID 674989-24 *ID 674989-74* | ID 674989-17 *ID 674989-67* | ID 674989-02 *ID 674989-52* | ID 674989-29 *ID 674989-79* |
| 6 | ✓ | | | | | | ID 674989-25 *ID 674989-75* | ID 674989-18 *ID 674989-68* | ID 674989-03 *ID 674989-53* | ID 674989-30 *ID 674989-80* |
| 7 | | ✓ | | | | | ID 674989-26 *ID 674989-76* | ID 674989-19 *ID 674989-69* | ID 674989-04 *ID 674989-54* | ID 674989-31 *ID 674989-81* |
| 8 | | ✓ | | | | | ID 674989-27 *ID 674989-77* | ID 674989-23 *ID 674989-73* | ID 674989-05 *ID 674989-55* | ID 674989-32 *ID 674989-82* |
| 9 | | | ✓ | | | | Only through subsequent enabling of control loops (additional axes) | | ID 674989-06 *ID 674989-56* | ID 674989-33 *ID 674989-83* |
| 10 | | | ✓ | | | | | | ID 674989-07 *ID 674989-57* | ID 674989-34 *ID 674989-84* |
| 11 | | | | ✓ | | | | | ID 674989-10 *ID 674989-60* | ID 674989-35 *ID 674989-85* |
| 12 | | | | ✓ | | | | | ID 674989-11 *ID 674989-61* | ID 674989-36 *ID 674989-86* |
| 13 | | | | | ✓ | | | | ID 674989-12 *ID 674989-62* | ID 674989-37 *ID 674989-87* |
| 14 | | | | | ✓ | | | | ID 674989-13 *ID 674989-63* | ID 674989-38 *ID 674989-88* |
| 15 | | | | | | ✓ | | | ID 674989-14 *ID 674989-64* | ID 674989-39 *ID 674989-89* |
| 16 | | | | | | ✓ | | | ID 674989-15 *ID 674989-65* | ID 674989-40 *ID 674989-90* |
| 17 – 24 | | | | | | | Only through subsequent enabling of control loops (additional axes) | | | |

) (Italics: export version)

For a description of the CC 3xx controller units, please refer to the *Gen 3 Drives for HEIDENHAIN Controls* brochure.

**Enabling further control loops**

Further control loops can be enabled either as groups or individually. The combination of control-loop groups and individual control loops makes it possible to enable any number of control loops. No more than **24 control loops** are possible.

| Control-loop groups | Software option | |
|---|---|---|
| 4 additional control loops | 77 | ID 634613-01 |
| 8 additional control loops | 78 | ID 634614-01 |

| Individual control loops | Software option | |
|---|---|---|
| 1st additional control loop | 0 | ID 354540-01 |
| 2nd additional control loop | 1 | ID 353904-01 |
| 3rd additional control loop | 2 | ID 353905-01 |
| 4th additional control loop | 3 | ID 367867-01 |
| 5th additional control loop | 4 | ID 367868-01 |
| 6th additional control loop | 5 | ID 370291-01 |
| 7th additional control loop | 6 | ID 370292-01 |
| 8th additional control loop | 7 | ID 370293-01 |

# 24-inch screen and keyboard

**BF 360 monitor**
Gen**3** exclusive

- Supply voltage: DC 24 V/≈ 35 W
- **24-inch**; 1920 x 1024 pixels
- HDL2 interface to the MC in the electrical cabinet
- Integrated USB hub with 4 USB ports on the rear
- Display for multi-touch operation

Via touchscreen operation:
- Soft-key row switchover
- Screen layout
- Operating mode switchover

**BF 360**    ID 1275079-xx
Mass         ≈ 9.5 kg



BF 360

**TE 360 keyboard with an integrated machine operating panel**
Gen**3** ready

General data:
- Fits the BF 360 or MC 366 (24-inch design)
- Axis keys
- The keys for axes IV and V are exchangeable snap-on keys
- Contouring keys
- Operating mode keys
- ASCII keyboard
- Spindle, feed-rate, and rapid-traverse override potentiometers
- USB interface to the MC main computer
- Trackball
- USB port with cover cap

Specifications:
- Supply voltage: DC 24 V/≈ 4 W
- 36 exchangeable snap-on keys with status LED, freely definable via PLC (assignment in accordance with PLC basic program: 12 axis keys, spindle start, spindle stop, 22 further function keys)
- Other operating elements: NC start[1], NC stop[1], emergency stop button, control voltage on[1]
- 4 holes for additional keys or keylock switches
- Connection for HR handwheel
- HSCI interface
- TE 360: 8 free PLC inputs and 8 free PLC outputs
  TE 360 FS: 4 free FS inputs and 8 free PLC outputs; additional dual-channel FS inputs for emergency stop and permissive buttons of the handwheel.

[1] Illuminated keys, addressable via PLC

Standard potentiometer layout:
**TE 360**      ID 1280184-xx
**TE 360 FS**   ID 1275710-xx
Mass            ≈ 5.8 kg

Alternative potentiometer layout:
**TE 360**      ID 1284265-xx
**TE 360 FS**   ID 1284263-xx
Mass            ≈ 5.8 kg



TE 360 with standard potentiometer layout



TE 360 with alternative potentiometer layout

# 19-inch screen and keyboard

**BF 860 monitor**

Gen**3** exclusive

- Supply voltage: DC 24 V/≈ 65 W
- **19-inch**; 1280 x 1024 pixels
- HDL2 interface to the MC in the electrical cabinet
- Integrated USB hub with 4 USB ports on the rear
- Display for multitouch operation

Via touchscreen operation
- Soft-key row switchover
- Screen layout
- Operating mode switchover

**BF 860**  ID 1244875-xx
Mass  ≈ 7.5 kg



BF 860

**TE 745 keyboard with an integrated machine operating panel**

Gen**3** ready

General data:
- Fits the BF 860 or MC 8532 (19-inch design)
- Axis keys
- The keys for axes IV and V are exchangeable snap-on keys
- Contouring keys
- Operating mode keys
- ASCII keyboard
- Spindle, feed-rate, and rapid-traverse override potentiometers
- USB interface to the MC main computer
- Touchpad
- USB port with cover cap

Specifications:
- Supply voltage: DC 24 V/≈ 4 W
- 36 exchangeable snap-on keys with status LED, freely definable via PLC (assignment in accordance with PLC basic program: 12 axis keys, spindle start, spindel stop, 22 other function keys)
- Other operating elements: NC start[1], NC stop[1], emergency stop button, control voltage on[1]
- 3 holes for additional keys or keylock switches
- Connection for HR handwheel
- HSCI interface
- TE 745: 8 free PLC inputs and 8 free PLC outputs
  TE 745 FS: 4 free FS inputs and 8 free PLC outputs; additional dual-channel FS inputs for emergency stop and permissive buttons of the handwheel.

[1] Illuminated keys, addressable via PLC

**TE 745**  ID 679817-13
**TE 745 FS**  ID 805482-13
Mass  ≈ 4.3 kg



TE 745

# Machine operating panel for the MC 8512

**MB 721 machine operating panel**

Gen**3** ready

- Supply voltage: DC 24 V/≈ 4 W
- 36 exchangeable snap-on keys with status LED, freely definable via PLC (assignment as per PLC basic program: 12 axis keys, spindle start, spindle stop, 22 further function keys)
- Other operating elements: NC start[1], NC stop[1], emergency stop button, control voltage on[1]
- Spindle-speed and feed-rate override potentiometers
- 3 holes for additional keys or keylock switches
- USB port with cover cap
- HSCI interface
- MB 721: 8 free PLC inputs and 8 free PLC outputs
  MB 721 FS: 4 free FS inputs and 8 free PLC outputs; additional dual-channel FS inputs for emergency stop and permissive buttons of the handwheel.

[1] Illuminated keys, addressable via PLC

| | |
|---|---|
| **MB 721** | ID 1164974-xx |
| **MB 721 FS** | ID 1164975-xx |
| Mass | ≈ 1.6 kg |



MB 721

# PL 6000 PLC input/output systems with HSCI

**PL 6000**

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

PLB 62xx

**Basic modules**

Basic modules with an **HSCI interface** exist for 4, 6, 8, and 10 modules. Fastening is performed on standard NS 35 rails (DIN 46227 or EN 50022).

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

[1] PLB 6xxx completely filled, incl. TS, TT.

**System PL with EnDat support**

- Required once for each control system (except with UEC)
- Connections for TS and TT touch probes
- TS and TT touch probes with EnDat interface are supported
- *Without FS*: 12 free inputs, 7 free outputs
  *With FS*: 6 free FS inputs, 2 free FS outputs
- Functional safety (FS) is enabled via SIK options 160 to 166
- Slots are equipped with cover strips

Gen**3** ready

| | | |
|---|---|---|
| **PLB 6204** | For 4 I/O modules | ID 1129809-02 |
| **PLB 6206** | For 6 I/O modules | ID 1129812-02 |
| **PLB 6208** | For 8 I/O modules | ID 1129813-02 |
| **PLB 6210** | For 10 I/O modules | ID 1278136-xx |

Gen**3** exclusive

| | | |
|---|---|---|
| **PLB 6204 FS** | For 4 I/O modules | ID 1223032-xx |
| **PLB 6206 FS** | For 6 I/O modules | ID 1223033-xx |
| **PLB 6208 FS** | For 8 I/O modules | ID 1223034-xx |
| **PLB 6210 FS** | For 10 I/O modules | ID 1290089-xx |

| **Expansion PL** | For connection to the system PL to increase the number of PLC inputs/outputs | | |
| --- | --- | --- | --- |
| Gen3 ready | | | |
| | **PLB 6104** | For 4 I/O modules | ID 1129799-xx |
| | **PLB 6106** | For 6 I/O modules | ID 1129803-xx |
| | **PLB 6108** | For 8 I/O modules | ID 1129804-xx |
| | **PLB 6104 FS** | For 4 I/O modules | ID 1129796-xx |
| | **PLB 6106 FS** | For 6 I/O modules | ID 1129806-xx |
| | **PLB 6108 FS** | For 8 I/O modules | ID 1129807-xx |

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

**I/O modules**

Gen3 ready

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

| **PLD-H 16-08-00** | I/O module with 16 digital inputs and 8 digital outputs | ID 594243-xx |
| --- | --- | --- |
| **PLD-H 08-16-00** | I/O module with 8 digital inputs and 16 digital outputs | ID 650891-xx |
| **PLD-H 08-04-00 FS** | I/O module with 8 digital FS inputs and 4 digital FS outputs | ID 598905-xx |
| **PLD-H 04-08-00 FS** | I/O module with 4 digital FS inputs and 8 digital FS outputs | ID 727219-xx |
| **PLD-H 04-04-00 HSLS FS** | I/O module with 4 digital FS inputs and 4 high-side/low-side FS outputs | ID 746706-xx |

| Total current | Outputs 0 to 7: ≤ 2 A per output (≤ 8 A simultaneously) |
| --- | --- |
| Power output | Max. 200 W |
| Mass | ≈ 0.2 kg |

| **PLA-H 08-04-04** | Analog module for PL 6xxx with | ID 675572-xx |
| --- | --- | --- |
| | • 8 analog inputs, ±10 V | |
| | • 4 analog outputs, ±10 V | |
| | • 4 analog inputs for PT 100 thermistors | |
| Mass | ≈ 0.2 kg | |

**I/O module for axis release**

Gen3 exclusive

Axis-release module for external safety. In combination with the PLB 620x without FS

| **PAE-H 08-00-01** | I/O module for the release of 8 axis groups | ID 1203881-xx |
| --- | --- | --- |

**IOconfig (accessory)**

PC software for configuring HSCI and PROFIBUS components

# Accessories
## HSCI adapter for OEM machine operating panel

**PLB 600x**

Gen**3** ready

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

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

| | |
|---|---|
| **PLB 6001** | ID 668792-02 |
| **PLB 6001 FS** | ID 722083-02 |
| **PLB 6002 FS** | ID 1137000-02 |
| Mass | ≈ 1.2 kg |
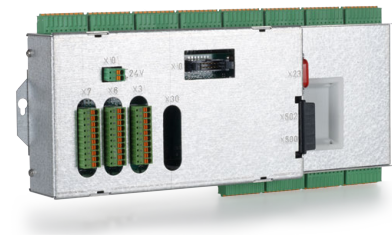


PLB 6001

# Additional modules

Gen**3** ready

**Module for analog axes**

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

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

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

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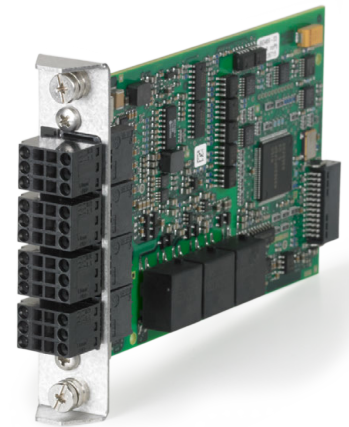


CMA-H 04-04-00

**Fieldbus systems**

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

**PROFIBUS DP module**

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

**PROFIBUS DP additional module for the MC 85x2 and MC 366**     ID 828539-xx
**Additional PROFIBUS DP module for the MC 306**     ID 1279074-xx



PROFIBUS DP module

**PROFINET IO module**

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

**PROFINET IO additional module for the MC 85x2 and MC 366**     ID 828541-xx
**Additional PROFINET IO module for the MC 306**     ID 1279077-xx



PROFINET IO module

**Combined PROFIBUS DP/ PROFINET IO module**

Additional module for PROFIBUS DP and PROFINET IO:
- Expansion board for the MC main computer
- Connection for RJ45 connector to X621 (PROFINET IO) and M12 connector to X121 (PROFIBUS DP)
- Additionally connectable terminating resistor for PROFIBUS DP with front LED

**Additional PROFIBUS DP and PROFINET IO module for the MC 85x2 and MC 366**     ID 1160940-xx
**Additional PROFIBUS DP and PROFINET IO modules for the MC 306**     ID 1233765-xx



Combined module

# Electronic handwheels

Gen**3** ready

**Overview**

Support for electronic handwheels is standard on the TNC 640:
• **HR 550 FS** wireless handwheel, or
• **HR 510** or **HR 520** portable handwheel, or
• **HR 130** panel-mounted handwheel

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

The mixed operation of handwheels with and without display is not possible. Handwheels with functional safety (FS) are short-circuit-proof due to special permissive-button logic.

**HR 510**

Portable electronic handwheel with:
• Keys for actual-position capture and the selection of five 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 with other symbols (see *Overview for the HR 510* in *Snap-on keys for the 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 start, FCT B, NC start | – | ID 1119974-xx |

Mass ≈ 0.6 kg

HR 510

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**HR 520**

Portable electronic handwheel with:
- Display for operating mode, actual position value, programmed feed rate and spindle speed, error messages
- Override potentiometers 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



HR 520

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

Mass ≈ 1 kg

**Holder for HR 520**  For attaching to a machine     ID 591065-xx

**HR 550 FS**

Electronic handwheel with wireless transmission. Display, operating elements, and functions are like those of the HR 520

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

| **HR 550 FS** | Without detent | ID 1200495-xx |
| | With detent | ID 1183021-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 FS onto the machine
- Integrated battery charger for HR 550 FS
- Connections to the control and the machine
- Integrated transceiver
- HR 550 FS magnetically held to front of HRA 551 FS

| **HRA 551 FS** | ID 1119052-xx |
| Mass | ≈ 1.0 kg |

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

| 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 | | – | – | ✓ | ✓ | ✓ (max. 2 m) | ID 296467-xx |
| | | ✓ | ✓ | – | – | – | ID 1117853-xx |
| HR adapter cable to MC, straight connector | | ✓ | ✓ | ✓ | ✓ | ✓[1] | ID 1161072-xx |
| HR adapter cable to MC, angled connector (1 m) | | ✓ | ✓ | ✓ | ✓ | ✓[1] | ID 1218563-01 |
| 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 |
| Adapter connector for handwheels without functional safety | | ✓ | – | ✓ | – | – | ID 271958-03 |
| Adapter connector for handwheels with functional safety | | – | ✓ | – | ✓ | ✓ | ID 271958-05 |

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

See also *Cable overview* on Page 41.

**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

# Industrial PCs/ITC

Gen**3** ready

**Additional operating station with touchscreen**

The additional ITC operating station (Industrial Thin Client) from HEIDENHAIN is a convenient solution for the additional, decentralized operation of the machine or of machine units such as tool changing stations. The remote operation strategy, which is tailored to the TNC 640, makes it very easy to connect the ITC over a standard Ethernet connection with a cable length of up to 100 m.

Connecting an ITC is very easy: as soon as the TNC 640 identifies an ITC, it provides it with a current operating system. After the ITC has been started, the complete content of the main screen is mirrored to the ITC's screen. As a result of this plug-and-play principle, no configuration by the machine tool builder is necessary. With the standard configuration of the Ethernet interface at X116, the TNC 640 integrates the ITC into the system fully self-sufficiently.

The **ITC 860** and the separately orderable keyboard unit together form a complete, second operating station.

| ITC 860 | | |
|---|---|---|
| | ID number | ID 1174935-xx |
| | Mass | ≈ 8.2 kg |
| | Installation type | Operating panel |
| | Screen | 19-inch touchscreen (1280 x 1024 pixels) |
| | Processor | Intel Atom E3845 1.9 GHz |
| | RAM | 2 GB |
| | Power consumption | ≈ 50 W |
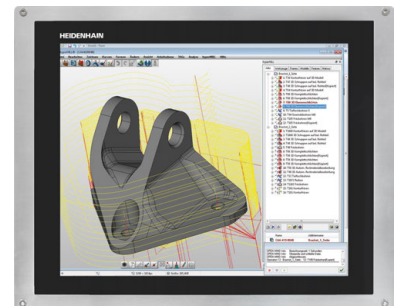


ITC 860

**IPC 306 / IPC 6641 for Windows**

With the help of the IPC 306 and IPC 6641 industrial PC, you can start and remotely operate Windows-based applications through the user interface of the TNC 640. The user interface is displayed on the control screen. Option 133 is required for this.

Since Windows runs on the industrial PC, it does not influence the NC machining process. The IPC is connected to the NC main computer via Ethernet. No second screen is necessary, since the Windows applications are displayed on the screen of the TNC 640 via remote accesses.

Along with the industrial PC, a separately orderable hard disk is required for operation. The Windows 8/10 operating system can be installed on the empty data carrier.

| **IPC 306** | | |
|---|---|---|
| | ID number | ID 1179966-xx |
| | Installation type | Electrical cabinet |
| | Mass | ≈ 5.0 kg |
| | RAM | 8 GB |
| | Processor | Intel Xeon, 2.1 GHz, quad-core |
| | Power consumption | 65 W |
| SSDR hard disk | ID number | ID 1282884-51 |
| | Capacitance | ≈ 240 GB |



IPC 306

| **IPC 6641** | | |
|---|---|---|
| | With 8 GB of RAM | ID 1039543-01 |
| | With 16 GB of RAM | ID 1039543-02 |
| | Mass | ≈ 4.0 kg |
| | Installation type | Electrical cabinet |
| | Processor | Intel Core i7-3 2.1 GHz, quad-core |
| | Power consumption | 75 W |
| HDR hard disk | ID number | ID 1074770-51 |
| | Capacitance | ≈ 320 GB |



IPC 6641

# Control of auxiliary axes

Gen **3** ready

**PNC 610**

The PNC 610 auxiliary axis control is designed for controlling PLC axes independently of the TNC 640. The PNC 610 does not have an NC channel and thus cannot perform interpolating NC movements. With the IPC auxiliary computer, SIK, and CFR storage medium, the PNC 610 is a separate HSCI system, which can be expanded with HEIDENHAIN inverters. The standard PNC 610 features activation for six PLC axes.

The system's design is identical to that of the TNC 640. All relevant HEIDENHAIN tools and a basic program can be used. The position information can be transmitted over PROFIBUS DP (optional), PROFINET IO (optional), or TCP/IP (integrated, system is not capable of real-time), regardless of the platform.

Auxiliary computer

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

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

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

Interfaces

USB 3.0, and Ethernet are available to the user on the MC. The connection to PROFINET IO or PROFIBUS DP is possible via an additional module.

Design

| **IPC 6490** | | |
|---|---|---|
| | ID number | ID 1039541-xx |
| | Installation type | Electrical cabinet |
| | Mass | ≈ 2.3 kg |
| | Power consumption | 48 W |
| | RAM | 2 GB |
| | Processor | Intel Celeron Dual Core, 1.4 GHz |

| **IPC 8420** | | |
|---|---|---|
| | ID number | ID 1249510-xx |
| | Installation type | Operating panel |
| | Mass | ≈ 6.7 kg |
| | Power consumption | 48 W |
| | Screen | 15.6-inch touchscreen (1366 x 768 pixels) |
| | RAM | 2 GB RAM |
| | Processor | Intel Celeron Dual Core, 1.4 GHz |

Export version

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

**Software options**

The performance of the PNC 610 can also be adapted to the actual requirements at a later time through software options. Software options are enabled and saved in the SIK component through the entry of keywords based on the SIK number. Please provide the SIK number when ordering new options.

| Option number | Option | ID | Remark | Page |
|---|---|---|---|---|
| **18** | HEIDENHAIN DNC | 526451-01 | Communication with external PC applications over COM component | 82 |
| **24** | Gantry Axes | 634621-01 | Gantry axes in master-slave torque control | |
| **46** | Python OEM Process | 579650-01 | Execute Python applications | 77 |
| **135** | Synchronizing Functions | 1085731-01 | Expanded synchronization of axes and spindles | 53 |
| **141** | Cross Talk Comp. | 800542-01 | CTC: compensation of axis couplings | 65 |
| **142** | Pos. Adapt. Control | 800544-01 | PAC: position-dependent adaptation of control parameters | 65 |
| **143** | Load Adapt. Control | 800545-01 | LAC: load-dependent adaptation of control parameters | 64 |
| **144** | Motion Adaptive Control | 800546-01 | MAC: motion-dependent adaptation of control parameters | 64 |
| **160** | Integrated FS: Basic | 1249928-01 | Enables functional safety and four safe control loops | 47 |
| **161** | Integrated FS: Full | 1249929-01 | Additional control loop 1 | 47 |
| **162** | Add. FS Ctrl. Loop 1 | 1249930-01 | Additional control loop 2 | 47 |
| **163** | Add. FS Ctrl. Loop 2 | 1249931-01 | Additional control loop 3 | 47 |
| **164** | Add. FS Ctrl. Loop 3 | 1249932-01 | Additional control loop 4 | 47 |
| **165** | Add. FS Ctrl. Loop 4 | 1249933-01 | Additional control loop 5 | 47 |
| **166** | Add. FS Ctrl. Loop 5 | 1249934-01 | Additional control loop 5 | 47 |

**Storage medium**    The storage medium is a CFR (= CompactFlash Removable) compact flash memory card. This contains the NC software and must be ordered separately from the main computer. The NC software is based on the HEIDENHAIN HEROS 5 operating system.

**CFR CompactFlash**, 30 GB              ID 1102057-58
No export license required
NC software                              817591-08
Free PLC memory space                    4 GB
Free NC memory space                     7.7 GB

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

**SIK component for PNC 610**            ID 617763-53

# Camera system

Gen**3** ready

**VS 101**

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

The camera system can be adapted to the given machine size through different objective lenses. The objective lens is selected based on various factors. For more information, please ask your contact person at HEIDENHAIN.



VS 101

**VS 101**                                     ID 1137063-xx
Mass ≈ 2.3 kg

# Snap-on keys for handwheels

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 five keys.

**Overview for HR 520, HR 520 FS, and HR 550 FS**

Axis keys
Orange

| Key | ID | Key | ID | Key | ID | Key | ID |
|---|---|---|---|---|---|---|---|
| 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

| Key | ID | Key | ID | Key | ID | Key | ID |
|---|---|---|---|---|---|---|---|
| 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

| Key | ID | Key | ID | Key | ID | Key | ID |
|---|---|---|---|---|---|---|---|
| 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

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

Other keys

| Key | ID | Key | ID | Key | ID | Key | ID |
|---|---|---|---|---|---|---|---|
| | Black ID 330816-01 | | Red ID 330816-50 | | ID 330816-90 | | ID 330816-93 |
| | Gray 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 for HR 510 and HR 510 FS**

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 | | |

Gray

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

Machine functions

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

Spindle functions

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

Other keys

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

# Snap-on keys for the control

Snap-on keys

The snap-on keys make it easy to replace the key symbols, thus allowing the keyboard to be adapted to different requirements. The snap-on keys are available in packs of five keys.

**Overview of control keys**

Keys
Orange

| Key | ID | Key | ID | Key | ID | Key | ID |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 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

| Key | ID | Key | ID | Key | ID | Key | ID |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 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

| Symbol | ID | Symbol | ID | Symbol | ID | Symbol | ID |
|--------|-----|--------|-----|--------|-----|--------|-----|
| | 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-F2 |
| | 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 |
| | Gray ID 679843-33 | | ID 679843-42 | | ID 679843-A7 | | ID 679843-F3 |
| | 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 | 0 | ID 679843-D5 | | |
| | ID 679843-38 | NC I | Green ID 679843-90 | NC 0 | Red ID 679843-D7 | | |

**Special keys**

Snap-on keys can also be made with special key symbols for special applications. The laser labeling differs in appearance from the labeling of the standard keys. If you need keys for special applications, please consult your contact person at HEIDENHAIN.

# Cable overview
## Control systems with CC



14.05.2020

HSCI total length 70 m  [icon] HSCI 1257765-xx

**1)** CCs with 2nd controller board
**2)** Cable included with the CC

**PL 610x (FS)**
**PL 620x (FS)**

X502    X500    X502

X501    X500    X502A    X500A    X502B [1]    X500B [1]

**MC 306**

X250
X141
X142

**CC 3xx**
**UEC 3xx**

X401A ... X404A    X431A ... X436A
X401B ... X406B [1]    X431B ... X436B [1]

**3)**    **3)**

Sub-D 25pol    Mini I/O

**3)** For the encoder connections, see the brochure "Cables and Connectors" (ID 1206103-xx)

HSCI

1161508-xx max. 20m

USB 2.0  354770-xx
USB 1.1  624775-xx

USB 2.0  354770-xx
USB 1.1  624775-xx

X502

Option 1

**BF 360**

**TE 360 (FS)**

Option 2

**BF 860**

**TE 745 (FS)**

# Inverter system

For maximum lengths, see "Inverter Systems GEN3" Technical Manual.

ID 1265351-xx

CC 3xx

CMH 3xx

UP 3xx

UM 3xx

UM 3xx

UM 3xx

UVR 3xx

UM 3xx

UM 3xx

DC-link and 24 V supply conductor-bar connection (included in delivery)

For power cables to the motor, see "HEIDENHAIN Motors" brochure.

SIEMENS Sitor gS or gR line fuse

L1 L2 L3

Line filter Epcos xxA

KDR 3xx

Optional overvoltage protector

ID 1265351-xx

CC 3xx

CMH 3xx

UP 3xx

UM 3xx

UM 3xx

UM 3xx

UVR 3xx

UM 3xx

UM 3xx

DC-link and 24 V supply conductor-bar connection (included in delivery)

For power cables to the motor, see "HEIDENHAIN Motors" brochure.

SIEMENS Sitor gS or gR line fuse

L1 L2 L3

Line filter Epcos xxA

KDR 3xx

Optional overvoltage protector

ID 1265351-xx

CC 3xx

UM 3xx

UM 3xx

UM 3xx

UVR 3xx

UM 3xx

DC-link and 24 V supply conductor-bar connection (included in delivery)

Line filter Epcos xxA

SIEMENS Sitor gS or gR line fuse

L1 L2 L3

Optional overvoltage protector

KDR 3xx

# Accessories



**CC 3xx/6xxx**
**UEC 11x**
**UMC 11x**

CMA-H 04-04-00
analog axis
688721-xx

HR 550 FS
1200495-xx
1183021-xx

HR 520 FS
670304-xx
670305-xx

HR 520
670302-xx
670303-xx

HR 510 FS
1119974-xx
1120311-xx
1120314-xx
1161281-xx

HR 510
1119971-xx
1120313-xx
1099897-xx
1184691-xx

HR 130
540940-01
-03

HRA 551 FS
1119052-xx

50m

50m

max. 2m

296467-xx

312879-01
296467-xx
296687-xx
1117852-03
1117853-xx
1117855-xx
271958-03
-05

50m

20m

7493368-xx
1161072-xx
1218563-01
1161072-xx
1218563-01

7493369-xx

VL
281429-xx

**MB 3xx/7xx**
**TE 3xx/7xx**
**PLB 600x**

X23

**MC 85x2**

X29

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

14.05.2020

- For the touch probe overview, see the brochure
  "Touch Probes for Machine Tools" (ID 1113984-xx)
- For the touch probe connections, see the brochure
  "Cables and Connectors" (ID 1206103-xx)

# PNC 610 with UEC

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

HSCI total length 70 m
HSCI 618893-xx

**1)** Adapter connector 544703-01 for spindle (if necessary)
**2)** Only for connection of the KTY/ PT 1000
**3)** EnDat with incremental signals
**4)** Purely serial EnDat 2.2
**5)** Adapter connector 367770-02
**6)** Optional for looping in KTY

12.12.2018

IPC 8420

PLB 600x

X500
X501
X502

Electrical cabinet

HSCI 688144-xx

M12

HSCI 722414-xx

PL 610x

X502

X500

UEC 11x

X502
X500

PLC I/O

38 inputs
23 outputs

X201 ... X204 (UEC 111)
X201 ... X205 (UEC 112)
X201 ... X206 (UEC 113)

X15 ... X18 (UEC 111)
X15 ... X19 (UEC 112)
X15 ... X20 (UEC 113)

X80 ... X85

Position inputs

Speed inputs

55m
12m
~1 Vpp
~1 Vpp
~1 Vpp

298429-xx
298430-xx
310199-xx
309783-xx

LC x83
30m

558714-xx   max. 30m
673459-xx   max. 20m

VL 323897-xx
368330-xx

332115-xx
533627-xx

55m
RCN 729
RCN 226
RCN 228
LC x83

55m
RCN 729
RCN 226
RCN 228
LC x83

1m
533631-xx   max. 9m
533661-xx   max. 16m

1m
533631-xx max. 6m

60m
LB/LS
~1 Vpp

VL 323897-xx

Voltage controller 5 V
383951-01

KTY
6)

509667-xx

Voltage controller 5 V
368210-02
KTY
2)

336376-xx

289440-xx

5), 6)
5), 6)
5), 6)

1)

289440-xx

Voltage controller 5 V
370226-01
KTY

VL 336847-xx

~ 1 Vpp

Axes + spindle: 60m

Voltage controller 5 V

336376-xx

EnDat 2.1 interface
VL (max. 6m)
340302-xx

VL 340302-xx

Axes: 60m

max. 9m

# Technical description
## Digital control design

**Uniformly digital**

In the uniformly digital control design from HEIDENHAIN, all of the components are connected with each other via purely digital interfaces. A high degree of availability for the entire system, from the main computer to the encoder, is thereby achieved, with the system being diagnosable and immune to noise. The outstanding characteristics of the uniformly digital design from HEIDENHAIN guarantee very high accuracy and surface finish quality, combined with high traversing speeds.

Connection of the components:
- Control components via **HSCI** (HEIDENHAIN Serial Controller Interface), the HEIDENHAIN real-time protocol for Gigabit Ethernet
- Encoders via the **EnDat 2.2** bi-directional interface from HEIDENHAIN
- Power modules via digital optical fiber cables

**HSCI**

HSCI, the HEIDENHAIN Serial Controller Interface, connects the main computer, controller(s), and other control components. The connection between two HSCI components is also referred to as an HSCI segment. HSCI communication in Gen 3 control systems is based on Gigabit Ethernet hardware. All HSCI components and HSCI cables must therefore be Gigabit-capable. A special interface component developed by HEIDENHAIN enables short cycle times for data transfer.

**Main advantages of the control design with HSCI:**
- Hardware platform for a flexible and scalable control system (e.g., decentralized axis systems)
- High noise immunity due to digital communication between components
- Hardware basis for implementing "functional safety"
- Simple wiring (commissioning, configuration)
- Inverter connection via digital optical fiber cables
- Large cable lengths in the entire system (HSCI segment up to max. 70 m)
- High number of possible control loops
- High number of PLC inputs/outputs
- Decentralized arrangement of the controller units

CC or UEC controller units, up to nine PL 6000 PLC I/O modules, and machine operating panels (e.g., MB 72x from HEIDENHAIN) can be connected to the serial HSCI bus of the MC main computer. The HR handwheel is connected directly to the machine operating panel. The combination of monitor and main computer is especially advantageous if the computer is housed in the operating panel. Besides the power supply, all that is then required is an HSCI line to the controller unit in the electrical cabinet.

Maximum cable lengths for HSCI:
- For one HSCI segment: 70 m
- For up to 11 HSCI slaves: 290 m (total of all HSCI segments)
- For up to 12 HSCI slaves (maximum configuration): 180 m (total of all HSCI segments)

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

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

# Control systems with integrated functional safety (FS)

**Basic principle**  With controls featuring integrated functional safety (FS) from HEIDENHAIN, it is possible to attain Safety Integrity Level 2 (SIL 2) in accordance with EN 61508, and Performance Level "d," Category 3, as per EN ISO 13849-1 (successor standard to EN 954-1). In these standards, the assessment of safety-related systems is based on, among other things, the failure probabilities of integrated components and subsystems. This modular approach aids the manufacturers of safety-related machines in implementing their systems, since they can then build upon prequalified subsystems. This design is taken into account for the TNC 640 control, as well as for safety-related position encoders. Two redundant, mutually independent safety channels form the basis of the controls with functional safety (FS). All safety-relevant signals are captured, processed, and output via two channels. Errors are detected through the mutual comparison of the states and data of both channels. Therefore, the occurrence of a single error in the control does not result in a loss of the safety function.

**Structure**  The safety-related controls from HEIDENHAIN have a dual-channel design with mutual monitoring. The SPLC (safety-related PLC program) and SKERN (safety kernel software) software processes are the basis of the two redundant systems. The two software processes run on the MC main computer (CPU) and CC controller unit components. The dual-channel configuration through the MC and CC is continued in the PLB 6xxx FS I/O systems and the MB machine operating panel with FS (e.g., MB 72x FS). This means that all safety-relevant signals (e.g., permissive buttons and keys, door contacts, emergency stop button) are captured via two channels, and are evaluated independently of each other by the MC and CC. The MC and CC use separate channels to also address the power modules, and to stop the motors in the event of an error.

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

Control components with functional safety are indicated by the suffix "FS" following the model designation (e.g., MB 72x FS).

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

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

**HR**  In systems with functional safety (FS), FS handwheels are required because they are the only ones equipped with the required cross-circuit-proof permissive buttons.

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

**Safety functions**
The following safety functions are integrated into the hardware and software:
- Safe stop reactions (SS0, SS1, and SS2)
- Safe torque off (STO)
- Safe operating stop (SOS)
- Safely limited speed (SLS)
- Safely limited position (SLP)
- Safe brake control (SBC)
- Safe operating modes
  - Operating mode 1: Automated or production mode
  - Operating mode 2: Set-up mode
  - Operating mode 3: Manual intervention
  - Operating mode 4: Advanced manual intervention, process monitoring

Please note:
Full functionality is not yet available for all machine types with functional safety (FS). Before planning a machine with functional safety, please inform yourself of whether the current scope of features suffices for your machine design.

**Activation of functional safety (FS)**
The following requirements are absolutely necessary:
- At least one PLB 62xx FS must be present in the system
- FS version of the safety-related control components (e.g., TE 745 FS, HR 550 FS)
- Safety-related SPLC program
- Configuration of safe machine parameters
- Wiring of the machine for systems with functional safety (FS)

Functional safety (FS) is scalable via software options. Only the number of safe drive systems actually needed must be enabled:

| Option number | Option | As of NC-SW | Description | ID |
|---|---|---|---|---|
| **160** | Integrated FS: Basic | 10 | Enables functional safety and 4 safe control loops | 1249928-01 |
| **161** | Integrated FS: Full | 10 | Enables functional safety and the maximum number of safe control loops (≥ 10) | 1249929-01 |
| **162** | Add. FS Ctlr. Loop 1 | 10 | Additional control loop 1 | 1249930-01 |
| **163** | Add. FS Ctlr. Loop 2 | 10 | Additional control loop 2 | 1249931-01 |
| **164** | Add. FS Ctlr. Loop 3 | 10 | Additional control loop 3 | 1249932-01 |
| **165** | Add. FS Ctlr. Loop 4 | 10 | Additional control loop 4 | 1249933-01 |
| **166** | Add. FS Ctlr. Loop 5 | 10 | Additional control loop 5 | 1249934-01 |

For every active drive that is assigned to a safe axis group, a safe control loop must be enabled. The control will otherwise display an error message.

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

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

# Control systems with external safety

**Basic principle**   In control systems without integrated functional safety (FS), no integrated safety functions, such as safe operating modes, safe speed monitoring, or safe operating stop, are available. Such functions must be implemented entirely with the help of external safety components.

Control systems without integrated functional safety (FS) solely support the realization of the safety functions STO (safe torque off: dual-channel interruption of the motor power supply) and SBC (safe brake control: dual-channel triggering of the motor holding brakes). The dual-channel redundancy of the functions must be realized by the OEM through appropriate wiring.

**Design**   In control systems with external safety, a special PL module for the dual-channel triggering of STO and SBC is absolutely necessary. This module is the PAE-H 08-00-01, with which up to eight axis groups can be individually controlled.

# Operating system

**HEROS 5**

The TNC 640 and PNC 610 work with the real-time capable HEROS 5 operating system (HEIDENHAIN Realtime Operating System). This future-oriented operating system contains the following powerful functions as part of its standard repertoire:

**Network**
- Network: management of network settings
- Remote Desktop Manager: management of remote applications
- Printer: management of printers
- Shares: management of network shares
- VNC: virtual network computing server

**Safety**
- Portscan (OEM): port scanner
- Firewall: protection against undesired network access
- SELinux: protection against unauthorized changes to system files
- Sandbox: running applications in separated environments

**System**
- Backup/Restore: function for backing-up and restoring the software on the control
- HELogging: evaluation and creation of log files
- Perf2: system monitor
- User administration: define users with different roles and access permissions

**Tools**
- Web browser: Firefox®*)
- Document Viewer: display PDF, TXT, XLS, and JPEG files
- File Manager: file explorer for managing files and memory media
- Gnumeric: spreadsheet calculations
- Leafpad: text editor for creating notes
- Ristretto: display of image files
- Orage Calendar: simple calendar function
- Screenshot: creation of screendumps
- Totem: media player for playing audio and video files

**User administration**

The improper operation of a control often leads to unplanned machine downtime and costly scrap. The user administration feature can significantly improve process reliability through the systematic avoidance of improper operation. Through the configurable linkage of rights with user roles, access can be tailored to the activities of the respective user.

- Logging on to the control with a user account
- User-specific HOME folder for simplified data management
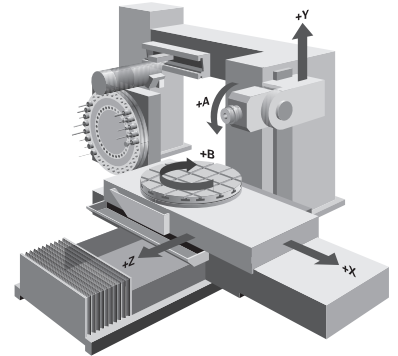- Role-based access to the control and network data
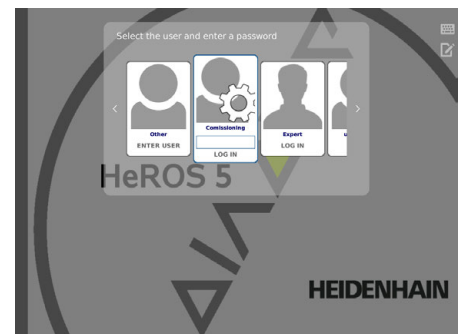


*) Firefox is a registered trademark of the Mozilla Foundation

# Axes

| | |
|---|---|
| **Linear axes** | Depending on its configuration, the TNC 640 can control linear axes with any axis designation (X, Y, Z, U, V, W, ...). |



| | |
|---|---|
| Display and programming | Feed rate in mm/min relative to the workpiece contour, or mm per spindle revolution |
| | Feed rate override: 0 % to 150 % |
| Traverse range | The machine tool builder defines the traverse range. The user can additionally limit the range of traverse in order to limit the working space. Three different traverse ranges can be defined (selection via PLC). |
| **Rotary axes** | The TNC 640 can control rotary axes with any axis designation (A, B, C, U, ...). Special parameters and PLC functions are available for rotary axes with Hirth coupling. |
| Display and programming | 0° to 360° or |
| | Feed rate in degrees per minute [°/min] |
| Traverse range | The machine tool builder defines the traverse range. The user can additionally limit the range of traverse in order to limit the working space. Various traverse ranges can be defined via parameter sets for each axis (selection via PLC). |
| Free rotation | For milling-turning operations, the rotary axis can be started via the PLC with a defined feed rate. For functions specific to milling-turning machines, see *Turning operations*. |
| **Cylinder Surface Interpolation (software option 8)** | A contour defined in the working plane is machined on a cylindrical surface. |
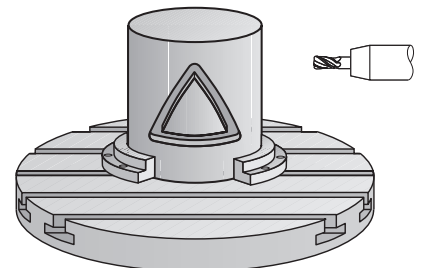
**Tilting the Working Plane (software option 8)**

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

The TNC can manage more than one machine configuration (e.g., different swivel heads).
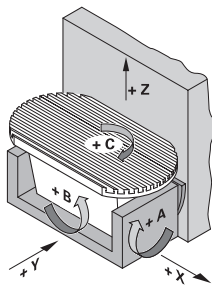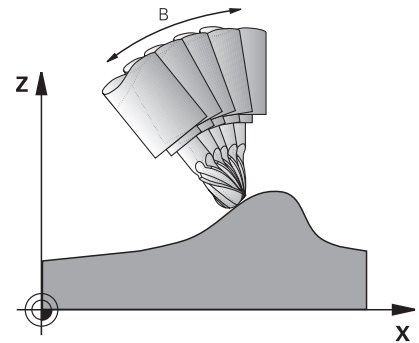
Tilting table
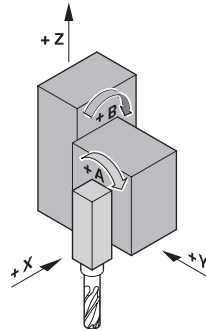
Swivel head

**5-Axis Machining (software option 9)**

Tool Center Point Management (TCPM)
The offset of the tilting axes is compensated for in a manner such that the position of the tool tip relative to the contour is maintained. Even during machining, handwheel positioning commands can be superimposed such that the tool tip remains on the programmed contour.

**Synchronized Axes**

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.

In the case of **gantry axes**, multiple gantry slave axes can be assigned to a single master axis. They may also be distributed to multiple controller units.
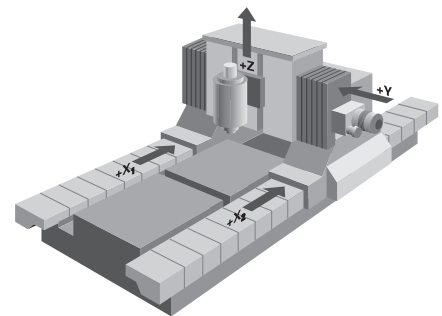
**Torque Control**

Torque control is used on machines with mechanically coupled motors, for which
• a defined distribution of drive torque is desired,
  or
• parts of the controlled system show a backlash effect that can be eliminated by "tensioning" the motors (e.g. toothed racks).

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

**52**
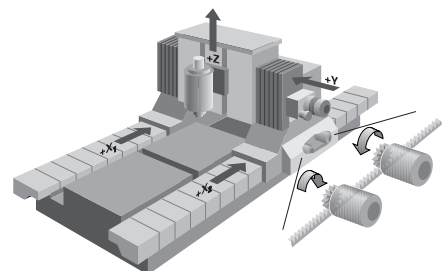
**Real-Time Coupling Function (software option 135)**

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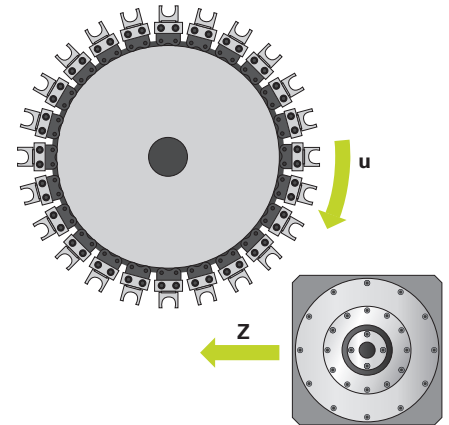


**Batch Process Manager (software option 154)**

Batch Process Manager provides functions for the planning and execution of multiple production jobs on the TNC. It makes it possible to easily edit pallets and to alter the sequence of pending jobs. Batch Process Manager also performs a duration calculation for all planned jobs or NC programs. It informs the user as to whether, for example, all NC programs can be executed without error or whether all required tools are available with sufficient tool life. Batch Process Manager thereby ensures the smooth execution of the planned jobs. Batch Process Manager also requires software option 22 (Pallet Management) to be enabled.
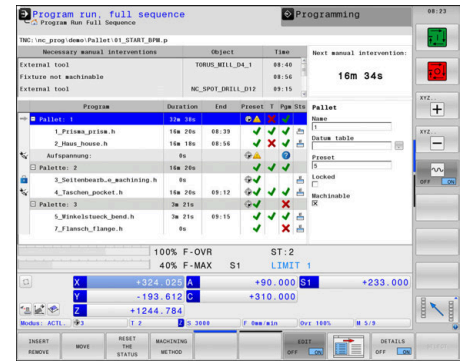


**Global PGM Settings (software option 44)**

The functions provided by global program settings allow adaptation of the machining process without changing the original NC program. This makes it easy to mirror axes or activate additional offsets, for example. The TNC 640 also provides the ability to use handwheel superimpositioning in various coordinate systems and utilize virtual tool axes. This function is typically employed in toolmaking and mold manufacturing.
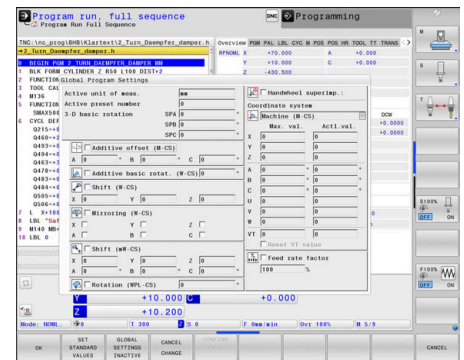


**PLC axes**

Axes can be defined as PLC axes. Programming is performed through M functions or OEM cycles. The PLC axes are positioned independently of the NC axes and are therefore designated as asynchronous axes.



**53**
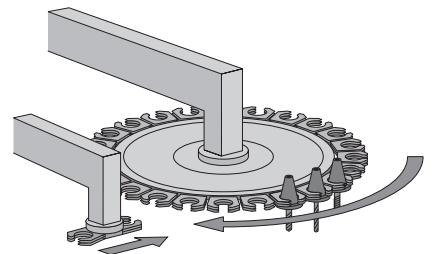
# Turning

**Performing Turning Operations (software option 50)**

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

In turning mode, the rotary table serves as the lathe spindle, while the milling spindle with the tool remains stationary. Milling-turning machines are subject to special demands. A basic prerequisite is a machine designed with high rigidity so as to ensure a low oscillation tendency even when the machine table (acting as a lathe spindle) is turning at high speeds.
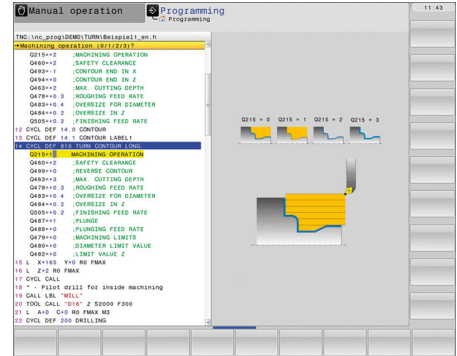
**Toggling between milling and turning modes**

During the transition between milling and turning mode, the TNC switches diameter programming on or off, selects the XZ working plane for turning, and displays "Milling" and "Turning" mode in the status display.

The user switches between turning and milling mode with the NC command FUNCTION MODE TURN or FUNCTION MODE MILL. The machine-specific procedures necessary for this are realized via OEM macros. In these macros, the OEM defines, for example, which kinematic model is active for the turning or milling operation, and which axis and spindle parameters take effect in milling or turning mode. Because the FUNCTION MODE TURN and FUNCTION MODE MILL commands are independent of the machine model, NC programs can be exchanged between different types of machines.

FUNCTION MODE TURN

FUNCTION MODE MILL

**Machine in milling mode**

**Machine in turning mode**
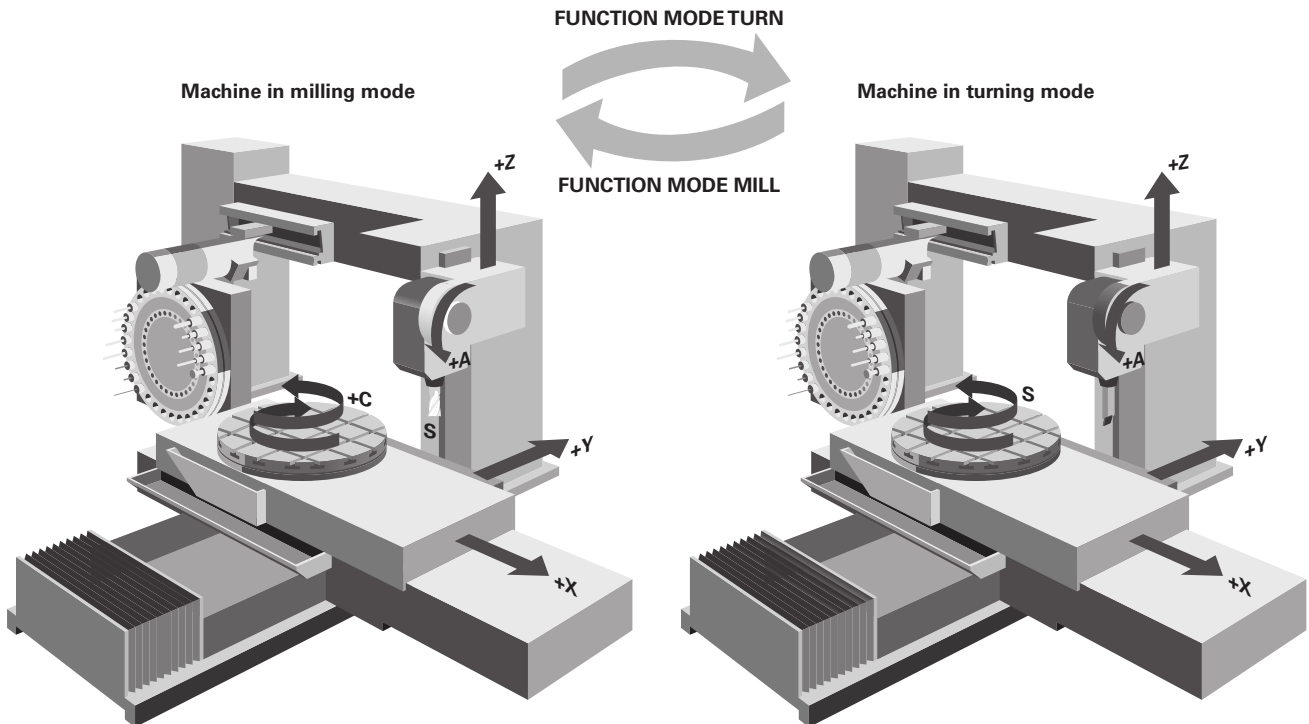
**Support for facing slides (facing heads)**

With complete support for facing slides, the TNC 640 provides a further way of performing turning operations on a milling machine. A longitudinal turning tool, for example, can be mounted to the facing slide and called with a TOOL CALL block. Even complex turning operations are programmed with familiar ease using cycles. Machining operations with the facing slide can be carried out with the TNC 640 in any inclination (PLANE functions). In addition, numerous useful turning functions, such as constant cutting speed, are available. The use of facing slides requires the enabling of software option 50 for turning operations on the TNC 640.

**Measuring unbalance and balancing**

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

An unbalance on the rotary table can endanger the safety of the user and has a negative effect on the quality of the workpiece and the service life of the machine.

The TNC 640 can detect an unbalance in the rotary table based on the effects of the centrifugal forces on neighboring linear axes. To this end, the rotary table should ideally be positioned via a linear axis. For other machine designs, unbalance detection by means of external sensors lends itself as a solution.

The TNC 640 features the following functions:
- **Unbalance calibration**
  A calibration cycle determines the unbalance behavior of the rotary table. This unbalance calibration is generally performed by the OEM before the machine is shipped. During execution of the calibration cycle, the TNC generates a table describing the unbalance behavior of the rotary table.
- **Balancing**
  After the blank to be turned has been set up, the user can ascertain the unbalance using a measuring cycle. During balancing, the TNC supports the user by displaying the mass and position of the balancing weights.
- **Unbalance monitoring**
  During the machining operation, the TNC continually monitors the unbalance. An NC stop is triggered if a specified limit value is exceeded.

**Gear Cutting (software option 157)**

The Gear Cutting software option provides user-friendly cycles for the economical production of external and internal gear teeth. The hobbing and skiving cycles enable the complete machining of high-quality gear teeth in a single setup, including static shifting for prolonged tool life and synchronous shifting for the production of helical gear teeth.

**Advanced Function Set Turning (software option 158)**

The Advanced Function Set Turning option expands the package of turning cycles to include Cycle 883 (TURNING SIMULTANEOUS FINISHING). This cycle enables the finishing of complex contours in a single run so as to avoid visible transitions.
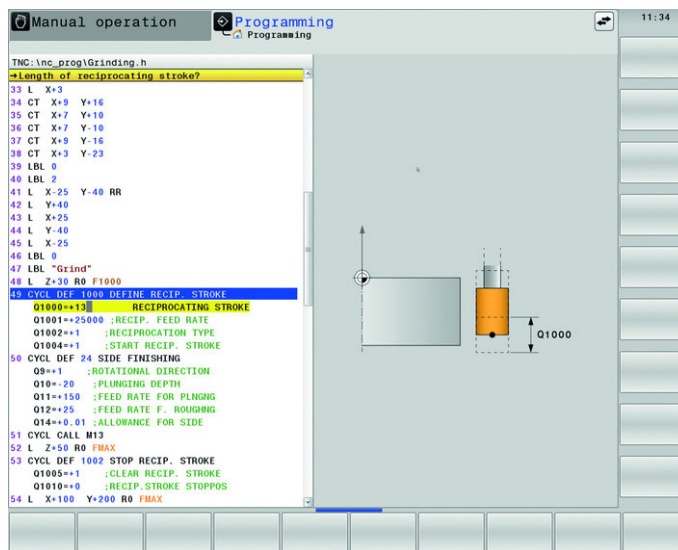
# Grinding operations

**Grinding (software option 156)**

With its Grinding option, the TNC 640 supports jig grinding technology for the fine finishing of 2-D contours.

Grinding operations are programmed with the familiar HEIDENHAIN Klartext dialog guidance. Convenient cycles are available to the user. Instead of a milling cutter, jig grinding employs a grinding tool (e.g., grinding pin) for material removal. Since machining is performed in milling mode, a separate operating mode is not needed.

A stroke movement or oscillating movement in the tool axis can be activated by means of a cycle. There is also the capability of dressing or truing-up grinding tools inside the machine.

# Spindle

| | |
|---|---|
| **Overview** | The TNC 640 contouring control is used in conjunction with the HEIDENHAIN inverter systems with field-oriented control. As an alternative, an analog nominal speed value can be output. |
| **Controller unit** | With the CC controller units and the UEC/UMC inverters, a fundamental PWM frequency can be set for each output. In this case, every output can have its own fundamental PWM frequency (e.g., with the CC 306: X551 = 4 kHz, X552 = 5 kHz, etc.).<br><br>Possible fundamental frequencies:<br>• 3.33 kHz<br>• 4 kHz<br>• 5 kHz<br><br>With software option 49 (double speed), this frequency can be increased to up to 16 kHz for fast-turning spindles (e.g., HF spindles). |
| **Maximum spindle speed** | The maximum spindle speed is calculated as follows:<br><br>$$n_{max} = \frac{f_{PWM} \cdot 60000 \text{ rpm}}{NPP \cdot 5000 \text{ Hz}}$$<br><br>$f_{PWM} =$ PWM frequency in Hz<br>$NPP =$ Number of pole pairs |
| **Operating mode switchover** | For controlling the spindle, different parameter sets can be saved for closed-loop control (e.g., for wye or delta connections). You can switch between the parameter sets in the PLC. |
| **Position-controlled spindle** | The position of the spindle is monitored by the control. |
| **Encoder** | HEIDENHAIN rotary encoder with sinusoidal voltage signals (1 $V_{PP}$) or EnDat interface. |
| **Tapping** | There are special cycles for tapping with or without a floating tap holder. For tapping without a floating tap holder, the spindle must be operated under position control. |
| **Spindle orientation** | With a position-controlled spindle, the spindle can be positioned exactly to 0.1°. |
| **Spindle override** | 0 % to 150 % |
| **Gear ranges** | A separate nominal speed is defined for each gear range. The gear code is output via the PLC. |
| **Multiple main spindles** | Up to four spindles can be controlled alternately. The spindles are switched by the PLC. One control loop is required for each active spindle. |
| **Spindle Synchronism (software option 131)** | The Spindle Synchronism software option allows the speed of two or more spindles to be synchronized. Spindle synchronization is also possible with a transmission ratio or a defined offset. |

# Encoders

**Overview**

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

**Incremental encoders**

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

Reference mark

After the machine has been switched on, the relationship between the measured value and the machine position must be established by traversing the reference marks. For encoders with distance-coded reference marks, the maximum travel until automatic reference mark storage for linear encoders is only 20 mm or 80 mm, depending on the model, or 10° or 20° for angle encoders.
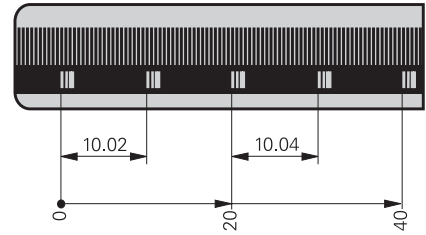


Evaluation of reference marks

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 $\sim 1\ V_{PP}$ 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. A reference-mark traverse is not necessary. Additional incremental signals are output for highly dynamic control loops.

EnDat interface

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

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

**Encoder inputs**

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

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

| Inputs | Signal level/ Interface[1] | Input frequency[1] | |
|---|---|---|---|
| | | **Position** | **Speed** |
| Incremental signals | $\sim 1\ V_{PP}$ EnDat 2.1 | 33 kHz/350 kHz | 350 kHz |
| Absolute position values | EnDat 2.1 EnDat 2.2 | – | – |

[1] Switchable

# Digital servo control

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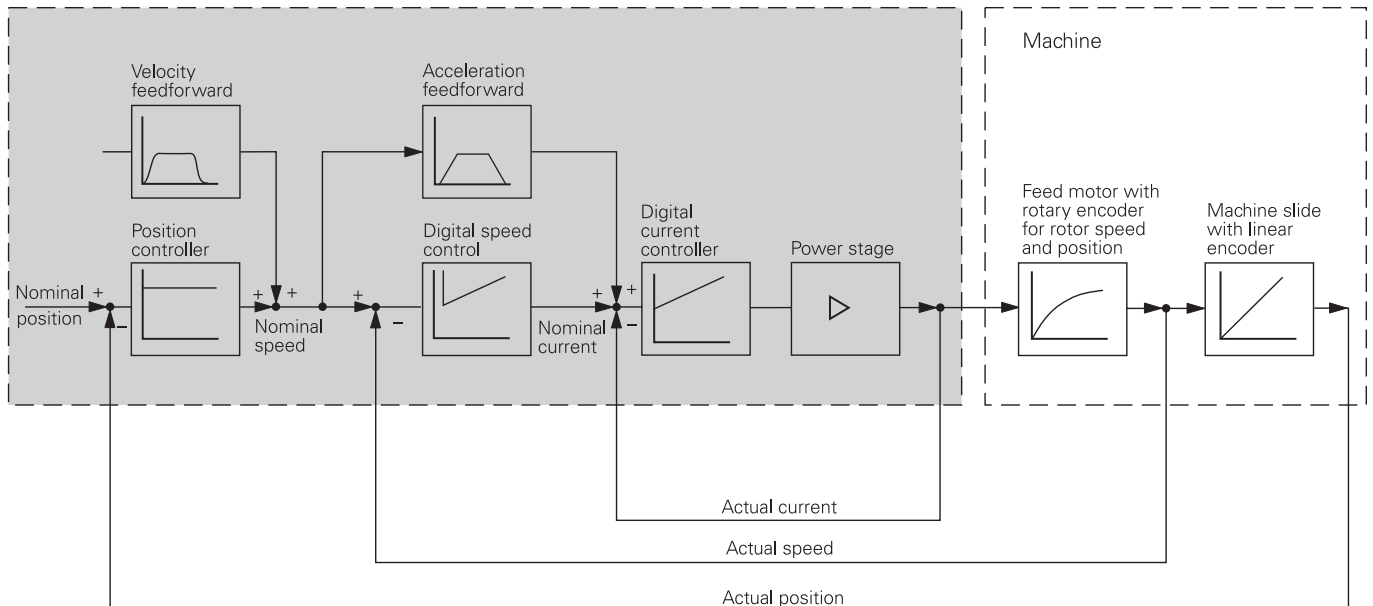


**Axis feedback control**  The TNC 640 can be operated with following error or feedforward control. During roughing operations at high speeds, for example, you can switch to velocity semi-feedforward control via an OEM cycle in order to machine faster at reduced accuracy.

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

$$v = k_v \cdot s_a$$

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

**Operation with feedforward control**  Feedforward means that a given velocity and acceleration are adapted to the machine. Together with the values calculated from the following error, this given velocity and acceleration becomes the nominal value. A much lower following error thereby manifests itself (in the range of only a few microns).

**Compensation of torque ripples**  The torque of synchronous, torque, and linear motors is subject to periodic oscillations, one cause of which can be permanent magnets. The amplitude of this torque ripple depends on the motor design and, under certain circumstances, can have an effect on the workpiece surface. During initial configuration of the axes with TNCopt, this "torque ripple" can be compensated for by means of the Torque Ripple Compensation (TRC) function of the CC or UEC.

| | **Control loop cycle times** |
|---|---|

**Control loop cycle times**

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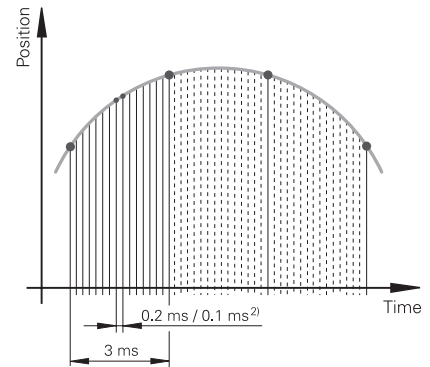


|  | **CC/UEC/UMC** |
|---|---|
| **Path interpolation** | 3 ms |
| **Fine interpolation** | 0.2 ms/0.1 ms[1] at $f_{PWM}$ = 5000 Hz |
| **Position controller** | 0.2 ms/0.1 ms at $f_{PWM}$ = 5000 Hz |
| **Speed controller** | 0.2 ms/0.1 ms[1] at $f_{PWM}$ = 5000 Hz |
| **Current controller** | 0.1 ms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

[1] Double speed (with software option 49)

**Axis clamping**

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

**Double Speed Control Loops (software option 49)**

Double-speed control loops permit higher PWM frequencies and shorter cycle times for the speed controller. This enables improved current control for spindles and higher controller performance for linear and torque motors.

**Crossover Position Filter (CPF)**

To increase the stability of the position control loop in systems with resonances, the position signal from the position encoder, which is filtered through a low-pass filter, is combined with the position signal from the motor speed encoder, which is filtered through a high-pass filter. This signal combination is made available to the position controller as the actual position value. The possible position controller gain ($k_V$ factor) is increased significantly by this. The filter separation frequency is set specifically for each axis via machine parameters. The CPF can be used only in dual-encoder systems on motors with speed and position encoders.
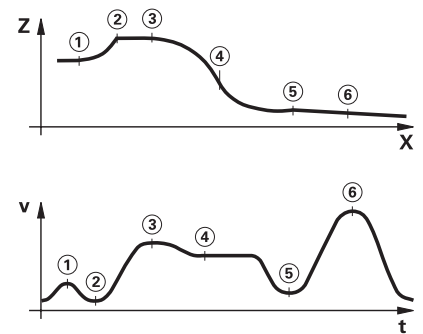
**60**

# Fast contour milling

**Short block processing time**

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

The block processing time of the MC is 0.5 ms. This means that, during the execution of long programs from the hard drive, the TNC 640 can even mill contours approximated in 0.2 mm line segments at a feed rate of up to 24 m/min.

**Look-ahead**

For feed rate adaptation, the TNC 640 performs a precalculation of the geometry (max. 5000 blocks). In this way, directional changes are detected in time to accelerate or decelerate the appropriate NC axes.

**Jerk**

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

**Jerk limiting**

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

**Smoothed jerk**

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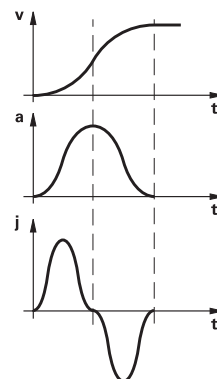
**Advanced Dynamic Prediction (ADP)**

The Advanced Dynamic Prediction (ADP) function enhances the conventional look-ahead of the permissible maximum feed rate profile, thereby enabling optimized motion control for clean surface finishes and perfect contours. The strengths of ADP are evident, for example, during bidirectional finish milling through symmetrical feed behavior on the forward and reverse paths, as well as through particularly smooth feed rate curves on parallel milling paths. NC programs that are generated on CAM systems have a negative effect on the machining process due to various factors such as short, step-like contours; coarse chord tolerances; and heavily rounded end-point coordinates. Through an improved response to such factors and the exact adherence to dynamic machine parameters, ADP not only improves the surface quality of the workpiece but also optimizes the machining time.

# Dynamic Efficiency

**Overview**

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

Dynamic Efficiency comprises three software functions:
- **ACC** (Active Chatter Control): this software option reduces chatter susceptibility, thus enabling higher feed rates and infeeds.
- **AFC** (Adaptive Feed Control): this software option controls the feed rate based on the machining situation.
- **Trochoidal milling**: a function for the roughing of slots that eases the load on the tool
- **OCM** (Optimized Contour Milling): the OCM software option allows pockets and islands of any shape to be machined with low tool wear using the highly efficient trochoidal milling method.

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

**Adaptive Feed Control (AFC), software option 45**

With Adaptive Feed Control (AFC), the contouring feed rate is controlled based on the respective percentage of spindle power.

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

Restrictions:
AFC cannot be used for analog spindles or in volts-per-hertz control mode.
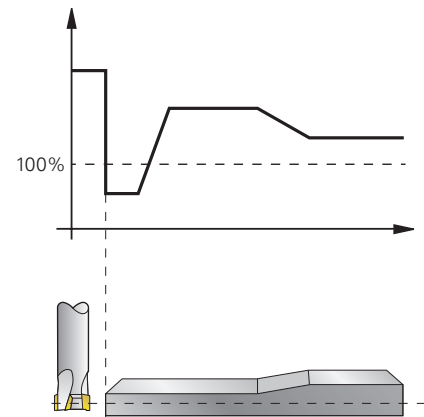
**Active Chatter Control (ACC), software option 145**

During heavy machining (roughing at a high removal rate), strong milling forces arise. Depending on the tool spindle speed, the resonances in the machine tool, and the chip volume (metal-removal rate during milling), the phenomenon known as "chatter" may occur. Chatter puts the machine under heavy strain and causes blemishes on the workpiece surface. Tool wear is also accelerated and less evenly distributed. In extreme cases, the tool may even break. To reduce chatter susceptibility, HEIDENHAIN now offers an effective remedy through its Active Chatter Control (ACC) option. This option is particularly beneficial during heavy machining. ACC enables substantially higher cutting performance: depending on the machine model, the metal removal rate can be increased by 25 % or more. Thus, you can reduce the load on your machine while simultaneously increasing the life of your tools.
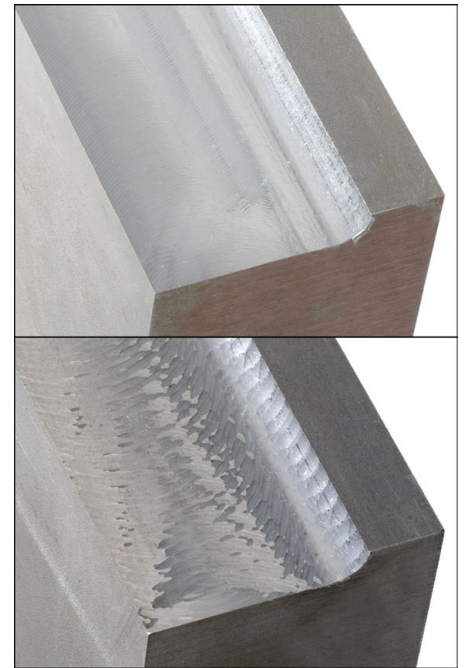
*Top figure:* part milled with ACC
*Bottom figure:* part milled without ACC

**Optimized Contour Milling (OCM), software option 167**

With Optimized Contour Milling (OCM), you can machine pockets and islands of any shape while reducing tool wear thanks to highly efficient trochoidal milling. You simply program the contour as usual directly in Klartext or make use of the convenient CAD Import function. The control then automatically calculates the complex movements required for trochoidal milling.

Advantages of OCM over conventional machining:
• Reduced thermal load on the tool
• Superior chip removal
• Uniform tool-workpiece contact
• Higher possible cutting parameters
• Higher removal rates
• No need for adjustments by the machine tool builder

# Dynamic Precision

**Overview**

The umbrella term Dynamic Precision encompasses a number of HEIDENHAIN milling solutions that significantly improve the dynamic accuracy of a machine tool. The dynamic accuracy of machine tools can be seen in the errors at the tool center point (TCP). The size of these errors depends on the magnitudes of the motion (e.g., speed and acceleration, as well as jerk) and result from the vibrations of the machine components, among other things. Taken together, all of these errors are partially to blame for dimensional errors and faults on the surfaces of workpieces. They therefore have a decisive impact on quality and, in the event of quality-related scrap, on productivity as well.

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

The software options that make up Dynamic Precision can be deployed by the machine manufacturer both alone or in combination:

- **CTC**: compensates for acceleration-dependent position errors at the tool center point, thereby increasing accuracy during acceleration phases
- **AVD**: active vibration damping improves surfaces
- **PAC**: position-dependent adaptation of control parameters
- **LAC**: load-dependent adaptation of control parameters enhances accuracy regardless of load and aging
- **MAC**: motion-dependent adaptation of control parameters

**Load Adaptive Control (LAC), software option 143**

With LAC (software option 143), you can dynamically adjust controller parameters based on the load or friction.

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

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

**Motion Adaptive Control (MAC), software option 144**

Along with the position-based modification of machine parameters through the PAC software option, the Motion Adaptive Control (MAC) software option allows machine parameters to be changed based on their initial values, such as speed, following error, or acceleration. Through this motion-dependent adaptation of the control parameters, a speed-dependent adaptation of the $k_v$ factor can be implemented for drive systems whose stability changes due to the different traversing speeds.

**dynamic + precision**

**Cross Talk Compensation (CTC), software option 141**

CTC (software option 141) enables the compensation of dynamic position errors potentially arising from acceleration forces.

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

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

If the dynamic position errors relative to the axis acceleration are known, then these acceleration-dependent errors can be compensated for by the Cross Talk Compensation (CTC) software option in order to avoid negative effects on the surface quality and accuracy of the workpiece. Often, the resulting error at the TCP depends not only on the acceleration but also on the position of the axes in the working space. This can also be compensated for by CTC.
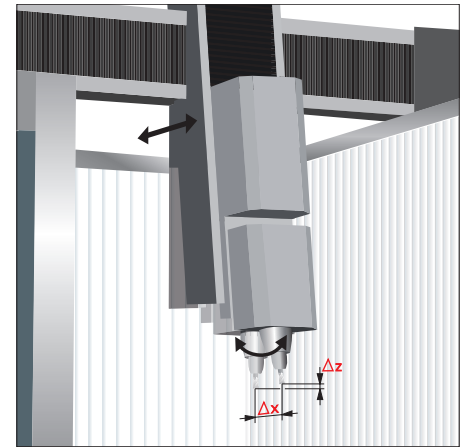
**Active Vibration Damping (AVD), software option 146**

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

**Position Adaptive Control (PAC), software option 142**

PAC (software option 142) permits the dynamic, position-dependent adaption of controller parameters based on the spatial position of the tool.

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

To take full advantage of the machine's dynamic performance, the Position Adaptive Control (PAC) software option enables changes to machine parameters based on position, thus permitting assignment of the respective optimal loop gain to defined interpolation points. Additional position-dependent filter parameters can be defined in order to further increase control loop stability.
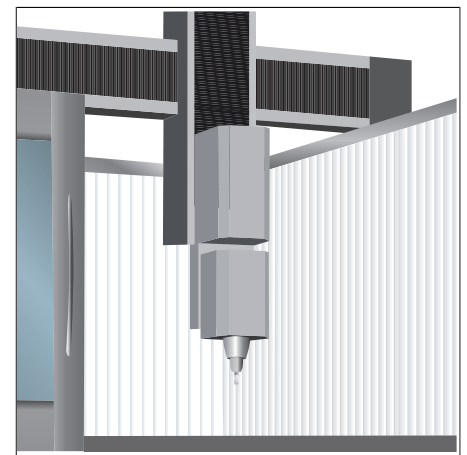
# Monitoring functions

**Description**  During operation, the control monitors the following details[*]:
- 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 distance traversed (movement monitoring)
- Position deviation at standstill
- Nominal speed value
- Checksum of safety-related functions
- Supply voltage
- Voltage of the backup battery
- Operating temperature of the MC and CPU
- Run time of the PLC program
- Motor current / motor temperature
- Temperature of the power module
- DC-link voltage

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

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

[*]  No safety functions

**Dynamic Collision Monitoring (DCM), software option 40**

With the Dynamic Collision Monitoring (DCM) software option, the TNC cyclically monitors the working space of the machine for possible collisions between machine components. To this end, the OEM must define three-dimensional collision objects in the working space that are to be monitored by the TNC during all machine movements, including those of the swivel head and tilting table. If two objects monitored for collision come within a defined distance of each other, the TNC outputs an error message. At the same time, the affected machine components are shown in red in the machine image. Collision monitoring is active in the manual operating modes and in the machine operating modes, and is indicated by a symbol in the operating mode line.



Please note:
- Collision objects (including fixtures) are defined exclusively by the OEM
- The collision of machine parts (e.g., the swivel head) with the workpiece cannot be detected
- Collision objects are not automatically transformed into rotationally symmetric objects in turning mode
- In servo-lag operation (no feedforward), DCM is inactive
- It is not possible to check for collisions in Test Run mode

Collision monitoring also protects fixtures and tool carriers from collisions.

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

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

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

**Context-sensitive help**

Context-sensitive help is available to the user through the HELP or ERR buttons. As a result, when there is an error message, the control displays the cause of the error, as well as possible solutions. The machine manufacturer can also implement this user support for PLC error messages.
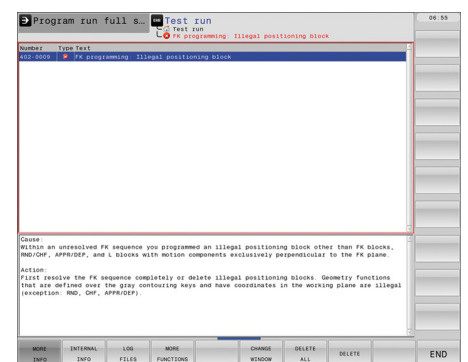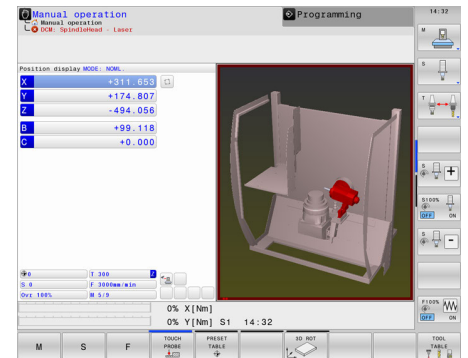
**KinematicsDesign (accessory)**

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

Kinematic descriptions created for the iTNC 530 can also be transferred into kinematic descriptions for the TNC 640/620/320/128.

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

Visualization options range from a pure depiction of the transformation chain and a wire model all the way to the complete machine model.
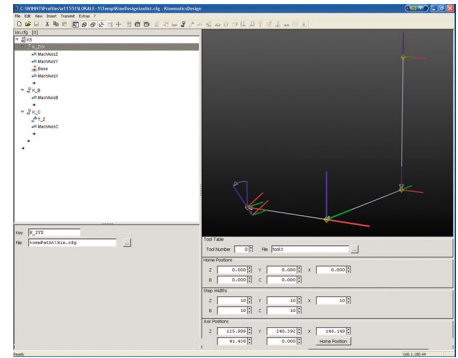


**M3D Converter**

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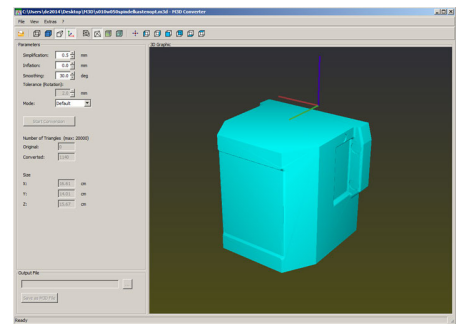


**Visual Setup Control (VSC), software option 136**

With the Visual Setup Control (VSC) option, the TNC can automatically monitor the current clamping or machining situation while the program is running. To make this possible, the VS 101 camera system takes reference photos of the first parts in a series and compares them with photos of subsequent parts. User-friendly cycles let you specify multiple locations within the NC program at which you want the control to perform a visual comparison between the nominal and actual conditions. If an error is detected, the TNC executes a reaction selected by the user.
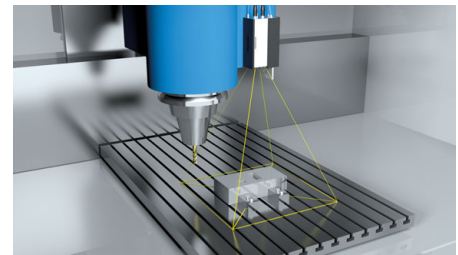


**Component Monitoring (software option 155)**

The overloading of machine components is often the cause of expensive machine damage and unplanned production downtime. Component monitoring keeps the user informed about the current load on the spindle bearings and reacts upon exceedance of the specified limit values (e.g., with an NC stop).

# Error compensation

**Overview**    The TNC 640 automatically compensates for mechanical errors of the machine.

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

**Nonlinear error**    The TNC 640 can compensate for ball-screw pitch errors and sag errors simultaneously. The compensation values are stored in a table. Nonlinear axis-error compensation also makes it possible to compensate for position-dependent backlash.
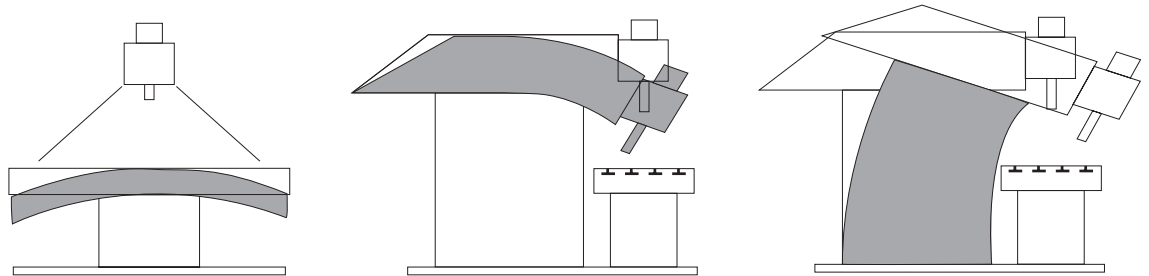
**Backlash**    The play between table movement and rotary encoder movement during direction changes can be compensated for in length measurements by the spindle and rotary encoder. This backlash is outside the controlled system.

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

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

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

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

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

The temperature is measured via thermistors connected to the analog inputs of the TNC 640. The PLC evaluates the temperature information and passes a compensation value to the NC.

**KinematicsOpt (software option 48)**

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

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

**Calibration sphere (accessory)**

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

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

| **KinematicsComp (software option 52)** | Increasingly stringent requirements on workpiece tolerances constantly increase the demands placed on the precision of a machine tool. However, components of the machine tool inevitably show imperfections that are, for example, caused by manufacturing or installation or result from elastic deformation. This is the reason why the commanded tool position and orientation are not always reached with exactness everywhere in the working space. The more axes a machine has, the more sources of error there are. The use of mechanical means to cope with these problems requires considerable effort, particularly in the field of 5-axis machining, or if large machines with parallel axes are involved. |
|---|---|
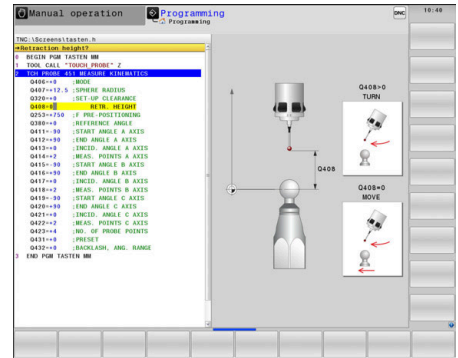


Fault characteristics according to ISO 230-1: EBA

The KinematicsComp software option allows the OEM to store a comprehensive description of the machine errors in the control. KinematicsComp then automatically compensates for the position error that results from static errors of the physical machine axes (volumetric compensation). The positions of all rotary and linear axes, as well as the current tool length, are included in the calculation. KinematicsComp can continue to be used to define position-dependent temperature compensation. The required data are supplied by multiple sensors located at representative positions on the machine.

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

The KinematicsComp software option cannot be enabled in the export versions.



Fault characteristics according to ISO 230-1: EXA

**3D-ToolComp (software option 92)**

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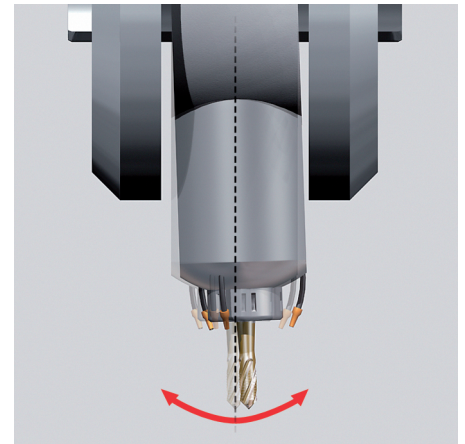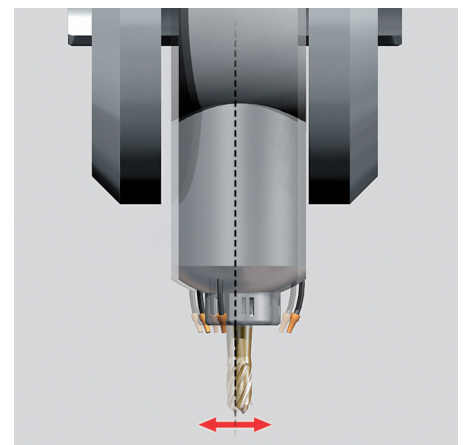
# Commissioning and diagnostic aids

**Overview**

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

**ConfigDesign (accessory)**

PC software for configuring the machine parameters
- Stand-alone machine-parameter editor for the control; all supporting information, additional data, and input limits are shown for the parameters
- 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)

**TNCdiag**

The HEIDENHAIN TNCdiag application evaluates the status and diagnostic information of HEIDENHAIN components (with an emphasis on the drive systems) and graphically images the data:
- Status and diagnostic information about the HEIDENHAIN components (drive electronics, encoders, input/output devices, etc.) connected to the control
- History of the recorded data
- Replaces DriveDiag for Gen 3 drives

TNCdiag comes in a PC version for the analysis of service files and in a control version for the display of live data.
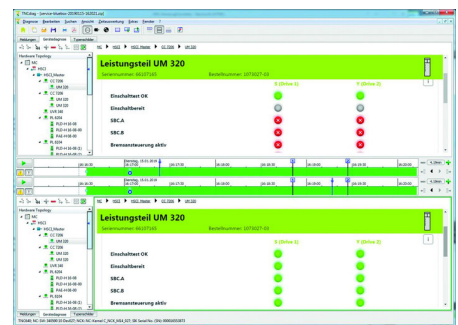


**Oscilloscope**

The TNC 640 features an integrated oscilloscope. Both X/t and X/Y graphs are possible. The following characteristic curves can be recorded and stored in six channels:
- Actual value and nominal value of the axis feed rate
- Contouring feed rate
- Nominal and actual position
- Following error of the position controller
- Nominal and actual values for speed, acceleration, and jerk
- Content of PLC operands
- Encoder signal (0°–A) and (90°–B)
- Difference between position and speed encoder
- Nominal velocity value
- Integral-action component of the nominal current value
- Torque-determining nominal current value

Logic signals

Simultaneous graphical representation of the logic states of up to 16 operands (markers, words, inputs, outputs, counters, timers)
- Marker      (M)
- Input       (I)
- Output      (O)
- Timer       (T)
- Counter     (C)
- IpoLogic    (X)
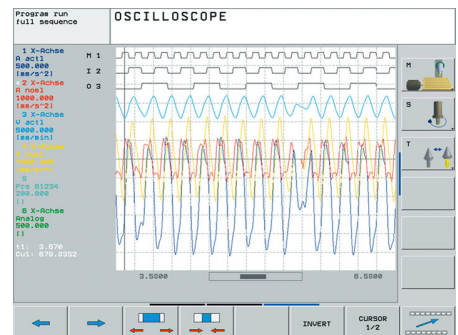
| | |
|---|---|
| **TNCopt<br>(accessory)** | PC software for commissioning digital control loops.<br>Functions (among others):<br>• Commissioning the current controller<br>• (Automatic) commissioning the velocity controller<br>• (Automatic) optimization of sliding-friction compensation<br>• (Automatic) optimization of compensation for reversal spikes<br>• (Automatic) optimization of the $k_V$ factor<br>• Circular interpolation test, contour test |



| | |
|---|---|
| **Online Monitor<br>(OLM)** | The online monitor is a component of the TNC 640 and is called<br>with a code number. It supports commissioning and diagnosis of<br>control components through the following:<br>• Display of control-internal variables for axes and channels<br>• Display of controller-internal variables (if a CC is present)<br>• Display of hardware signal states<br>• Various trace functions<br>• Activation of spindle commands<br>• Enabling of control-internal debug outputs |
| **TNCscope<br>(accessory)** | PC software for transferring the oscilloscope files to a PC.<br>With TNCscope you can record and save up to 16 channels<br>simultaneously.<br>**Note:** The trace files are saved in the TNCscope data format. |
| **API DATA** | With the API DATA function, the control displays the states or<br>contents of the symbolic API markers and API double words. |
| **Table function** | The current conditions of the markers, words, inputs, outputs,<br>counters, and timers are displayed in tables. The conditions can be<br>changed through the keyboard. |
| **Trace function** | The current content of the operands and the accumulators is<br>shown in the statement list in each line in hexadecimal or decimal<br>code. The active lines of the statement list are marked. |
| **Log** | For the purpose of error diagnostics, all error messages and<br>keystrokes are recorded in a log. The entries can be read using the<br>**PLCdesign** or **TNCremo** software for PCs. |

**TeleService (accessory)**

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

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

**Bus diagnosis**

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

**State Reporting (software option 137)**

With the State Reporting Interface (SRI) software option, HEIDENHAIN offers an interface for the simple provision of machine operating states for a higher-level machine data or production data acquisition system (MDA/PDA).

**TNCtest**

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

The TNCtest and TestDesign program package 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, and perform automatic configurations, as well as record data and evaluate the data semiautomatically. A tester must evaluate manually whether a test case passed or failed.

**TNCanalyzer**

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

Function:
- Loading of service and log 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
- Graphical display of signals via TNCscope
- Interaction with other tools that are intended for the display of special sections of the service file

# Integrated PLC

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

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

**PLC programming**

| Format | Statement list |
|---|---|
| Memory | Min. 1 GB (depending on the data carrier used) |
| Cycle time | 9 ms to 30 ms (adjustable) |
| Command set | • Bit, byte, and word commands<br>• Logical operations<br>• Arithmetic commands<br>• Comparisons<br>• Bracketed terms<br>• Jump commands<br>• Subprograms<br>• Stack operations<br>• Submit programs<br>• Timers<br>• Counters<br>• Comments<br>• PLC modules<br>• Strings |

**Encryption of PLC data**
The encrypted PLC partition (PLCE:) provides the machine tool builder with a tool for preventing third parties from viewing or changing files. The files on the PLCE partition can be read only by the control itself or by using the correct OEM keyword. This ensures that proprietary know-how and special customer-specific solutions cannot be copied or changed.

The machine manufacturer can also determine the size of the encrypted partition. This is not determined until the machine manufacturer creates the PLCE partition. Another advantage is that, in spite of the encryption, the data can backed up from the control to a separate data medium (USB drive, network, e.g., through TNCremo) and later restored. You need not enter the password, but the data cannot be read until the keyword is supplied.

**PLC window**    The TNC 640 can display PLC error messages in the dialog line during operation.

Small PLC window    The TNC 640 can show additional PLC messages and bar diagrams in the small PLC window.
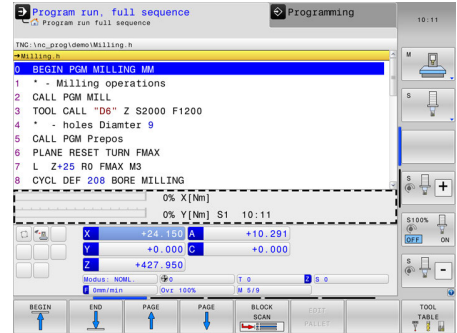
**PLC soft keys**    The machine manufacturer can display his own PLC soft keys in the vertical soft-key row on the screen.

**PLC positioning**    All closed-loop axes can also be positioned via the PLC. PLC positioning of the NC axes cannot be superimposed on NC positioning.
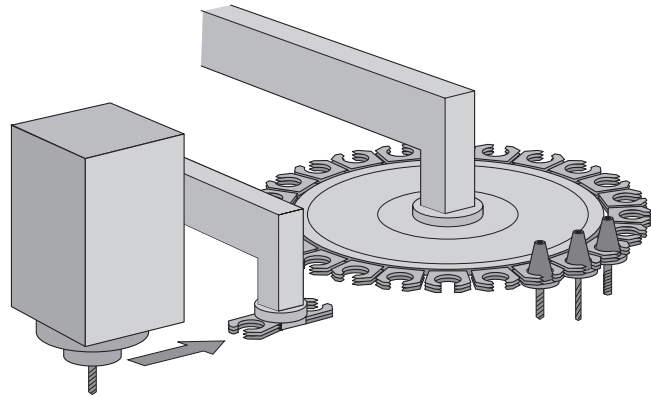
**PLC axes**    Axes can be defined as PLC axes. They are programmed by means of M functions or OEM cycles. The PLC axes are positioned independently of the NC axes.

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

Functions:
- Easy-to-use text editor
- Menu-guided operation
- Programming of symbolic operands
- Modular programming techniques
- "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

76

**Python OEM Process (software option 46)**

The Python OEM Process software option gives the machine manufacturer a powerful tool for using a high-level, object-oriented programming language in the control (PLC). Python is an easy-to-learn script language supporting 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 software option (software option 46). Ten megabytes of dedicated memory are reserved for this function. For more information, refer to the *Python in HEIDENHAIN Controls* Technical Manual.
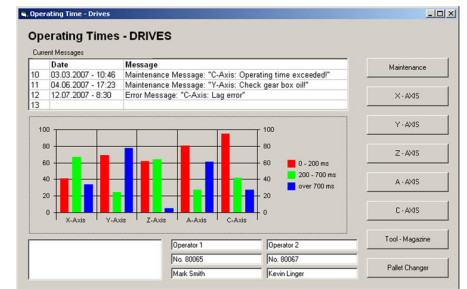
**PLC basic program**

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:

**Axes**
– Control of analog and digital axes
– Axes with clamping mode
– Axes with central drive
– Axes with Hirth grid
– Synchronized axes
– 3-D head with C-axis mode
– Reference run, reference end position
– Axis lubrication

**Spindles**
– Control and orientation of the spindles
– Spindle clamping
– Alternative double-spindle operation
– Parallel spindle operation
– Conventional 2-stage gear system
– Wye/delta connection switchover (static, dynamic)

**Tool changers**
– Manual tool changer
– Tool changer with pick-up system
– Tool changer with dual gripper
– Tool changer with positively driven gripper
– Rotating tool magazine with closed-loop axis
– Rotating tool magazine with controlled axis
– Servicing functions for the tool changer
– Python tool management

**Pallet changers**
– Translational pallet changer
– Rotary pallet changer
– Servicing functions for the pallet changer

**Safety functions**
– Emergency stop test (EN 13849-1)
– Brake test (EN 13849-1)
– Repeated switch-on test for a wireless handwheel

**General functions**
– Feed rate control
– Control of the coolant system (internal, external, air)
– Toggling between milling and turning modes
– Temperature compensation
– Activate tool-specific torque monitoring
– Hydraulic control
– Chip conveyor
– Indexing fixture
– Touch probes
– PLC support for handwheels
– Control of doors
– Handling of M functions
– PLC log
– Display and management of PLC error messages
– Diagnostics screen (Python)
– Python example applications
– Status display in the small PLC window

# 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. Complete tool management with tool life monitoring and replacement tool monitoring is carried out by the TNC 640.

**Tool Calibration**

Tool touch probes can be measured and checked with the **TT** tool touch probe system (accessory). Standard cycles for automatic tool measurement are available in the control. The control calculates the probing feed rate and the optimal spindle speed. The measured data are stored in a tool table.

**Touch-Probe Configuration**

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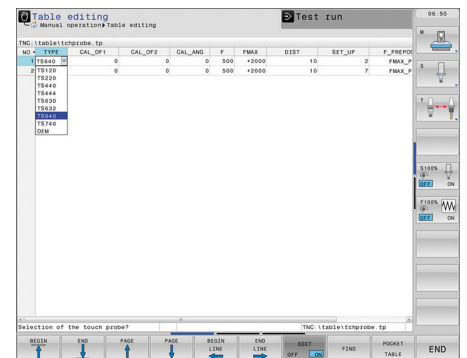
**Pallet Management**

Pallet feeding can be controlled via PLC axes. The user defines the pallet sequence, pallet presets, and workpiece presets in the pallet tables. The pallet tables are freely configurable; any information can be stored in the tables and called via the PLC. Pallet table execution can be workpiece- or tool-oriented.
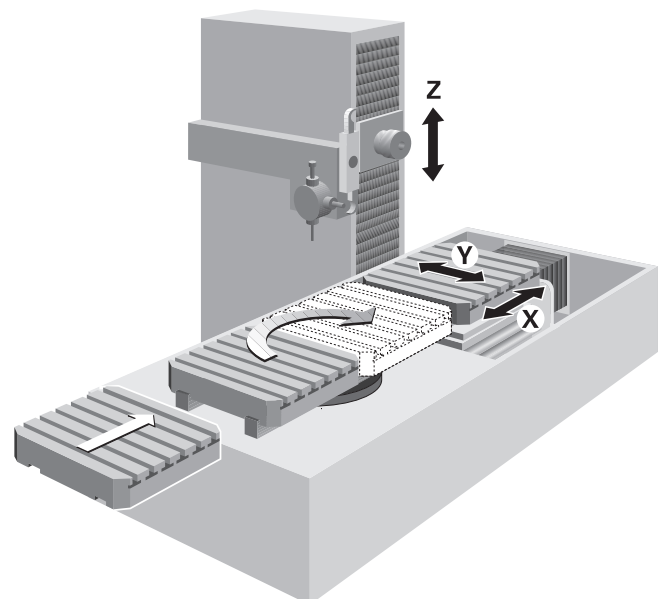
# Data transfer and communication

## Data interfaces

| | |
|---|---|
| **Overview** | The TNC 640 is connected to PCs, networks, and other data storage devices via data interfaces. |
| **Ethernet** | The TNC 640 can be interconnected via the Ethernet interface. For connection to the data network, the control features a 1000BASE-T (twisted pair Ethernet) connection.<br><br>Maximum transmission distance:<br>Unshielded: 100 m<br>Shielded: 400 m |
| Protocol | The TNC 640 communicates using the TCP/IP protocol. |
| Network connection | • NFS file server<br>• Windows networks (SMB) |
| Data transmission speed | Approx. 400 to 800 Mbit/s (depending on the file type and network utilization) |
| **Protocols** | The TNC 640 can transfer data using various protocols. |
| Standard data transmission | 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. A block check character (BCC) is used for data backup. This method improves data security. |
| LSV2 | Bidirectional transfer of commands and data as per DIN 66019. The data is divided into telegrams (blocks) and transmitted. |
| **USB** | The TNC 640 features USB interfaces for the connection of standard USB devices such as a mouse, hard drive, etc. On the back of the MC 85x2 and MC 3xx are four USB 3.0 ports. One of them leads to the TE, where a cover cap protects it from contamination. More USB 2.0 ports are in the integrated USB hub on the rear of the BF. The USB ports are rated for a maximum of 0.5 A. |
| **USB cables** | Cable length of up to 5 m ID 354770-xx<br>Cable length of 6 m to 30 m with integrated amplifier; limited to USB 1.1. ID 624775-xx |

**Software for data transfer**

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

**TNCremo (accessory)**

This PC software package supports the user in transmitting data from the PC to the control. This software implements blockwise data transfer with block check characters (BCC).

Functions:
- Data transfer (including 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 already familiar 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:
- Interrogation of control information (NC uptime, machine uptime, 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 job management possible in networked manufacturing. You also profit from:
- Easy data usage
- Time-saving procedures
- Transparent processes

**connected**
**machining**

**Remote Desktop Manager (software option 133)**

Remote control and display of external computers over an Ethernet connection (e.g., Windows PC). The information is displayed on the control's screen. 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 (software option 18)**

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

The flexibility of the PC software and the large selection of ready-to-use software components and standard tools in the development environment enable you to develop PC applications of great use to your customers in a very short time, for example:
- Error reporting systems that, for example, send the customer a text message to his cell phone reporting problems on the currently running machining process
- Standard or customer-specific PC software that decidedly increases process reliability and equipment availability
- Software solutions controlling the processes of manufacturing systems
- Information exchange with job management software

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

**RemoTools SDK (accessory)**

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

**RemoTools SDK**                        ID 340442-xx

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

**virtualTNC (accessory)**

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

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

For more information, refer to the *HEIDENHAIN DNC* brochure.
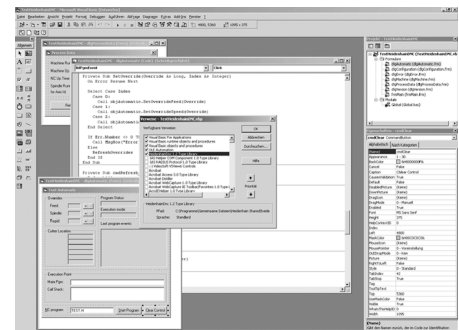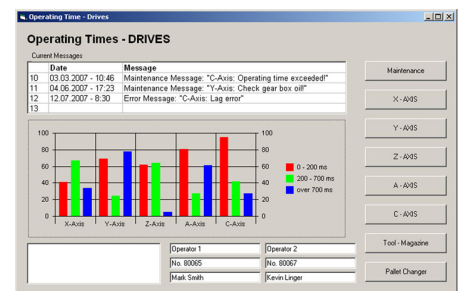
**OPC UA NC Server (software option 56-61)**

The Open Platform Communications Unified Architecture (OPC UA) standard has emerged in recent years as a well-established interface for secure and reliable data exchange in industrial environments. The new HEIDENHAIN OPC UA NC Server software option makes this forward-looking interface available on the TNC 640. OPC UA features cross-operating system capability: along with the widespread Windows systems, OPC UA also allows Linux-based systems or Apple Computers with macOS*, for example, to be connected to the HEIDENHAIN control.

Numerous developer toolkits are available for OPC UA. RemoTools SDK is not needed. Thanks to the standardized protocol, the freedom to choose the toolkit, and the application-oriented HEIDENHAIN information model, highly individualized applications and standard software can be developed with significantly reduced time to market.

The HEIDENHAIN OPC UA NC Server supports the following OPC UA services:
• Reading and writing variables
• Subscribing to value changes
• Executing methods
• Subscribing to events

With Sign&Encrypt, HEIDENHAIN ensures that even the standard solution provides state-of-the-art IT security:
• SecurityMode: Sign&Encrypt
• Cryptographic algorithm: Basic256Sha256 (recommendation of OPC Foundation) – X.509 Certificates
• User authentication through X.509 certificates

\*          Apple and macOS are trademarks of Apple Inc.

# Mounting information
## Clearances and mounting

**Proper minimum clearance**

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

Installation in an electrical cabinet
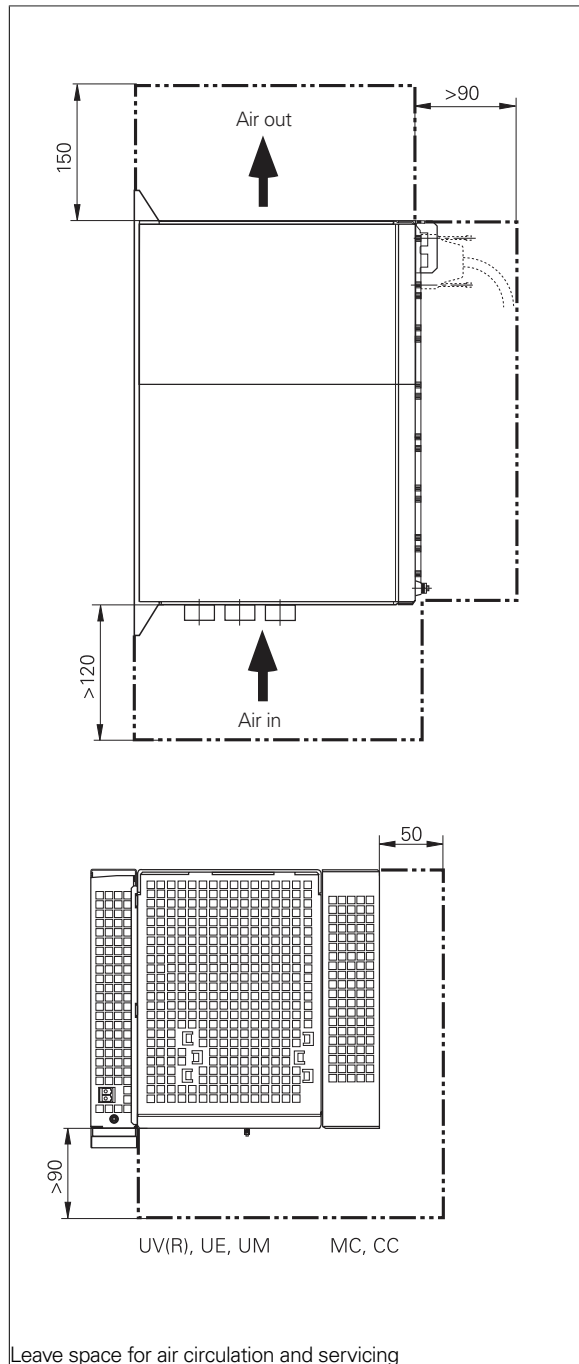
Installation in an operating panel



Leave space for air circulation and servicing



Leave space for air circulation and servicing
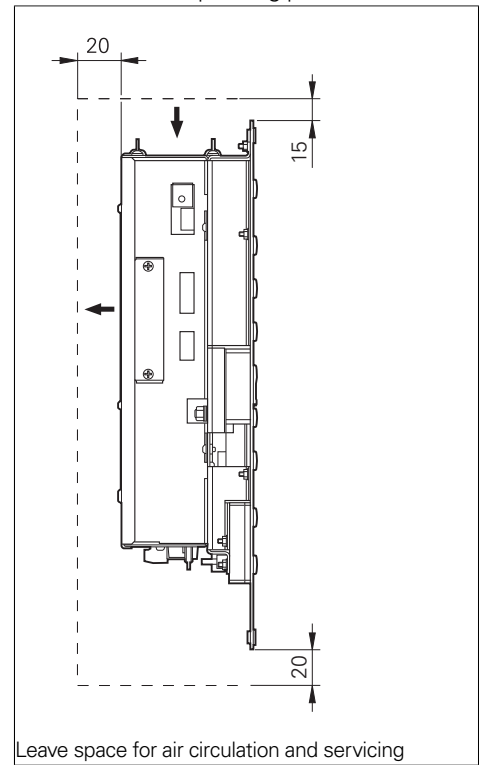
| | |
|---|---|
| **Mounting and electrical installation** | Observe the following points during mounting and electrical connection:<br>• National regulations for low-voltage installations at the operating site of the machine or components<br>• National regulations regarding interference and noise immunity at the operating site of the machine or components<br>• National regulations regarding electrical safety and operating conditions at the operating site of the machine or components<br>• Specifications for the installation position<br>• Specifications of the Technical Manual |
| **Degrees of protection** | The following components fulfill the requirements for IP54 (dust protection and splash-proof protection):<br>• Display unit (when properly installed)<br>• Keyboard unit (when properly installed)<br>• Machine operating panel (when properly installed)<br>• Handwheel<br><br>All electric and electronic control components must be installed in an environment (e.g., electrical cabinet, housing) with an IP54 rating (dust and splash-proof protection) in order to fulfill the requirements of pollution degree 2. All components of the OEM operating panel must also have an IP54 rating, just like the HEIDENHAIN operating panel components. |
| **Electromagnetic compatibility** | Protect your equipment from interference by observing the rules and recommendations specified in the Technical Manual. |
| Intended place of operation | This unit fulfills the requirements of 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.:<br>• Strong magnetic fields from transformers or electric motors<br>• Relays, contactors, and solenoid valves<br>• High-frequency equipment, pulse equipment, and stray magnetic fields from switch-mode power supplies<br>• Power lines and leads to the above equipment |
| Protective measures | • Ensure that the MC, CC, and signal lines are at least 20 cm away from interfering devices<br>• Ensure that the MC, CC, and signal lines are at least 10 cm away from cables carrying interfering signals. For cables in metallic ducting, adequate decoupling can be achieved by using a grounded separation shield.<br>• Shielding according to EN 50178<br>• Use equipotential bonding lines according to the grounding plan. Please refer to the Technical Manual of your control.<br>• 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. |

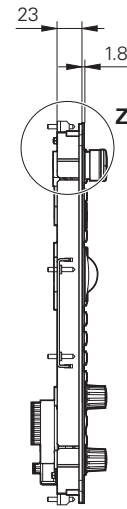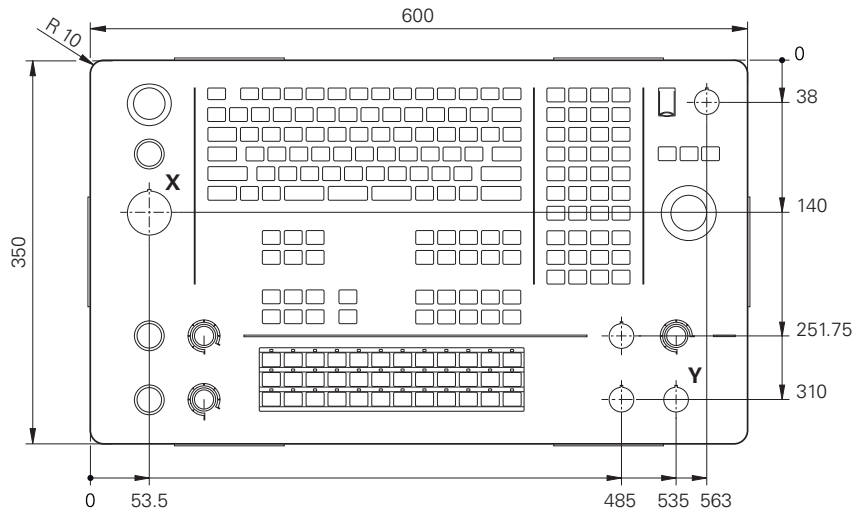# Overall dimensions

## Main computer

**IPC 6641**

mm

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

59.5+0.5

25

24.75

7

Ø 5.5

Ø 12

480

456+5

280.5

28.75

422.5

269

24.75
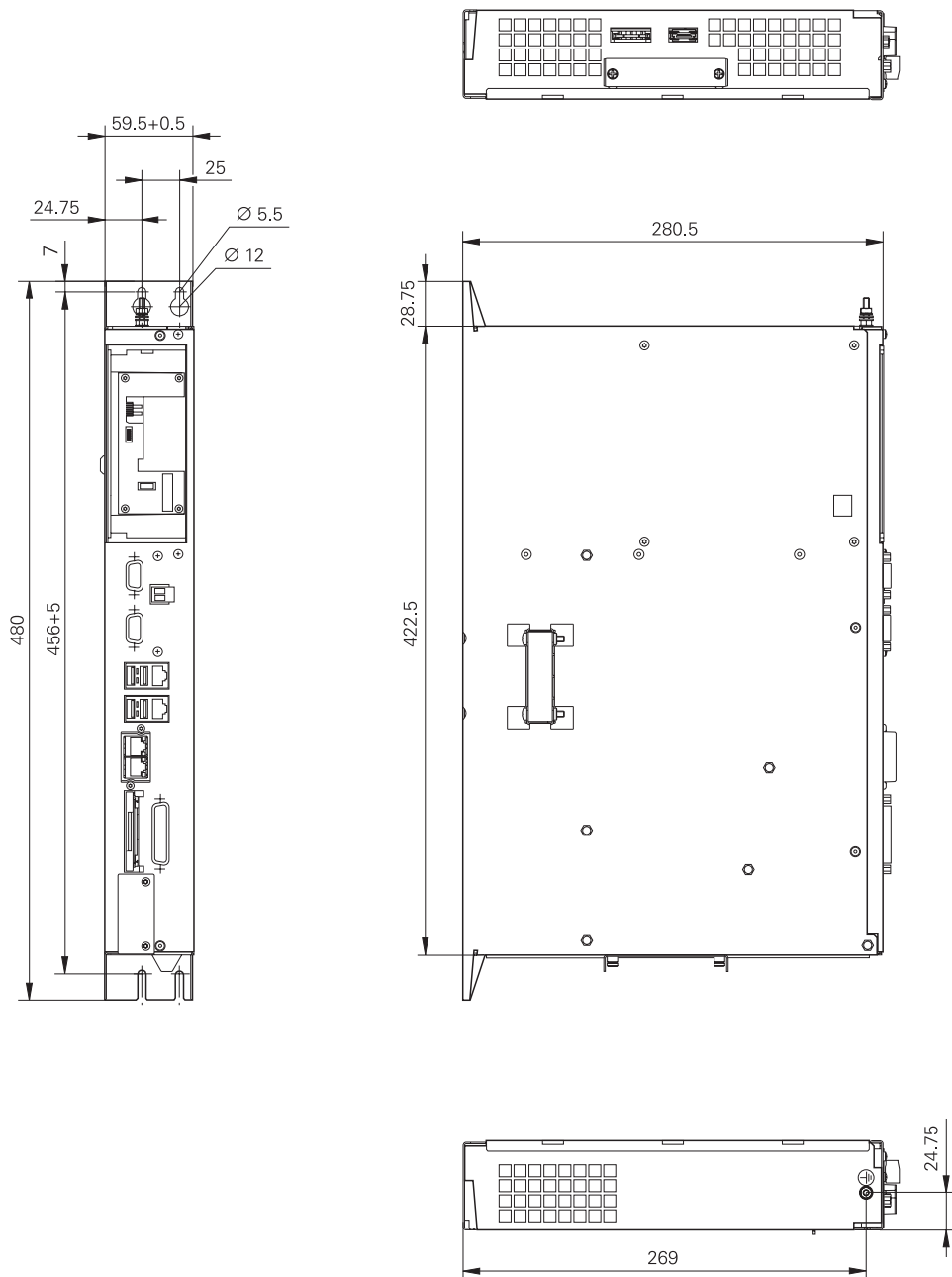
**MC 306, IPC 306**

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

74.5+0.5

300

234

15

410

380

M5

396+2

24.75

25

8

9

Ø 6.5

Ø 13

**MC 8512**

mm

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

90°

28+2

87.4+2

400

376±0.2

12±0.2

8

470

454±0.2

Ø 5.5

R5

20

1–0.5

16.95±1

15

M5

B

Ø 10

15

1.4

3

4.75

376±0.2

4x M5

F 459+1

15x45°

454±0.2

0.5  M

2.5

F 385.5+1

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

**MC 8532**

mm

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

12±1

90°
10
1−0.5
31.4+2

87.4+2

12±1

500±0.3
476±0.2
12

8

400±0.3
384±0.2

20.9±1
10

B

20

M5

25.5±1
10

1.4

3

Ø 5.5

R5

2
476±0.2
4×M5

14×45°

384±0.2

F 380+1

2

F 480+1

0.5  M

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

**89**

**MC 366**

mm

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

**Z**
3:1

1.5 - 6

13
7

138                          156

600

365

R 10

① 0.5 Ⓜ

R 5 (4x)

Ⓕ 590+1

Ⓕ 355+1

20
15

51

Ⓑ

M5

52
15

57+2

91+2

Ⓕ = Front panel opening
Ⓜ = Mounting surface
Ⓑ = Space for air circulation
1 = Holding clamp (6x), each with two M4 setscrews with hexagon socket and cone point
2 = O-ring cord, EPDM

# Operating panel, screen, and keyboard

**BF 860, ITC 860**

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm
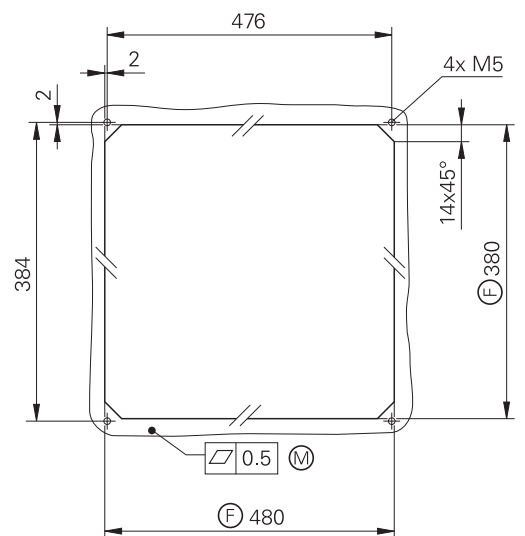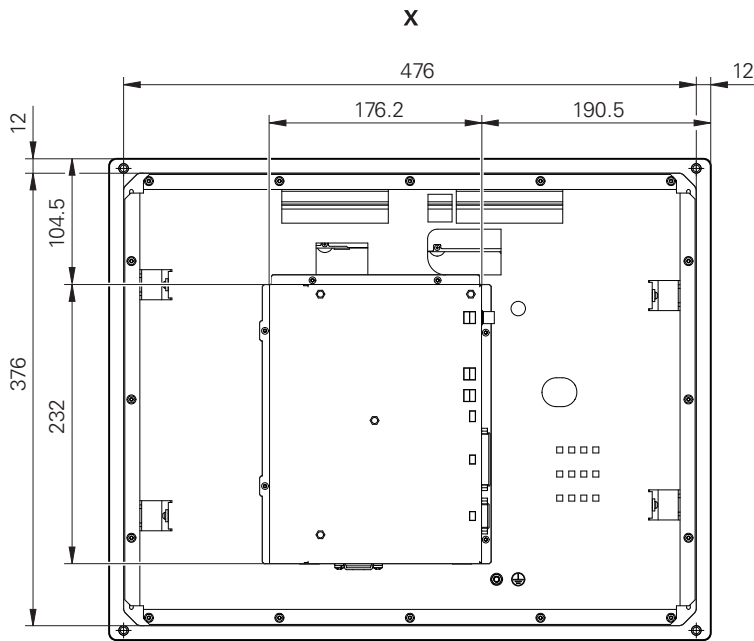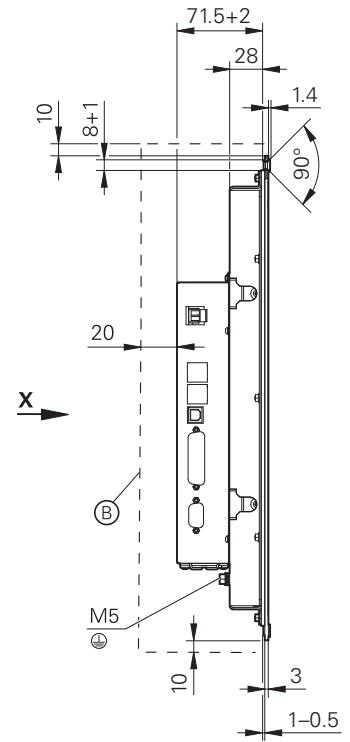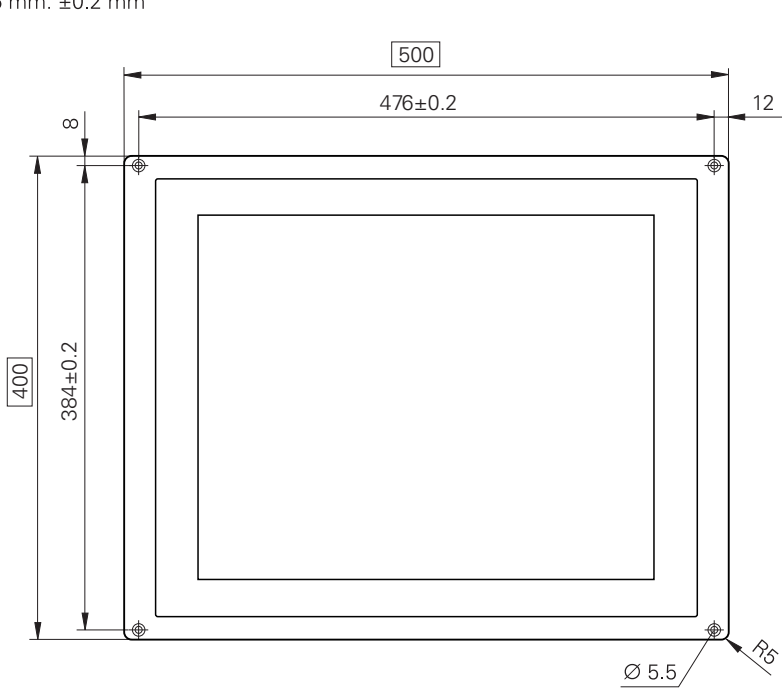
Ⓕ = Front panel opening
Ⓜ = Mounting surface
Ⓑ = Space for air circulation

**BF 360**



mm

Tolerancing ISO 8015
ISO 2768 - m H
≤ 6 mm: ±0.2 mm
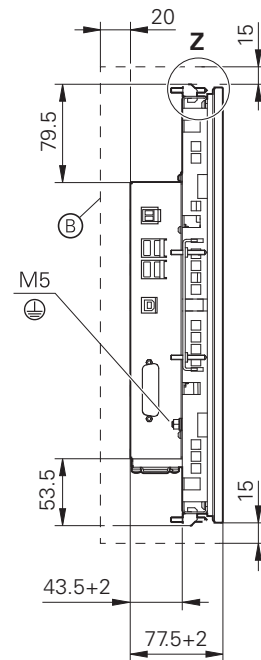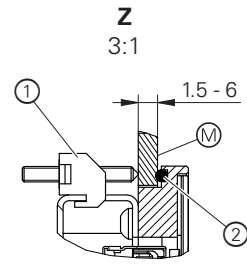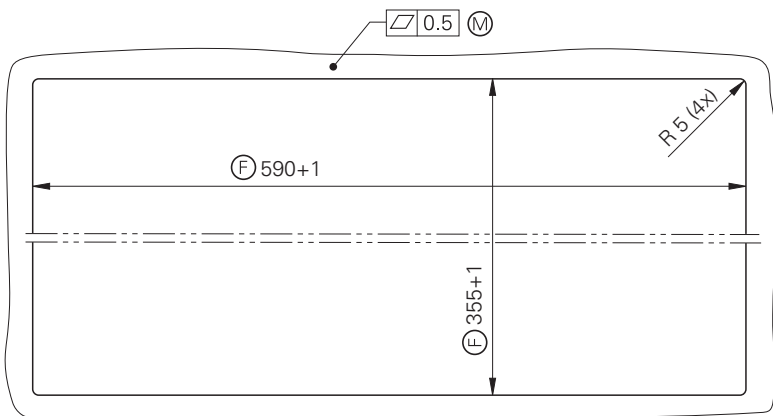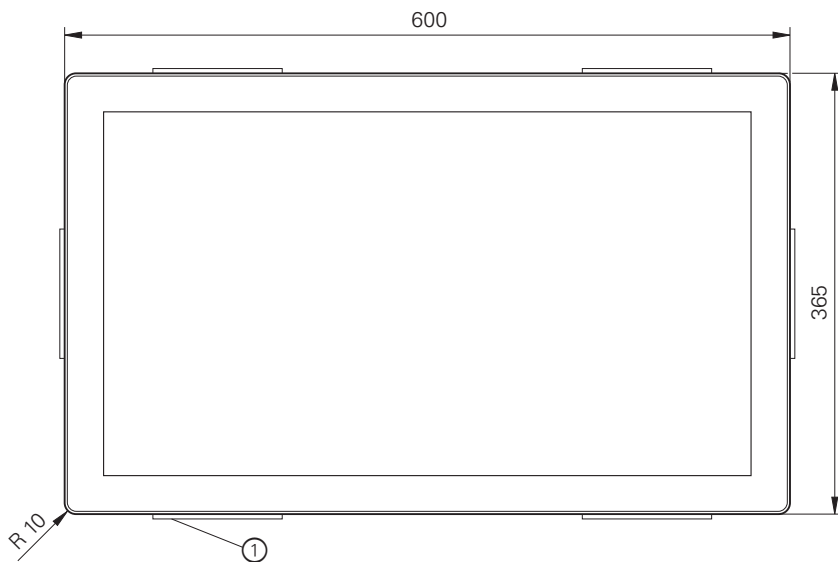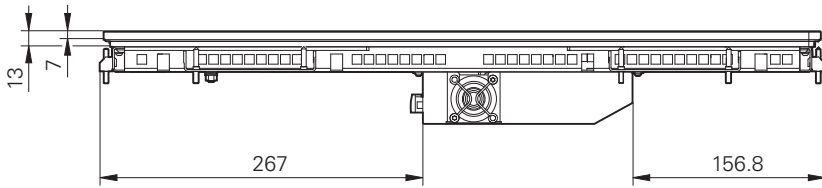
**Z**
3:1

13
7
267
156.8

1.5 - 6
M
1
2

600
365

20
15
79.5
B
M5
53.5
15
43.5+2
77.5+2

R 10
1

0.5 M

F 590+1
R 5 (4x)
F 355+1

F  =  Front panel opening
M  =  Mounting surface
B  =  Space for air circulation
1  =  Holding clamp (6x), each with two M4 setscrews with hexagon socket and cone point
2  =  O-ring cord, EPDM

**TE 745, TE 745 FS**

mm

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

500
476±0.2
12
8
0
350
334±0.2
X
170.5
319
43.5
460
Ø 5.5
R5

37.4
45+5
2-0.9
90°
M5
Ø 10
Ø 8+1
1.4
5.4

4
476±0.2
4x M5
334±0.2
F 334+1
13x45°
F 484+1
0.5 M

X (3x)
2:1
2.3±0.1
24.3±0.2
24.3±0.2
3.3±0.1
Ø 22.5±0.2

F = Front panel opening
M = Mounting surface

**93**

**TE 360**

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

**X** 2:1

3
41.6
Ø 40.2

**Y** (4x) 2:1

3.2±0.1
24.3±0.2
Ø 22.5±0.2

**Z** 3:1

1.5 - 6
①
Ⓜ
②
③

600
R 10
350

0
38
140
251.75
310

0   53.5
485   535   563

23
1.8
**Z**

10
580±0.2
330±0.2
10

M5

2.5
580±0.2
2.5
⊘ 0.5 Ⓜ
25x45°
Ⓕ 585+1
330±0.2
Ⓕ 335+1
Ø 5.5±0.2

Ⓕ = Front panel opening
Ⓜ = Mounting surface
Ⓑ = Space for air circulation
1 = Holding clamp (6x), each with two M4 setscrews with hexagon socket and cone point
2 = Seal
3 = Weld stud M5 (4x)

**PLB 600x**

mm

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

48+2
40
24

⌀7
3.4

6
109.5±0.2
133+2

288.4
295
304
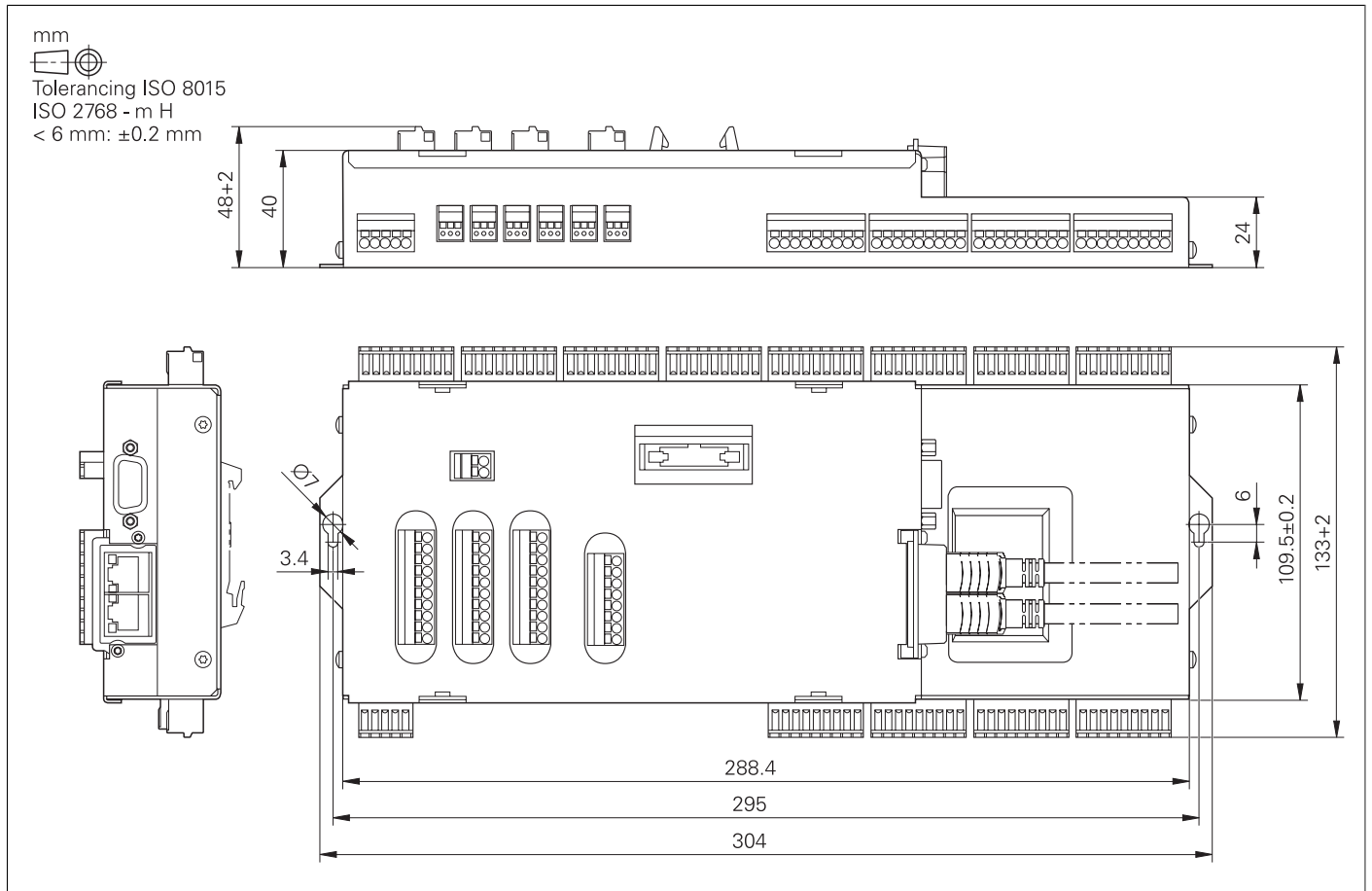
# PLC inputs and outputs

**PL 6000 (PLB 62xx, PLB 61xx)**

mm

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

Clearance for air circulation

100

2.75

136

51

PL 6x04: 139, PL 6x06: 183, PL6x08: 227

119

132

100

148
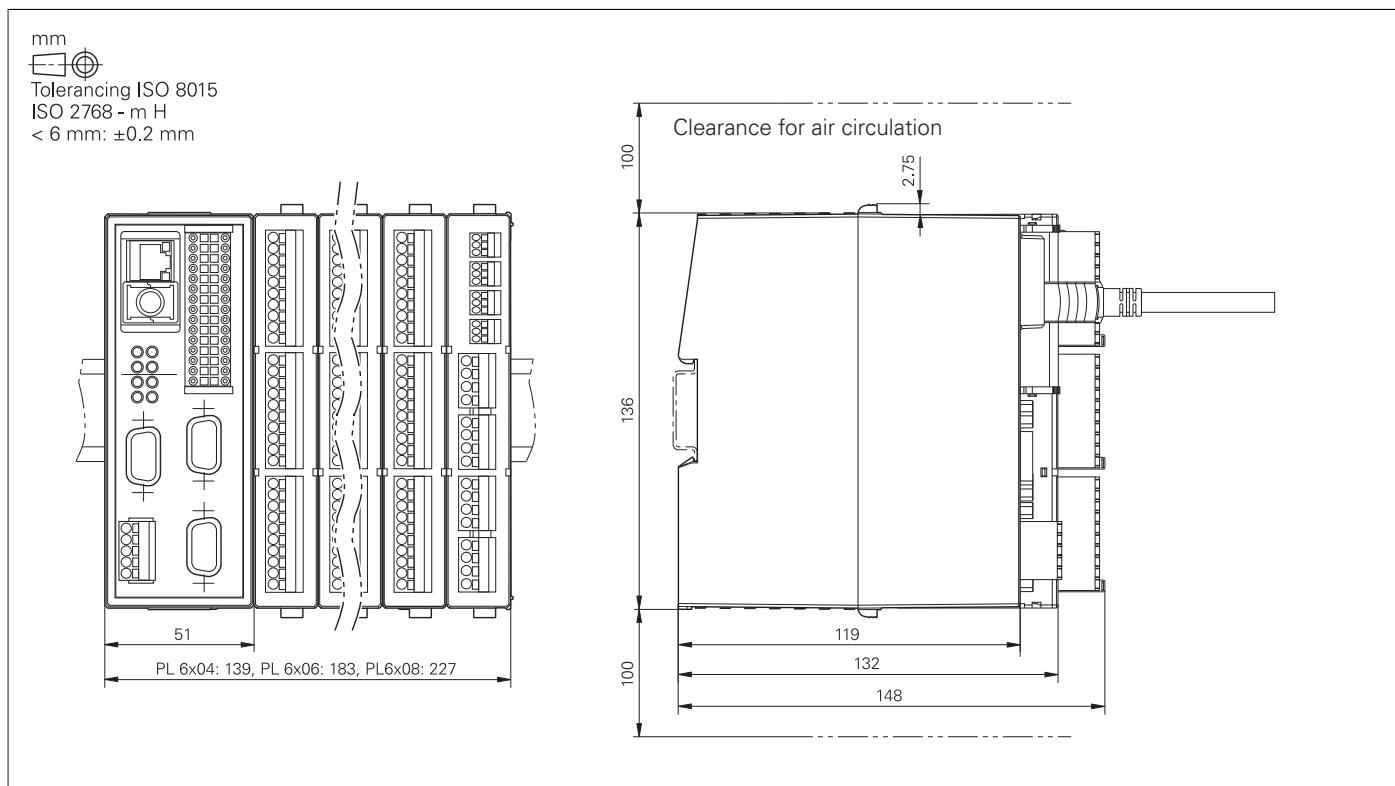
# Electronic handwheels

**HR 510, HR 510 FS**

mm

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

76.5
46
3
278
296

**HR 520, HR 520 FS**

mm

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

79.7
78.7
46
90
311.7
336
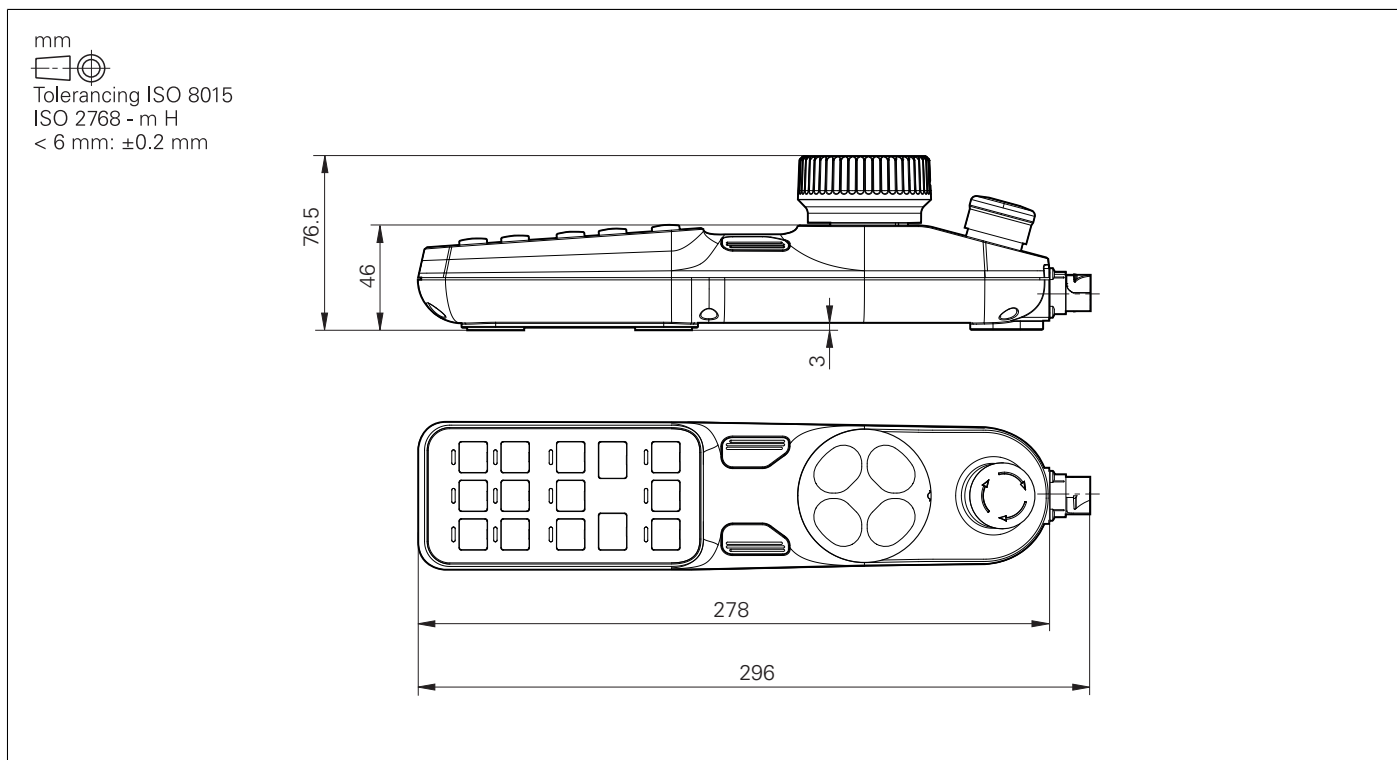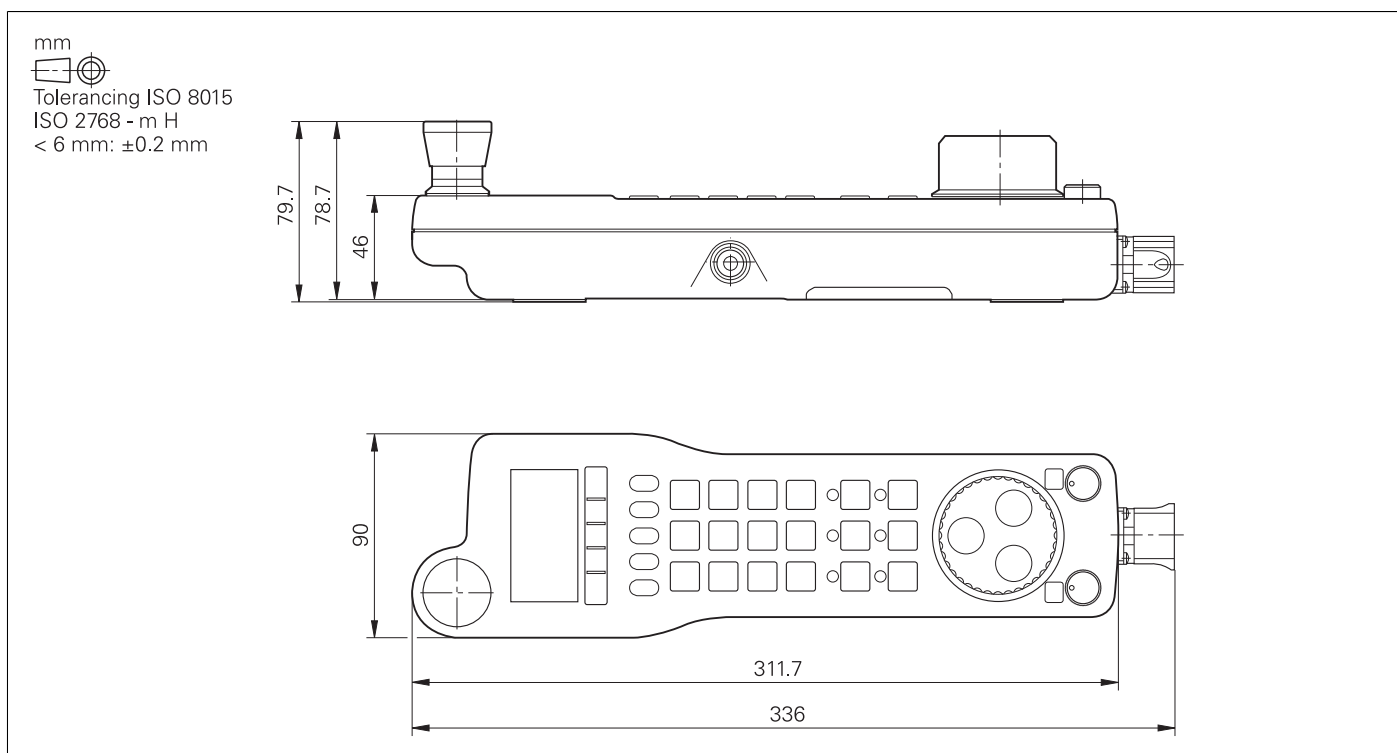
**Holder for HR 520, HR 520 FS**
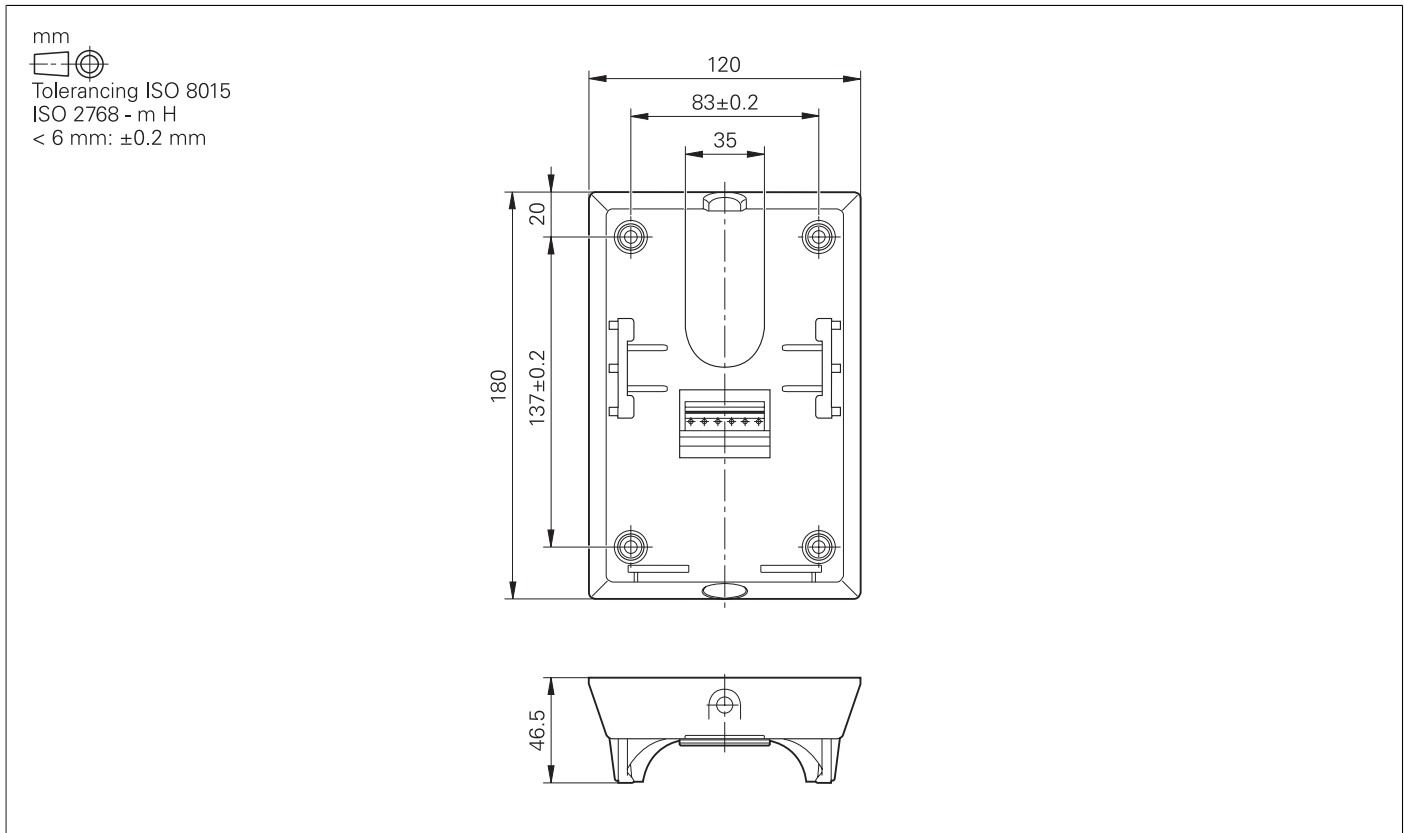
mm

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

70.3
69.3
46
73.5
90
72
312

**HRA 551 FS**

mm

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

120

83±0.2

210
204
192±0.2
180
6
12

M5

Ø5.5
4x

32

122

68.6

48.6

4

320

116

**HR 130**

mm

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

36.7±0.5

0.08 A

10

Ø 0.08 B

B

Ø 56
Ø 58

A

E

Ø 36f8

Ø 10 −0.01 −0.02

E

C

20±0.5

Ø 6

0.03 A

4.4

3x 120°

Ø 48

M3 x 5

3x

Ø 0.25 C

17.7

10

4

3 x

SW 2

SW 5.5

M3

M3

12

7

6

Ø 10H7

(12)

6

22

2

70

100
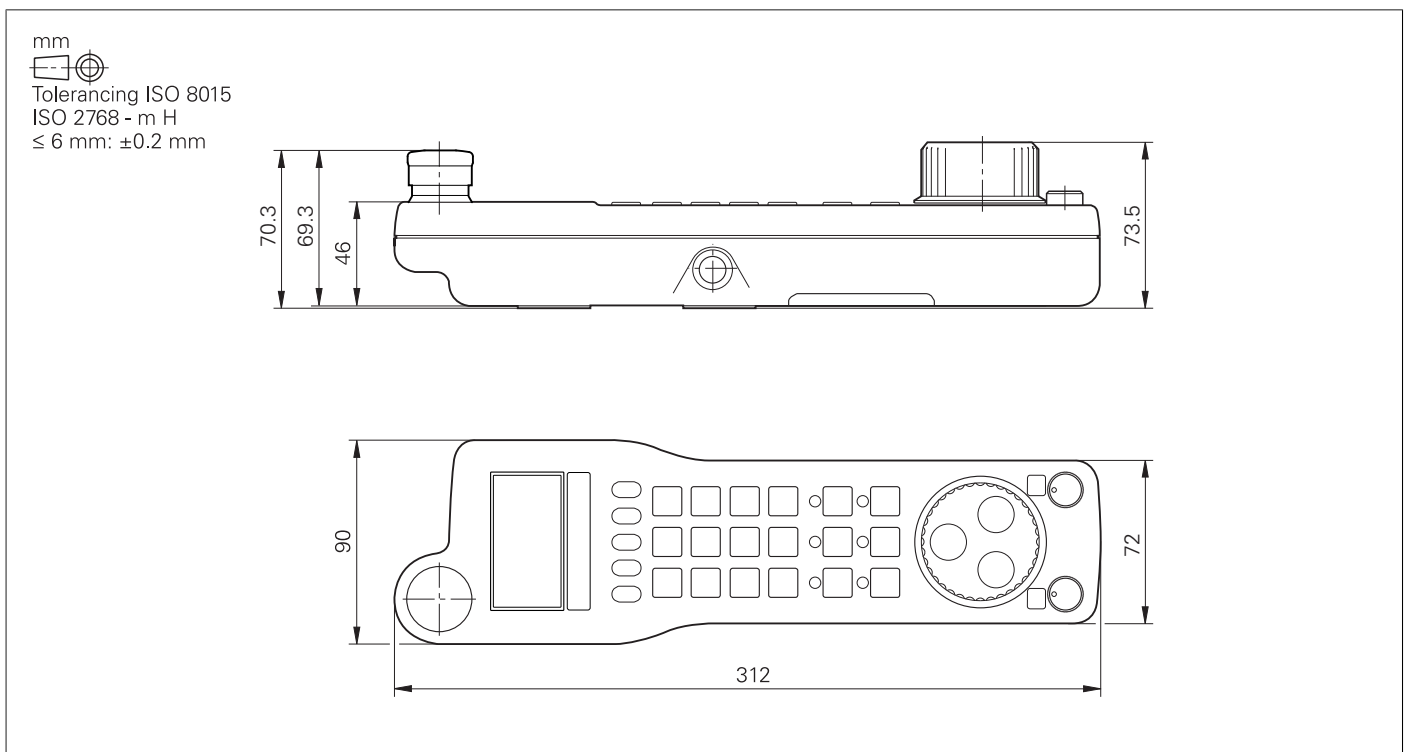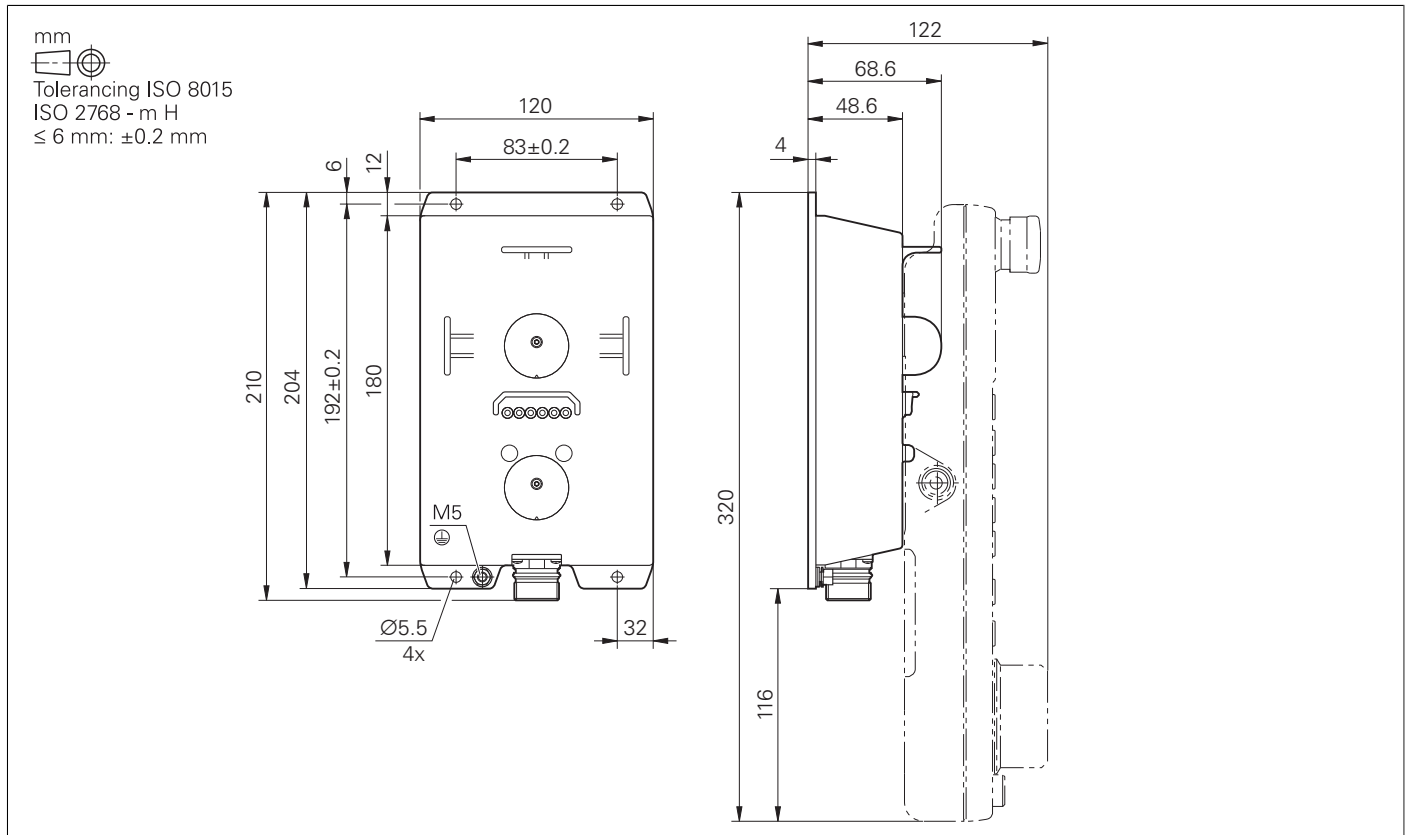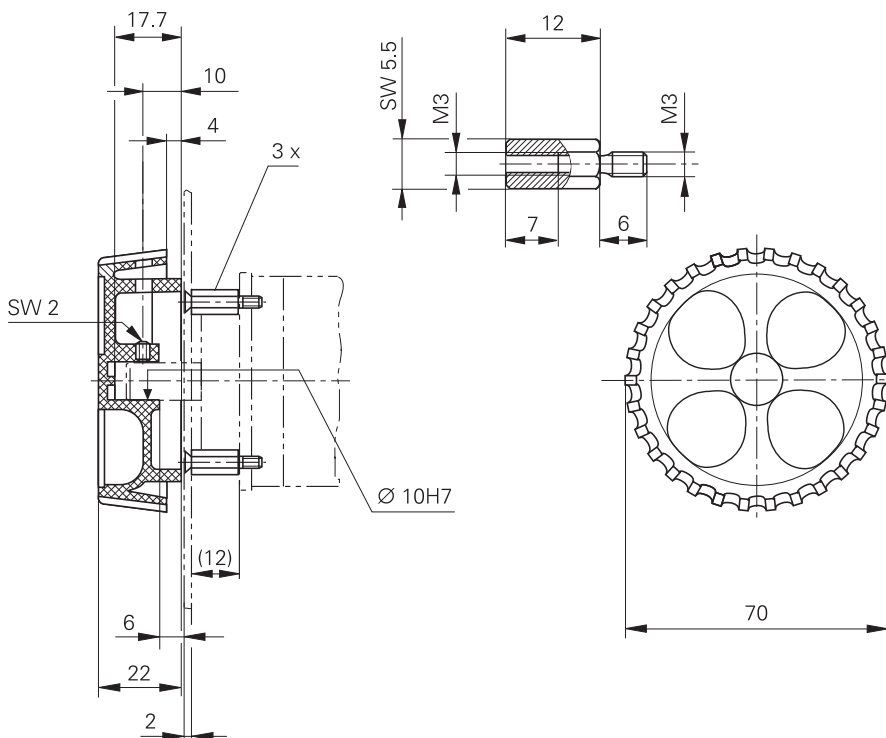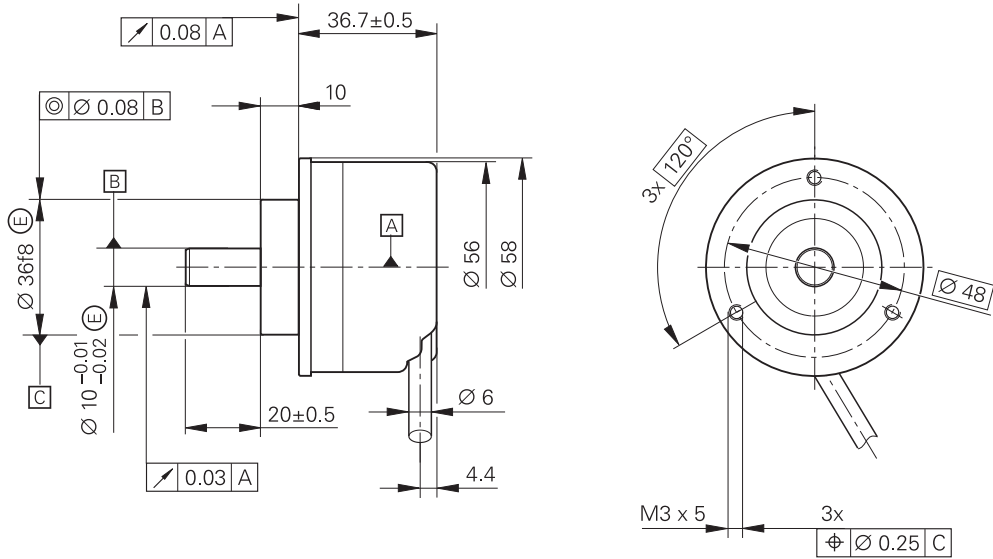
**Adapter cable for handwheels (straight)**

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



① Mounting opening up to wall thickness S = 4

② Mounting opening for wall thickness S = 4 or more
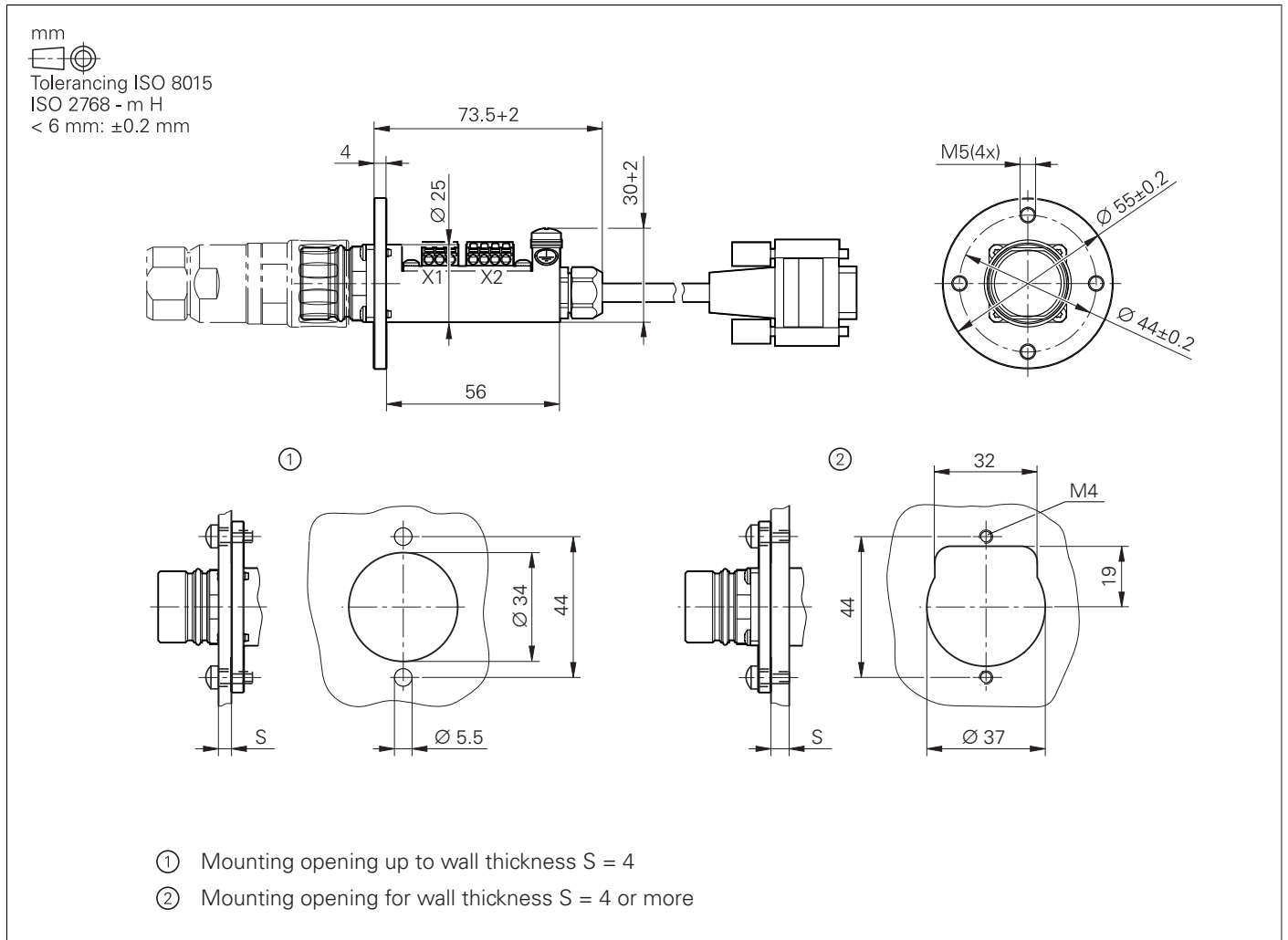
HR/HRA adapter cable to MC (straight connector)

**Adapter cable for handwheels (angled)**

mm

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

73.5+2

4

30+2

56

M5(4x)

Ø 55±0.2

Ø 44±0.2

Ø 25

X1  X2

36

Mounting opening

32

M4

19

44

Ø 37
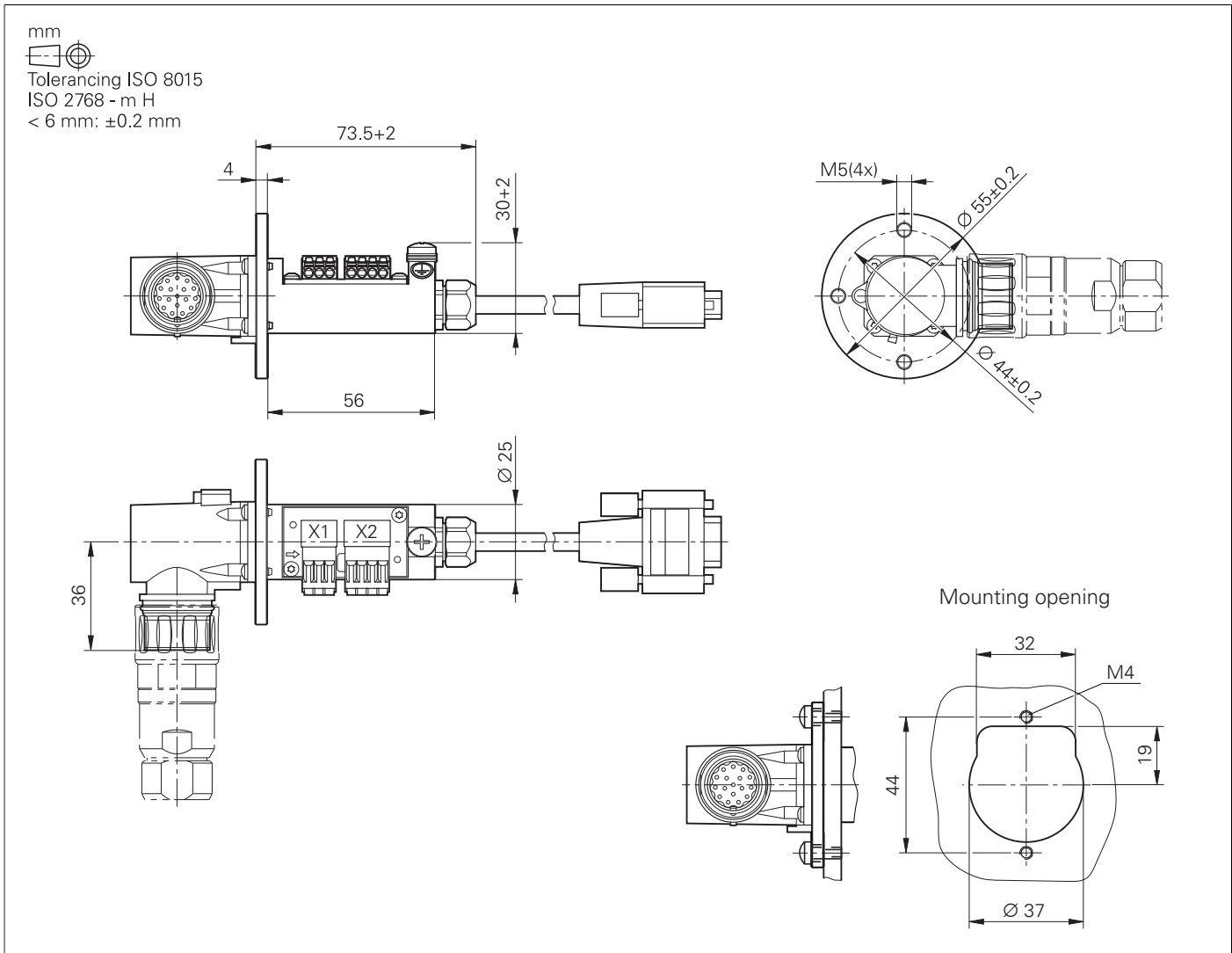
Adapter cable for HR/HRA to MC (angled connector)

# 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
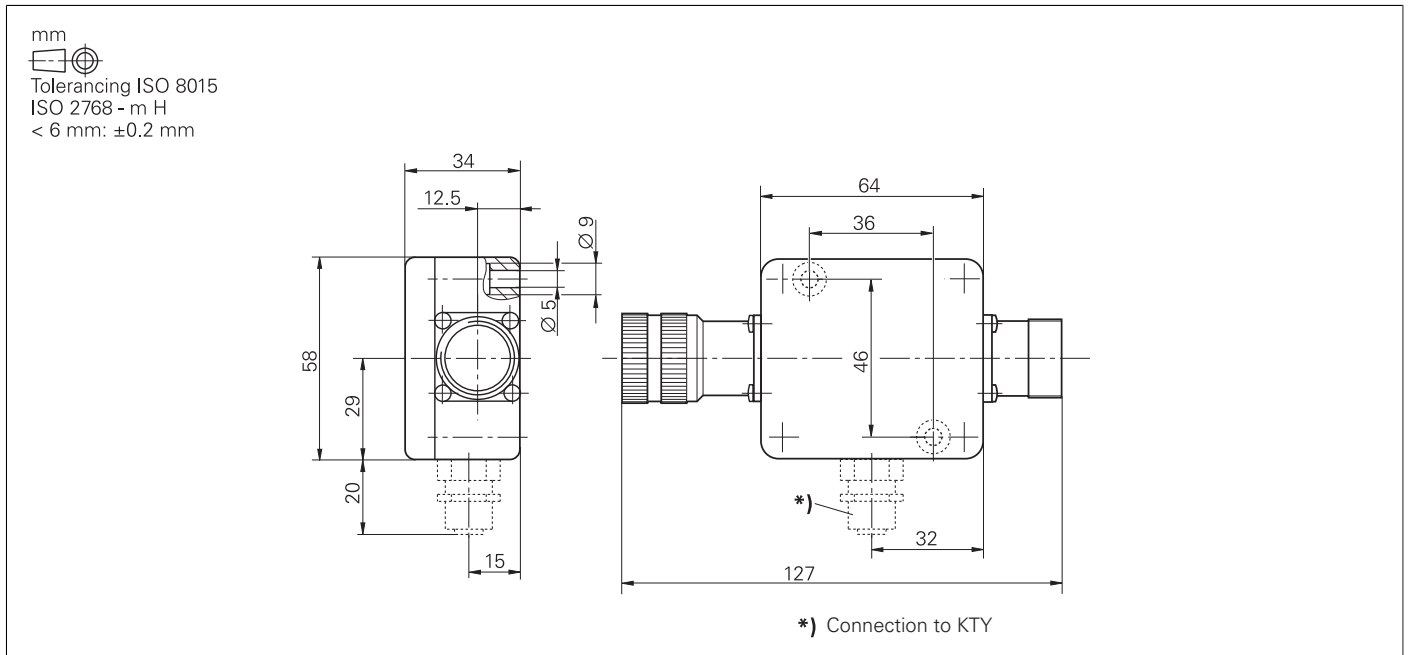
**USB extension cable with hubs**

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
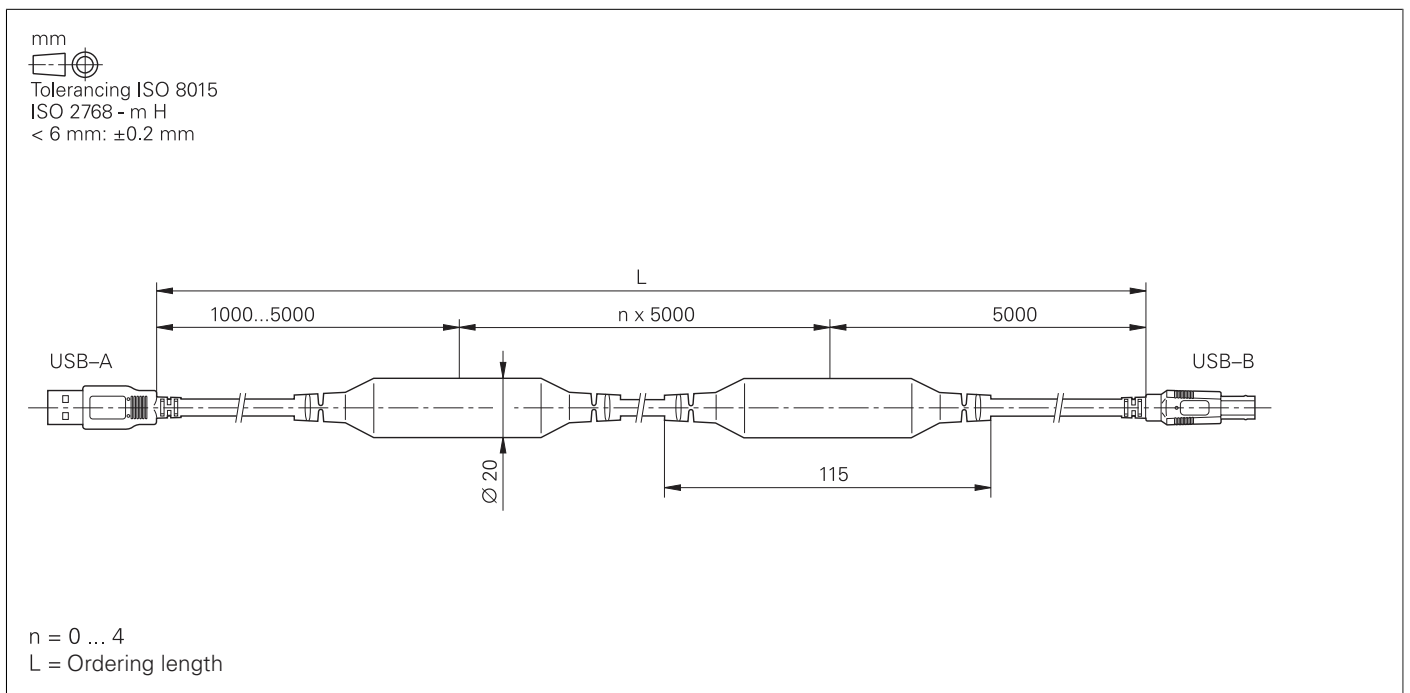
**KTY adapter connector**

mm

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

Leave space for connecting cable!

15

16

86

55

# Camera system

**VS 101**

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

125

184.5

37

15.5

7.6

50±0.1

M5

67.25

49.5

37

65.5

74.4

96.04

92.9

56.5

17.5

37.2

9.2

53

28.2

46.2

21.2

52.8
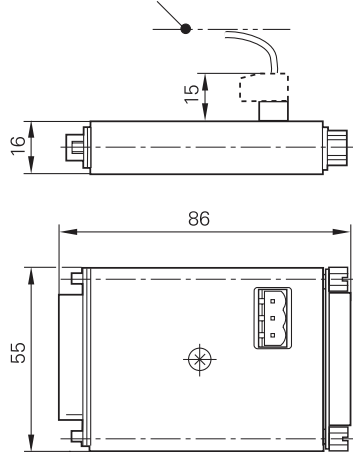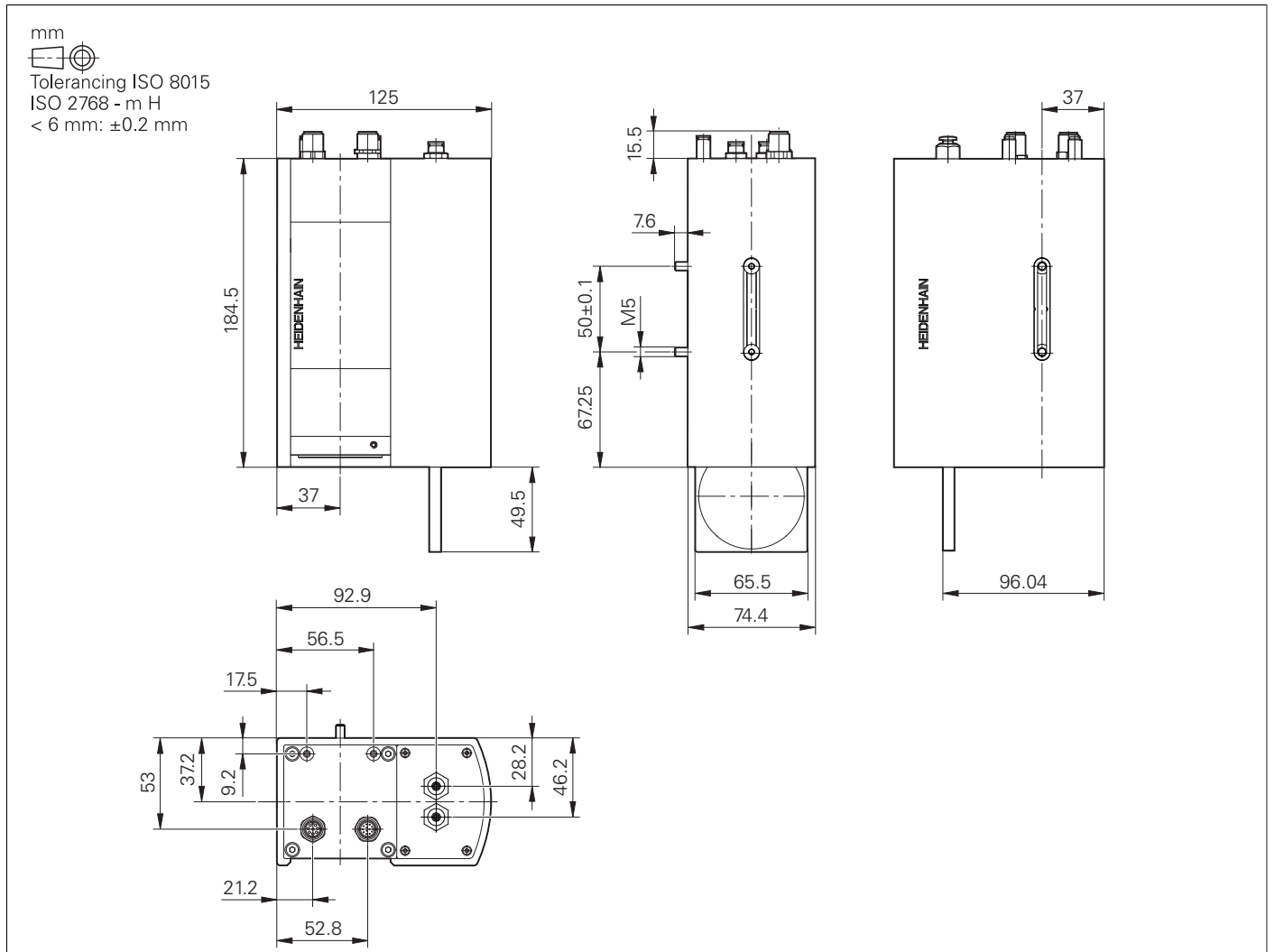
# General information

## Documentation

| | | |
|---|---|---|
| **Technical documentation** | **Technical Manuals** (PDF format on HESIS-Web including Filebase) | |
| | • TNC 640 | ID 892899-xx |
| | • PNC 610 | ID 1191125-xx |
| | • 1xx Inverter Systems | ID 208962-xx |
| | • Gen 3 Drives | ID 1252650-xx |
| | • Functional Safety (FS) | ID 749363-xx |
| | **Mounting Instructions** | |
| | • TS 260 | ID 808652-9x |
| | • TS 460 | ID 808653-9x |
| | • TS 740 | ID 632761-9x |
| | • TT 160 | ID 808654-xx |
| | • TT 460 | ID 808655-xx |
| **User documentation** | **User's Manuals** *TNC 640* | |
| | • Klartext Conversational Programming | ID 892903-xx |
| | • Setup, Testing, and Running NC Programs | ID 1261174-xx |
| | • Cycle Programming | ID 892905-xx |
| | • ISO Programming | ID 892909-xx |
| | *General* | |
| | • TNCremo | Integrated help |
| | • TNCremoPlus | Integrated help |
| | • PLCdesign | Integrated help |
| | • CycleDesign | Integrated help |
| | • IOconfig | Integrated help |
| | • KinematicsDesign | Integrated help |
| | • M3D converter | Integrated help |
| **Other documentation** | **Brochures** | |
| | • TNC 640 | ID 892916-xx |
| | • Functions of the TNC 640 | ID 1110731-xx |
| | • Touch Probes | ID 1113984-xx |
| | • Gen 3 Drives | ID 622420-xx |
| | • Motors | ID 208893-xx |
| | • RemoTools SDK virtualTNC | ID 628968-xx |
| | **Product Information documents** | |
| | • HR 550FS | PDF |
| | **Product Overviews** | |
| | • Remote Diagnosis with TeleService | ID 348236-xx |
| | **DVDs** | |
| | • Touch Probes | ID 344353-xx |
| | • Programming Station: TNC 640 (Demo Version) | ID 1114029-xx |
| | **Technical Information documents** | |
| | • Safety-Related Control Technology | PDF |
| | • Safety-Related Position Encoders | PDF |
| | • Uniformly Digital | PDF |
| **Safety parameters** | For HEIDENHAIN products (such as control components, encoders, or motors), the safety characteristics (such as failure rates or statements on fault exclusion) are available on product-specific request from your HEIDENHAIN contact person. | |
| **Basic circuit diagram** | More information on basic circuit diagrams can be requested from your HEIDENHAIN contact person. | |

# Service and training

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

**Exchange control**   In the event of a malfunction, HEIDENHAIN guarantees the timely shipment of an exchange control (usually within 24 hours in Europe).

**Helpline**   Our customer service technicians are available for questions regarding adaption or in the event of malfunctions:

**NC support**
(initial configuration/optimization,
field service/troubleshooting)

+49 8669 31-3101
E-mail: service.nc-support@heidenhain.de

**PLC/Python programming**
Functional safety (FS)

+49 8669 31-3102
E-mail: service.plc@heidenhain.de

**NC/Cycle programming and kinematics**

+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

**Application 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:

**Customer service, Germany**

+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 servicing
- Encoder servicing
- Special training for specific customers

**For more information on dates or registration:**

| Technical training courses in Germany | +49 8669 31-3049 |
| --- | --- |
| | E-Mail: mtt@heidenhain.de |
| Technical training courses outside of Germany | www.heidenhain.de<br>EN ▶ Company ▶ Contact ▶ HEIDENHAIN worldwide |

# Other HEIDENHAIN controls
## Examples

**TNC 620**

Information:
*TNC 620* brochure
- Compact contouring control for **milling, drilling, and boring machines**
- Axes: 8 control loops, up to two of which are configurable as spindles
- For operation with HEIDENHAIN inverter systems and ideally HEIDENHAIN motors
- Uniformly digital with HSCI interface and EnDat interface
- Compact size
- CompactFlash memory card
- Programming in HEIDENHAIN Klartext format or G-code (ISO)
- Standard milling, drilling, and boring cycles
- Touch probe cycles
- Short block processing time (1.5 ms)

Version with touchscreen:
- 19-inch screen (portrait), keyboard, and main computer in one unit (MC 8410)
- Integration of the keyboard in the lower screen area
- Multi-touch operation

**CNC PILOT 640**

Information:
*CNC PILOT 640* brochure
- Contouring control for **lathes and turning-milling machines**
- Suitable for horizontal and vertical lathes as well as vertical boring and turning mills
- Axes: max. 24 control loops (22 control loops with functional safety (FS), max. 8 NC axes per channel, max. 6 spindles in the overall system
- Multi-channel capability: up to 3 channels for asynchronous multi-slide machining
- Up to 3 principal axes (X, Z, and Y), B axis, closed-loop spindle and counter spindle, C1/C2 axis and driven tools
- 5-axis simultaneous machining (X, Z, Y, B, and C axes)
- Up to 3 programmable auxiliary axes (U, V, W) for control of steady rest, tailstock and counter spindle
- The position of a parallel secondary axis can be shown combined with its principal axis
- For operation with HEIDENHAIN inverter systems and ideally with HEIDENHAIN motors
- Uniformly digital with HSCI interface and EnDat interface
- 19-inch or 15.6-inch multi-touch display
- CFR CompactFlash memory card (CFast)
- Programming of turning, drilling, and milling operations with smart.Turn, according to DIN, or via cycles
- TURN PLUS for automated smart.Turn program generation
- ICP free contour programming for turning and milling contours
- For simple tool holders (multifix), turrets, or magazines

CNC PILOT 640
with 15.6-inch multi-touch display

# Subject index

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www.heidenhain.ch

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www.heidenhain.com.cn

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www.heidenhain.cz

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www.tp-gruppen.dk

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E-mail: neumo@neumo-vargus.co.il

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