TNC 640
For Gen 3 Drives

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, of which up to 4 can be configured as spindles
- For operation with HEIDENHAIN inverter systems and ideally with HEIDENHAIN motors
- Uniformly digital with HSCI interface and EnDat interface
- Version with touchscreen for multi-touch operation
- Solid state disk (SSDR)
- Programming in HEIDENHAIN Klartext or G-code (ISO)
- Comprehensive cycle package for milling and turning operations
- Tool radius compensation
- Touch probe cycles
- Free contour programming (FK)
- 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

Intel, Intel Xeon, Core, and Celeron are registered trademarks of Intel Corporation.

Validity

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

- TNC 640 with NC software versions
  - 340590-17 (export license required)
  - 340591-17 (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 standard components and FS components (FS = Functional Safety) are not explicitly differentiated, then the information applies to both versions (e.g., TE 361, TE 361 FS).

Components for which there is also a version with functional safety bear the identifier "FS" at the end of the product designation, e.g., UEC 3xx (FS)
Overview tables

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<td>(1024 x 768 pixels)</td>
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<td>100</td>
</tr>
<tr>
<td>TNcScope(^{1})</td>
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<tr>
<td>TNcOpt(^{1})</td>
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<td>I0Config(^{1})</td>
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<tr>
<td>RemoTools SDK(^{1})</td>
<td>Function library for developing customized applications for communication with HEIDENHAIN controls</td>
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<td>Control component for virtual machines</td>
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<td>100</td>
</tr>
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</table>

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.

\(^{1}\) May be necessary depending on the configuration

\(^{2}\) For more information, refer to the "Inverter Systems for Gen 3 Drives" brochure
### Specifications

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<td>Up to 24 control loops, of which up to 4 can be configured as spindles</td>
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<tr>
<td>Rotary axes</td>
<td>Max. 3</td>
<td></td>
</tr>
<tr>
<td>Synchronized axes</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>PLC axes</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><strong>Main spindle</strong></td>
<td></td>
<td>69</td>
</tr>
<tr>
<td>Milling: max. 4; second, third, and fourth spindle can be controlled alternately with the first turning: max. 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>Max. 60,000 rpm for motors with a single pole pair (with software option 49: max. 120,000 rpm)</td>
<td>69</td>
</tr>
<tr>
<td>Operating mode switchover</td>
<td>✓</td>
<td>69</td>
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<td>Position-controlled spindle</td>
<td>✓</td>
<td>69</td>
</tr>
<tr>
<td>Oriented spindle stop</td>
<td>✓</td>
<td>69</td>
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<tr>
<td>Gear shifting</td>
<td>✓</td>
<td>69</td>
</tr>
<tr>
<td>NC program memory</td>
<td>= 17 GB (with 32 GB SSDR) = 189 GB (with 240 GB SSDR)</td>
<td>17</td>
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<td>Down to 0.01 µm</td>
<td></td>
</tr>
<tr>
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<td>Down to 0.000 01°</td>
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<td>For applications with up to</td>
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<td></td>
</tr>
<tr>
<td>• SIL 2 as per EN 61508</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Category 3, PL d as per EN ISO 13849-1: 2008</td>
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<td></td>
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<td>Straight line</td>
<td>In 4 axes; in max. 6 axes with software option 9</td>
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<td>Circle</td>
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<td>✓</td>
<td></td>
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<td>With feedforward</td>
<td>✓</td>
<td></td>
</tr>
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<td>Path interpolation</td>
<td>3 ms</td>
<td></td>
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<tr>
<td>Fine interpolation</td>
<td>Applies to ( f_{\text{PWM}} = 5 ) kHz</td>
<td>Single-speed: 0.2 ms Double-speed: 0.1 ms (software option 49)</td>
</tr>
<tr>
<td>Position controller</td>
<td></td>
<td></td>
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<tr>
<td>Speed controller</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current controller</td>
<td>( f_{\text{PWM}} )</td>
<td>( T_{\text{ctrl}} )</td>
</tr>
<tr>
<td>3333 Hz</td>
<td>150 µs</td>
<td></td>
</tr>
<tr>
<td>4000 Hz</td>
<td>125 µs</td>
<td></td>
</tr>
<tr>
<td>5000 Hz</td>
<td>100 µs</td>
<td></td>
</tr>
<tr>
<td>6666 Hz with software option 49</td>
<td>75 µs with software option 49</td>
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<tr>
<td>8 000 Hz with software option 49</td>
<td>62.5 µs with software option 49</td>
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</tr>
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<td>10 000 Hz with software option 49</td>
<td>50 µs with software option 49</td>
<td></td>
</tr>
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<td>13 333 Hz with software option 49</td>
<td>37.5 µs with software option 49</td>
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<td>Storage: -20 °C to 60 °C</td>
</tr>
</tbody>
</table>
Interfacing to the machine

### Error compensation
- Linear axis error ✓
- Nonlinear axis error ✓
- Backlash ✓
- Reversal spikes during circular movement ✓
- Hysteresis ✓
- Thermal expansion ✓
- Static friction ✓
- Sliding friction ✓
- Dynamic compliance during acceleration phases ✓
- Volumetric compensation with KinematicsComp ✓
- Integrated PLC ✓
- Program format Statement list
- Program input at the control ✓
- Program input by PC ✓
- Symbolic PLC-NC interface ✓
- PLC memory ± 1 GB (with 32 GB SSDR)
- PLC memory ± 4 GB (with 240 GB SSDR)
- PLC cycle time 9 ms to 30 ms (adjustable)
- PLC inputs/outputs For the maximum configuration of the PLC system, see Page 57
- PLC inputs, DC 24 V Via PL, UEC, UMC
- PLC outputs, DC 24 V Via PL, UEC, UMC
- Analog inputs ±10 V Via PL
- Inputs for PT 100 thermistors Via PL
- Analog outputs ±10 V Via PL
- PLC functions ✓
- Small PLC window ✓
- PLC soft keys ✓
- PLC positioning ✓
- PLC Basic Program ✓
- Integration of applications ✓
- High-level language programming Use of the Python programming language in conjunction with the PLC (software option 46)
- User interfaces can be custom-designed Creation of individualized user interfaces by the machine manufacturer with the Python programming language with Qt/QML. Programs up to a memory limit of 10 MB are enabled in standard mode. More can be enabled via software option 46.
## Functions for the user

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### Short description
- Basic version: 3 axes plus closed-loop spindle
- A total of 14 additional NC axes or 15 additional NC axes plus second spindle
- Digital current and speed control

### Program entry
- HEIDENHAIN Klartext
- Direct loading of contours or machining positions from CAD files and saving as Klartext contouring program or point table

### Position values
- Nominal positions for straight lines and arcs in Cartesian coordinates or polar coordinates
- Incremental or absolute dimensions
- Display and entry in mm or inches

### Tool compensation
- Tool radius in the working plane and tool length
- Radius-compensated contour look-ahead for up to 99 blocks (M120)
- Three-dimensional tool radius compensation for changing tool data without having to recalculate an existing program

### Tool tables
- Multiple tool tables with any number of tools

### Cutting data
- Automatic calculation of spindle speed, cutting speed, feed per tooth, and feed per revolution

### Constant contour speed
- Relative to the path of the tool center point
- Based on the tool’s cutting edge

### Parallel operation
- Creating a program with graphical support while another program is being run

### 3D machining
- Motion control with smoothed jerk
- 3D tool compensation via surface-normal vectors
- Alteration of the swivel head angle via the electronic handwheel during program run without changing the position of the tool center point (TCPM = Tool Center Point Management)
- Keeping the tool perpendicular to the contour
- Tool radius compensation normal to the tool direction
- Manual traverse in the active tool-axis system
- 3D radius compensation depending on the tool’s contact angle

### Rotary table machining
- Programming of cylindrical contours as if in two axes
- Feed rate in mm/min

### Tumbling
- Program-controlled switchover between milling and turning
- Constant cutting speed
- Tool-tip 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
- 1) Turning v2 (software option 158) includes the functions of software option 50

### Collision monitoring
- Dynamic Collision Monitoring (DCM)
- Graphic depiction of the active collision objects (high-resolution 3D format)
- Tool carrier monitoring
- Fixture 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
- Subprograms
- Program-section repeat
- Any program as a subprogram

### Fixed cycles
- Drilling, tapping with a floating tap holder, rigid tapping
- Peck drilling, reaming, boring, counterboring, centering
- Area clearance cycles, longitudinal and transverse, paravial and contour-parallel
- Recessing cycles, radial/axial
- Radial/axial recess turning cycles (combined recessing and roughing motion)
- Tilting of internal and external threads
- Turning of internal and external threads
- Cycles for hobbing and skiving
- Simultaneous roughing and finishing
- Interpolation turning
- Clearing level and oblique surfaces
- Multi-operation machining of straight and circular slots
- Multi-operation machining of rectangular and circular pockets
- Cartesian and polar point patterns and point patterns for DataMatrix code
- Contour train, contour pocket
- Contour slot with trochoidal milling
- OEM cycles (special cycles developed by the machine manufacturer) can be integrated
- Engraving cycle: engrave text or numbers in a straight line or on an arc

### Coordinate transformations
- Shifting, rotating, mirroring, scaling (axis-specific)
- Tilting the working plane, PLAN function
- Manually definable: shifts, rotations, and handwheel superimpositioning can be manually defined via global program settings

**1) Turning v2 (software option 158) includes the functions of software option 50**
### Function

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<tr>
<th>Standard</th>
<th>Option</th>
<th>TNC 640</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q parameters</strong></td>
<td>✓</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>Programming with variables</strong></td>
<td>✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Programming aids</td>
<td>✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>CAD viewer</strong></td>
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<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>CAD Model Optimizer</strong></td>
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<td>✓ ✓ ✓ ✓ ✓</td>
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<tr>
<td>Teach-in</td>
<td>✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>Test graphics</strong></td>
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<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
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<td><strong>Depictions</strong></td>
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<td>✓ ✓ ✓ ✓ ✓</td>
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<td>✓ ✓ ✓ ✓ ✓</td>
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<tr>
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<td>✓ ✓ ✓ ✓ ✓</td>
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<tr>
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<td>✓ ✓ ✓ ✓ ✓</td>
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<tr>
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<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>Returning to the contour</strong></td>
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<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>Preset management</strong></td>
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<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>Datum tables</strong></td>
<td>✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>Pallet tables</strong></td>
<td>✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
</tbody>
</table>

### Function

<table>
<thead>
<tr>
<th>Standard</th>
<th>Option</th>
<th>TNC 640</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parallel secondary axes</strong></td>
<td>✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>Touch probe cycles</strong></td>
<td>✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>Conversational languages</strong></td>
<td>✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
</tbody>
</table>

### Mathematical functions
- =, +, –, *, /, sin α, cos α, tan α, arcsin, arc cos, arc tan, e^x, ln, log, square root of a, square root of (a^2 + b^2)
- Calculating with parentheses
- Absolute value of a number, constant π, negative, truncation of digits before or after the decimal point
- Functions for calculation of circles
- Functions for text processing

### Programming aids
- Calculator
- Complete list of all current error messages
- Context-sensitive help function for error messages
- TNCguide (integrated help system); user information directly available on the TNC 640; context-sensitive calling possible
- Graphical support for the programming of cycles
- Comment and structure blocks in the NC program

### CAD viewer
- Display of standardized CAD file formats on the TNC

### CAD Model Optimizer
- Optimize CAD models

### Teach-in
- Application of actual positions directly in the NC program

### Test graphics
- Graphic simulation before a program run, even while another program is running
- Plan view / projection in 3 planes / 3D view, also in tilted working plane
- Detail zoom

### Depictions
- For verification of programs created offline

### 3D line graphics
- In the Programming mode, the contours of entered NC blocks are rendered (2D pencil-trace graphics), even while another program is running

### Programming graphics
- Graphic simulation during real-time machining
- Plan view / projection in 3 planes / 3D view

### Display modes
- Calculating the machining time in the Test Run operating mode
- Display of the current machining time in the Program Run operating modes

### Returning to the contour
- Midprogram startup in any block in the program, returning the tool to the calculated nominal position to continue machining
- Program interruption, contour departure and return

### Preset management
- One table for saving any reference points (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 programs, and datums)

---

1) Turning v2 (software option 158) includes the functions of software option 50
Software options

<table>
<thead>
<tr>
<th>Option number</th>
<th>Software option</th>
<th>With NC software 34059x or later</th>
<th>ID</th>
<th>Comment</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Additional Axis 1</td>
<td>01</td>
<td>354540-01</td>
<td>Additional control loop 1</td>
<td>21</td>
</tr>
<tr>
<td>1</td>
<td>Additional Axis 2</td>
<td>01</td>
<td>353904-01</td>
<td>Additional control loop 2</td>
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<td>2</td>
<td>Additional Axis 3</td>
<td>01</td>
<td>353905-01</td>
<td>Additional control loop 3</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>Additional Axis 4</td>
<td>01</td>
<td>367867-01</td>
<td>Additional control loop 4</td>
<td>21</td>
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<tr>
<td>4</td>
<td>Additional Axis 5</td>
<td>01</td>
<td>367868-01</td>
<td>Additional control loop 5</td>
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<tr>
<td>5</td>
<td>Additional Axis 6</td>
<td>01</td>
<td>370291-01</td>
<td>Additional control loop 6</td>
<td>21</td>
</tr>
<tr>
<td>6</td>
<td>Additional Axis 7</td>
<td>01</td>
<td>370292-01</td>
<td>Additional control loop 7</td>
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<td>7</td>
<td>Additional Axis 8</td>
<td>01</td>
<td>370293-01</td>
<td>Additional control loop 8</td>
<td>21</td>
</tr>
<tr>
<td>8</td>
<td>Advanced Function Set 1</td>
<td>01</td>
<td>617920-01</td>
<td>Rotary table machining</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Programming of cylindrical contours as if in two axes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Feed rate in mm/min</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Coordinate transformations</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Tilting the working plane, PLANE function</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Interpolation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Circular in 3 axes with tilted working plane</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Advanced Function Set 2</td>
<td>01</td>
<td>617921-01</td>
<td>3D machining</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• 3D tool compensation via surface normal vectors</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Using the electronic handwheel to change the angle of the swivel head</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Keeping the position of the tool point (TCPM = Tool Center Point )</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Turning-specific contour elements using the electronic handwheel</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Tilting the working plane, PLANE function</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Tool radius compensation perpendicular to the tool direction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Manual traverse in the active tool-axis system</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Coordinate transformations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Linear in more than 4 axes (export license required)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>HEIDENHAIN DNC</td>
<td>01</td>
<td>526451-01</td>
<td>Communication with external PC applications over COM component</td>
<td>97</td>
</tr>
<tr>
<td>40</td>
<td>DCM Collision</td>
<td>01</td>
<td>526452-01</td>
<td>Dynamic Collision Monitoring (DCM)</td>
<td>81</td>
</tr>
<tr>
<td>42</td>
<td>CAD Import</td>
<td>06</td>
<td>526450-01</td>
<td>Importing of contours from 2D and 3D models (e.g., STEP, IGES, DXF)</td>
<td>64</td>
</tr>
<tr>
<td>44</td>
<td>Global PGM Settings</td>
<td>05</td>
<td>576557-01</td>
<td>Global program settings</td>
<td>64</td>
</tr>
<tr>
<td>45</td>
<td>Adaptive Feed Control (AFC)</td>
<td>02</td>
<td>579648-01</td>
<td>Adaptive feed control</td>
<td>75</td>
</tr>
<tr>
<td>46</td>
<td>Python OEM Process</td>
<td>01</td>
<td>579650-01</td>
<td>Execution of Python applications</td>
<td>92</td>
</tr>
<tr>
<td>48</td>
<td>KinematicsOpt</td>
<td>01</td>
<td>630091-01</td>
<td>Touch-probe cycles for the automatic measurement of rotary axes</td>
<td>85</td>
</tr>
<tr>
<td>49</td>
<td>Double-Speed Axes</td>
<td>01</td>
<td>632223-01</td>
<td>Short control-loop cycle times for direct drives</td>
<td>72</td>
</tr>
<tr>
<td>Option number</td>
<td>Software option</td>
<td>With NC software</td>
<td>ID</td>
<td>Comment</td>
<td>Page</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------</td>
<td>----------------------------</td>
<td>------------</td>
<td>----------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>152</td>
<td>CAD Model Optimizer</td>
<td>3409x or later</td>
<td>1353918-01</td>
<td>Conversion and optimization of CAD models</td>
<td>82</td>
</tr>
<tr>
<td>154</td>
<td>Batch Process Manager</td>
<td></td>
<td>1219521-01</td>
<td>Planning and executing multiple machining operations</td>
<td>64</td>
</tr>
<tr>
<td>155</td>
<td>Component Monitoring</td>
<td></td>
<td>1226633-01</td>
<td>Monitoring for component overloading and wear</td>
<td>68</td>
</tr>
<tr>
<td>156</td>
<td>Grinding</td>
<td>10</td>
<td>1237252-01</td>
<td>Grinding function</td>
<td>83</td>
</tr>
<tr>
<td>157</td>
<td>Gear Cutting</td>
<td>09</td>
<td>1237239-01</td>
<td>Functions for the machining of gear teeth</td>
<td>66</td>
</tr>
<tr>
<td>158</td>
<td>Turning v2</td>
<td>17</td>
<td>1359605-01</td>
<td>Turning functions (mill-turning version 2)</td>
<td>67</td>
</tr>
<tr>
<td>160</td>
<td>Integrated FS: Basic</td>
<td></td>
<td>1249628-01</td>
<td>Enables functional safety and four safe control loops</td>
<td>58</td>
</tr>
<tr>
<td>161</td>
<td>Integrated FS: Full</td>
<td></td>
<td>1249629-01</td>
<td>Enables functional safety and the maximum number of safe control loops</td>
<td>58</td>
</tr>
<tr>
<td>162</td>
<td>Add. FS Ctrl. Loop 1</td>
<td></td>
<td>1249600-01</td>
<td>Additional control loop 1</td>
<td>58</td>
</tr>
<tr>
<td>163</td>
<td>Add. FS Ctrl. Loop 2</td>
<td></td>
<td>1249631-01</td>
<td>Additional control loop 2</td>
<td>58</td>
</tr>
<tr>
<td>164</td>
<td>Add. FS Ctrl. Loop 3</td>
<td></td>
<td>1249632-01</td>
<td>Additional control loop 3</td>
<td>58</td>
</tr>
<tr>
<td>165</td>
<td>Add. FS Ctrl. Loop 4</td>
<td></td>
<td>1249633-01</td>
<td>Additional control loop 4</td>
<td>58</td>
</tr>
<tr>
<td>166</td>
<td>Add. FS Ctrl. Loop 5</td>
<td></td>
<td>1249634-01</td>
<td>Additional control loop 5</td>
<td>58</td>
</tr>
<tr>
<td>167</td>
<td>Optimized Contour Milling</td>
<td></td>
<td>1289647-01</td>
<td>OCM: optimize roughing processes and fully utilize</td>
<td>76</td>
</tr>
<tr>
<td>169</td>
<td>Add. FS Full</td>
<td>11</td>
<td>1319091-01</td>
<td>Enabling of all FS axis options or control loops. Options</td>
<td>58</td>
</tr>
</tbody>
</table>

**HSCI control components**

**Main computers**

The MC main computers feature the following:
- Intel high-performance processor
- Dual RAM
- Gbit HSCI interface to the controller unit and to other control components
- HDL2 interface to the BF monitor (with electrical cabinet versions)
- Four USB 3.0 ports (e.g., to the TE 381 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 enabling control loops and software options.

The following HSCI components are required for operation of the TNC 640:
- MC main computer
- Controller unit
- PLB 62xx or PLB 62xx FS PLC I/O unit (system PL; integrated in UCl)
- TE 361 or TE 361 FS or TE 360 or TE 360 FS keyboard unit with an integrated machine operating panel

**Interfaces**
The MC is equipped with USB 3.0 and Ethernet ports. Connection to PROFINET IO is optionally possible via the individual additional modules or a combined 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: These components can be used in systems with Gen 3 drives (UVR 3xx, UM 3xx, CC 3xx) and also in systems with a 1xx inverter system (UVR 1xx, UE 2xx, UR 2xx, CC 61xx).
- Gen 3 exclusive: These components can be used only in systems with Gen 3 drives (UVR 3xx, UM 3xx, CC 3xx).
Various versions of the MC main computer are available:

- **Installation in the electrical cabinet:**
  The MC 306 is 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.

### Installation types

<table>
<thead>
<tr>
<th>Installation type</th>
<th>Storage medium</th>
<th>Processor</th>
<th>RAM</th>
<th>Power consumption(\text{a})</th>
<th>Mass</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC 8512(\text{a}) Operating panel (19-inch, portrait)</td>
<td>SSDR (32 GB)</td>
<td>Intel Core i7-3, 1.7 GHz, dual-core</td>
<td>4 GB</td>
<td>≈ 75 W</td>
<td>≈ 8.8 kg</td>
<td>1243919-xx</td>
</tr>
<tr>
<td>MC 8522(\text{a}) Operating panel (15-inch)</td>
<td>SSDR (32 GB)</td>
<td>Intel Core i7-3, 1.7 GHz, dual-core</td>
<td>4 GB</td>
<td>≈ 75 W</td>
<td>≈ 6.6 kg</td>
<td>1302998-xx</td>
</tr>
<tr>
<td>MC 8532(\text{a}) Operating panel (19-inch)</td>
<td>SSDR (32 GB)</td>
<td>Intel Core i7-3, 1.7 GHz, dual-core</td>
<td>4 GB</td>
<td>≈ 75 W</td>
<td>≈ 9.7 kg</td>
<td>1189190-xx</td>
</tr>
<tr>
<td>MC 306 Electrical cabinet</td>
<td>SSDR (240 GB)</td>
<td>Intel high-performance CPU</td>
<td>8 GB</td>
<td>≈ 65 W</td>
<td>≈ 4.2 kg</td>
<td>1180045-xx</td>
</tr>
<tr>
<td>MC 366(\text{a}) Operating panel (24-inch)</td>
<td>SSDR (32 GB / var. 02: 240 GB)</td>
<td>Intel Core i7-3, 1.7 GHz, dual-core / Intel high-performance CPU</td>
<td>8 GB</td>
<td>≈ 75 W</td>
<td>≈ 11.4 kg</td>
<td>1246890-01</td>
</tr>
</tbody>
</table>

\(\text{a}\) Test conditions: Windows 7 (64-bit) operating system, 100% processor load, interfaces not loaded, no fieldbus module

### Optional installation kit for MC 360 and BF 360

For fastening the MC 366 or BF 360 with mounting braces (set of 6 pieces). Up to six mounting braces can be fastened to the MC and BF.

### 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 14. 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: SSDR solid-state drive

The storage medium, which must be ordered separately from the main computer, is removable. It contains NC software 34059x.xxx. The NC software is based on the HEIDENHAIN HEROS 5 operating system.

<table>
<thead>
<tr>
<th>Operating panel</th>
<th>Electrical cabinet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free PLC memory space</td>
<td>32 GB</td>
</tr>
<tr>
<td>≈ 1 GB</td>
<td>≈ 4 GB</td>
</tr>
<tr>
<td>Free NC memory space</td>
<td>17 GB</td>
</tr>
<tr>
<td>For main computer</td>
<td>MC 85x2 and MC 366 var. -01</td>
</tr>
<tr>
<td>Export license required</td>
<td>ID 810298-1x</td>
</tr>
<tr>
<td>No export license required</td>
<td>ID 810298-6x</td>
</tr>
</tbody>
</table>

### SIK component

The SIK component contains the NC software license for enabling control loops and software options. It provides the main computer with 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.

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**

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.

---

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

<table>
<thead>
<tr>
<th>Active control loop</th>
<th>CC 308</th>
<th>CC 310</th>
<th>CC 308 + CC 310</th>
<th>CC 2 x CC 308</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommended combinations</strong></td>
<td><strong>NC software license</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Without option</th>
<th>Incl. option 8</th>
<th>Incl. options 8 + 9</th>
<th>Incl. options 8 + 9 + 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIK</td>
<td>SIK</td>
<td>SIK</td>
<td>SIK</td>
</tr>
</tbody>
</table>

- **4**  ✓
  - SIK: ID 674889-20
  - ID 674889-09
  - ID 674889-01
  - ID 674889-28
  - ID 674889-78

- **5**  ✓
  - SIK: ID 674889-24
  - ID 674889-17
  - ID 674889-02
  - ID 674889-29

- **6**  ✓
  - SIK: ID 674889-25
  - ID 674889-18
  - ID 674889-03
  - ID 674889-30

- **7**  ✓
  - SIK: ID 674889-26
  - ID 674889-19
  - ID 674889-04
  - ID 674889-31

- **8**  ✓
  - SIK: ID 674889-27
  - ID 674889-23
  - ID 674889-05
  - ID 674889-32

- **9**  ✓
  - SIK: ID 674889-28
  - ID 674889-56
  - ID 674889-07
  - ID 674889-34

- **10** ✓
  - SIK: ID 674889-29
  - ID 674889-57
  - ID 674889-10
  - ID 674889-36

- **11** ✓
  - SIK: ID 674889-30
  - ID 67489-60
  - ID 674889-11
  - ID 674889-37

- **12** ✓
  - SIK: ID 674889-31
  - ID 674889-63
  - ID 674889-12
  - ID 674889-38

- **13** ✓
  - SIK: ID 674889-32
  - ID 674889-66
  - ID 674889-13
  - ID 674889-39

- **14** ✓
  - SIK: ID 674889-33
  - ID 674889-68
  - ID 674889-14
  - ID 674889-40

- **15** ✓
  - SIK: ID 674889-34
  - ID 674889-70
  - ID 674889-15
  - ID 674889-41

- **16** ✓
  - SIK: ID 674889-35
  - ID 674889-72
  - ID 674889-16
  - ID 674889-42

- **17 – 24** ✓
  - Only through subsequent enabling of control loops (additional axes)

---

### 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.

<table>
<thead>
<tr>
<th>Control-loop groups</th>
<th>Software option</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Additional Control Loops</td>
<td>77</td>
</tr>
<tr>
<td>8 Additional Control Loops</td>
<td>78</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Individual control loops</th>
<th>Software option</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st additional control loop</td>
<td>0</td>
</tr>
<tr>
<td>2nd additional control loop</td>
<td>1</td>
</tr>
<tr>
<td>3rd additional control loop</td>
<td>2</td>
</tr>
<tr>
<td>4th additional control loop</td>
<td>3</td>
</tr>
<tr>
<td>5th additional control loop</td>
<td>4</td>
</tr>
<tr>
<td>6th additional control loop</td>
<td>5</td>
</tr>
<tr>
<td>7th additional control loop</td>
<td>6</td>
</tr>
<tr>
<td>8th additional control loop</td>
<td>7</td>
</tr>
</tbody>
</table>

---

**For a description of the CC 3xx controller units, please refer to the Gen 3 Drives for HEIDENHAIN Controls brochure.**
### General Data:
- **BF 360**
  - **Monitor:** 24-inch screen and keyboard
  - **Supply voltage:** DC 24 V/ ≈ 35 W
  - **Integrated USB hub with four USB ports on the rear
  - **Display for multi-touch operation
  - **Fulfills IP54 when installed**

- **BF 360 ID 1275799-xx**
  - **Mass:** ≈ 8.6 kg

- **BF 360 Optional installation kit for MC 360 and BF 360**
  - **For fastening the MC 360 or BF 360 with mounting braces (set of 6 pieces). Up to six mounting braces can be fastened to the MC and BF.**

- **TE 360 keyboard with an integrated machine operating panel**
  - **Fits the BF 360 or MC 366 (24-inch design)
  - **All keycaps are exchangeable
  - **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 key1), NC stop key1), emergency stop button, control voltage on/off key1)
  - **Override potentiometers for feed rate, rapid traverse, and spindle speed (all override potentiometers are fitted with an adapter so that they can be mounted in any 22.3 mm opening)
  - **4 openings for operating elements with a mounting diameter of 22.3 mm
  - **Interface for HR handwheel
  - **HSCI interface, (Gbit HSCI)
  - **TE 361: 8 free PLC inputs and 8 free PLC outputs
  - **TE 361 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**
  - **Mass:** ≈ 5.8 kg

- **TE 360 FS**
  - **ID 1275710-xx**
  - **Mass:** ≈ 5.8 kg

#### Alternative Potentiometer Layout:
- **TE 360**
  - **ID 1284265-xx**
  - **Mass:** ≈ 5.8 kg

#### Extraction Tool for TE 361 ID 1325134-xx

- **For exchanging keycaps on the TE 361**

#### Optional Installation Kit for TE 361 ID 1278826-xx

- **For fastening the TE 361 with mounting braces (set of 6 pieces). Up to 4 mounting braces can be fastened to a TE 361.**

### TE 361 keyboard with an integrated machine operating panel
- **General data:**
  - **Fits the BF 360 or MC 366 (24-inch design)
  - **All keycaps are exchangeable
  - **USB interface to the MC main computer
  - **Trackball
  - **USB port with cover cap

#### Control keyboard (long stroke):
- **Alphabetic keyboard block
  - **Axis input and value input block
  - **Programming block
  - **Operating modes block
  - **Operating aids block
  - **Navigation block

#### Specifications:
- **Supply voltage:** DC 24 V/ ≈ 4 W
- **Fulfills IP54 when installed (all keycaps must be in place)
- **Integrated machine operating panel with 30 exchangeable, freely assignable keycaps with status LED, freely definable via PLC assignment in accordance with PLC basic program:** 12 axis keys, spindle start, spindle stop, 16 further function keys)
- **Other operating elements:** NC start key1), NC stop key1), emergency stop button
- **Override potentiometers for feed rate, rapid traverse, and spindle speed (all override potentiometers are fitted with an adapter so that they can be mounted in any 22.3 mm opening)
- **4 openings for operating elements with a mounting diameter of 22.3 mm
  - **Interface for HR handwheel
  - **HSCI interface, (Gbit HSCI)
  - **TE 361: 8 free PLC inputs and 8 free PLC outputs
  - **TE 361 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 361**
  - **ID 1313011-xx**
  - **Mass:** ≈ 3.7 kg

- **TE 361 FS**
  - **ID 1326583-xx**
  - **Mass:** ≈ 3.7 kg

#### Extraction Tool for TE 361 ID 1325134-xx

- **For exchanging keycaps on the TE 361**

#### Optional Installation Kit for TE 361 ID 1278826-xx

- **For fastening the TE 361 with mounting braces (set of 6 pieces). Up to 4 mounting braces can be fastened to a TE 361.**
19-inch display and keyboard

- Supply voltage: DC 24 V/ ≈ 65 W
- 19-inch, 1280 x 1024 pixels
- HDS2 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
- Operating mode switchover

BF 860
ID 1244875-xx
Mass ≈ 7.7 kg

TE 745 keyboard with an integrated machine operating panel

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-speed and feed-rate 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, spindle stop, 22 further function keys
- Other operating elements: NC start<sup>1)</sup>, NC stop<sup>1)</sup>, emergency-stop key, control voltage on<sup>1)</sup>, two holes for additional keys or keylock switches
- 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.

MB 720 machine operating panel

- 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)
- Further operating elements: NC start<sup>1)</sup>, NC stop<sup>1)</sup>, emergency-stop key, control voltage on<sup>1)</sup>, two holes for additional keys or keylock switches
- HSCI interface
- MB 720: 8 free PLC inputs and 8 free PLC outputs
- MB 720 FS: 4 free FS inputs and 8 free PLC outputs; additional dual-channel FS inputs for emergency stop and permissive buttons of the handwheel.

MB 721 machine operating panel

- Same as the MB 720, except:
  - Suitable for the MC 8512
  - Changed front panel
  - 3 holes for additional buttons or keylock switches
  - Spindle-speed and feed-rate override potentiometers
  - USB port with cover cap

1) Illuminated keys, addressable via PLC

MB 720
ID 794803-xx
Mass ≈ 1.3 kg

MB 720 FS
ID 805474-xx
Mass ≈ 1.5 kg

MB 721
ID 1164974-xx
Mass ≈ 15 kg

15-inch machine operating panels

- Suitable for the MC 8522 (15-inch version)
- Axis keys
- The keys for axes IV and V are exchangeable snap-on keys
- Contouring keys
- Operating mode keys
- ASCII keyboard
- Spindle-speed and feed-rate override potentiometers
- USB interface to the MC main computer
- Touchpad

TE 730
ID 805489-xx
Mass ≈ 2.4 kg

TE 730 F S
ID 805483-xx
Mass ≈ 3.4 kg

MB 720 machine operating panel

Same as the MB 720, except:
- Suitable for the MC 8512
- Changed front panel
- 3 holes for additional buttons or keylock switches
- Spindle-speed and feed-rate override potentiometers
- USB port with cover cap

MB 721
ID 1164974-xx
Mass ≈ 15 kg
PL 6000 PLC input/output systems with HSCI

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.

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: ≈ 48 W at DC 24 V NC, ≈ 21 W at DC 24 V PLC

† PLB 6xxx completely filled, incl. TS, TT

System PL with EnDat support

- Required once for each control system (except with UxC)
- 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

I/O modules

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: 16 digital inputs and 8 digital outputs
- PLD-H 08-16-00: 8 digital inputs and 16 digital outputs
- PLD-H 04-08-00 FS: 4 digital FS inputs and 8 digital FS outputs
- PLD-H 04-04-00: 4 digital FS inputs and 4 digital FS outputs
- PLA-H 08-04-04: 8 analog inputs, ±10 V, 4 analog outputs, ±10 V

Expansion PL

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

- 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 units can be connected to the control.

Note about the "Gen 3 ready" label:
The label expresses the fact that a component is basically ready for operation in a Gen 3 (Gbit HSCI) drive system. Whether a component is suitable for functional safety (IFS), integrated FS, external FS, enabling of FS must be considered separately.

PLA-H 08-04-04 Analog module for PL 6xxx with 8 analog inputs, ±10 V
- 4 analog outputs, ±10 V
- 4 analog inputs for PT 100 thermistors

Mass ≈ 0.2 kg
Accessories

HSCI adapter for OEM machine operating panel

The PLB 600x HSCI adapter is required in order to connect an OEM-specific machine operating panel to the TNC 640.

- HSCI interface
- Connection for HR handwheel
- Inputs and outputs for keys and key illumination
  - PLB 6001: Terminals for 72 PLC inputs / 40 PLC outputs
  - PLB 6001 FS: Terminals for 36 FS inputs / 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

<table>
<thead>
<tr>
<th>Model</th>
<th>ID</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLB 6001</td>
<td>668792-xx</td>
<td>≈ 0.9 kg</td>
</tr>
<tr>
<td>PLB 6001 FS</td>
<td>722083-xx</td>
<td></td>
</tr>
<tr>
<td>PLB 6002 FS</td>
<td>1137000-xx</td>
<td></td>
</tr>
</tbody>
</table>

Additional modules

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.

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

<table>
<thead>
<tr>
<th>Model</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMA-H 04-04-00</td>
<td>688721-xx</td>
</tr>
</tbody>
</table>

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**

- Expansion board for the MC main computer
- Connection for 9-pin D-sub connector (female) to X121

<table>
<thead>
<tr>
<th>Model</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC 85x2, MC 368</td>
<td>828539-xx</td>
</tr>
<tr>
<td>MC 306 and MC 366 as of variant -02</td>
<td>1279074-xx</td>
</tr>
</tbody>
</table>

**PROFINET IO module**

- Expansion board for the MC main computer
- RJ45 connection at X621 and X622

<table>
<thead>
<tr>
<th>Model</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC 85x2, MC 368</td>
<td>828541-xx</td>
</tr>
<tr>
<td>MC 306 and MC 366 as of variant -02</td>
<td>1279077-xx</td>
</tr>
</tbody>
</table>

**Combined PROFIBUS DP/PROFINET IO module**

- Expansion board for the MC main computer
- RJ45 connection at X621 (PROFINET IO) and M12 connector at X121 (PROFIBUS DP)
- Additionally connectable terminating resistor for PROFIBUS DP with front LED

<table>
<thead>
<tr>
<th>Model</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC 85x2, MC 368</td>
<td>1160945-xx</td>
</tr>
<tr>
<td>MC 306 and MC 366 as of variant -02</td>
<td>1233765-xx</td>
</tr>
</tbody>
</table>
Overview

The standard TNC 640 supports the use of electronic handwheels:

- HR 550 FS wireless handwheel or
- HR 510, HR 510 FS or HR 520, HR 520 FS portable handwheel or
- HR 130 panel mounted handwheel

Several handwheels can be operated on a single TNC 640:

- One handwheel via the handwheel input of the main computer (not on main computers in the electrical cabinet)
- One handwheel each on HSCI machine operating panels or PLB 6501 or PLB 660x FS HSCI adapters (for the maximum number possible, see Page 57)

The mixed operation of handwheels with and without display is not possible. Handwheels with functional safety (FS) are cross-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).

<table>
<thead>
<tr>
<th>Keys</th>
<th>Without detent</th>
<th>With detent</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR 510</td>
<td>ID 1119971-xx</td>
<td>ID 1120313-xx</td>
</tr>
<tr>
<td>FCT A, FCT B, FCT C</td>
<td>ID 1099897-xx</td>
<td>–</td>
</tr>
<tr>
<td>Spindle right/left/stop</td>
<td>ID 1184691-xx</td>
<td>–</td>
</tr>
<tr>
<td>HR 510 FS</td>
<td>ID 1120311-xx</td>
<td>ID 1161281-xx</td>
</tr>
<tr>
<td>FCT A, FCT B, FCT C</td>
<td>–</td>
<td>ID 1120314-xx</td>
</tr>
<tr>
<td>Spindle start, FCT B, NC start</td>
<td>–</td>
<td>ID 1119974-xx</td>
</tr>
</tbody>
</table>

Mass ≈ 0.5 kg

HR 520

Portable electronic handwheel with:

- Display for operating mode, actual position value, programmed feed rate, spindle speed, and 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

<table>
<thead>
<tr>
<th>Without detent</th>
<th>With detent</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR 520</td>
<td>ID 670302-xx</td>
</tr>
<tr>
<td>HR 520 FS</td>
<td>ID 670304-xx</td>
</tr>
</tbody>
</table>

Mass ≈ 0.8 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)

<table>
<thead>
<tr>
<th>Without detent</th>
<th>With detent</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR 550 FS</td>
<td>ID 1200495-xx</td>
</tr>
</tbody>
</table>

Replacement battery

For HR 550 FS ID 623166-xx

HRA 551 FS

Handwheel holder for HR 550 FS:

- For docking the HR 550 FS on 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 ≈ 0.7 kg

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

<table>
<thead>
<tr>
<th>Connecting cable</th>
<th>HR 510</th>
<th>HR 510 FS</th>
<th>HR 520</th>
<th>HR 520 FS</th>
<th>HR 550 FS with HRA 551 FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(spiral cable) to HR (3 m)</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>ID 312879-01</td>
</tr>
<tr>
<td>Connecting cable with metal armor</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>ID 1117852-03</td>
</tr>
<tr>
<td>Connecting cable without metal armor</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>ID 296687-xx</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>✓ (max. 2 m)</td>
<td>ID 296467-xx</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>ID 1117853-xx</td>
<td></td>
</tr>
<tr>
<td>HR adapter cable to MC, straight connector</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>ID 1161072-xx</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>ID 1219563-01</td>
<td></td>
</tr>
<tr>
<td>Extension cable to adapter cable</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>ID 281429-xx</td>
</tr>
<tr>
<td>Adapter cable for HRA to MC</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>ID 749368-xx</td>
</tr>
<tr>
<td>Extension cable to adapter cable</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>ID 749369-xx</td>
</tr>
<tr>
<td>Adapter connector for handwheels without functional safety</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>ID 271968-03</td>
</tr>
<tr>
<td>Adapter connector for handwheels with functional safety</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>ID 271968-05</td>
</tr>
</tbody>
</table>

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

See also Cable overview on Page 55.

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.

<table>
<thead>
<tr>
<th>HR 130</th>
<th>Without detent</th>
<th>With detent</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID 540940-02</td>
<td>ID 540940-01</td>
<td></td>
</tr>
<tr>
<td>Mass = 0.3 kg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Industrial PCs/ITC

The additional ITC operating stations (Industrial Thin Client) from HEIDENHAIN are convenient solutions 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. All ITCs fulfill IP54 when installed.

Connecting an ITC is very easy: as soon as the TNC 640 identifies an ITC, it provides it with a current operating system. After booting of the ITC, the complete content of the control’s screen is mirrored 1:1 on the ITC’s screen. As a result of this plug&play principle, no configuration by the machine manufacturer 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 362 or ITC 860 is an additional operating station for control systems with a main screen.

The ITC 362 or ITC 860 and the separately orderable keyboard unit together form a complete, second operating station.

Along with the touchscreen, the ITC 855 also has an ASCII keyboard and the most important function keys of the TNC 640.

<table>
<thead>
<tr>
<th>ITC 362</th>
<th>ID number ID 1346871-xx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass = 8.6 kg</td>
<td></td>
</tr>
<tr>
<td>Installation type</td>
<td>Operating panel</td>
</tr>
<tr>
<td>Monitor</td>
<td>ITC 755</td>
</tr>
<tr>
<td>Processor</td>
<td>Intel Atom processor</td>
</tr>
<tr>
<td>RAM</td>
<td>2 GB</td>
</tr>
<tr>
<td>Power consumption</td>
<td>50 W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ITC 860</th>
<th>ID number ID 1174935-xx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass = 8.2 kg</td>
<td></td>
</tr>
<tr>
<td>Installation type</td>
<td>Operating panel</td>
</tr>
<tr>
<td>Display</td>
<td>19-inch touchscreen</td>
</tr>
<tr>
<td>Processor</td>
<td>Intel Atom E3845</td>
</tr>
<tr>
<td>RAM</td>
<td>2 GB</td>
</tr>
<tr>
<td>Power consumption</td>
<td>50 W</td>
</tr>
</tbody>
</table>
With the IPC 306 industrial PC, you can start and remotely operate Windows-based applications via 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. Windows 8, 10 or 11 can be installed on the empty data carrier as the operating system.

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 PROFINET IO or PROFIBUS DP (optional), the platform is not capable of real-time, regardless of the platform.

**Auxiliary computer**
- Intel mid-level processor
- RAM main memory
- HSCI interface to the CC controller unit or to the UxC and to other control components
- USB 3.0 ports

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

The following HSCI components are required for operating the PNC 610:
- IPC auxiliary computer
- Controller unit
- PLB 62xx PLC I/O unit (system PL; integrated into UxC)

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

**Design**
- **IPC 6490**
  - ID number: ID 1039541
  - Installation type: Electrical cabinet
  - Mass: ≈ 2.3 kg
  - Power consumption: 48 W
  - RAM: 2 GB
  - Processor: Intel Celeron

- **IPC 8420**
  - ID number: ID 1249510
  - Installation type: Operating panel (IP54 when installed)
  - Mass: ≈ 6.6 kg
  - Power consumption: 48 W
  - Monitor: 15.6-inch touchscreen (1366 x 768 pixels)
  - RAM: 2 GB
  - Processor: Intel Celeron

**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.

<table>
<thead>
<tr>
<th>Option number</th>
<th>Option ID</th>
<th>ID</th>
<th>Comment</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>HEIDENHAIN DNC</td>
<td>526451-01</td>
<td>Communication with external PC applications over COM component</td>
<td>97</td>
</tr>
<tr>
<td>24</td>
<td>Gantry Axes</td>
<td>634621-01</td>
<td>Gantry axes via master-slave torque control</td>
<td>63</td>
</tr>
<tr>
<td>135</td>
<td>Synchronizing Functions</td>
<td>1085731-01</td>
<td>Advanced synchronization of axes and spindles</td>
<td>64</td>
</tr>
<tr>
<td>141</td>
<td>Cross Talk Comp.</td>
<td>800542-01</td>
<td>CTC: compensation of axis couplings</td>
<td>78</td>
</tr>
<tr>
<td>142</td>
<td>Pos. Adapt. Control</td>
<td>800544-01</td>
<td>PAC: position-dependent adaptation of control parameters</td>
<td>79</td>
</tr>
<tr>
<td>143</td>
<td>Load Adapt. Control</td>
<td>800545-01</td>
<td>LAC: load-dependent adaptation of control parameters</td>
<td>77</td>
</tr>
<tr>
<td>144</td>
<td>Motion Adapt. Control</td>
<td>800546-01</td>
<td>MAC: motion-dependent adaptation of control parameters</td>
<td>78</td>
</tr>
<tr>
<td>160</td>
<td>Integrated FS: Basic</td>
<td>1248929-01</td>
<td>Enables functional safety and four safe control loops</td>
<td>58</td>
</tr>
<tr>
<td>161</td>
<td>Integrated FS: Full</td>
<td>1248929-01</td>
<td>Enables functional safety and the maximum number of safe control loops</td>
<td>58</td>
</tr>
<tr>
<td>162</td>
<td>Add. FS Ctrl. Loop 1</td>
<td>1248930-01</td>
<td>Additional control loop 1</td>
<td>58</td>
</tr>
<tr>
<td>163</td>
<td>Add. FS Ctrl. Loop 2</td>
<td>1248931-01</td>
<td>Additional control loop 2</td>
<td>58</td>
</tr>
<tr>
<td>164</td>
<td>Add. FS Ctrl. Loop 3</td>
<td>1248932-01</td>
<td>Additional control loop 3</td>
<td>58</td>
</tr>
<tr>
<td>165</td>
<td>Add. FS Ctrl. Loop 4</td>
<td>1248933-01</td>
<td>Additional control loop 4</td>
<td>58</td>
</tr>
<tr>
<td>166</td>
<td>Add. FS Ctrl. Loop 5</td>
<td>1248934-01</td>
<td>Additional control loop 5</td>
<td>58</td>
</tr>
<tr>
<td>169</td>
<td>Add. FS Full</td>
<td>1319091-01</td>
<td>Enabling of all FS axis options or control loops. Options 160 and 162 to 166 must already be set.</td>
<td>58</td>
</tr>
</tbody>
</table>

Storage medium
The storage medium is a CFR (= CompactFlash Removable) compact flash memory card. It 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.

<table>
<thead>
<tr>
<th>CFR CompactFlash</th>
<th>ID</th>
<th>GB</th>
<th>No export license required</th>
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</thead>
<tbody>
<tr>
<td>30 GB</td>
<td>1102057-xx</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>4 GB</td>
<td>817591-xx</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>7.7 GB</td>
<td></td>
<td>7.7</td>
<td></td>
</tr>
</tbody>
</table>

SIK component
The SIK component holds the NC software license for enabling software options. It provides the main computer with 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 617363-53
Vision System for Tool Inspection

The VT 121 vision system, combined with the VTC (visual tool control) PC software, enables automated and time-saving in-process tool inspection inside the machine. Using TNC 640 cycles, for example, you can monitor and document a tool’s condition and level of wear even during unattended shifts.

The sealed and highly rugged VT 121 vision system is designed to be installed inside the machine’s working space. It requires compressed air only during the cycles for cleaning the workpiece or tool. The vision system can be used regardless of whether cooling lubricant or dry machining is performed. Compressed air from the integrated jets cleans the tools and the camera’s cover glass.

In order to integrate VTC on the TNC, you need both an IPC (on which the VTC PC software runs) and software option 46 (Python OEM Process). For more information, please ask your contact person at HEIDENHAIN. For detailed information on the VT 121 and VTC (specifications, accessories, software options, etc.) please refer to the “VT 121 VTC” Product Information document (ID 1324220).

Snap-on keys for handwheels

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

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

<table>
<thead>
<tr>
<th>Axis keys</th>
<th>Orange</th>
<th>Gray</th>
<th>Black</th>
<th>Red</th>
<th>Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>ID 3301642</td>
<td>ID 3301646</td>
<td>ID 3301644</td>
<td>ID 3301652</td>
<td>ID 3301650</td>
</tr>
<tr>
<td>B</td>
<td>ID 3301647</td>
<td>ID 3301651</td>
<td>ID 3301653</td>
<td>ID 3301655</td>
<td>ID 3301657</td>
</tr>
<tr>
<td>C</td>
<td>ID 3301648</td>
<td>ID 3301652</td>
<td>ID 3301654</td>
<td>ID 3301656</td>
<td>ID 3301658</td>
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</tbody>
</table>

Machine functions

<table>
<thead>
<tr>
<th>Black</th>
<th>ID 3301660</th>
<th>ID 3301670</th>
<th>ID 3301680</th>
<th>ID 3301690</th>
<th>ID 3301640</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>ID 3301661</td>
<td>ID 3301671</td>
<td>ID 3301681</td>
<td>ID 3301691</td>
<td>ID 3301641</td>
</tr>
</tbody>
</table>

Spindle functions

<table>
<thead>
<tr>
<th>Black</th>
<th>ID 3301640</th>
<th>ID 3301650</th>
<th>ID 3301660</th>
<th>ID 3301670</th>
<th>ID 3301680</th>
</tr>
</thead>
</table>

Other keys

<table>
<thead>
<tr>
<th>Black</th>
<th>ID 3301660</th>
<th>ID 3301670</th>
<th>ID 3301680</th>
<th>ID 3301690</th>
<th>ID 3301640</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>ID 3301661</td>
<td>ID 3301671</td>
<td>ID 3301681</td>
<td>ID 3301691</td>
<td>ID 3301641</td>
</tr>
</tbody>
</table>

VT 121 with VTC

The VT 121 vision system, combined with the VTC (visual tool control) PC software, enables automated and time-saving in-process tool inspection inside the machine. Using TNC 640 cycles, for example, you can monitor and document a tool’s condition and level of wear even during unattended shifts.

The sealed and highly rugged VT 121 vision system is designed to be installed inside the machine’s working space. It requires compressed air only during the cycles for cleaning the workpiece or tool. The vision system can be used regardless of whether cooling lubricant or dry machining is performed. Compressed air from the integrated jets cleans the tools and the camera’s cover glass.

In order to integrate VTC on the TNC, you need both an IPC (on which the VTC PC software runs) and software option 46 (Python OEM Process). For more information, please ask your contact person at HEIDENHAIN. For detailed information on the VT 121 and VTC (specifications, accessories, software options, etc.) please refer to the “VT 121 VTC” Product Information document (ID 1324220).

VT 121

Mass ≈ 1 kg
### Overview for HR 510 and HR 510 FS

#### Axis keys

- **Orange**
  - A: ID 1092562-02
  - B: ID 1092562-03
  - C: ID 1092562-01

- **Gray**
  - X: ID 1092562-28
  - Y: ID 1092562-29
  - Z: ID 1092562-30

- **Other keys**
  - [Green] ID 1092562-07
  - [Black] ID 1092562-09
  - [Red] ID 1092562-10

#### Machine functions

- **Black**
  - Id 1092562-14
  - P: Id 1092562-15
  - R: Id 1092562-33

- **Red**
  - Id 1092562-08

- **Other colors**
  - [Green] Id 1092562-23
  - [Black] Id 1092562-38

#### Spindle functions

- **Green**
  - Id 1092562-20

- **Black**
  - Id 1092562-11

- **Red**
  - Id 1092562-12

- **Other colors**
  - [Green] Id 1092562-21

---

### Snap-on keys for the control

**Overview of control keys**

The snap-on keys with ID 679843-xx are suitable for the following machine operating panels:

- TE 360 or TE 360 FS (integrated machine operating panel)
- TE 735 or TE 735 FS (integrated machine operating panel)
- TE 745 or TE 745 FS (integrated machine operating panel)
- MB 720 or MB 720 FS
- MB 721 or MB 721 FS

**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.

---

**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.
<table>
<thead>
<tr>
<th>Keys</th>
<th>ID</th>
<th>Keys</th>
<th>ID</th>
<th>Keys</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray</td>
<td></td>
<td>Other keys</td>
<td></td>
<td>Other keys</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Machine functions</td>
<td></td>
<td>Machine functions</td>
<td></td>
</tr>
</tbody>
</table>

**Spindle functions**

- Black: Red ID 679843-32
- Green: Red ID 679843-48
- Orange: Red ID 679843-52
- Red: Red ID 679843-54
- Black: Red ID 679843-62
- Orange: Red ID 679843-63
- Red: Red ID 679843-64
- Black: Red ID 679843-65

**Other keys**

- Black: Red ID 679843-26
- Green: Red ID 679843-49
- Orange: Red ID 679843-53
- Red: Red ID 679843-55

**Machine functions**

- Black: Red ID 679843-23
- Green: Red ID 679843-45
- Orange: Red ID 679843-53
- Red: Red ID 679843-55

**Keys**

- Red: Red ID 679843-18
- Green: Red ID 679843-47
- Orange: Red ID 679843-51
- Red: Red ID 679843-99
- Black: Red ID 679843-32
- Green: Red ID 679843-48
- Orange: Red ID 679843-52
- Red: Red ID 679843-99
Keycaps for keyboard units and machine operating panels

The keycaps make it easy to replace the key symbols, thus allowing the keyboard to be adapted to different requirements.

### Overview of control keys

The keycaps with IDs 12869xx-xx and 1344337-xx are suitable for use on the following keyboard units and machine operating panels:
- TE 361
- TE 361 FS

### Keycaps for alphabetic keyboard

<table>
<thead>
<tr>
<th>Keycap ID</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1286909</td>
<td></td>
</tr>
<tr>
<td>1286936</td>
<td></td>
</tr>
<tr>
<td>1344337</td>
<td></td>
</tr>
</tbody>
</table>

### Keycaps for operating aids

<table>
<thead>
<tr>
<th>Keycap ID</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1286909</td>
<td></td>
</tr>
<tr>
<td>1286936</td>
<td></td>
</tr>
</tbody>
</table>

### Keycaps for operating modes

<table>
<thead>
<tr>
<th>Keycap ID</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1286909</td>
<td></td>
</tr>
<tr>
<td>1286936</td>
<td></td>
</tr>
</tbody>
</table>

### Keycaps for programming

<table>
<thead>
<tr>
<th>Keycap ID</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1286909</td>
<td></td>
</tr>
<tr>
<td>1286936</td>
<td></td>
</tr>
</tbody>
</table>

---

1. With tactile mark

---

**Table of Keycaps**

<table>
<thead>
<tr>
<th>Keycap ID</th>
<th>Function 1</th>
<th>Function 2</th>
<th>Function 3</th>
<th>Function 4</th>
<th>Function 5</th>
<th>Function 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1286909</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1286936</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Diagram of Keycaps**

[Diagram of Keycaps]
**Keycaps for axis input and value input**

<table>
<thead>
<tr>
<th>ID</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>U</th>
<th>V</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>1286909</td>
<td>Orange</td>
<td>Orange</td>
<td>Orange</td>
<td>Orange</td>
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<td>Orange</td>
<td>Orange</td>
<td>Orange</td>
<td>Orange</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>0E</th>
<th>0F</th>
<th>0G</th>
<th>0H</th>
<th>2L</th>
<th>2M</th>
</tr>
</thead>
<tbody>
<tr>
<td>1344337(*)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<td>–</td>
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</tbody>
</table>

(*) With tactile mark

**Keycaps for navigation**

<table>
<thead>
<tr>
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<th>-0T</th>
<th>-0U</th>
<th>-0V</th>
<th>-0W</th>
<th>-0Y</th>
<th>-0Z</th>
<th>-1A</th>
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</thead>
<tbody>
<tr>
<td>1286909</td>
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<td>–</td>
<td>–</td>
<td>–</td>
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<td>–</td>
</tr>
</tbody>
</table>

(*) With tactile mark

**Keycaps for machine functions**

<table>
<thead>
<tr>
<th>ID</th>
<th>-1D</th>
<th>-1E</th>
<th>-1F</th>
<th>-1G</th>
<th>-1H</th>
<th>-1K</th>
<th>-1L</th>
<th>-4X</th>
<th>-1N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1286909</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

(*) With tactile mark

<table>
<thead>
<tr>
<th>ID</th>
<th>-1P</th>
<th>-1R</th>
<th>-1S</th>
<th>-1T</th>
<th>-1U</th>
<th>-1V</th>
<th>-1W</th>
<th>-1X</th>
<th>-1Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1286909</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

(*) With tactile mark
Cable overview
Control systems with CC or UEC (MC in electrical cabinet)

Keycaps can also be made with special key symbols for special applications. If you need keys for special applications, please consult your contact person at HEIDENHAIN.
Control system with CC or UEC (MC in operating panel)

Inverter system

For maximum lengths, see "Gen 3 Drives" Technical Manual.

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

SIEMENS Sitor gS or gR line fuse

Optional overvoltage protector

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

Line filter Epcos

ID 1265351-xx

For the encoder connections, see the brochure "Cables and Connectors" (ID 1299703-xx)

Line filter Epcos

ID 1265351-xx

SIEMENS Sitor gS or gR line fuse

Optional overvoltage protector

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

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

For maximum lengths, see "Gen 3 Drives" Technical Manual.

Optional overvoltage protector

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

Siemens Sitor gS or gR line fuse

UEC 3xx (FS)
**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 referred to as an HSCI segment. HSCI communication in Gen 5 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 makes short cycle times for data transfer possible.

Main advantages of the control design with HSCI:
- Hardware platform for a flexible and scalable control system (e.g., decentralized axis systems)
- High noise immunity due to digital communication between components
- Hardware basis for implementing functional safety
- Simple wiring (commissioning, configuration)
- Inverter connection via digital optical fiber cables
- Long line lengths in the overall system
- 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 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 an HSCI segment: 70 m
- For up to 12 HSCI slaves: 200 m (total of all HSCI segments)
- For up to 13 HSCI slaves (maximum configuration): 180 m (total of all HSCI segments)

The order of the HSCI slaves can be freely chosen.

<table>
<thead>
<tr>
<th>Gbit HSCI component</th>
<th>Maximum number in the control system</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC, IPC</td>
<td>HSCI master</td>
</tr>
<tr>
<td>CC, UEC (drive-control motherboards)</td>
<td>HSCI slave</td>
</tr>
<tr>
<td>UVR</td>
<td>HSCI slave</td>
</tr>
<tr>
<td>MB, PLB 600x</td>
<td>HSCI slave</td>
</tr>
<tr>
<td>PLB 6XXX (integrated in UEC 3xx (FS))</td>
<td>HSCI slave</td>
</tr>
<tr>
<td>PLB 6XX FS (integrated in UEC 3xx FS)</td>
<td>HSCI slave</td>
</tr>
<tr>
<td>HR</td>
<td></td>
</tr>
<tr>
<td>PLD-H xxx-xx-xx FS</td>
<td>In PLB 6xx FS</td>
</tr>
<tr>
<td>PLD-H xxx-xx-xx</td>
<td>In PLB 6xx (FS)</td>
</tr>
<tr>
<td>PLA-H xxx-xx-xx</td>
<td>In PLB 62xx</td>
</tr>
<tr>
<td>PAE-H xxx-xx-xx</td>
<td></td>
</tr>
<tr>
<td>UEC 3xx for external safety</td>
<td>HSCI slave (PAE module integrated)</td>
</tr>
</tbody>
</table>

1) For more information on the NCK software, see the Technical Manual of the respective control.
2) Total maximum of 1000 inputs/outputs and maximum of 10 PL units (PL, PLB, MB, TE)
3) Only in systems without integrated functional safety (FS)
Control systems with integrated functional safety (FS)

Basic principle
With controls with integrated functional safety (FS) from HEIDENHAIN, Safety Integrity Level 2 (SIL 2) as per the standard EN 61508 and Performance Level “d” Category 3 as per EN ISO 13849-1 can be attained. 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 a reciprocal data comparison of the two channels’ states. Consequently, the occurrence of a single error in the control does not cause a loss in safety functionality.

Design
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 MC and CC is continued in the PLB 6xxx FS (IO systems and MB machine operating panel with FS (e.g., MB integrated in TE 361 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 case of an error.

Components
In systems with functional safety, certain hardware components assume safety-relevant tasks. In systems with FS, only safety-relevant components are permitted to be used that, including their variant from HEIDENHAIN, are approved for this. Control components with functional safety FS can be recognized based on the addition of “FS” after the type designation (e.g., TE 361 FS).

For a current list of the components approved for functional safety (FS), refer to Functional safety (FS) supplement to the Technical Manual (ID 1177599).

MB and TE
An MB machine operating panel with functional safety 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.

Safety functions
Safety functions integrated into 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 (FS), please determine whether the current scope of features is sufficient 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
• Safety-relevant control components in FS design (e.g., TE 361 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) can be scaled via software options 160 to 166 and 169 (see Page 14). Only the number of safe drive systems actually needed must be enabled.

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 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
- Per12: 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 manufacturer 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 manufacturer 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 the 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).

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.
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 function allows complex, simultaneous movements of multiple NC or PLC axes to be implemented. The interdependencies of the axes are 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 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.

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 requirement is a machine designed with high rigidity so as to ensure a low oscillation tendency even when the machine table (acting as lathe spindle) is turning at high speeds.

When switching between milling and turning mode, the TNC switches diameter programming on or off, selects the XZ working plane for turning, and displays “Milling” or “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.

Machine in milling mode
FUNCTION MODE MILL

Machine in turning mode
FUNCTION MODE TURN

Turning
Support for facing slides (facing heads)

With complete support for facing slides, the TNC 640 provides an additional 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 requirement for turning operations is that the radial runout of the workpiece has been balanced. Both the machine (rotary table) and the workpiece must be balanced before machining. If the clamped workpiece has an unbalance, undesirable centrifugal forces can result, influencing the accuracy of the runout.

An unbalance 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 offers 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.

Turning v2 (software option 158)

The software option Turning v2 includes all functions of software option 50 (Turning).

In addition, software option 158 offers the following advanced turning functions:

- Cycle 882 SIMULTANEOUS ROUGHING FOR TURNING
- Cycle 883 TURNING SIMULTANEOUS FINISHING

The advanced turning functions make it possible, for example, to rough and finish complex contours in one run to avoid optical transitions, to produce workpieces with undercuts, and to better utilize indexable inserts. Furthermore, the TNC 640 makes it possible to define FreeTurn tools and to use them, for example, for inclined or simultaneous turning operations. FreeTurn tools are lathe tools that are equipped with multiple cutting edges. Depending on the variant, a single FreeTurn tool may be capable of axis-parallel and contour-parallel roughing and finishing. Thanks to the use of FreeTurn tools, fewer tool changes are required, reducing the machining time.
**Grinding operations**

With its Grinding option, the TNC 640 supports jig grinding technology for the fine machining of 2D 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 operates 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 UxC 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.).

Possible fundamental frequencies are 3.33 kHz, 4 kHz, or 5 kHz.

With software option 49 (Double Speed), this frequency can be increased up to 16 kHz for fast-turning spindles (e.g., HF spindles).

**Maximum spindle speed**

The maximum spindle speed is calculated as follows:

\[
 n_{\text{max}} = \frac{f_{\text{PWM}} \cdot 60000}{N_{\text{PP}}} \text{ rpm}
\]

- \( f_{\text{PWM}} \): PWM frequency in Hz
- \( N_{\text{PP}} \): 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 connection). 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 Vp-p) 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 stages**

A specific nominal speed can be defined for each gear stage. The gear code is output via the PLC.

**Multiple main spindles**

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

**Spindle Synchronism (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 ~1 Vpp levels are suitable for connection to HEIDENHAIN numerical controls.

Absolute encoders
With absolute encoders, the position information is contained in several coded tracks. Thus, an absolute reference is available immediately after switch-on. Reference-mark traverse is not necessary. For cyclical closed-loop operation, position information from incremental signals can be used, or from serial absolute signals (EnDat 2.2) with very short cycles.

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 layout 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 the encoder inputs of the controller unit (only purely serial encoders with EnDat 2.2 can be connected to mini-I/O connectors).

<table>
<thead>
<tr>
<th>Channel inputs</th>
<th>Signal level/Interface</th>
<th>Input frequency&lt;sup&gt;1)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental signals</td>
<td>~1 Vpp</td>
<td>33 kHz/350 kHz 350 kHz</td>
</tr>
<tr>
<td>EnDat 2.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absolute position values</td>
<td>EnDat 2.1 EnDat 2.2</td>
<td>– –</td>
</tr>
</tbody>
</table>

1) Switchable

Digital servo control

Integrated inverter
HEIDENHAIN synchronous or asynchronous motors are connected to the TNC 640.

Axis feedback control
The TNC 640 can be operated with feedforward control or servo lag.

Operation with feedforward control
Feedforward means that a given velocity and acceleration are adapted to the machine. Together with the values calculated from the servo lag, this given velocity and acceleration becomes the nominal value. A much lower servo lag thereby manifests itself.

Operation with servo lag
The term “servo lag” denotes the distance between the momentary nominal position and the actual position of the axis. The velocity is calculated as follows:

\[ v = k_v \cdot s_a \]

\[ v = \text{Velocity} \]
\[ k_v = \text{Position loop gain} \]
\[ s_a = \text{Servo lag} \]

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.
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 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**: See values on Page 6
- **Fine interpolation**
- **Position controller**
- **Speed controller**
- **Current controller**

### 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 (kV factor) is increased significantly by this. The filter separation frequency is set specifically for each axis via machine parameters. The CPF can be used only in dual-encoder systems, i.e., on motors with a speed encoder and position encoder.

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**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 less than 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 greater than 24 m/min.

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

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

**Jerk limiting**
To prevent machine oscillations, the jerk is limited 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 permitted tolerance is programmed by the user via a cycle. Special filters for HSC machining (HSC filters) can suppress machine-specific natural frequencies. The desired accuracy along with very high surface quality is attained.
The Advanced Dynamic Prediction (ADP) function enhances the 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 endpoint 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.

With the concept of Dynamic Efficiency, HEIDENHAIN offers innovative TNC functions that help the user to make heavy machining and roughing more efficient while also enhancing 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.

Optimized Contour Milling (OCM, software option 167) takes the Dynamic Efficiency package of functions into the second generation.

Dynamic Efficiency Generation 2 covers 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.
- 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.

Individually, each of these solutions delivers key improvements to the machining process. But in combination, these TNC functions bring out the full potential of the machine and tool while reducing the mechanical load.

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 high cutting power), 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 subjects the machine to heavy strain and causes ugly marks on the workpiece surface. The tool, too, undergoes heavy and irregular wear due to chatter, even breaking in extreme cases. To reduce chatter tendencies, HEIDENHAIN offers an effective option with its Active Chatter Control (ACC) solution. This option is particularly advantageous 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.

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 cutting conditions
- Higher possible cutting parameters
- Higher removal rates
- No need for adjustments by the machine manufacturer
- Cutting data calculator for the automatic calculation of cutting values

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, various controller parameters (e.g., loop gains, and feedforward controls for acceleration, holding torque, static friction, and friction at high shaft speeds) can be adapted to the currently active load.

Dynamic Precision

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.

The functions of the Machine Vibration Control (MVC) software option and the expanded functions of the Motion Adaptive Control (MAC) software option characterize the second generation of Dynamic Precision.

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. As a result, production time and cost are reduced.

The software options that make up Dynamic Precision Generation 2 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 in acceleration phases
- MVC: damps machine oscillations to improve workpiece surface quality through the following functions:
  - AVD (Active Vibration Damping)
  - FSC (Frequency Shaping Control)
- 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

With LAC (software option 143), you can dynamically adjust controller parameters based on the load or friction.
Along with the load-based modification of machine parameters through the LAC software option, the Motion Adaptive Control (MAC) software option allows machine parameters to be changed based on their initial values, such as speed, servo lag, 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.

The software option MAC was enhanced with the adaptive gear-error compensation of Dynamic Precision Generation 2. Surface quality problems often do not arise from machine resonances but rather from transmission errors in mechanical components of the feed drive systems. Transmission elements in the machine tool’s power train, such as a rack and pinion, often cause unwanted shading on the workpiece surface. This results in cost-intensive rework, particularly in tool and mold making. The active gear-error compensation minimizes these periodic interferences.

Cross Talk Compensation (CTC, software option 141) enables the compensation of dynamic position errors potentially arising from acceleration forces. To increase productivity, machine tool users ask for ever higher feed rates and acceleration values, while at the same time needing to maintain the highest possible surface quality and accuracy, placing very special requirements on path control.

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

If the dynamic position 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.

Machine Vibration Control (MVC, 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. With Machine Vibration Control (MVC, software option 146), two functions that effectively suppress low-frequency vibrations are available.

Active Vibration Damping (AVD)

The Active Vibration Damping (AVD) controller function increases dynamic rigidity and damps the especially critical low-frequency oscillations. At the same time, it optimizes the control behavior of the affected axis so that high-accuracy workpieces with excellent surface quality can also be produced at high feed rates.

Frequency Shaping Control (FSC)

The Frequency Shaping Control (FSC) function suppresses the inducement of low-frequency oscillations through a specific feedforward control. This can be used to increase dynamic limit values (e.g. jerk), and therefore make reduced machining times possible. The combination of the two functions (AVD and FSC) optimizes the dynamics, surface quality, and productivity.

Position Adaptive Control (PAC, software option 142)

Position Adaptive Control (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, among others:
- Amplitude of encoder signals
- Edge separation of encoder signals
- Absolute position for encoders with distance-coded reference marks
- Current position (servo lag monitoring)
- Actual path traversed (movement monitoring)
- Nominal speed value
- Checksum of safety-related functions
- Supply voltage
- Voltage of the buffer battery
- Operating temperature of MC and CPU
- Motor current / motor temperature
- Temperature of power module
- Difference between position and speed encoder (PosDiff)
- Serial connection of all devices in the HSCI chain
- Quality of optical connections between CC and UM
- Voltages of the main power supply
- Utilization of the 24 V supply

With EnDat 2.2 encoders:
- 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.

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**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:
- 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

Collision monitoring also protects fixtures and tool carriers from collisions.

The 3D 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 machine’s workspace

**Context-sensitive help**
A context-sensitive help function is available to the user via the HELP key or ERR key. In the event of an error message, the control displays the cause of the error and the possibilities for fixing it. The machine manufacturer can also implement this user support for PLC error messages.
The CAD Model Optimizer software option gives the user the power to simplify and heal 3D models, and thus create valid STL files for collision monitoring or workpiece blanks for simulation. The user loads the output model into the CAD viewer. The 3D mesh function simplifies the model and autonomously corrects errors such as small holes in the solid-model or self-intersecting lines on a surface. The result is a valid STL file that can be used for various functions of the control.

KinematicsDesign (accessory)

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

If KinematicsDesign is connected to a control online (operation is also possible with the programming station software), then machine movements can be simulated when the axes are moved. Together with the TNC 640, KinematicsDesign simulates the working space when DCM is active, and collisions that occur—as well as machine components that are 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

The TNC 640 lets you import collision objects from a CAD file and incorporate them as M3D data into the machine kinematics. 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 CAD data for 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).

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). The MONITORING HEATMAP function allows you to color, with the status of a monitoring task from within the NC program, the concurrent material removal simulation. That way the workpiece shows you where a component was subject to a strong load.

During their lifecycle, the machine components which are subject to loads (e.g., guides, ball screws, etc.) become worn and thus the quality of the axis movements deteriorates. This, in turn, affects production quality. With Component Monitoring option 155 and a cycle, the control is able to measure the current condition of the machine. As a result, any deviations from the machine’s shipping condition due to wear and aging can be measured. The machine manufacturer can read and evaluate the data, and react using predictive maintenance, thereby avoiding unplanned machine downtimes.
Error compensation

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

Linear error
Linear error can be compensated for 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 manufacturers or 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 measuring process is the same, regardless of whether the rotary axis is a rotary table, tilting table, or a swivel head.

Calibration sphere (accessory)
HEIDENHAIN offers calibration spheres as accessories for the measurement of rotary axes with KinematicsOpt:

<table>
<thead>
<tr>
<th>Calibration sphere (accessory)</th>
<th>Height</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>KKH 80</td>
<td>80 mm</td>
<td>655475-03</td>
</tr>
<tr>
<td>KKH 250</td>
<td>250 mm</td>
<td>655475-01</td>
</tr>
</tbody>
</table>
Increasingly stringent requirements on workpiece tolerances constantly increase the demands placed on the precision of a machine tool. However, components of machine tools inevitably show imperfections that are, for example, caused by manufacturing or assembly or result from elastic deformation. This is the reason why the commanded tool position and orientation are not always reached exactly everywhere in the working space. The more axes a machine has, the more sources of 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 when large machines with parallel axes are involved.

The KinematicsComp software option allows the machine manufacturer to save 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 3D-ToolComp software option provides 3D 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 the 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 Advanced Function Set 2 software option must be enabled. During probing with a touch probe, these compensation values are taken into account only in appropriately prepared new probing cycles (e.g., Cycle 444).

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

PC software for configuring the machine parameters
- Stand-alone machine parameter editor for the control; all support 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)

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

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

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
- Servo lag 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

Simultaneous graphic 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)
- IpoLogik (X)
**TNCopt** *(accessory)*
PC software for initial setup of digital control loops.
Functions (among others):
- (Automatic) initial setup of the control loops (current, speed, position)
- (Automatic) optimization of various feedforward controls
  - Reversal peaks
  - Friction parameters, acceleration feedforward control
  - Torsion compensation
- (Automatic) system identification
- Circular form test, contour test
- Working space scan, 3D workspace inspector

**Online Monitor (OLM)**
The online monitor is a component of the TNC 640 and is called with a code number. It supports initial setup and diagnosis of control components through the following:
- Display of control-internal variables for axes and channels
- Display of controller-internal variables (if a CC is present)
- Display of hardware signal states
- Various trace functions
- Activation of spindle commands
- Enabling of control-internal debug outputs

**TNCscope** *(accessory)*
PC software for transferring the oscilloscope files to a PC. With TNCscope you can record and save up to 32 channels simultaneously.

**RemoteAccess** *(accessory)*
PC software for remote diagnostics, monitoring and operation.
RemoteAccess grants quick and easy access to HEIDENHAIN controls that are installed within the same local network (intranet).
RemoteAccess offers the following functions:
- Display of the control’s user interface on the PC
- Operating the control directly through the live view as well as with the integrated keyboard
- HEIDENHAIN PC tools are integrated automatically
- Can be enhanced with OEM-specific applications

**API DATA**
With the API DATA function, the control displays the states or contents of the symbolic API markers and API double words.

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

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

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

**Bus diagnosis**
In Diagnosis mode, the structure of the connected bus systems as well as the details of the connected components can be shown in an intuitive manner.

**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 configuration, 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 servicing and log files:
- Loading of servicing 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
- Graphic display of signals via TNCscope
- Interaction with other tools that are intended for the display of special sections of the service file
Integrated PLC

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

PLC inputs/outputs
PLC I/Os are available via the external PL 6000 and UxC. The PLC I/Os and the PROFINET I/O or PROFIBUS DP-capable I/O system must be configured with the IOconfig PC software.

PLC programming

<table>
<thead>
<tr>
<th>Format</th>
<th>Statement list</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory</td>
<td>At least 1 GB (depending on the data carrier used)</td>
</tr>
<tr>
<td>Cycle time</td>
<td>9 ms to 30 ms (adjustable)</td>
</tr>
</tbody>
</table>

Command set
- Bit, byte, and word commands
- Logical operations
- Arithmetic commands
- Comparisons
- Bracketed terms
- Jump commands
- Subprograms
- Stack operations
- Submit programs
- Timers
- Counters
- Comments
- PLC modules
- Strings

Encryption of PLC data
The encrypted PLC partition (PLCE:) provides the machine manufacturer 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 be backed up from the control to a separate data medium (USB drive or 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.

Functions:
- User-friendly text editor
- Menu-guided operation
- Programming of symbolic operands
- Modula 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
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 employed universally for machine functions, complex calculations, and the display of 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 can also be executed without enabling Python OEM Process (software option 46). Reserved for this function are 10 MB of dedicated memory. 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 axes
- Axes with clamping mode, central drive, and the Hirth grid
- Synchronized axes
- 3D 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
- Rotatory 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
- Diagnosis screen (Python)
- Python example applications
- Status display in the small PLC window
Interfacing to the machine

OEM cycles
The machine manufacturer 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 measurement
With the TT tool touch probe systems (accessory), tools can be measured and inspected. 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 the touch-probe table. All HEIDENHAIN touch probe systems are preconfigured and can be selected through a drop-down menu.

Pallet management
Pallet insertions 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

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 a data network, the control features a 1000BASE-T (twisted pair Ethernet) connection.

Maximum transmission distance:
- Unshielded: 100 m
- Shielded: 400 m

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

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

Data transfer speed
- Approx. 400 to 800 Mbit/s (depending on the file type and network utilization)

Protocols
The TNC 640 can transfer data using various protocols.

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

Blockwise data transfer
The data is transferred blockwise. A block check character (BCC) is used for data backup. This method improves data security.

OPC UA NC Server
Connection of an OPC UA application

USB
The TNC 640 features USB ports for connecting standard USB devices such as a mouse, disk drive, etc. The MCs have 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 up to 5 m
- Cable length 6 m to 30 m with integrated amplifier; limited to USB 1.1.
Software for data transfer

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

This PC software package supports the user in transferring 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

TN Cremo
( 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 up time, machine up time, machine running time, spindle running time, pending errors, data from the data servers—e.g., symbolic PLC operands)
- Overwriting of specific tool data based on values from 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

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 job 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 come to terms with the increasingly complex requirements of the machine’s environment.

The flexibility of the PC software and the large selection of ready-to-use software components and standard tools in the development environment enable you to develop PC applications of great use to your customers in a very short time, for example:
- Error reporting systems that, for example, send the customer a text message to his cell phone reporting problems on the currently running machining process
- Standard or customer-specific PC software that decidedly increases process reliability and equipment availability
- Software solutions controlling the processes of manufacturing systems
- Information exchange with order 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 workstation ID 1122145-02
For 14 workstations ID 1113935-02
For 20 workstations ID 1113936-02

For more information, refer to the HEIDENHAIN DNC brochure.
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 (recommended by the 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 installing the control components and power modules, take note of the minimum spacing, space needed for servicing, and the appropriate length and location of the connecting cables as detailed in the Technical Manual of the TNC 640.

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

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

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
The units comply with EN 50370-1 and EN 61800-3, and are intended for use in industrially zoned areas.

Likely sources of interference
Interference is produced by capacitive and inductive coupling into electrical conductors or into device connections. This is caused, for example, by:
- Strong magnetic fields from transformers or electric motors
- Relays, contactors, and solenoid valves
- High-frequency equipment, pulse equipment, and switch-mode power supplies
- 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
- Minimum distance of 10 cm between MC, CC, and signal lines to cables carrying interfering signals (in metal cable ducts, a grounded separation wall suffices for decoupling)
- Shielding by means of closed, grounded metal enclosures (e.g., an electrical cabinet)
- Use equipotential bonding lines in accordance with the grounding diagram (comply with the Technical Manual of your control)
- Use only genuine HEIDENHAIN cables and connecting elements

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

* Apple and macOS are trademarks of Apple Inc.
Key dimensions
Main computer

IPC 8420

IPC 6490
Operating panel, monitor, and keyboard

Front panel opening
Mounting surface
Space for air circulation
Mounting brace (6x), each with two M4 setscrews with hexagon socket and centering cone (Md = 0.4 – 0.5 Nm)
O-ring cord, EPDM

= 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
TE 361, TE 361 FS

- Front panel cutout
- Mounting surface
- Nut M5
- Optional mounting braces (6x), each with two M5 setscrews with hexagon socket and centering cone (N_a = 0.4 - 0.5 Nm)
- Seal
- Weld stud with external thread M5 (4x)

TE 730

- Front panel opening
- Mounting surface

Tolerancing ISO 8015
ISO 2288 - m H
± 6 mm; ±0.2 mm
TE 735, TE 735 FS

Front panel opening
Mounting surface

MB 720, MB 720 FS

Front panel opening
Mounting surface
MB 721, MB 721 FS

PLB 6001, PLB 600x FS

= Front panel opening
= Mounting surface
PLC inputs and outputs

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

Clearance for air circulation

Electronic handwheels

**HR 510, HR 510 FS**

**HR 520, HR 520 FS**
HR 130

Adapter cable for handwheels (straight)

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

HR/HRA adapter cable to MC (straight connector)
**Adapter cable for handwheels (angled)**

**Line-drop compensator for encoders with EnDat interface**

**USB extension cable with hubs**

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**If you have any specific questions or need further assistance, feel free to ask!**
KTY adapter connector

Leave space for connecting cable!

VT 121

View with fixing clamps, cables, and compressed air tubes

1 = Focal plane
2 = Focus range
3 = Field of view

Vision system
**General information**

**Documentation**

**Technical documentation**

- Technical Manuals (PDF format on HESIS-Web including Filebase)
  - TNC 640 ID 892889
  - PNC 610 ID 1191125
  - Inverter Systems for Gen 3 Drives ID 1252650
  - Functional Safety (FS) ID 743983
  - Functional Safety (FS) Supplement to the Technical Manual ID 1177599
  - Python in HEIDENHAIN Controls ID 757807
  - OPC UA NC Server ID 1300685

**User documentation**

- User's Manuals
  - TNC 640:
    - Klartext programming ID 892903-xx
    - Setup, Testing, and Running NC Programs ID 1261174-xx
    - Programming of Machining Cycles ID 1303406-xx
    - Programming of Measuring Cycles for Workpieces and Tools ID 1303409-xx
    - ISO Programming ID 892909-xx
  - General:
    - TNCremo Integrated help
    - TNCremoPlus Integrated help
    - PLCdesign Integrated help
    - CycleDesign Integrated help
    - IQconfig Integrated help
    - KinematicsDesign Integrated help
    - M3D converter Integrated help

**Other documentation**

- Brochures
  - TNC 640 ID 892916-xx
  - Touch Probes ID 1113984-xx
  - Inverter Systems for Gen 3 Drives ID 1303180-xx
  - Motors ID 208893-xx
  - RemoTools SDK virtualTNC ID 628968-xx
  - Programming Station for TNC Controls ID 825930-xx
  - Options and Accessories for TNC Controls ID 827222-xx

- Booklets
  - HR 550 FS ID 638227-xx
  - OPC UA NC Server ID 135079-xx

- DVDs
  - Touch Probes ID 344353-xx
  - Programming Station: TNC 640 Demo Version ID 114029-xx

**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 technical support to the machine manufacturer in order to optimize the interfacing 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** +49 8669 31-3101
  E-mail: service.nc-support@heidenhain.de
- **PLC/Python programming** +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.com](http://www.heidenhain.com) [Service & Support] [Technical training]