



TNC7

Contouring Control for
Machining Centers and
Milling-Turning Machines

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This brochure describes the functions and specifications of the TNC7 with NC software 81762x-16.

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Intuitive, task-focused and customizable

TNC contouring control for milling and milling-turning machines

For more than 45 years, TNC controls from HEIDENHAIN have proven themselves every day on milling machines, machining centers, and drilling machines, and they have continually been further developed over this period. TNC7, the next level of control technology, supports the operator from the initial idea to the finished workpiece:

- From one-off jobs to serial production
- From simple slots to complex contours
- From machine setup to program execution

Task-focused support

In fact, the entire user guidance system is designed around this. You intuitively operate highly complex applications directly on the touchscreen. Many integrated solutions for standard tasks simplify your daily work. Specially developed touch probe cycles guide you through the probing process step by step.

Intelligent solutions

The TNC7 makes machining even easier, for everything from programming to program validation and from machine setup to actual machining. The TNC7 provides you with task-focused support and thoughtfully designed solutions at every stage along

the way, from initial design to the finished workpiece. Take the graphical programming feature: you draw the workpiece directly on the touchscreen, and the TNC7 then converts your drawing into Klartext, all at the highest computing speeds.

Enjoy a customizable user interface

The TNC7 can be customized: you store favorites and decide for yourself where the status information is shown on the dashboard or in the workspaces. You can choose this for your entire shop, for separate teams, or even for each individual user. That way you always see exactly what is needed at the moment, making the machine much easier to operate every step of the way.



Universally applicable

The TNC7 is particularly well suited to milling, turning, grinding, HSC, and 5-axis machining on machines with up to 24 axes. The following applications play to the strengths of the TNC7:

Milling-turning machines

- Easy, program-controlled switching capability between milling and turning
- Extensive package of turning cycles
- Constant surface speed
- Cutter radius compensation

Universal milling machines

- Shop-floor programming in Klartext, the conversational programming language from HEIDENHAIN
- Rapid preset setting with HEIDENHAIN touch probes
- Electronic handwheel

High speed milling

- Fast block processing
- Short control-loop cycle time
- Motion control with jerk compensation
- High spindle speed
- Fast data transfer

Boring mill

- Cycles for drilling, boring, and spindle alignment
- Drilling of oblique holes
- Control of quills (parallel axes)

Five-axis machining with swivel head and rotary table

- Tilting the working plane
- Cylinder surface machining
- Tool Center Point Management (TCPM)
- 3D tool compensation
- Fast program execution thanks to short block-processing times

Machining centers and automated machining

- Tool management
- Pallet management
- Controlled preset setting
- Preset management
- Automatic workpiece measurement with HEIDENHAIN touch probes
- Automatic tool measurement and breakage inspection
- Connection with host computer

Grinding operations

- Convenient functions for jig grinding and dressing
- Reciprocating stroke superimposed onto the tool axis
- User-friendly cycles



Intuitive and user-friendly

State-of-the-art multi-touch operation

Monitor

The 24-inch full-HD screen shows a clear overview of all relevant information for programming, operating and monitoring the control. Along with its extensive functionality, the TNC7 provides maximum flexibility for everyday work. A user can optimally adapt the screen's content to his individual tasks, meaning that the TNC7 makes customized solutions possible that are perfectly adapted to the needs of a company, a team, or even individual users.

Operating panel

With its optimized operating design, the TNC7 sets new standards in terms of efficient and ergonomic work at the machine tool. The operating design of the TNC7 is fully touch-optimized. You can rotate images, select functions, and navigate, all with dynamic tapping and swiping motions on the touchscreen. But you still have the convenience and ergonomics of

using a keyboard and trackball if desired. The keys of the machine operating panel are designed for precise operation of machine functions. Comments can also be easily entered using the alphanumeric keypad. Thanks to the reduced depth of the keyboard, the user is closer to the control screen. All screen areas are thus within hand's reach, which is ideal for operating the touchscreen ergonomically.

Ergonomic and sturdy design

The anodized finish on the keyboard unit is highly resilient to chemical and mechanical factors. The engraved keyboard lettering, such as on the potentiometer scale, exhibits high scratch and abrasion resistance.

Full-fledged touch operation

Touch gestures are perfect for operating the TNC7. The high-performance user interface reacts quickly to input. The touch control is as smooth, precise and familiar as that of a smartphone or tablet PC. You can also use familiar gestures to smoothly reposition or zoom in on complex 3D models.

The workpiece and work envelope are virtually simulated for every task, thus providing the user with continuous 3D visualization support. Rounding off the TNC7 design are operating components with optimized ergonomics for working at the machine.

Practical touchscreen

With an IP54 rating, the touchscreen is designed to handle harsh shop conditions thanks to these characteristics:

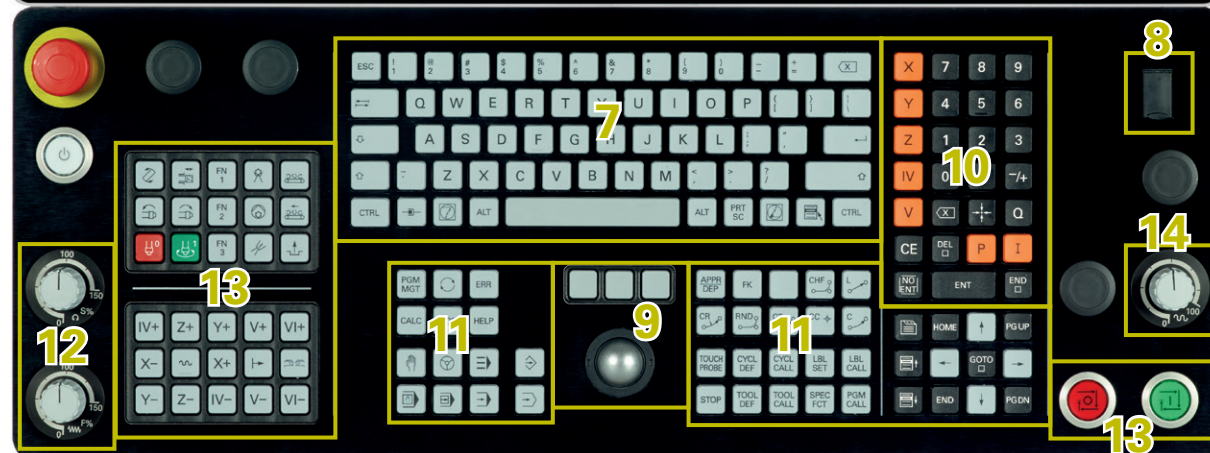
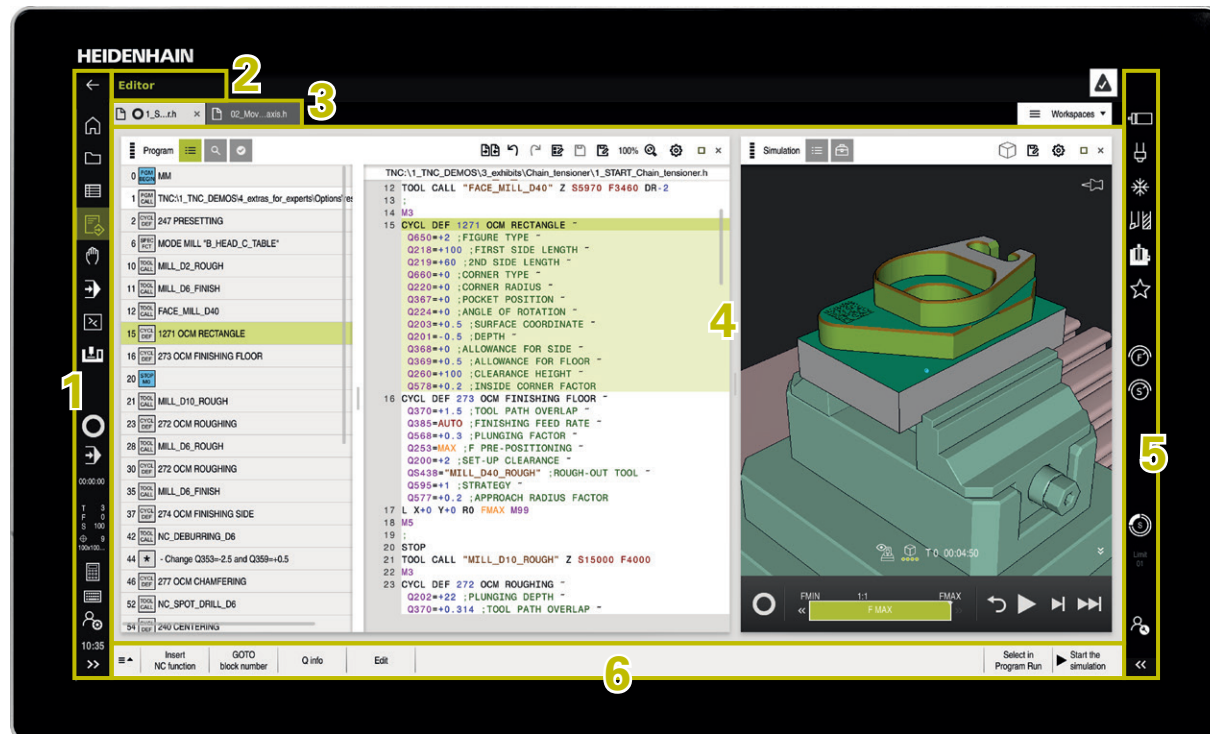
- Dust-protected
- Splash-proof
- Scratch-proof

To clean the screen, simply select the touchscreen cleaning mode. This locks the screen to prevent unintended operation.

Gestures for multi-touch operation

You can operate the screen of the TNC7 with gestures already familiar to you from your smartphone or tablet. For example, you can zoom in or out with two fingers, or swipe to rapidly navigate through menus.

Icon	Gesture
	Tap
	Double tap
	Long press
	Swipe
	Drag
	Two-finger drag
	Spread
	Pinch



- TNC bar** with a "Go back" command, operating modes, status overview, calculator, on-screen keyboard, settings, date and time
- Information bar** with the active operating mode and a message menu
- Application bar** with tabs for opened applications, selection menu for workspaces
- Workspaces**
- OEM bar**
- Function bar** with buttons and selection menu for buttons
- Standard keyboard** for comments and a set of PC keys for controlling operating system functions
- USB port** for additional data storage or pointing devices
- Trackball and mouse buttons** for easy operation
- Axis-selection keys and numeric keypad**
- Function keys** for programming modes, machine operating modes, TNC functions, management, and navigation
- Override potentiometers** for feed rate and spindle speed
- Machine operating panel** with snap-on keys and LEDs
- Override potentiometer** for rapid traverse

Intuitive and user-friendly

Highly practical user interface

The key to safe and low-fatigue work is having an intuitive screen layout and an ergonomic, well-arranged keyboard. Although HEIDENHAIN has been adhering to these principles for a long time, the TNC7 offers a number of features that make working with the control even simpler and easier than before.

Different tasks require individualized work environments, and the TNC7 lets you customize your screen content as desired. The users store favorites and decide for themselves where important status information or workspaces are shown: to the entire shop, to separate teams, or to each individual user. Depending on the respective application, certain contents can be given more emphasis while others are relegated to the background or even hidden. Also, the possible settings are easily reached, since they are not hidden in the depths of machine parameters.

The user interface of the TNC7 is designed to optimally assist you in your daily work, making results fast and easy to attain. Based on fillable forms and dialog guidance, it delivers optimal operating convenience and navigation. The TNC7 achieves this level of performance thanks to its touch-operated software. You can rotate images, zoom in and out, select functions, and navigate, all with dynamic tapping and swiping motions on the touchscreen.

Leading-edge design

The user interface of the TNC7 boasts a sleek outer appearance with a task-oriented structure and a pleasingly uniform font. The different screen areas are clearly delineated, and the operating modes are indicated by special operating mode symbols. The TNC and information bars give you a perfect overview for confident navigation. The TNC7 lets you individually arrange the TNC and OEM bars, such as for switching between right-handed and left-handed operation.

To help you evaluate the priority of error messages, the TNC7 displays them in color-coded categories. Programming errors are even highlighted directly within the NC program.

The smartSelect functions overview

With dialog guidance you quickly and easily choose functions from a central window. A tree structure shows all of the subordinate functions that can be defined in the control's current operating state. In the left part of the window, the TNC displays favorites and recently called functions. That makes it very easy for you to mark frequently used functions as favorites. There are also NC functions for defining path functions, labels, tool calls, and cycles, as well as for special functions, parameter functions and miscellaneous functions.

Easy to operate

New users will quickly find their way, thanks to the task-oriented operating modes and the perfectly designed visuals. Experienced TNC users will also be on familiar territory, since the well-proven function keys for navigation, operating modes and axis selection, for example, are still there. Along with being very intuitive, the TNC7 also provides brief training videos where new functions are clearly explained step-by-step.

A special feature of the TNC7 is its Home operating mode, which gives you simple and direct access to functions that are important to you. Two examples of this are the search function and a selection of frequently used favorites. By being able to define files, cycles, status parameters, etc. as favorites, you always have the necessary files and applications within easy reach. Naturally the common keyboard shortcuts, such as for copying, pasting and undoing, are always at your fingertips.

Straightforward program layout

The content of a program line can be quite extensive:

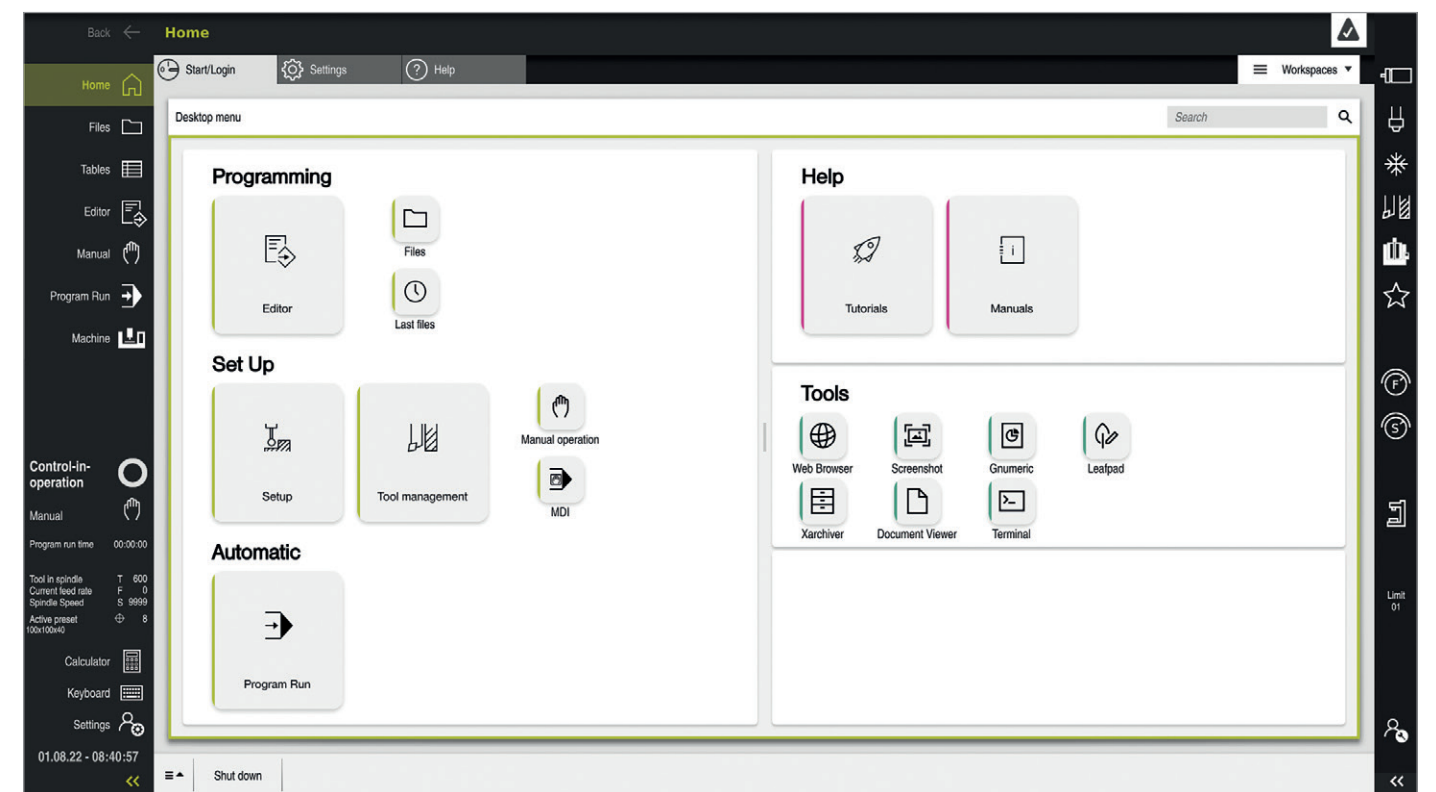
- Line number
- Program function
- Input value
- Comment

To make sure you always keep an overview even in complex programs, the TNC7 displays the individual program elements in different colors. This allows you to see at a glance which input values are editable. Also, on the TNC7, you can open more than one NC program at a time, for example in order to compare contents and copy them from one program to another.

The structuring function facilitates precise and efficient navigation within an NC program. The control creates a structure with configured elements, such as tool change, NC functions, and cycles. You can then use these structure items to jump directly to the corresponding location in the NC program. Additionally, program calls (CALL PGM) can be opened as new tabs.

File and table management

The file management of the TNC7 lets you open multiple folders and switch between the windows as desired. The copy, paste, undo and redo functions are also available here. If you accidentally delete any files, you can restore them from the recycle bin. In the table management you can open multiple tables and switch between them at any time. The table editor offers numerous practical features. For example, in the tool management you can use the sort and search function to sort all tools according to their various tool types. By selecting favorites, you can individually customize your table forms any time you want.



Multi-operation machining

Milling, turning and grinding on one machine (option)

Does your workpiece need to be moved to a lathe or grinding machine for additional machining steps after milling? Is all the additional capacity planning, fixture production, workpiece setup, and finished-part inspection a burden? If so, then a TNC7 on a milling-turning machine can save you a lot of time. With the TNC7, you can machine the complete part in one setup using milling, turning and grinding operations in any sequence desired. And when you're finished, you can measure the finished part inside the machine using a HEIDENHAIN touch probe.

The TNC7 provides powerful functions for NC-program-driven switching between turning, dressing and milling mode. This gives you complete freedom to decide how and when you want to combine the various machining methods. And naturally, the ability to switch between machining modes is independent of the machine and its axis configuration. When switching between modes, the TNC7 automatically handles all of the internal changes, such as switching to diameter display, setting the preset in the center of the rotary table, and machine-dependent functions such as clamping the tool spindle.*

* The machine must be prepared for this function by the machine manufacturer.

Programming as usual

You program machining operations as always using the proven and convenient HEIDENHAIN Klartext conversational programming language or graphical programming. In addition, turning-specific recessing and undercutting contour elements are available and can be defined with informative help illustrations. Even grinding operations can be programmed as usual with HEIDENHAIN Klartext dialog guidance. If the contour is available as a CAD file, then you can easily import it with the aid of the CAD Import function (option).

Milling, turning and grinding cycles

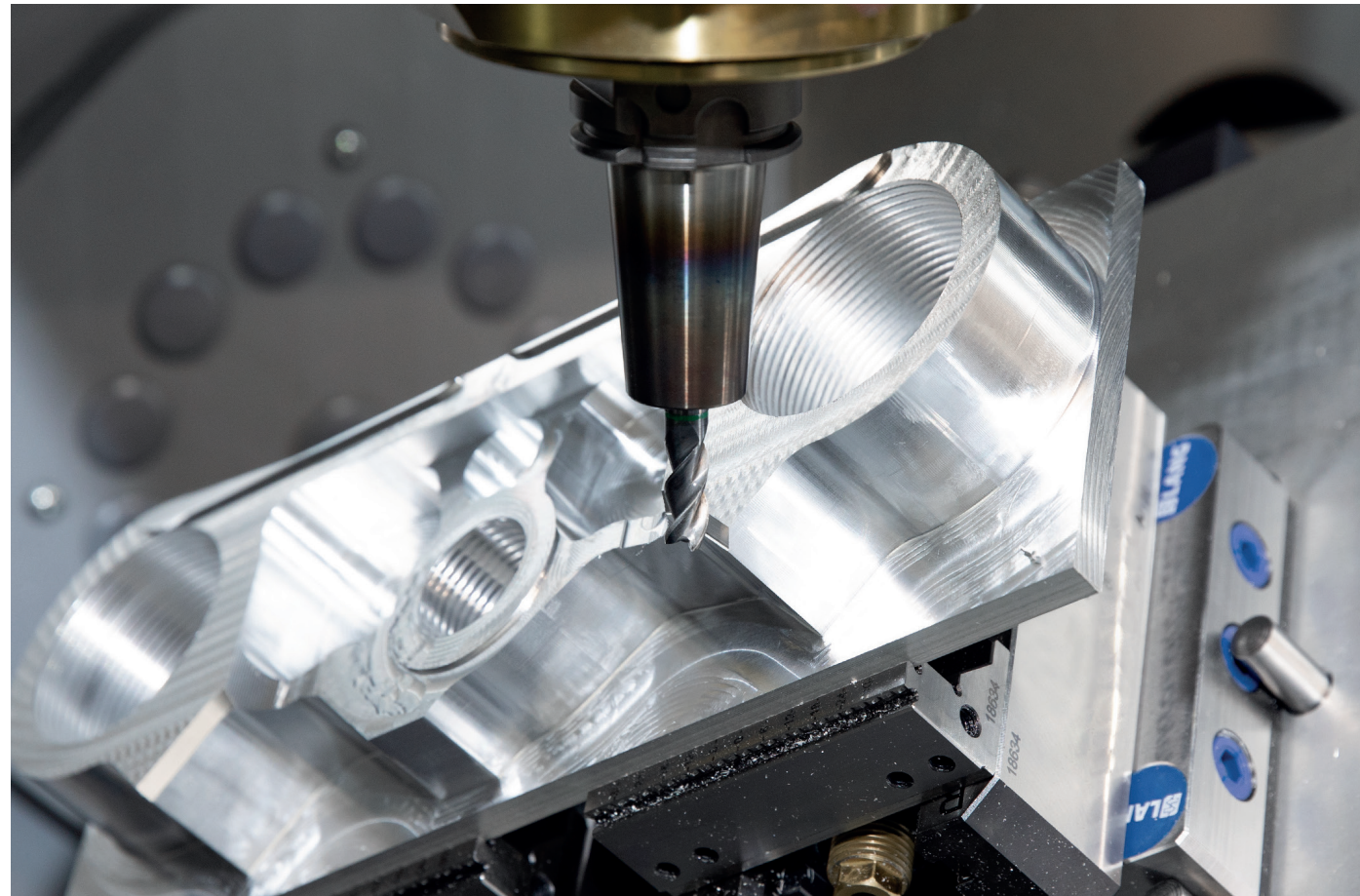
HEIDENHAIN controls have always been known for their extensive, high-tech package of cycles. The cycles of the TNC7 include multi-step, frequently recurring operations. As you program, conversational guidance and informative help graphics illustrating the required parameter data provide support. In addition to the well-known TNC milling and drilling cycles, the TNC7 also provides a plethora of turning cycles for roughing, finishing, recessing, thread cutting, recess turning, and more. These turning functions are based on software from the long-proven HEIDENHAIN turning controls, allowing you to program even complex turning operations with ease on the machine.

The TNC7's more complex turning cycles employ the same techniques as those used for milling. As a result, TNC programmers can build on their prior knowledge to rapidly enter the world of turning operations on a milling machine without retraining. The control also features grinding cycles, including:

- Define reciprocating stroke
- Activate wheel edge
- Profile dressing

Polar kinematics

With polar kinematics, the motions in the working plane are performed by one linear axis and one rotary axis. This greatly increases the machining operations possible on machines which have only two linear axes. For example, front-face operations become possible on rotary and cylindrical grinding machines. And on milling machines, suitable rotary axes can replace various linear axes, for example when working on very large surfaces on large machine tools.



Programming, editing and testing

A full range of possibilities with the TNC7

Programming at the machine

HEIDENHAIN controls are designed for shop-friendly programming right at the machine. Instead of requiring you to know G-codes, the Klartext conversational programming language provides its own buttons and keys for programming straight lines, arcs and cycles. At the push of a button, HEIDENHAIN Klartext dialog guidance opens and actively helps you during programming on the TNC. Its clear instructions prompt you to enter all of the required data.

The TNC7 also offers form-based programming, where you enter syntax elements or cycle parameters with dialog guidance in clearly structured forms. Along with the proven path functions, the TNC7 also features graphical contour programming, with which you can very easily program contours that are not dimensioned for NC.

If you detect an error during the simulation, you can directly edit the NC program without having to switch the operating mode. You decide on the size and arrangement of the program windows, simulation windows, etc., based on your own requirements.

Multiple programs can be open simultaneously on the TNC7. Naturally you can also copy parts of programs from an opened program to another program.

The "program comparison" function of the TNC7 is a very practical feature for finding differences between NC programs. You can even copy the program sequences into the active NC program as required. Also, with this function you can compare unsaved program changes with the last saved version of the program.

All interface texts, including Klartext tips, dialog prompting, program steps, and buttons, are available in numerous languages.

Just like with all other HEIDENHAIN controls, the greatest possible compatibility was also emphasized for the TNC7. Already existing NC programs and tool tables of the TNC 640 and TNC 620 can easily be incorporated. Programs from older TNC controls also run on the TNC7, but some slight modifications might be necessary.

Creating programs offline

The TNC7 is also well equipped to handle offline programming. Its interfaces allow the control to be integrated into networks or to connect with other data storage media.

Individual machining steps

You don't need to create a complete program in order to start machining with the TNC7. You can machine a workpiece step-by-step using both manual machining and automatic positioning in any sequence.

Minimize setup times

The TNC7 makes setup easy

Before machining can begin, the workpiece must first be clamped, the machine must be set up, the position of the workpiece in the machine must be determined, and the preset must be set. This is a time-consuming but indispensable procedure because any error directly reduces the machining accuracy. Particularly in small and medium-sized production runs, as well as in the case of very large workpieces, setup times become a significant factor.

The TNC7 features application-oriented, real-world setup functions that support the user, help reduce non-productive time, and enable overnight, unattended production. In conjunction with the **touch probes**, the TNC7 offers numerous probing cycles for automatic workpiece setup, setting the preset, and measuring workpieces and tools.

The TNC7 simplifies machine setup thanks to manual, smart probing functions. Via a button menu, the user can select the desired probing function. The probing functions then provide step-by-step guidance through the measuring task, with intuitive user guidance, context-sensitive help images, and a clear presentation of the probing results.

Fine manual axis control

During setup, you can use the axis-direction keys to move the machine axes manually or with an incremental jog. A simpler and more reliable way, however, is to use the electronic handwheels from HEIDENHAIN. With these handwheels, you are always close to the action, enjoy a close-up view of the setup process, and can control the infeed responsively and precisely.

Adapting the probing speed

In many cases, the workpiece must be probed at unseen positions or in cramped spaces, and the standard probing feed rate is usually too fast for this. In such situations, you can use the override knob to change the feed rate during probing without affecting the accuracy.

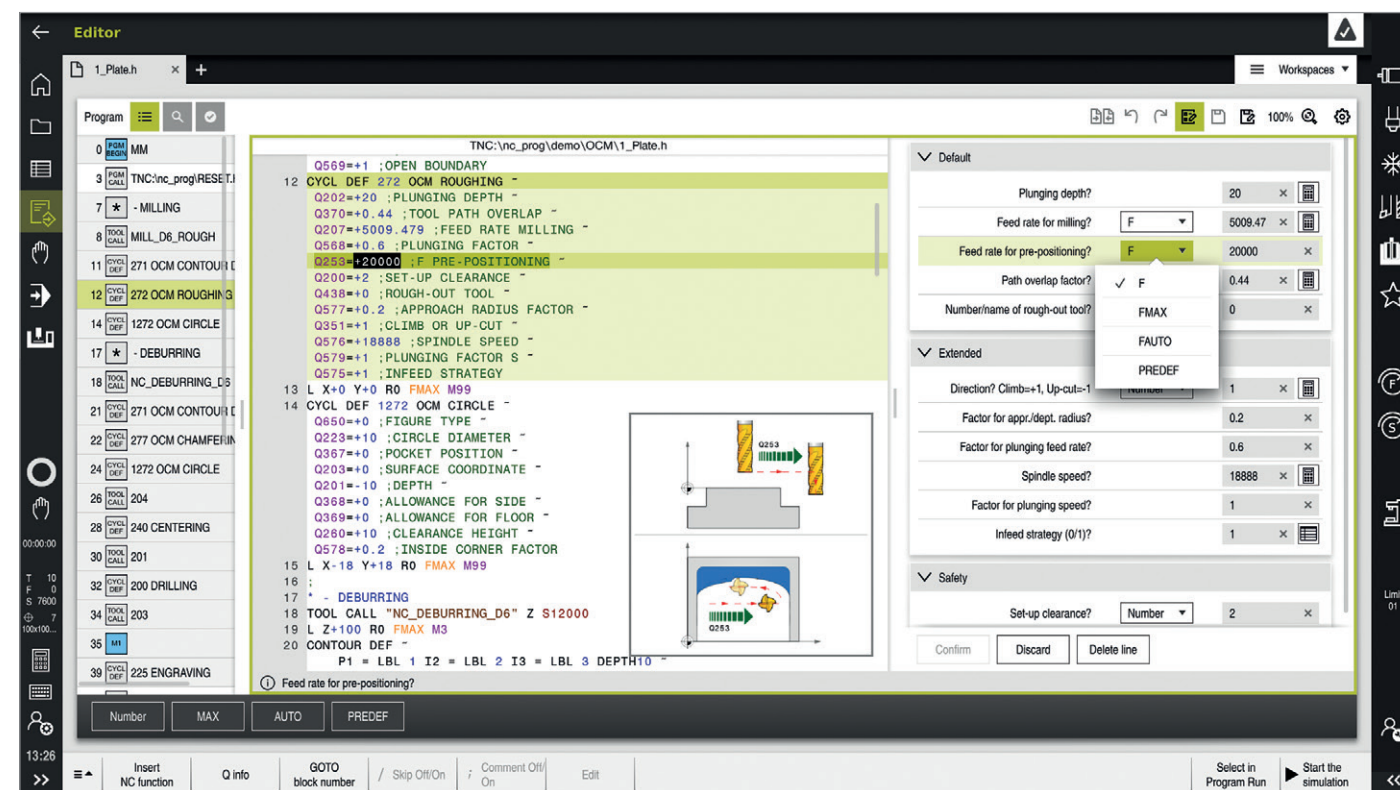
Workpiece alignment

The HEIDENHAIN touch probes and probing functions of the TNC7 reduce the need for tedious manual alignment of the workpiece:

- You start by simply clamping the workpiece in any position.
- The touch probe probes a surface to determine the amount of workpiece misalignment
- The TNC7 compensates for this misalignment with a "basic rotation," either by rotating the NC program to the ascertained angle or by correcting the actual misalignment through a turn of the rotary table.

The TNC7 offers you a comprehensive package of cycles for setting up the machine tool:

- Manual, automatic, and semiautomatic cycles for presetting and for compensating for misalignments in two or three dimensions
- Automatic probing cycle for repeating a measurement along a line
- A cycle with graphical support for calibration of fixtures
- Manual and automatic cycles for workpiece and tool measurement
- Semiautomatic tolerance monitoring and actual-to-nominal value transfer



Automated machining

The TNC7 measures, manages and communicates automatically

Workpiece presetting

A preset allows you to assign a defined value displayed by the TNC to any position on the workpiece. Finding this point quickly and reliably reduces non-productive time and increases machining accuracy.

The TNC7 features probing cycles for automatically setting presets. Ascertained presets can be saved as follows:

- Using the preset management
- In a datum table
- Through direct setting of the display

Preset management with the preset table

Preset management enables flexible machining, shorter setup times, and higher throughput. Setting up your machine is greatly simplified.

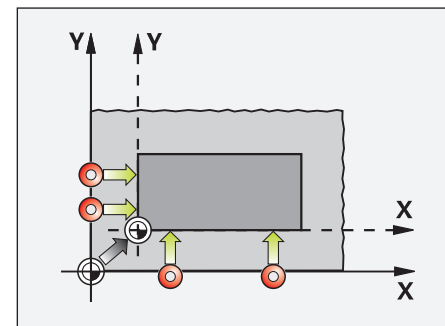
In preset management, you can save **any number of presets** and assign an individual basic rotation to each one. In order to permanently save fixed presets in the machine's workspace, you can also write-protect individual lines.

There are three possibilities for rapidly saving the presets:

- Manually in the manual operation mode
- Via the probing functions
- With the automatic probing cycles

Saving datums

Datum tables let you save positions or measured values from the workpiece. Datums are always defined relative to the active preset.



Setting a preset

At a corner, for example, or in the center of a circular stud

The requirements gap between machining centers and typical tool and moldmaking machines is becoming ever narrower. Of course, the TNC7 is also very capable of controlling automated manufacturing processes. It features the necessary functionality to initiate the proper machining operation in concatenated machining scenarios with individual workpieces in any workholding arrangement.

Automated inspection of workpieces for proper machining and dimensional accuracy

The TNC7 features numerous automatic measuring cycles for inspecting the geometry of machined workpieces. This requires inserting a touch probe from HEIDENHAIN into the spindle in place of the tool. This allows you to do the following:

- Recognize a workpiece and call the appropriate part program
- Check for correct execution of all machining operations

- Determine infeeds for finishing
- Detect and compensate for tool wear
- Inspect workpiece geometry and sort parts
- Log measured data
- Ascertain the machining trend
- Check tolerances and configure various reactions, such as an error message

Measure milling cutter and automatically compensate tool data

In conjunction with the TT tool touch probe, the TNC7 lets you automatically measure milling tools in the machine. The TNC7 then stores the determined values, such as tool length and radius, in its tool memory. By inspecting the tool during machining, you can quickly detect wear or breakage for preventing scrap and rework. If the measured deviations lie outside the specified tolerances or if the monitored tool life has been exceeded, the TNC7 locks the tool and automatically inserts a replacement tool.

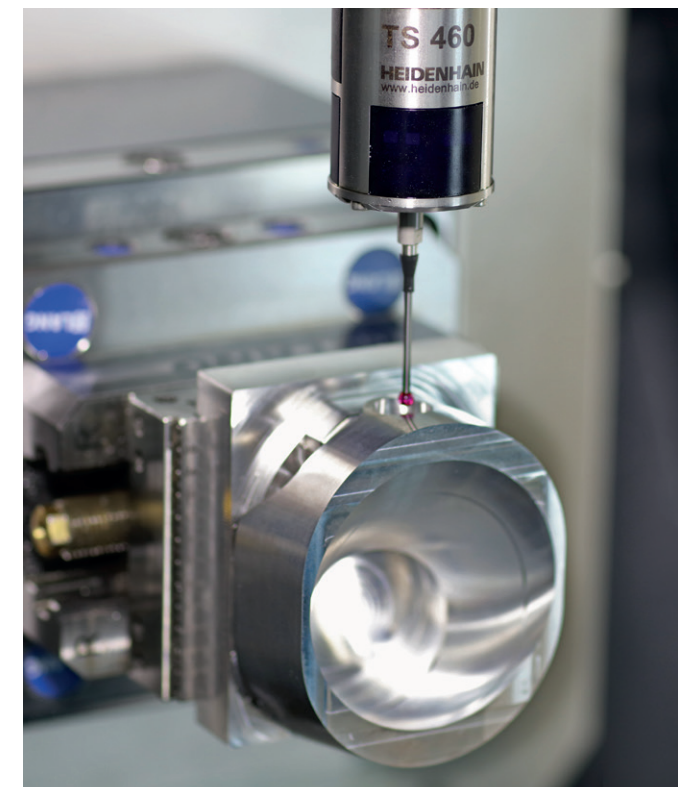
Tool management

For machining centers with automatic tool changers, the TNC7 offers a central tool memory for any number of tools. This tool memory area is a freely configurable file that can be optimally adapted to your needs. You can even have the TNC7 manage your tool names. The control prepares the next tool change while the current tool is still cutting. This significantly reduces the non-cutting time required for tool changes.

With the Expanded Tool Management option, the control shows only the required input fields regardless of the selected tool type. Any data can also be graphically depicted.*

* The machine must be adapted by the machine manufacturer for this function.

NO	DOC	X	Y	Z	SPA	SPB	SPC	X_OFFS	Y_OFFS	Z_OFFS	A_OFFS
0		0	0	102	0	0	0	0	0	0	0
1	50x50x80	0	0	336	0	0	0	0	0	0	0
2	50x50x80	-25	-25	336	0	0	0	0	0	0	0
3	60x60x80	0	0	336	0	0	0	0	0	0	0
4	60x60x80	-30	-30	336	0	0	0	0	0	0	0
5	100x100x20	0	0	276	0	0	0	0	0	0	0
6	100x100x20	-50	-50	276	0	0	0	0	0	0	0
7	100x100x40	0	0	296	0	0	0	0	0	0	0
8	100x100x40	-50	-50	296	0	0	0	0	0	0	0
9	100x100x70	0	0	326	0	0	0	0	0	0	0
10	100x100x70	-50	-50	326	0	0	0	0	0	0	0
11	50x50x80_KIN-AB	0	336	0	0	0	0	0	0	0	0
12	CLIMBING-PLATE	0	0	40	0	0	0	0	0	0	0
13	D80x80	0	0	283.55	0	0	0	0	0	0	0
14	D100x100	0	0	303.55	0	0	0	0	0	0	0



Global Program Settings (option)

The global program settings, which come into play particularly in large-scale mold making, are available in Program Run and MDI. This option allows you to perform a variety of coordinate transformations and settings, and then apply them globally to a selected NC program without actually modifying it.

You can even change the global program settings mid-program during a program stop. A clearly structured form is provided for this. When the program is started, the TNC7 moves to a new position as needed in accordance with a positioning logic that you have defined.

The following functions are available:

- Shifting the home position of an axis
- Adding a rotation to a basic rotation or 3D basic rotation
- Shifting the workpiece preset in any axis
- Mirroring individual axes
- Additive datum shift
- Rotation about the active tool axis
- Handwheel superimpositioning
- Feed rate factor

Handwheel superimpositioning is possible in various coordinate systems:

- Machine coordinate system
- Workpiece coordinate system (the active basic rotation is taken into account)
- Tilted coordinate system

You can select the desired coordinate system in a clearly structured form.



Pallet management and serial machining

Pallet management

Pallet management functionality lets you automatically machine workpieces in any order. Upon insertion of the pallet, the correct machining program and preset are automatically selected. You can also apply coordinate transformations and measuring cycles in the part programs. A pallet counter function lets you easily define the desired quantity to be produced.

Batch Process Manager (option 154)

Batch Process Manager is a powerful function for pallet machining and series production. Its straightforward user interface helps you plan your production process and gather important information on upcoming machining operations.

Batch Process Manager automatically checks for missing tools, insufficient tool life, and required manual tool changes. The results are displayed in the status overview.

Batch Process Manager shows the following information before beginning the machining operation:

- The time of the next manual intervention
- Run time of NC programs
- Availability of tools
- Correctness of NC program

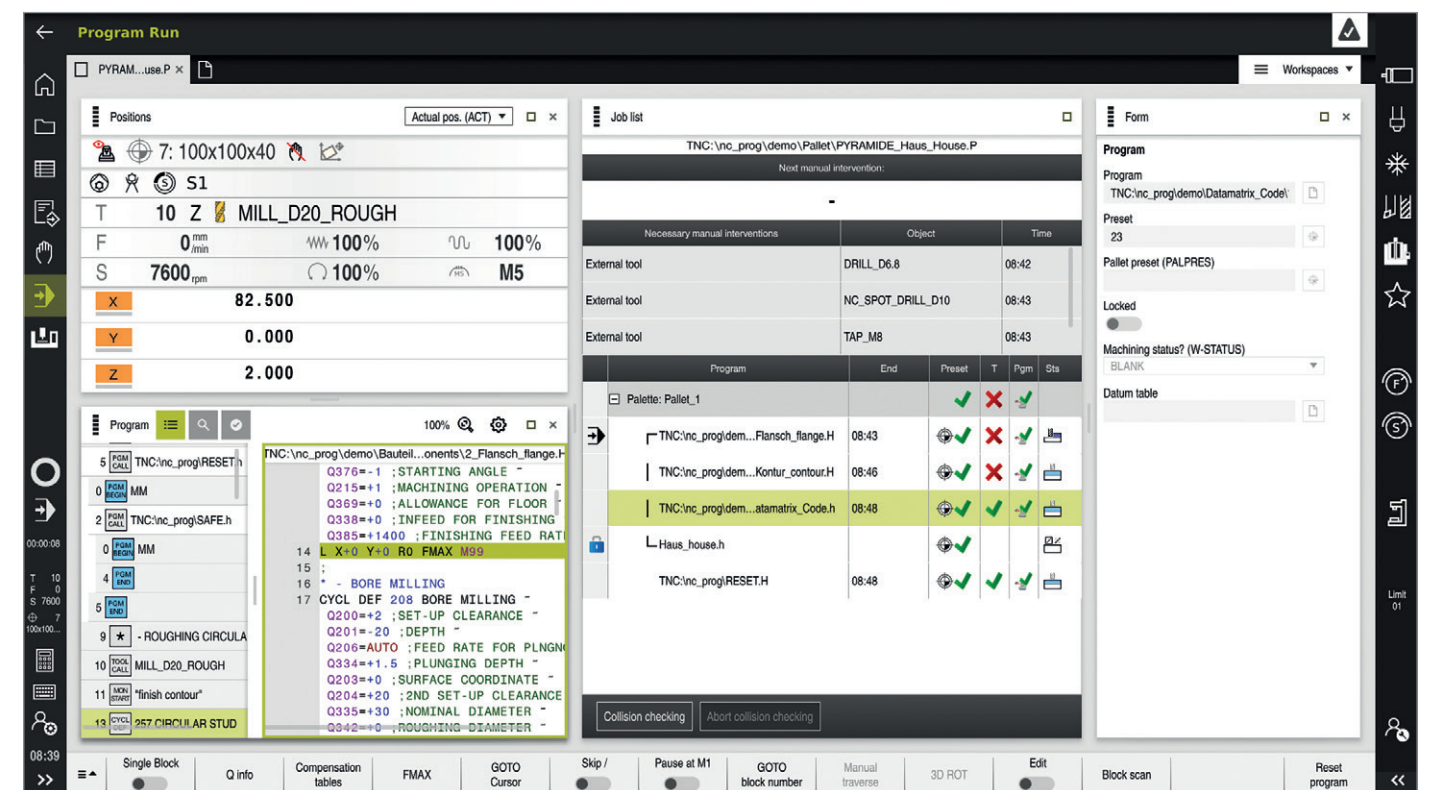
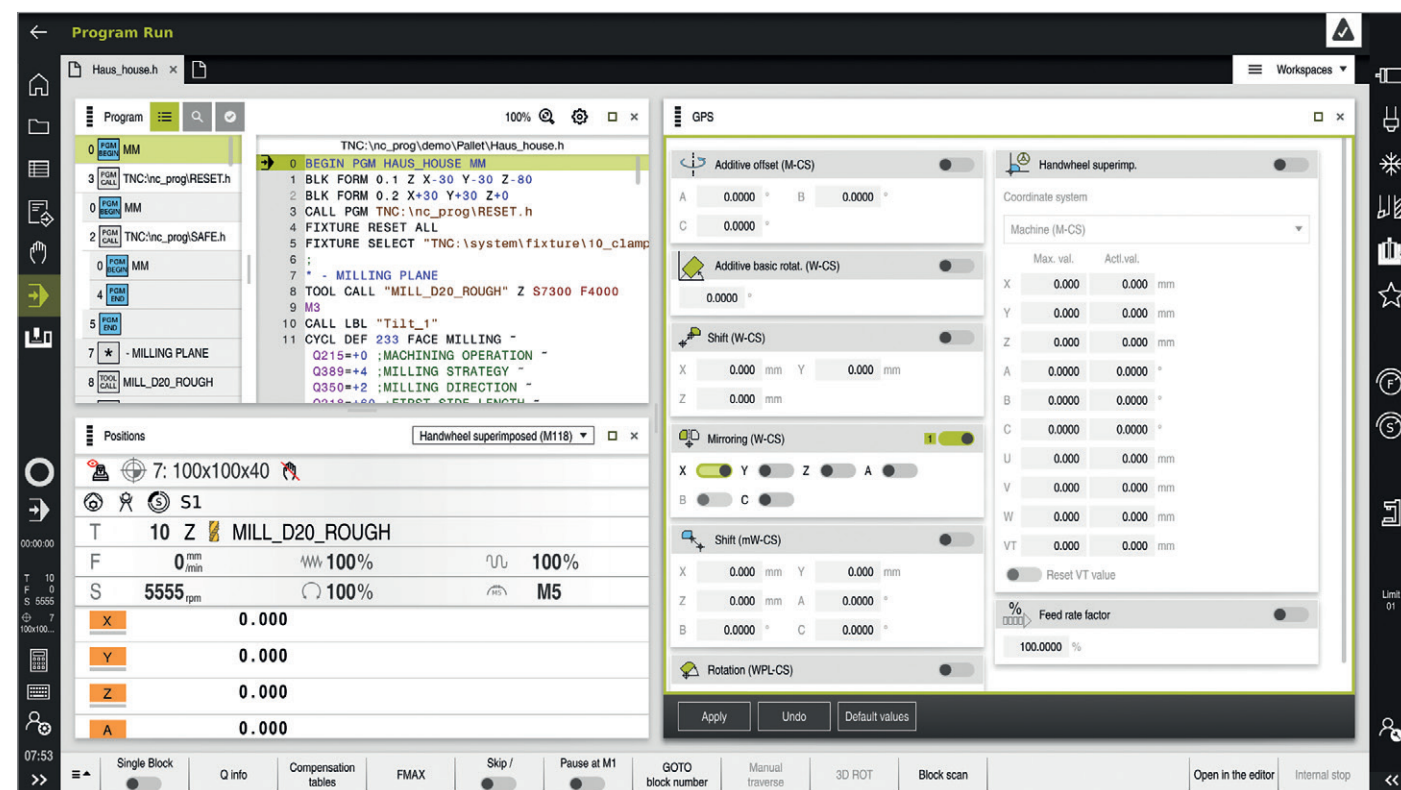
Additionally, the TNC7 can actively check for collisions in all pallet subprograms during program run (option 40 or 140 is necessary for this).

Tool-oriented machining

In tool-oriented machining, a single machining step is performed on all of a pallet's workpieces before moving to the next machining step. This keeps the number of tool changes to a minimum and significantly shortens the machining time.

The TNC7 supports you with convenient fillable forms that allow you to assign a tool-oriented operation to a pallet with multiple workpieces. As always, you still write the machining program in the normal workpiece-oriented sequence.

You can also use this function even if your machine does not support pallet management. In this case, you simply define the position of the workpiece on the machine table in the pallet file.



Intelligent machining

Dynamic Collision Monitoring (DCM, option)

The complex machine movements and the generally high traversing speeds involved in 5-axis machining make axis movements difficult to predict. This makes collision monitoring a valuable function that relieves the user and protects the machine from damage.

NC programs from CAM systems may be able to avoid collisions of the tool or tool holder with the workpiece but do not account for machine components in the workspace—unless you invest in expensive offline machine simulation software. But even then, there is no guarantee that the arrangement of machine components still matches the simulation. In the worst case scenario, collisions won't manifest themselves until the part is actually machined.

In these cases, the user is supported by the TNC7's **Dynamic Collision Monitoring (DCM)*** option. The control interrupts the machining process whenever a collision is imminent, thus increasing safety for both the machine and its user. This, in turn, helps prevent machine damage and any resulting costly downtime. Unattended shifts also become more reliable.

Dynamic Collision Monitoring (DCM) is active not only while a program is being executed, but also during manual operation and in simulations. If an impending collision is already detected during workpiece setup, for example, the axis motion is stopped with an error message.

The fixture import feature of DCM not only enables graphical representation of the fixtures, but also provides for collision checking during simulation and the actual machining process. An additional level of reliability is gained with the enhanced checking for collisions between the workpiece and the non-cutting part of the tool or the tool holder.

* The machine and TNC must be adapted for these functions by the machine manufacturer.

The machine manufacturer defines the machine components by using geometric bodies to describe the workspace and the collision objects. For tilting devices, the machine manufacturer can also use the description of the machine kinematics to define the collision objects.

The 3D format for collision objects offers further interesting benefits:

- Convenient data transfer of standard 3D file formats
- Detailed rendering of machine components
- Greater exploitation of the machine's workspace

The TNC7 can also monitor tool carriers such as holders for milling cutters or touch probe housings. To this end, a tool-carrier kinematic model is assigned to the tool in the tool table. When the tool is inserted, the respective tool carrier is activated in the collision monitoring function.

Because the machine design itself prevents collisions between certain machine components, not all of the machine parts require monitoring. For example, a HEIDENHAIN TT tool touch probe clamped to the machine

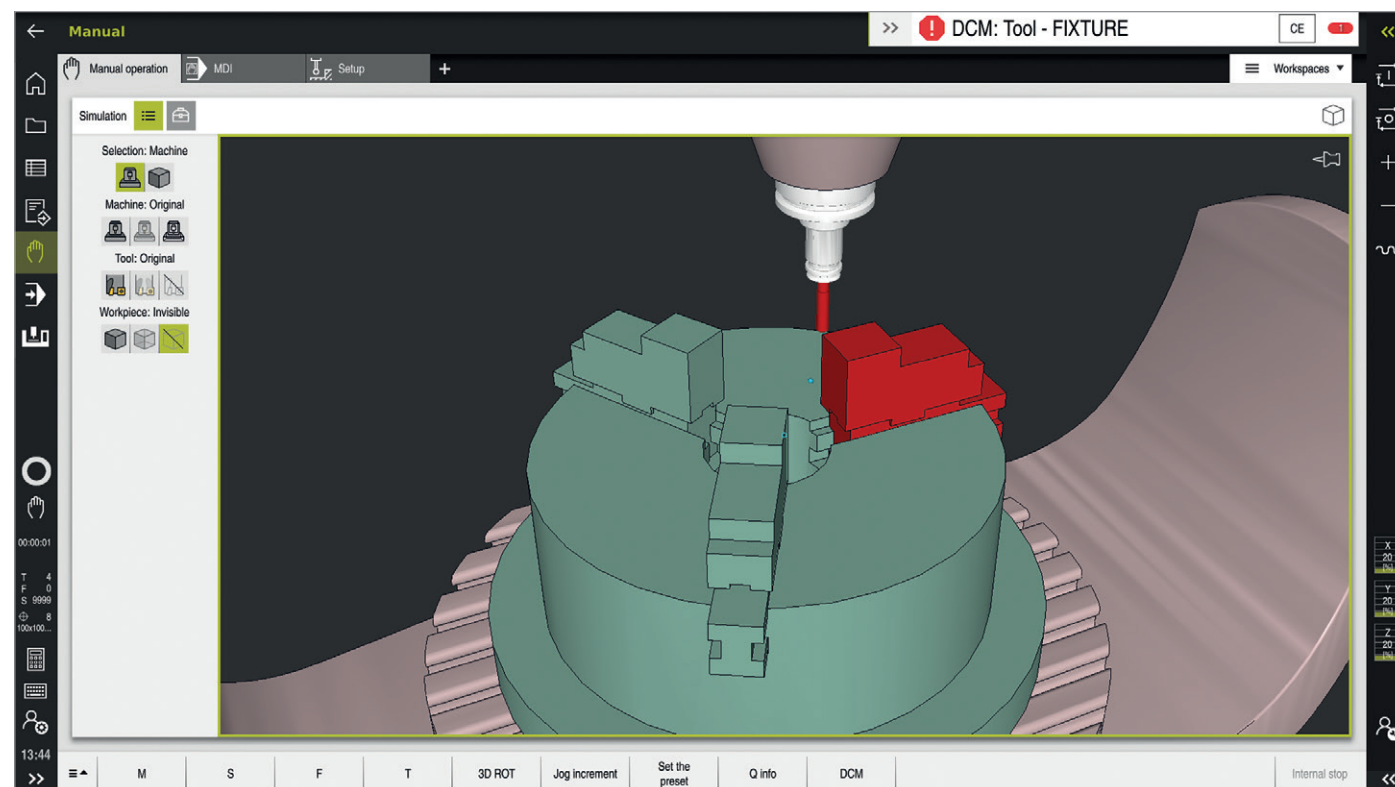
table for purposes of tool measurement will never collide with the machine cabin. The machine manufacturer can therefore limit the machine elements that could collide with each other.

When using Dynamic Collision Monitoring, please note the following:

- DCM can help reduce the danger of collision, but DCM cannot completely prevent all collisions.
- Only the machine manufacturer can define machine components.
- Collisions between machine components (such as a swivel head) and the workpiece cannot be detected.
- DCM cannot be used in servo-lag operation (no feedforward).
- DCM cannot be used for eccentric turning.

Expanded Collision Monitoring (option 140)

The expanded collision monitoring of the TNC7 not only prevents tools from colliding with machine components, but also with fixtures. The TNC7 features a special probing function that graphically and interactively assists you in determining the exact position of the fixture. That way you don't have to worry about either the sequence or the actual probing functions. Colored arrows in a virtualized work envelope show you whether the position is correct and the probing operation can be performed. This graphically supported measurement can be used for any workholding equipment. An accurate 3D model is all that is needed.



Dynamic collision monitoring (DCM) with warning of an impending collision



"Set up fixtures" function with Simulation workspace open

Fast and reliable machining at high contour fidelity

Dynamic Precision



The TNC7 is designed for exceptional accuracy and surface quality at high machining speeds, regardless of whether you are milling or turning. A variety of technologies, cycles and functions operating separately or in concert ensure perfect surface finishes in extremely short machining times:

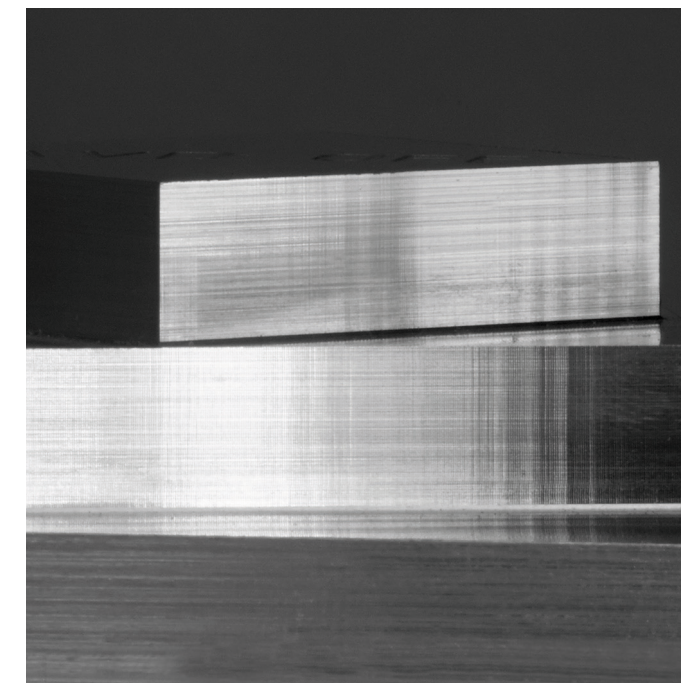
- Optimized motion control
- Effective jerk reduction
- Dynamic contour look-ahead

The umbrella term **Dynamic Precision** covers a number of HEIDENHAIN cutting solutions that can dramatically improve the dynamic accuracy of a machine tool. These solutions shed new light on the competing demands of accuracy, high surface quality, and short machining times. The dynamic accuracy of machine tools manifests itself in deviations at the tool center point (TCP). These deviations depend on kinetic quantities such as speed and acceleration (including jerk) arising from the vibration of machine components and other factors.

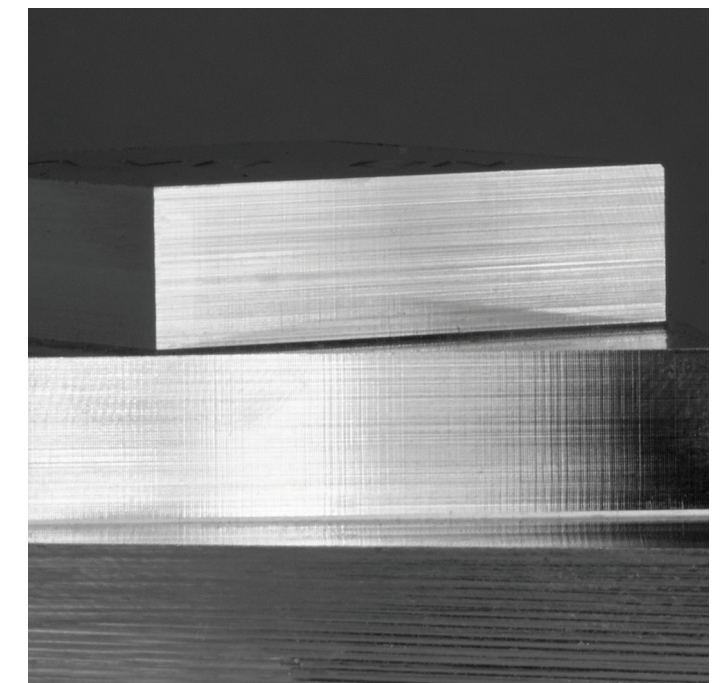
All of these factors contribute to dimensional inaccuracy and the formation of defects on the workpiece surface, thereby impacting both quality and productivity (in the case of quality-related scrap). Dynamic Precision counteracts these problems with intelligent control technology to help improve the quality and dynamic performance of a machine tool. As a result, production time and cost are reduced.

Dynamic Precision contains the following functions, which can be deployed separately or in combination.

Function		Benefits
CTC (Cross Talk Compensation)	Compensation of acceleration-dependent position errors at the TCP	Greater accuracy during acceleration phases
MVC (Machine Vibration Control)	Damping of machine oscillations: <ul style="list-style-type: none"> • AVD (Active Vibration Damping): Compensates undesired effects of vibrations on the feed axes • FSC (Frequency Shaping Control): Suppresses the inducement of vibrations through a correspondingly filtered feedforward control 	A superior surface finish
CTC + MVC	–	Faster and more accurate machining
PAC (Position Adaptive Control)	Position-dependent adaptation of control parameters	Greater contour fidelity
LAC (Load Adaptive Control)	Load-dependent adaption of control parameters and the maximum axis acceleration	Higher accuracy whatever the load
MAC (Motion Adaptive Control)	Motion-dependent adaptation of control parameters	Less vibration and higher maximum acceleration during rapid traverse



Vibration can significantly impair surface quality.



Visibly superior surface quality can be attained with MVC.



Optimal tool guidance by the TNC7

High contour fidelity and surface quality
TNC controls from HEIDENHAIN are known for their **low-jerk and speed/acceleration-optimized motion control**, enabling optimized surface quality and workpiece accuracy. With the TNC7, you are able to leverage the latest technological developments. The TNC7 anticipates and thinks along with you, dynamically calculating the contour ahead of time. In addition, special filters suppress machine-specific natural frequencies.

With its **Look Ahead** function, the TNC7 recognizes directional changes ahead of time and adapts the traversing speed to the shape of the contour and the surface to be machined. You simply program the maximum machining speed as the feed rate and, in **Cycle 32TOLERANCE**, enter the maximum permissible deviations from the ideal contour. The TNC7 automatically adapts the machining operations to the tolerance that you define. This method prevents contour defects.

Advanced Dynamic Prediction (ADP) expands upon the previous look-ahead calculation of the permissible maximum feed rate profile. ADP compensates for differences in the feed rate profiles resulting from the point distribution on neighboring paths, especially in NC programs originating from CAM systems. Among other benefits, this results in particularly symmetrical feed rate behavior on the back-and-forth paths during bidirectional finish milling, as well as very smooth feed rate curves on neighboring milling paths.

Fast machining and computing processes

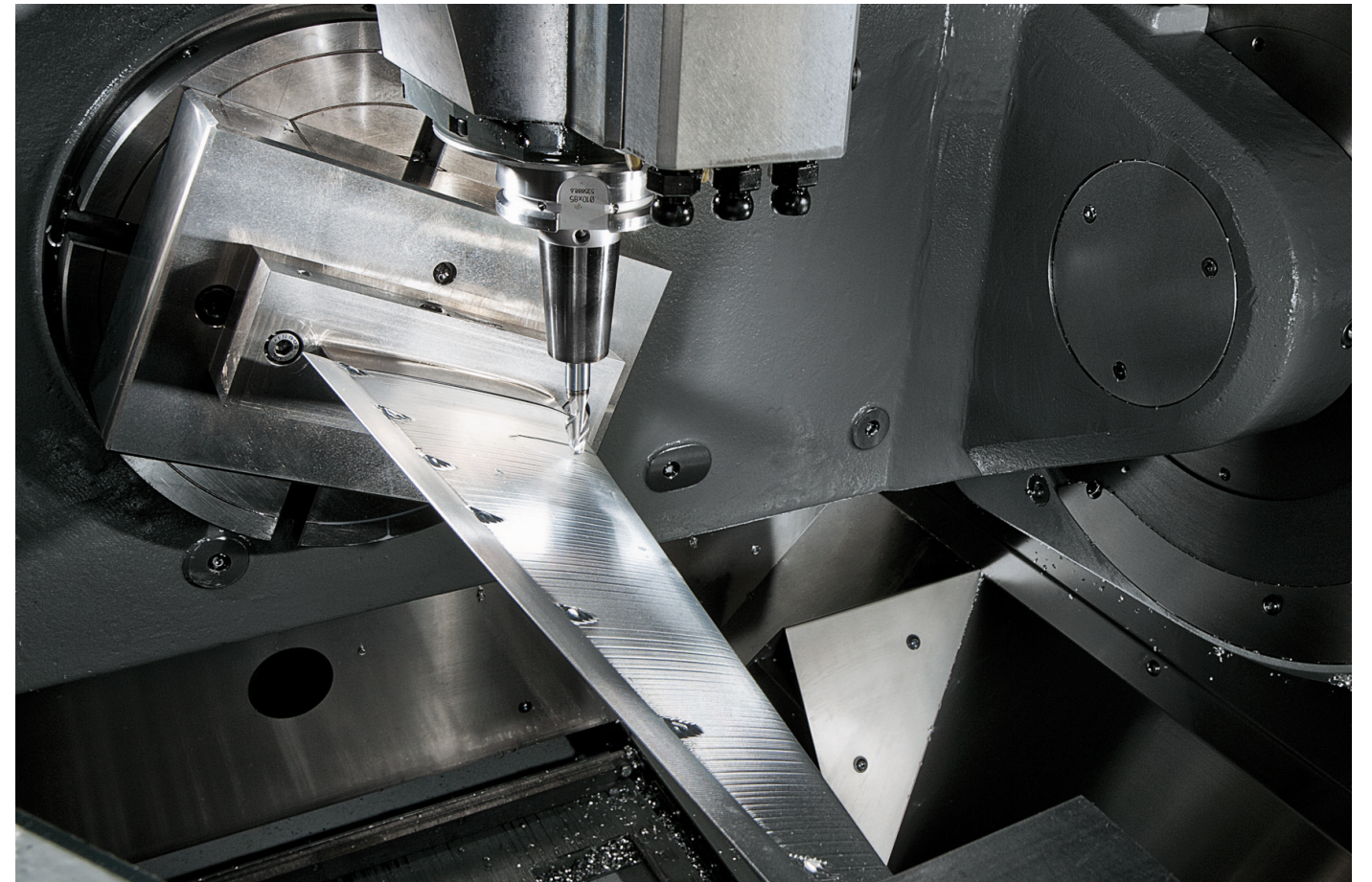
With a short block-processing time of at most 0.5 ms, the TNC7 can run fast look-ahead calculations for optimal use of the machine's dynamic parameters. Functions such as ADP and Look Ahead therefore ensure not only high contour fidelity and surface quality but also optimize the machining time.

One basis for the TNC7's high speed is its **uniformly digital control design**. This includes the integrated digital drive technology from HEIDENHAIN as well as digital interfaces connecting all of the control components with each other:

- Control components via HSCI (HEIDENHAIN Serial Controller Interface)
- Encoders via EnDat 2.2

As a result, exceptionally high feed rates can be implemented. In the process, the TNC7 is capable of interpolating up to five or more axes at the same time. To attain the required cutting speeds, the TNC7 digitally controls spindle speeds up to **100000 rpm**.

The TNC7's powerful 5-axis machining capability even lets you economically manufacture complex 3D contours. Programs for such contours are usually created offline with CAM systems and typically contain numerous short line blocks that are transferred to the control. With its short block-processing time, the TNC7 quickly executes even complex NC programs. The control's computing power can handle complex look-ahead calculations in simpler NC programs as well. Thus, regardless of the data volume of the NC programs from your CAM system, the TNC7 will machine the workpiece to near-perfect conformity with your program.



Compensating for tool form error

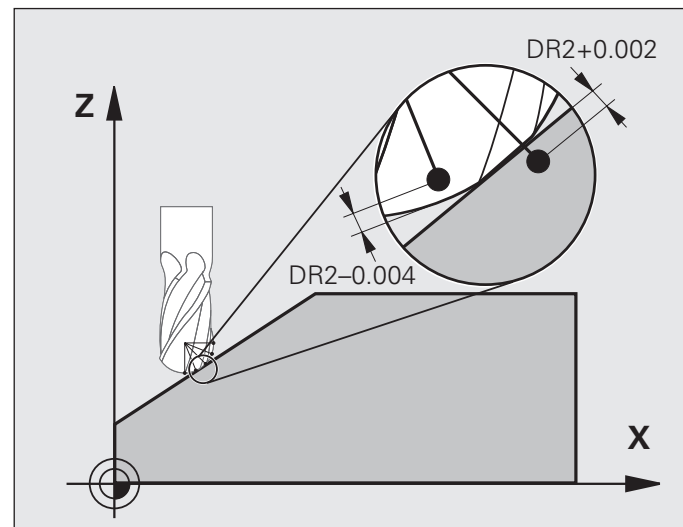
Option 92, **3D-ToolComp**, is a powerful option for three-dimensional tool radius compensation. Angle-dependent delta values describing the deviation of the tool from a perfect circle can be defined in a compensation table (see graphic).

The TNC7 then corrects the radius value defined for the tool's current point of contact with the workpiece. In order to determine the exact point of contact, the NC program must be created with surface-normal blocks (LN blocks) by a CAM system. The surface-normal blocks specify the theoretical center point of the tool and, if applicable, the tool orientation relative to the workpiece surface.

Ideally, the compensation-value table is generated fully automatically by way of a special cycle that uses a laser system to measure the form of the tool so that the TNC7 can use this table directly. If the form errors of the tool being used are available in a calibration chart from the tool manufacturer, then you can also create the compensation table manually.

Measuring 3D geometries

Cycle 444, 3D probing, allows you to measure points on 3D geometries. To do so, you enter the coordinates of the measuring point and the associated normal vectors into the cycle. After probing, the TNC automatically calculates whether the measuring points are within a prescribed tolerance. You can then call the result via system parameters in order, for example, to have the program initiate rework. You can also trigger a program stop and output a message. After measurement, the cycle automatically generates a straightforward measurement report in HTML format. To obtain even more accurate results, you can perform a 3D calibration of the touch probe prior to running Cycle 444. The cycle then compensates for the switching behavior of the individual touch probe in all directions. Option 92 is required for 3D calibration and for Cycle 444.



CAM systems generate 5-axis programs using a postprocessor. In principle, such programs contain either all of the coordinates of the machine's existing NC axes, or they contain NC blocks with surface normal vectors. During five-axis machining with three linear axes and two additional tilting axes,* the tool is always perpendicular to the workpiece surface or is tilted at a specific angle relative to it (inclined tool machining).

Regardless of the type of five-axis programs you wish to run, the TNC7 performs all of the necessary compensating movements in the linear axes arising from movements in the tilting axes. The TNC7's **TCPM function** (Tool Center Point Management), an improvement upon the proven TNC function M128, provides optimal tool guidance and prevents contour gouging.

* The machine and TNC must be adapted for these functions by the machine manufacturer.

With TCPM, you can define the behavior of the tilting and compensating movements that are automatically calculated by the TNC7:

- TCPM defines the interpolation between the start and end positions:
- **Face Milling:** In face milling, primary cutting is performed using the front face of the tool (or the corner radius in the case of toroid cutters). In the process, the tool center point moves along its programmed path.
 - **Peripheral Milling:** In peripheral milling, primary cutting is performed with the lateral surface of the tool. The tool tip also travels along its programmed path, but machining with the circumference of the tool results in a clearly defined plane. As a result, peripheral milling is well suited for the production of precise surfaces using gear hobbing processes.

TCPM defines the **effect of the programmed feed rate** with two possibilities to choose from:

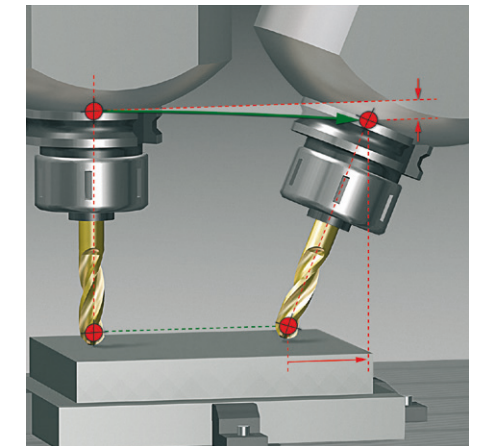
- The actual speed of the tool tip relative to the workpiece: in the case of large compensating movements while machining close to the center of tilt, very high axis feed rates may arise.
- Contouring feed rate of the axes programmed in the respective NC block: the feed rate is generally lower, but you attain better surface quality with large compensating movements.

In order to achieve better surface quality, an **inclination angle** is often configured for contour machining, with corresponding angle values in the NC program. The effect of the inclination angle can also be configured via TCPM:

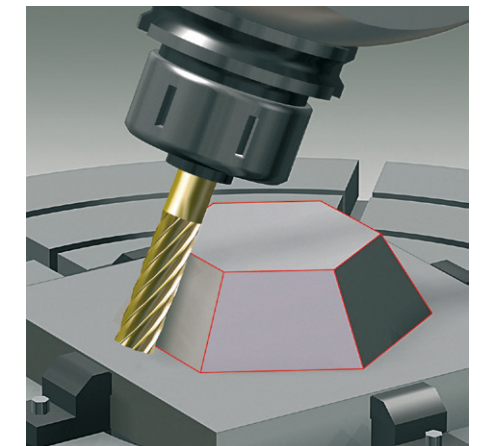
- Angle of inclination defined as an axis angle
- Angle of inclination defined as a spatial angle

The TNC takes the inclination angle into account in all 3D machining operations, including with 45° swivel heads or tilting tables. You can specify the angle of inclination in the NC program via a miscellaneous function or manually set it with an electronic handwheel. The TNC7 ensures that the tool remains on the contour and does not damage the workpiece.

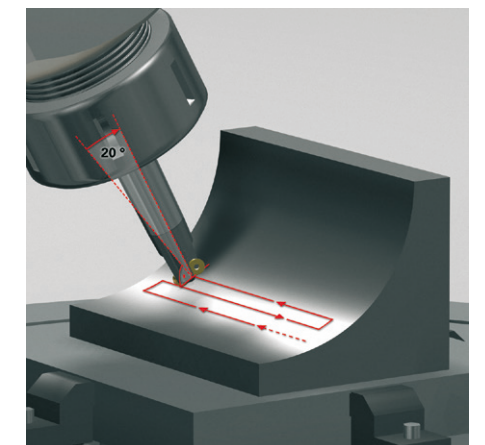
You can use Cycle 444 to measure 3D geometries even when TCPM is active. The TNC7 then automatically takes the inclination angle of the touch probe into account.



Face milling



Peripheral milling



Inclined-tool machining

TNC7-controlled swivel head and rotary table

Many five-axis operations that initially appear to be highly complex can be broken down into common 2D movements that have been tilted about one or more rotary axes or wrapped around a cylindrical surface. In order for you to create and edit such programs quickly and easily without a CAM system, the TNC supports you with helpful functions.

Tilting the working plane*

Programs for contours and holes on inclined surfaces are often extremely complex and require time-consuming computing and programming work. In cases like these, the TNC7 can save you a great deal of programming time. You simply program the machining operation as usual in the main plane (e.g., in XY); the machine then performs the operation in a tilted plane.

The PLANE function makes it easy for you to define a tilted working plane: tilted working planes can be specified in seven different ways depending on the information available in the workpiece drawing. Help images support you during program entry.

You can also use the PLANE function to define the positioning behavior during tilting to avoid unpleasant surprises when the program is run. The settings for defining the positioning behavior are identical for all PLANE functions, making operation much easier.

* The machine and TNC must be adapted for these functions by the machine manufacturer.

Manual axis motion in the tool direction on 5-axis machines

Correct tool retraction is very important in five-axis machining. The virtual tool axis function provides assistance by allowing you to move the tool in the direction of the tool axis using external direction keys or a handwheel. This function is especially useful if you want to

- retract the tool in the direction of the tool axis during an interruption of a 5-axis machining program,
- use the handwheel or external direction keys to perform an operation in Manual mode with an inclined tool, or
- move the tool with the handwheel in the active tool axis direction during machining.

Feed rate for rotary tables in mm/min*

By default, rotary axis feed rates are programmed in degrees/min, but the TNC7 can interpret this feed rate in mm/min as well. The feed rate at the contour is then independent of the distance of the tool center point from the center of the rotary axis.

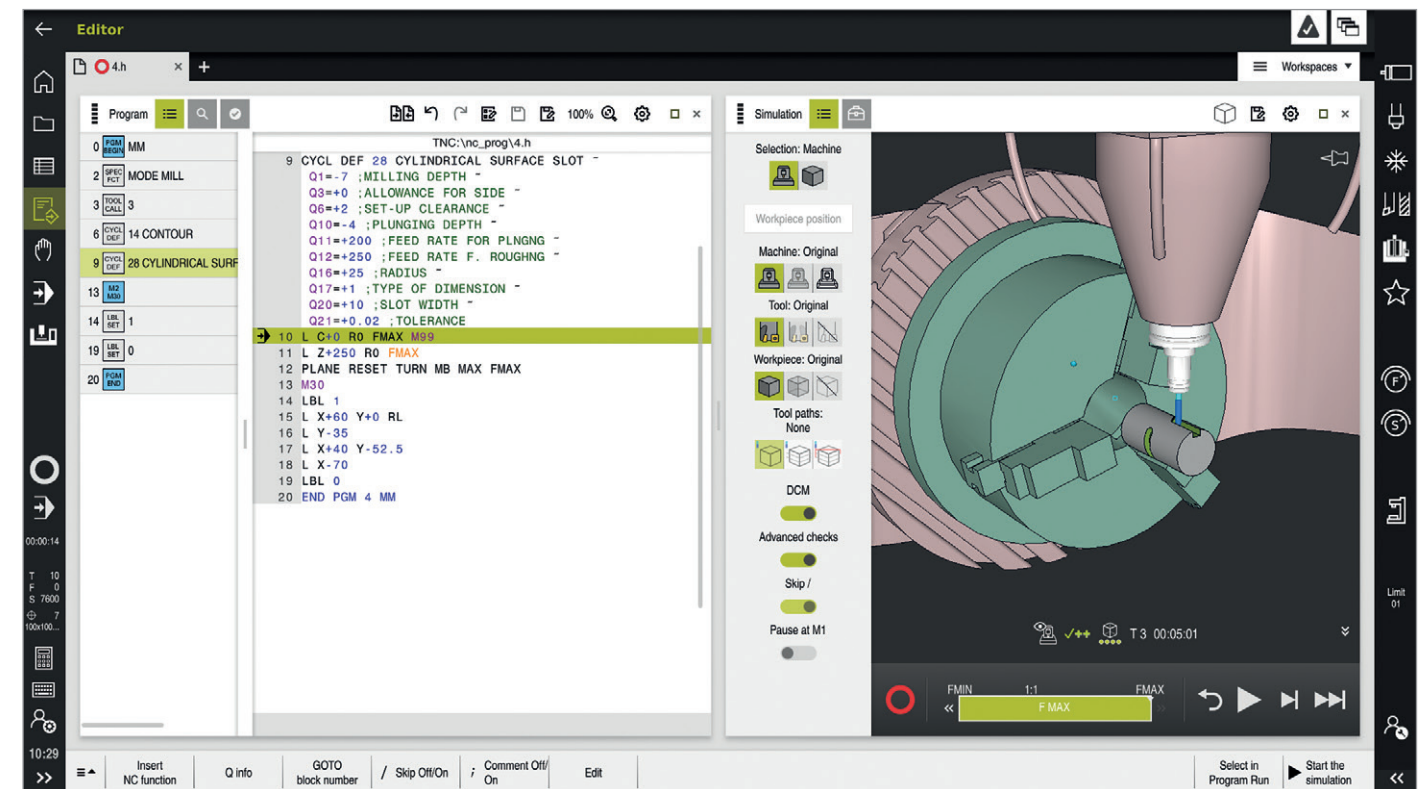
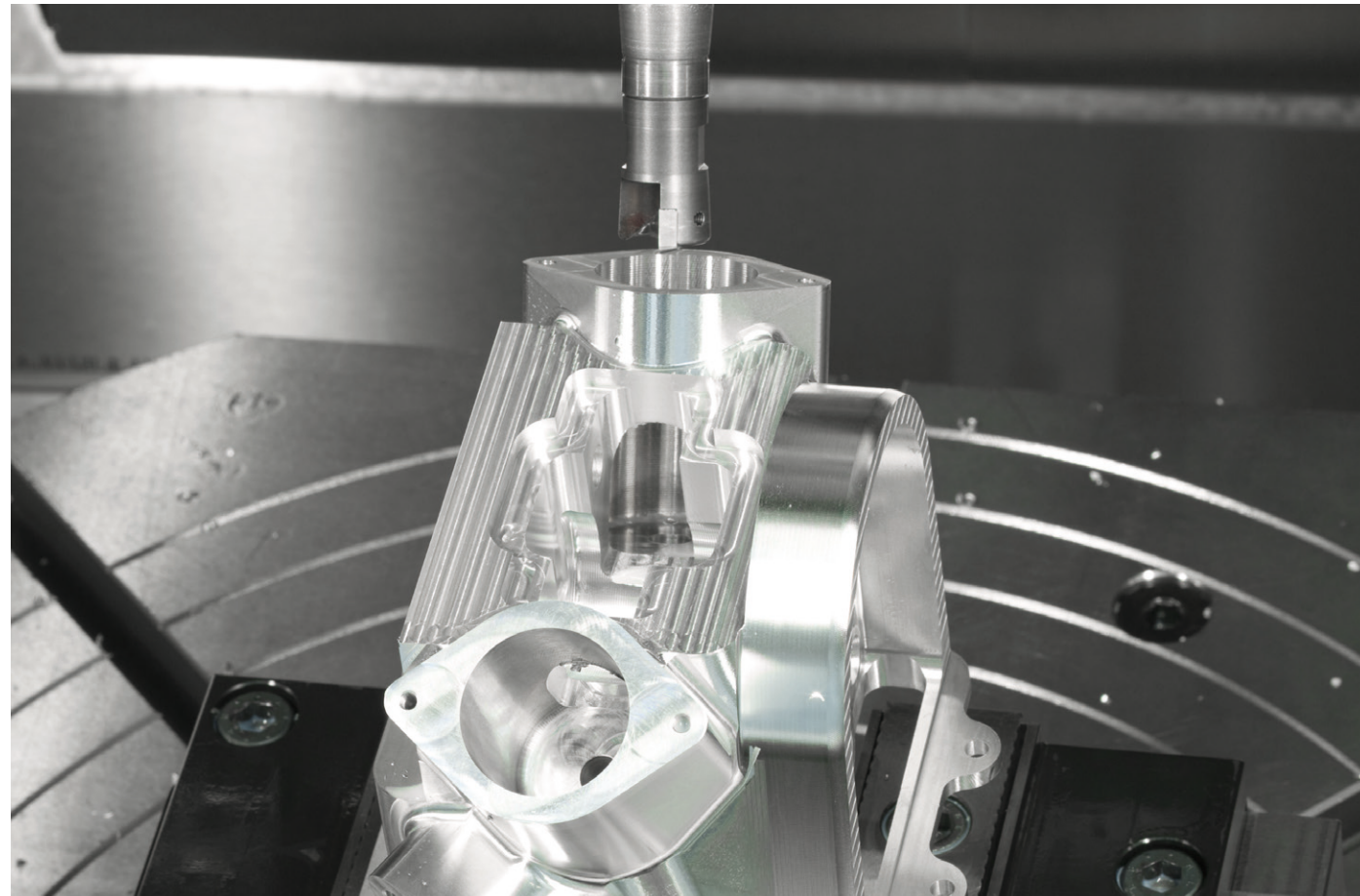
Cylinder surface machining*

With the TNC7 it is quite easy to program contours (which consist of straight lines and arcs) on cylindrical surfaces using rotary and tilting tables: You simply program the contour in a plane as if the cylinder surface were unrolled. The TNC7 then executes the programmed machining operation on the cylinder surface.

The TNC7 provides four cycles for cylinder surface machining:

- Slot milling (the slot width and tool diameter are equivalent)
- Guide-groove milling (the slot width is greater than the tool diameter)
- Ridge milling
- Outside contour milling

* The machine and TNC must be adapted for these functions by the machine manufacturer.



Inspecting and optimizing machine accuracy

Easy calibration of rotary axes with KinematicsOpt (option)

Accuracy demands are on the rise, particularly in the realm of 5-axis machining. Complex parts are expected to be machined to exact specifications with reproducible accuracy over extended periods.

The TNC function **KinematicsOpt** is an important ingredient in helping you meet these high requirements: with a HEIDENHAIN touch probe inserted, a cycle measures your machine's rotary axes fully automatically. The measuring process is the same, regardless of whether the rotary axis is a rotary table, tilting table, or a swivel head.

For calibrating the rotary axes, a calibration sphere is mounted at any position on the machine table and probed with the HEIDENHAIN touch probe. Prior to probing, you can set the resolution and define a different measuring range for each rotary axis.

Based on the measured values, the TNC calculates the static tilting accuracy. The software minimizes the spatial error arising from the tilting movements and, at the end of the measuring process, automatically saves the machine geometry in the respective machine constants of the kinematics description.

Of course, a detailed log file is also available containing the actual measured values, the measured and optimized dispersion (for the static tilting accuracy), and the actual compensation values.

Optimal use of KinematicsOpt requires a highly rigid calibration sphere for reducing the deformations caused by probing forces. For this purpose, HEIDENHAIN offers calibration spheres with highly rigid holders of various lengths.



Monitoring functions

Component Monitoring (option 155)

Overload often leads to damaged machine components, and therefore to machine downtime. For example, the spindle bearing is often subject to a very high load in machining strategies that have been optimized for maximum efficiency, and can therefore sustain undetected damage. Component Monitoring warns you about these dangers, and can even stop the machine tool if necessary. Thanks to continuous monitoring of the bearing load and visualization of these values, the machining processes can be optimized correspondingly.

However, the production quality of a machine tool is influenced not only by overload. Components that are constantly under load, such as guideways or the recirculating ball screw, are subject to wear and thus have an influence on the finished product. The TNC7 uses the Component Monitoring option to measure and document the momentary machine status. The machine manufacturer can read and

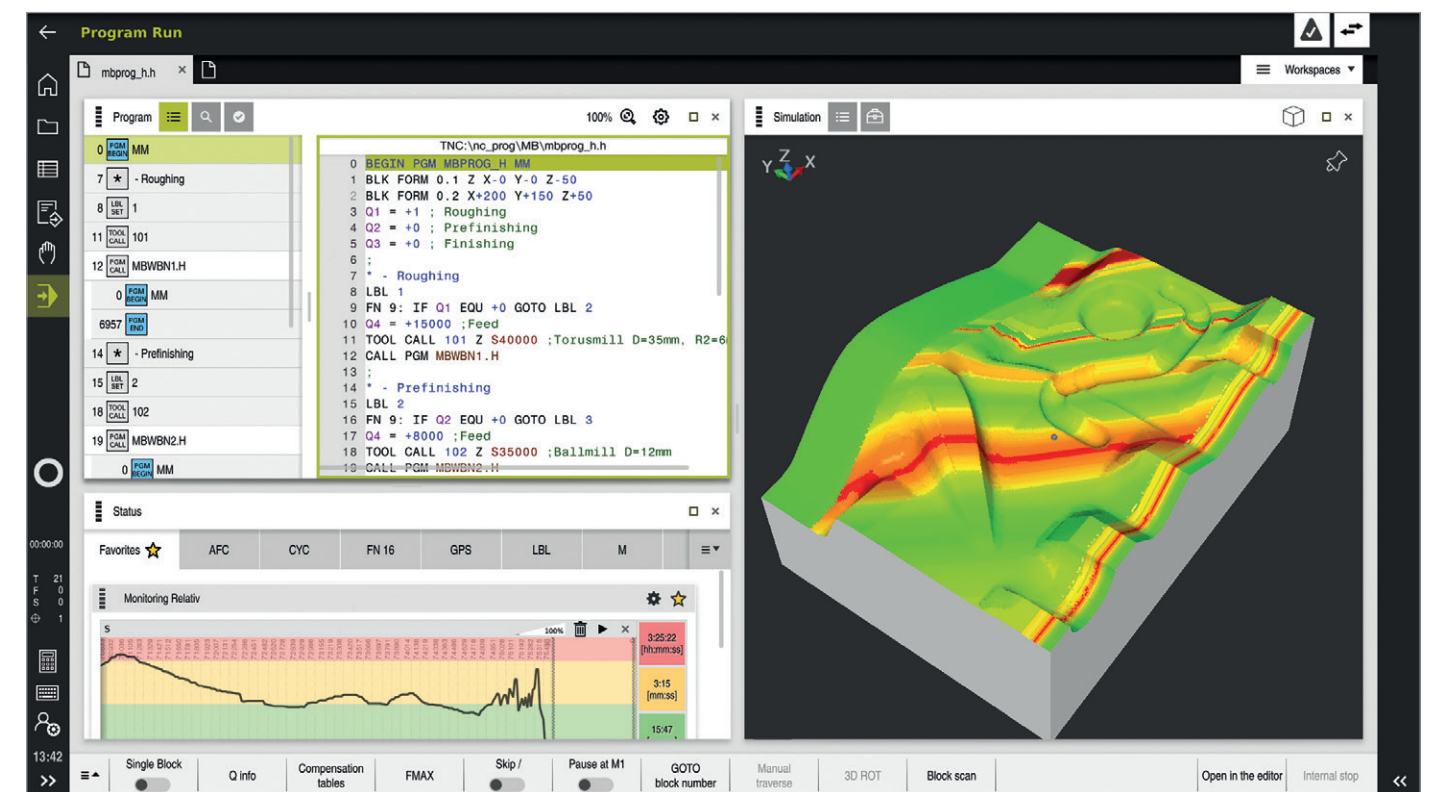
evaluate these data, and react using predictive maintenance, thereby avoiding unplanned machine downtimes. The MONITORING HEATMAP function within the NC program lets you color the concurrent material removal simulation in the workpiece view with the status of a monitoring task. That way you see in the workpiece view where a component was subject to a strong load.

Process Monitoring (option 167)

The fully-integrated process monitoring feature of the TNC7 is an outstanding possibility to make your production process safer and more reliable. After you have recorded a reference machining operation, the TNC7 monitors all subsequent such operations and reacts to any deviations. Various reactions, such as insertion of a replacement tool, can be defined for the possible faults. That way the machine tool remains productive despite the fault, and no manual intervention is necessary. Process Monitoring uses internal control signals and does not require any additional sensors.

Process Monitoring increases safety and efficiency:

- Detect deviations from a reference machining run
- Reliable monitoring due to robust synchronization down to the program block level
- Ensure productivity through an extensive range of possible reactions, such as inserting a replacement tool
- Easy checking of the process result via 3D visualization of the workpiece and a 2D graph
- Easy programming
- Benefit from zero installation effort



Programming on the shopfloor

Straightforward function keys for complex contours

Programming 2D contours

Two-dimensional contours are the bread and butter of a modern machine shop, which is why the TNC7 offers a variety of ways to handle them.

Programming with function keys

Are the contours properly dimensioned for NC machining? In other words, are the end points of the contour elements provided in either Cartesian or polar coordinates? If yes, then you can create the NC program straightaway using function keys.

Straight lines and circular elements

To program a line segment, for example, simply select the "linear traverse" path function. The Klartext conversational programming language of the TNC7 then prompts you for all of the information needed by the programming block, including the target coordinates, feed rate, tool compensation value, and machine functions. Functions for circular movements, chamfers, and corner rounding also simplify your programming work. In order to avoid surface blemishes during approach or departure from the contour, movement must be seamless—that is, tangential.

You simply specify the starting point or end point of the contour and the approach or departure radius of the tool. The control handles the rest.

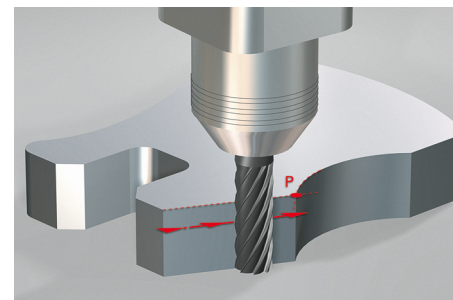
The TNC7 can foresee a contour with radius compensation by up to 99 blocks, thus taking back-cutting into account and avoiding contour gouging. This could be the case, for example, when roughing a contour with a large tool.

Graphical programming

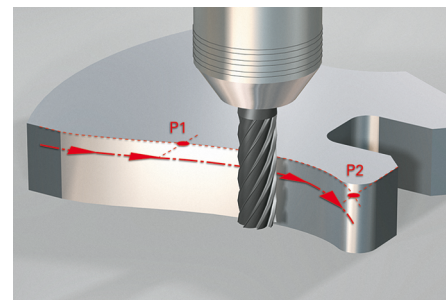
The TNC7 supplements the familiar Klartext programming with smart functions. With the newly developed graphical programming feature, you draw contours directly on the touchscreen. Other detailed information about contour elements is specified in context-sensitive dialogs. The TNC7 then converts your drawing into Klartext and saves it, or you can save the contour as its own program (.tncdrw). Existing programs can be modified very easily.

The graphical programming function makes it possible to quickly and easily program contours that are not properly dimensioned for NC machining. Even FK programs from older TNC controls are very easily modified with graphical programming. The TNC7 then generates a finished Klartext contour program.

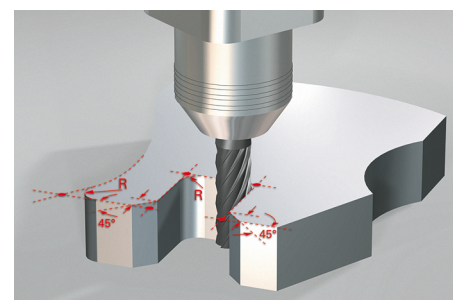
Even already programmed contours can be edited using this graphic support. To do so, simply select the contour in the Klartext editor, and then drag and drop it to the contour editor for modification. Once editing is finished, the final result is applied to the Klartext program.



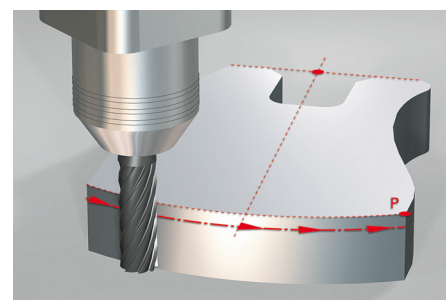
L Straight line defined by its end point



CT Circular path with seamless (tangential) transition from the preceding contour element, defined by its end point



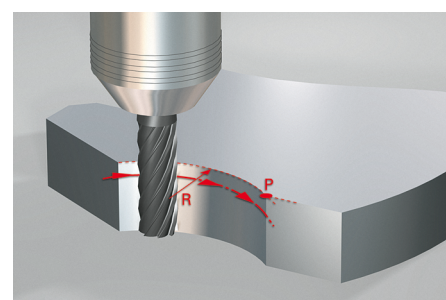
RND Corner rounding: circular path with a seamless (tangential) transition, defined by its radius and corner point



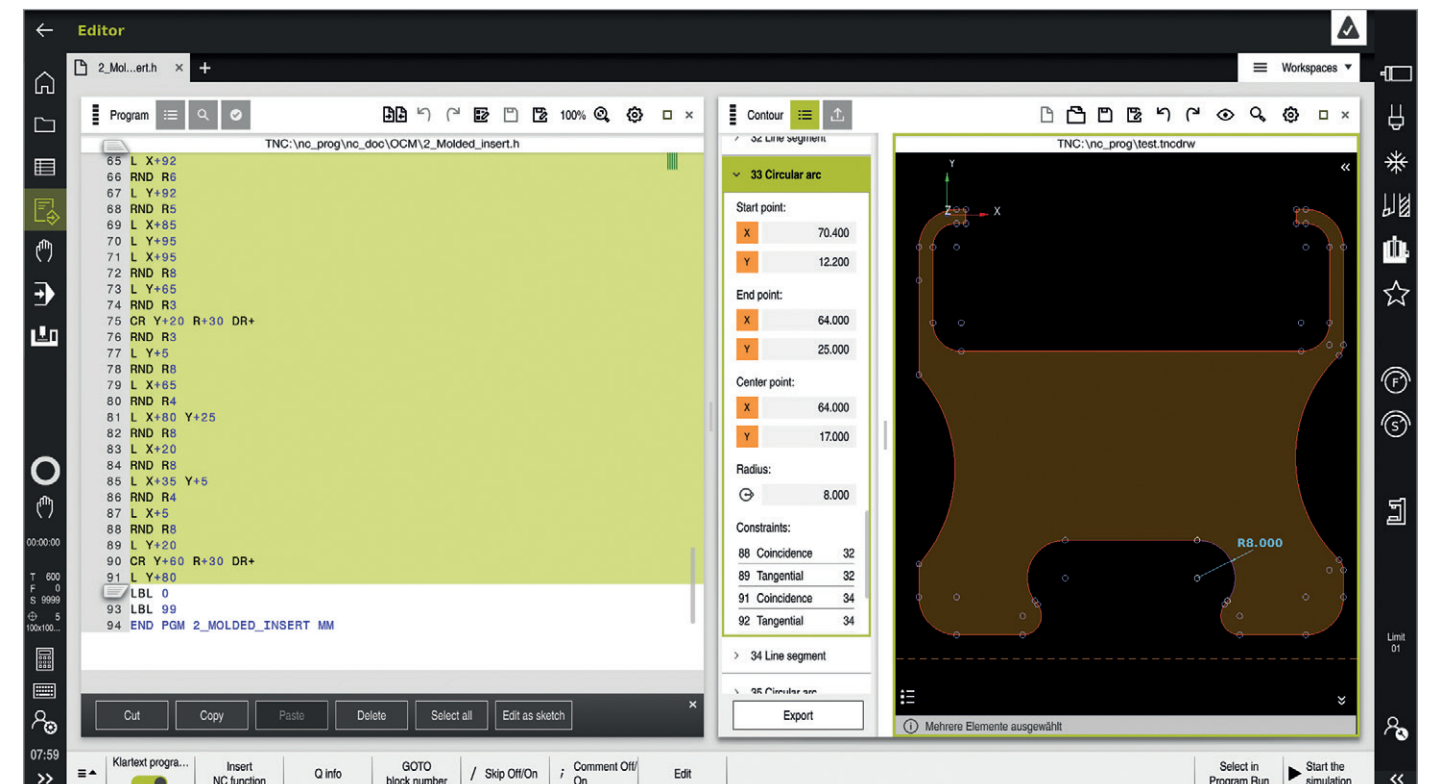
CC **C** Circular path defined by its center, end point, and rotational direction



CHF Chamfer defined by the corner point and chamfer length



CR Circular path defined by its radius, end point, and rotational direction



Comprehensive fixed cycles for milling, drilling and boring

The TNC7 offers you a package covering a broad range of cycles, so you'll surely find the right one for each task. The cycles are divided into groups based on the machining technologies and strategies, ensuring that you always maintain a clear overview. You program them using form-based conversational guidance, assisted by graphics that clearly illustrate all required input parameters.

Standard cycles

In addition to drilling and tapping cycles (with or without a floating tap holder), a variety of selectable cycles are available:

- Thread milling
- Reaming
- Engraving
- Boring
- Hole patterns
- Milling cycles for face milling a flat surface
- Roughing and finishing of pockets, slots and studs

Programming machining patterns with ease and flexibility

Positions to be machined are often arranged in patterns on the workpiece. The TNC7's graphical support helps you program a wide range of machining patterns with ease and exceptional flexibility. You can define as many point patterns as desired with various numbers of points. During machining, you can then have all of the points executed as a unit, or each point individually.

Fast and easy programming of a scannable Data Matrix code

Cycle 224 (Data Matrix code pattern) lets you convert any text into a Data Matrix code and machine it onto your workpiece as a point pattern using, say, drilling operations. The Data Matrix code can be decoded with common scanning devices. Serial numbers and production data can thus be permanently machined onto the part. All you need to do after defining a

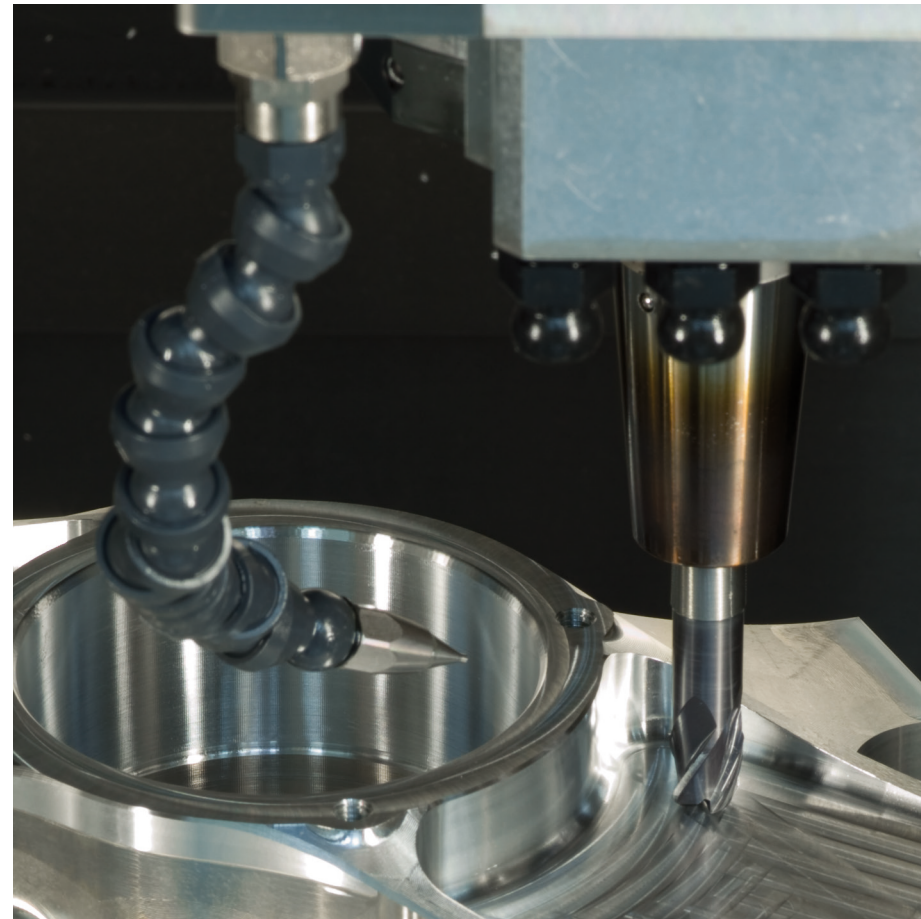
machining cycle is enter the text (up to 255 characters) into the cycle and specify the size and position of the drilling pattern. The control automatically calculates the Data Matrix code and performs the machining work on its own.

Cycles for complex contours

Of great help in roughing pockets with any contour are the control's **SL cycles** (SL = Subcontour List) and **OCM** functionality (Optimized Contour Milling, option 167). These functions refer to machining cycles for pilot drilling, roughing, and finishing in which the contour or subcontours are defined in subprograms. As a result, a single contour description can be used for various operations with different tools.

Up to twelve **subcontours** can be superimposed for the machining operation. The control automatically calculates the resulting contour and the tool paths for roughing or clearing the surfaces. Subcontours can be pockets or islands. Multiple pockets are combined to form a single pocket, with the tool bypassing any islands. You can also program void areas that are excluded from machining. This significantly reduces machining times for cast parts or pre-machined workpieces.

During roughing, a **finishing allowance** on the wall and floor surfaces is also taken into account by the TNC7. When **roughing** with different tools, the control identifies residual material to be removed by smaller tools. A separate cycle is used for finishing to the final dimensions.



OEM cycles

As original equipment manufacturers, machine manufacturers can contribute their special manufacturing know-how by designing additional fixed cycles and saving them in the TNC7. However, the user can write his own cycles as well. HEIDENHAIN makes this possible with its PC software CycleDesign, which allows you to create input parameters and arrange the menu key structure of the cycles as desired.

3D machining with parametric programming

With parameter functions you can program simple 3D geometric figures that can easily be described mathematically. At your disposal are basic arithmetical operations, trigonometric functions, roots, powers, logarithmic functions, parentheses, and logical comparisons with conditional jump instructions. Parametric programming also gives you a simple way to implement 3D operations. Of course, parametric programming is also well-suited for **2D contours** that cannot be described with lines or circular arcs but rather through mathematical functions.

Interpolation turning (option 96)

Although you can create ring slots, recesses, tapers, or any turning contour using conventional turning operations, you can also take advantage of interpolation turning. In interpolation turning, the tool executes a circular movement using the linear axes. For outside turning, the cutting edge is oriented towards the circle center, and for internal turning, away from the center. By varying the circle radius and the axial position, any rotationally symmetric body can be produced, even in a tilted working plane. The TNC7 provides two cycles for interpolation turning:

- Cycle 291 activates the coupling of the spindle positions with the axis positions, allowing you to program any desired axial or radial tool movement
- Cycle 292 activates spindle coupling and automatically controls the machining of a programmed turning contour

Producing gears more effectively*

Highly complex motion sequences are necessary during the machining of gears. The TNC7 gives you multiple cycles that allow you to produce gears easily and economically. You can choose between these two machining technologies:

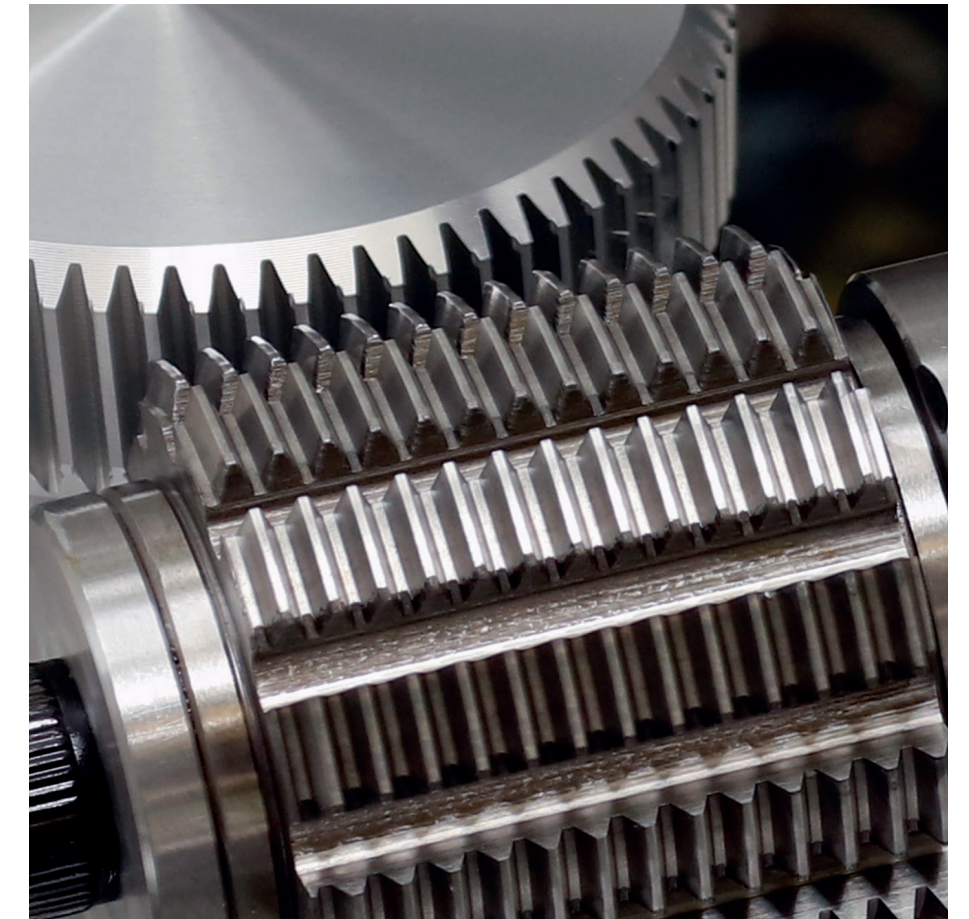
- Skiving
- Hobbing

During **skiving**, cutting action is performed by means of an axial tool feed and a rolling motion. Skiving is suited for the production of straight or oblique internal and external gear teeth. Significant advantages can be gained by skiving particularly during the production of internal gear teeth, compared with traditional gear shaping. Additionally, the continuous cutting process makes excellent surface definition possible while at the same time reducing process times.

Hobbing is a continuous cutting method suitable for the production of straight or oblique external gear teeth. This method lets you manufacture gears productively, accurately, and flexibly.

In both methods, axial motion is superimposed onto a synchronized rotation of the tool and workpiece. The tool and the workpiece axis must both be positioned at defined angles relative to each other. The TNC7 handles these complex calculations for you and automatically executes all of the required motion and synchronization.

* Option 157 (with turning mode, option 50 as well)



Practical turning cycles (option)

The TNC7 also offers an extensive and technologically sophisticated package of turning cycles. These cycles are equivalent to the well-proven and long-standing core functions of the HEIDENHAIN lathe controls. The appearance and functions of the user interface, however, are aligned with the familiar and well-proven Klartext conversational programming language. Cycle parameters used for both milling and turning are naturally designated by the same number. Graphical illustrations assist you with program entry in the usual manner for turning as well.

Machining simple contours

Various cycles are available for the longitudinal and transverse machining of simple contours. The area to be machined can also be inclined, thus requiring a plunging movement. Of course, the TNC7 automatically takes the angle of the turning tool into account.

Machining any contours

If the contours to be machined are complex and can no longer be defined with simple cycle parameters, you can still describe them using contour subprograms. This process is identical to the procedure used for SL cycles in milling, for which you use Cycle 14 to define the subprogram describing the finished contour. You can define the technology parameters in the respective turning cycle.

For the contour description, you use exactly the same Klartext functions as you would for defining a milling contour. Turning-specific recess and undercut contour elements are also available, which you can insert between contour elements in the same manner as chamfers and rounding arcs. Besides radial and axis recesses, E, F, H, K, and U undercuts are available, as are thread undercuts.

Depending on the cycle, the TNC7 machines parallel to the axis or the contour. You define the machining operations (roughing, finishing) or the oversize with dialog guidance in the corresponding parameters.

Orientation of the turning tool

On milling-turning machines, it may be necessary to incline the tool during turning or change the side from which machining should be performed. With the help of a cycle, the TNC can change the inclination angle of the tool for back cutting or can convert an external turning tool into an internal turning tool without the operator needing to adjust the cutter position or the orientation angle in the tool table.

Blank form update

Another highlight of the TNC7 is its blank form update feature. If you define the workpiece blank at the beginning of your program, the control computes the new blank form for each following step. The machining cycles always adapt to the current workpiece blank. The blank form update feature helps you avoid air cuts and optimize approach paths.

Recessing

For these operations, as well, the TNC7 features ample flexibility and functionality. Simple longitudinal and transverse recessing operations are possible, as are contour recessing operations in which the cycle is machined along any desired contour. You can work particularly effectively when performing recess turning: due to the direct alternation between infeed and cutting, air cuts are hardly necessary. Here, too, the TNC takes the technological constraints into account (width of recessing tool, overlap, feed-rate factor, etc.) and executes the operations both quickly and reliably.

In multiple plunging the solid material is repeatedly plunged into along the contour, and subsequently the remaining material is cut away. This makes it possible to safely machine materials that are difficult to cut, since there are no radial loads and chips are removed centrally.

Simultaneous machining

The simultaneous roughing cycle and the simultaneous finishing cycle both adapt the inclination angle of the tool to the workpiece contour while turning. During this process, the complex tool movements are continuously monitored in order to avoid collisions between the workpiece and the tool or tool holder. In simultaneous machining, the tool is continuously engaged at the optimal inclination angle, allowing you to attain perfect surfaces while increasing tool service life.

Thread machining

Simple and extended cycles are available for the longitudinal and transverse machining of cylindrical or tapered threads. You can use cycle parameters to define the manner in which the thread is produced. This enables you to machine a wide variety of materials.

Turning with a facing slide

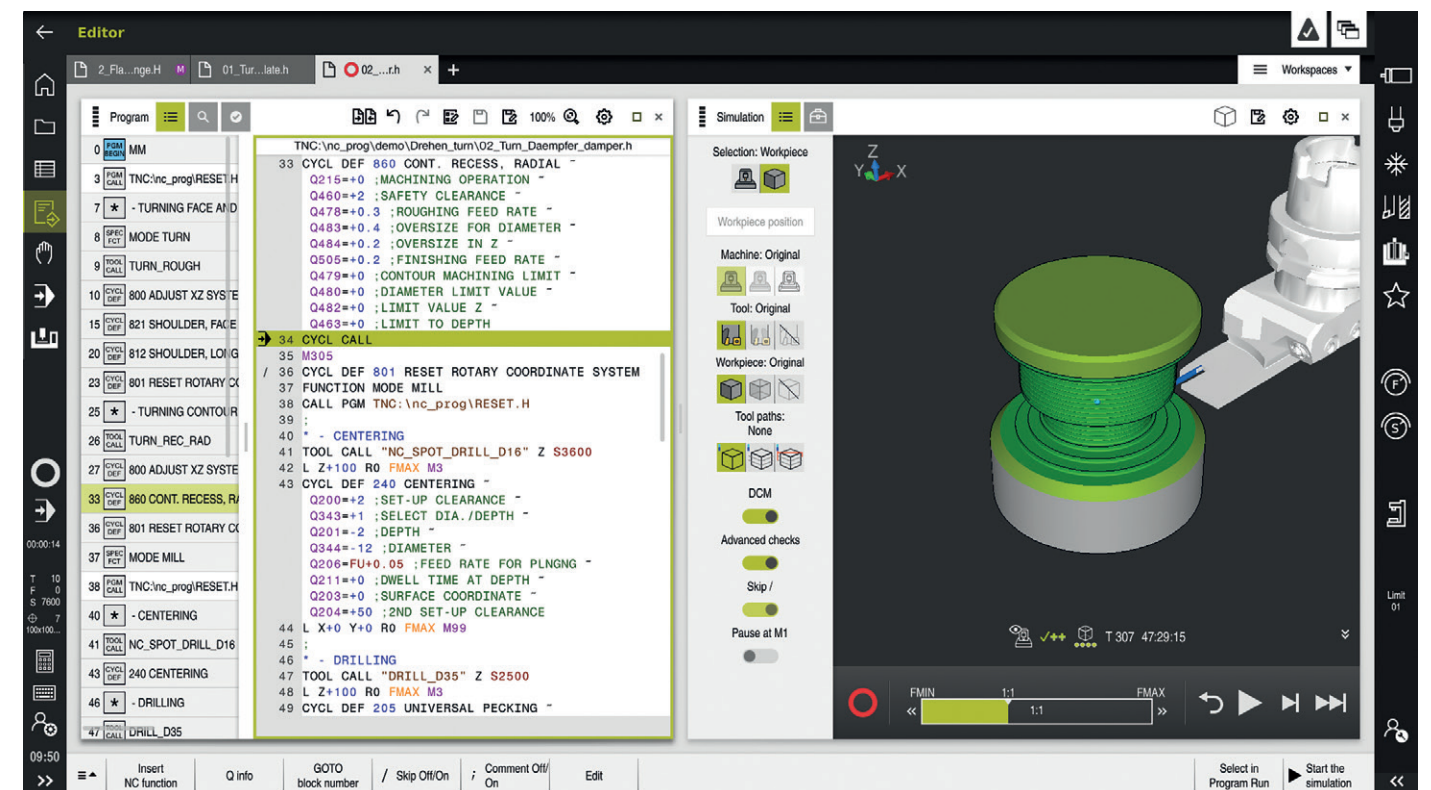
A facing slide allows you to perform turning operations on a stationary workpiece, thereby enabling off-center or tilted-plane turning operations. With a facing slide, rotational movement is implemented by the spindle, where an axis integrated into the facing slide determines the extension of the turning tool (facing stroke). With the TNC7, you don't need to worry about the complex motion involved. You simply select the facing-slide mode with a programming command and program as always with standard turning cycles. The TNC7 handles all of the calculations and executes the motion sequences.

Eccentric turning (option)

With the eccentric turning function, you can perform turning operations even if the workpiece axis is not aligned with the axis of rotation due to the setup configuration. During machining, the TNC7 compensates for any eccentricity with compensating movements in the linear axis coupled with the rotating spindle.

Machining with FreeTurn tools

The TNC7 now supports efficient outside turning operations with FreeTurn tools. FreeTurn tools have different cutting edges for different machining tasks, such as for roughing and finishing. A rotation of the tool axis switches the cutting edges. This reduces the number of tool changes and thus machining times.



The TNC7 also lets you perform grinding operations on your machine. Cycles for jig grinding and dressing allow you to program the respective function with great convenience. In addition, the TNC7 can superimpose a tool-axis reciprocating stroke onto the programmed movements. Optimized tool management supports the user during every process, including grinding and dressing. The TNC7 is therefore the ideal basis for attaining the highest degree of surface quality and accuracy in your application.

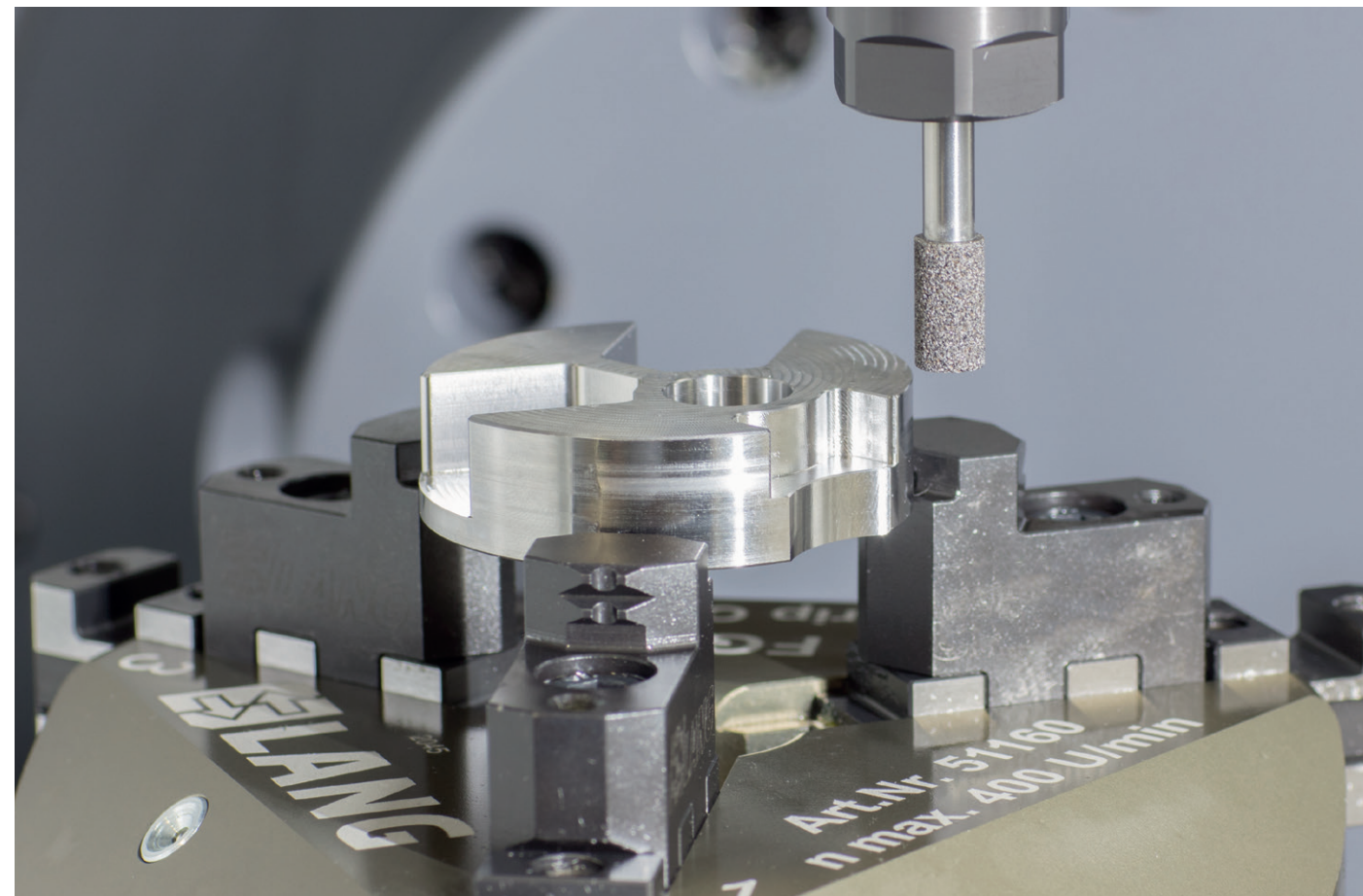
Jig grinding*

Jig grinding is the grinding of a 2D contour. On a milling machine, jig grinding is primarily used for finishing holes or pre-machined contours using a grinding tool. You can program open and closed grinding contours in the predefined grinding cycles and then machine them. You also have the option of superimposing a tool-axis reciprocating stroke onto the tool's motion. Special cycles allow you to define, start, and stop the reciprocating stroke. The reciprocating stroke enables uniform wear on the grinding tool and precise geometries on ground surfaces.

Dressing*

Dressing cycles allow you to "true up" grinding tools inside the machine. During dressing, the grinding tool is machined with a special dressing tool. Klartext cycles are available for dressing the grinding tool's diameter or profile.

* The machine must be adapted by the machine manufacturer for this function.



Coordinate transformation

If you need a pre-programmed contour at different locations and in different sizes on the workpiece, then the TNC7 offers you a convenient solution in the form of coordinate transformations.

Depending on the operation, you can shift the datum (milling, grinding, and turning) and rotate the coordinate system (milling and grinding) as well as mirror the contour (milling and grinding). With a scaling factor (milling and grinding), you can enlarge or reduce contours to account for shrinkage or oversizes.

Program-section repeats, subprograms, program calls

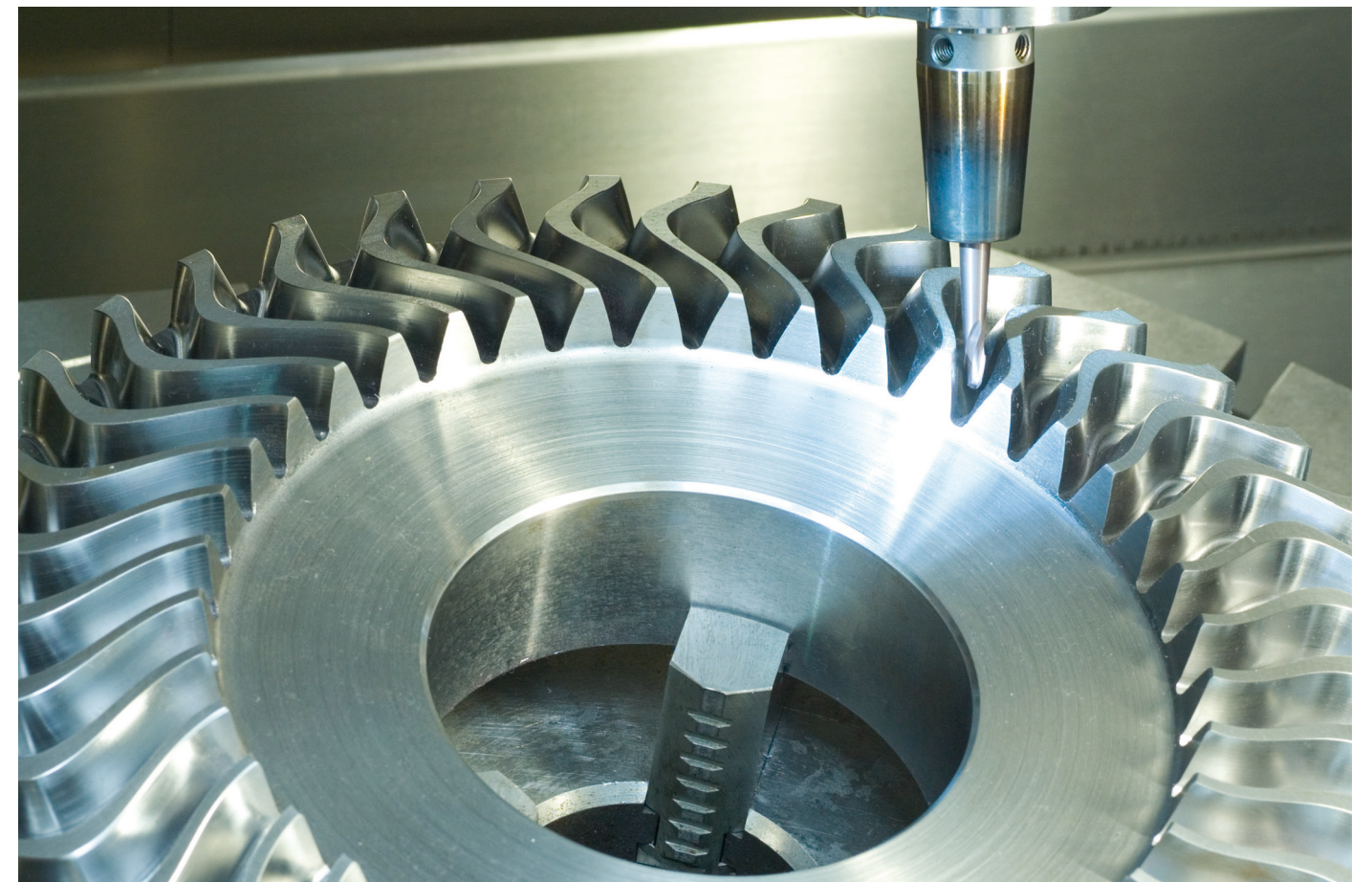
Many machining operations repeat themselves either on the same workpiece or on different workpieces. Once you have programmed a detail, there is no need to program it again. With its subprogram technology, the TNC can save you a great deal of programming time.

In **program-section repeats**, you can label a section of the program, and the TNC will repeat this section as many times as required.

You can mark a program section as a **subprogram** and then call it at any point in the program and as often as you want.

With the **program call** function, you can even use a completely separate program at any location in your current program. This allows you to leverage already programmed and frequently required working steps or contours.

Of course, you can also combine these programming techniques as often as desired.



Graphical support in any scenario

Simulation

For added certainty prior to machining, the TNC7 can simulate and render the machining of the workpiece at high resolution. The TNC7 offers optimal assistance through virtual simulation of the machined part and work envelope. The machining operation can be visualized in various manners:

- Plan view at different levels of depth
- Various projections
- 3D view

Touch gestures can be used throughout the simulation. This means that rotating or moving the simulation graphic, or zooming in and out, is particularly easy. The Simulation workspace is available directly within the Editor operating mode. This means you don't need to switch between operating modes when testing and editing an NC program.

You select the type and quality of the image, and a powerful zoom function lets you see even the tiniest details. During the machining simulation, the TNC7 can also display all of the machine components defined by the machine manufacturer, in addition to the workpiece and tool. That way you already know in advance in which areas it will be tight or the traverse paths will not suffice—an enormous advantage when working with tilting axes. You should also use the simulation to very thoroughly inspect programs created externally for irregularities before machining, for example in order to detect undesirable traces of the machining process on the workpiece.

Display functions

In the simulation, the TNC7 displays the calculated machining time in hours, minutes and seconds. Also, all surfaces of the simulation graphic are color-coded based on the tool that was used. That way you see at a glance which area was machined with which tool. Thanks to the high degree of flexibility when arranging the display elements, the simulation can easily be individually customized with all necessary information.

The TNC7 also features a cutout view that lets you move the cutting edge along the selected plane, so you can look inside the workpiece in order to evaluate internal machining operations, for example.

STL import

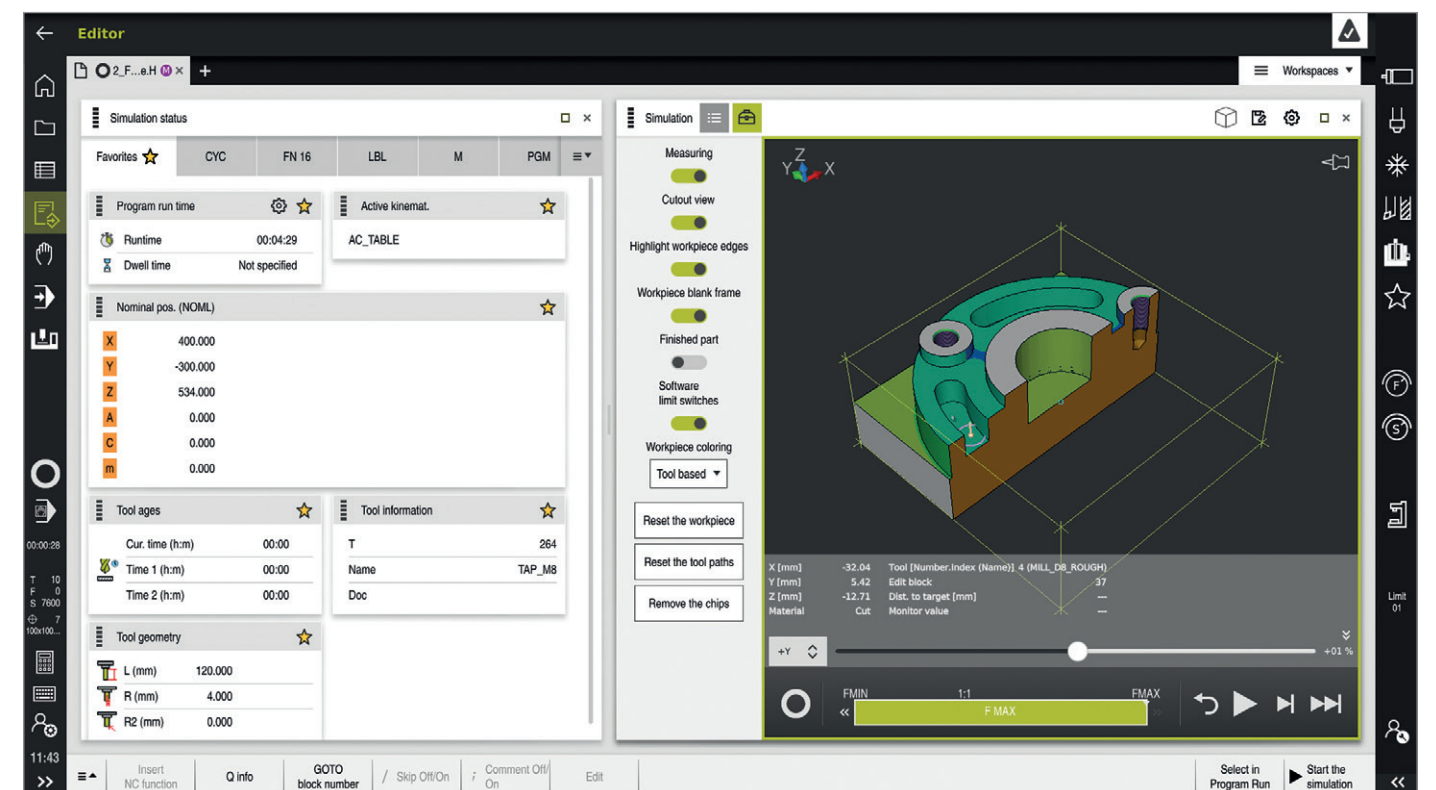
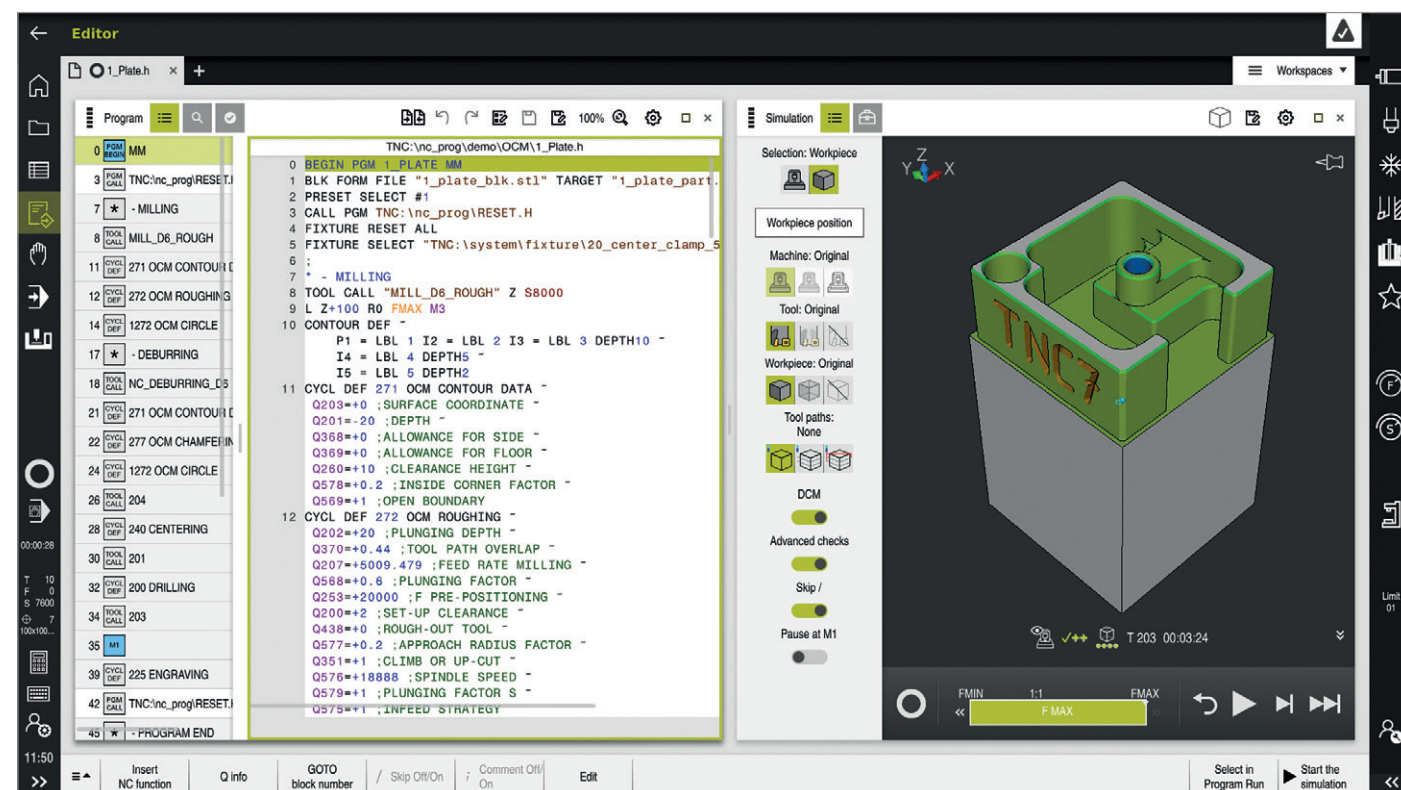
The importing of STL files enables the convenient incorporation of complex workpiece blanks and finished parts, such as 3D models from CAM systems. Furthermore, a simulated workpiece can be saved as an STL file and then integrated into another program as a workpiece blank.

Model comparison

The TNC7 has a feature for comparing the workpiece blank and the finished part. The colors in the model indicate where residual material still remains, or even places where too much material was removed. There is also a measuring function, where you place the cursor anywhere you want. Along with the depth and position, the control then also displays the tool used there and the corresponding NC block.

Program run

Direct observation of the real workpiece is usually impossible due to coolant and the safety enclosure. The simulation synchronously traces the machining operations while the program is running. That way you can always see the current machining status of the workpiece as well as the positions of the collision objects. During machining, you can switch between various operating modes at any time in order to create programs, for example.



Do you have questions about a programming step, but your User's Manual is not at hand? No problem: the TNC7 control features TNCguide, a convenient help system that displays the user documentation in a separate window.

You can activate TNCguide by simply pressing the help key on the TNC keyboard or directly on the touchscreen. In the factory default setting, the control offers the integrated product help TNCguide in German and English language versions. You can download the documentation in other languages free of charge from the HEIDENHAIN website and save it to the appropriate language directory.

The documentation includes NC examples for the various functions. Use the copy function to copy these NC examples from the documentation to your NC program.

The TNC7 offers you training videos for learning about the control's user interface, functions and operating possibilities. These brief instructional videos also provide you with useful terminology. Knowing the correct terms makes it easier and quicker to find the information you are looking for in the User's Manuals or in the integrated TNCguide.

The following User's Manuals are collected in a central help system:

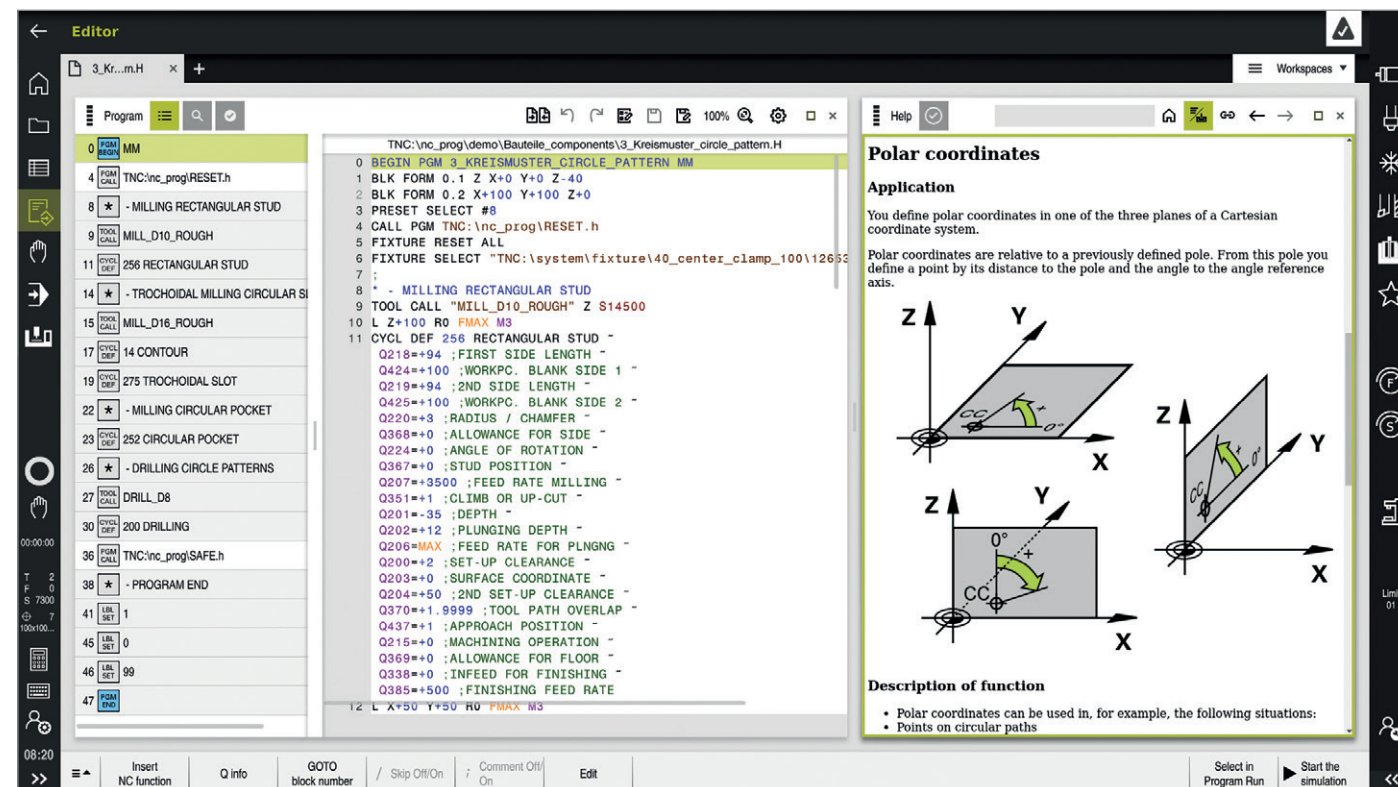
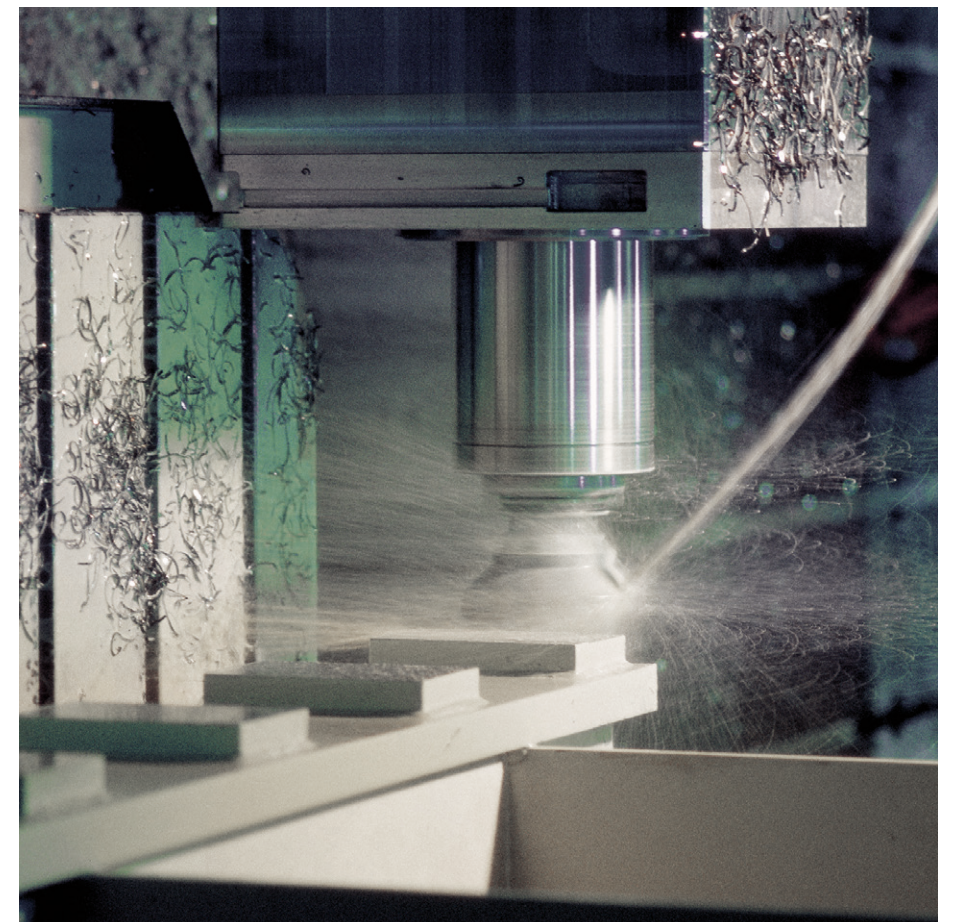
- Setup and Program Run
- Programming and Testing
- Machining Cycles
- Measuring Cycles for Workpieces and Tools

Under the rubric of **Dynamic Efficiency**, HEIDENHAIN offers innovative TNC functions that help the user make heavy machining more efficient and improve process reliability. These software functions not only support the user but also make the manufacturing process itself faster, more stable, and more predictable—in short, more efficient. Dynamic Efficiency permits higher removal rates and therefore increases productivity without making the user resort to special tools. At the same time, it prevents tool overloading and premature cutter wear. Dynamic Efficiency makes your manufacturing overall more economical while increasing process reliability.

Dynamic Efficiency encompasses four software functions:

- **Active Chatter Control (ACC)** is an option for reducing chatter tendencies and permits higher infeeds
- **Adaptive Feed Control (AFC)** is an option for regulating the feed rate based on the machining situation
- **Trochoidal milling** is a function for tool- and machine-friendly roughing of slots and pockets
- **Optimized Contour Milling (OCM)** is an option for tool-friendly machining of any pocket and island under consistent process conditions

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. They also prove their worth under changing machining conditions, such as interrupted cuts, varying plunging processes, or simple roughing operations. In practice, removal rate increases of **20 to 25 percent** are possible.



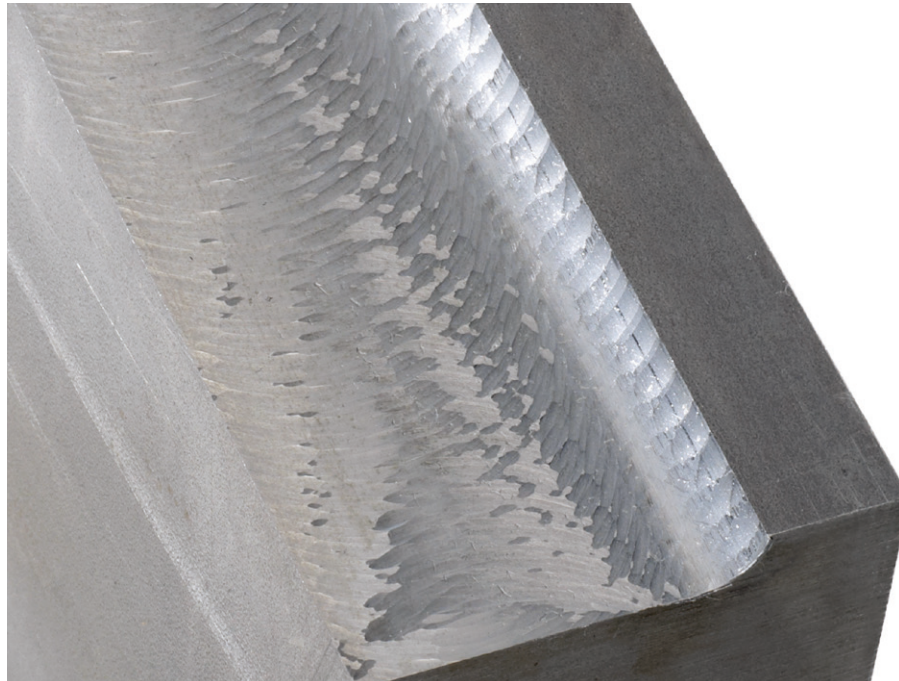
TNCguide integrated into the control, e.g., on the TNC7

dynamic + efficiency

High-performance roughing operations give rise to strong milling forces. Depending on the rotational tool speed, the resonances in the machine tool, and the chip volume (metal-removal rate during milling), a phenomenon known as "chatter" may occur. Chatter puts the machine under heavy strain and causes blemishes on the workpiece surface. Tool wear is also accelerated and less evenly distributed. In extreme cases, the tool may even break.

To reduce chatter susceptibility, HEIDENHAIN now offers a highly effective optional control function called Active Chatter Control (ACC). This option is particularly beneficial during heavy machining:

- Improved cutting performance
- Higher removal rates (up to 25% and more)
- Lower forces on the tool, with increased tool life
- Less strain on the machine



Heavy machining without ACC



Heavy machining with ACC

HEIDENHAIN controls have always allowed the user to enter the feed rate for each block or cycle and also manually adjust the feed rate to the actual machining situation using an override potentiometer. But this approach relies on the experience of the user and requires him to be at the machine.

Adaptive Feed Control (AFC) automatically regulates the feed rate of the TNC, taking into consideration the given spindle power and other process data. During a teach-in cut, the TNC records the maximum occurring spindle power. Prior to machining, you define the limits (in a table) within which the TNC is allowed to influence the feed rate in "control" mode. Naturally, various overload reactions can be specified as well, including by your machine manufacturer.

Adaptive Feed Control (AFC) offers a series of benefits:

Process reliability

Roughing at high material removal rates involves strong cutting forces, which in practice can cause tool defects. If the user is unable to react quickly, perhaps because he is responsible for multiple machines or because the shift is unattended, then significant secondary damage and cost may be incurred:

- Costly rework on the workpiece
- Irreparable workpiece damage
- Damage to the tool holder
- Machine downtime due to spindle damage

Continuous monitoring detects any increase in spindle power due to tool wear or defective inserts, and a replacement tool can be inserted automatically.* In this manner, AFC prevents potential secondary damage due to tool wear while increasing process reliability.

dynamic + efficiency

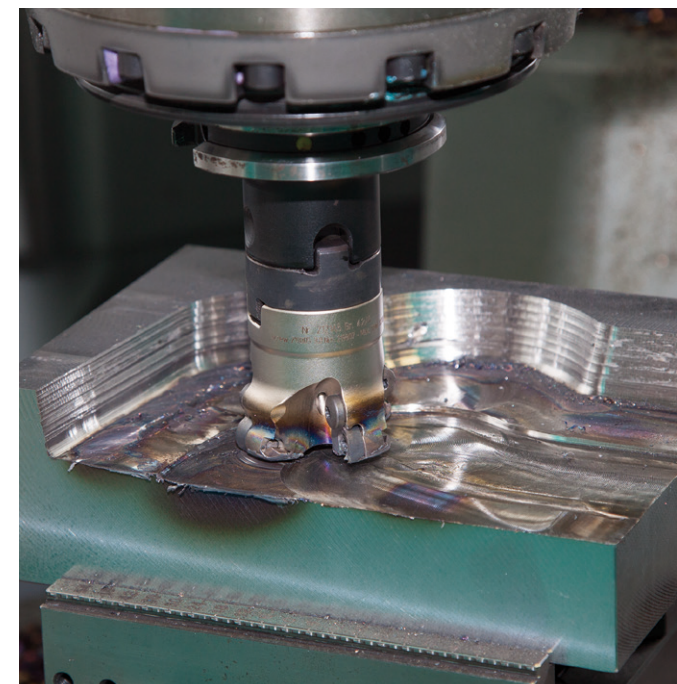
Reduced machining time

AFC regulates the feed rate of the TNC based on the given spindle power. In machining areas requiring less material removal, the feed rate is appropriately increased. This can significantly reduce the machining time.

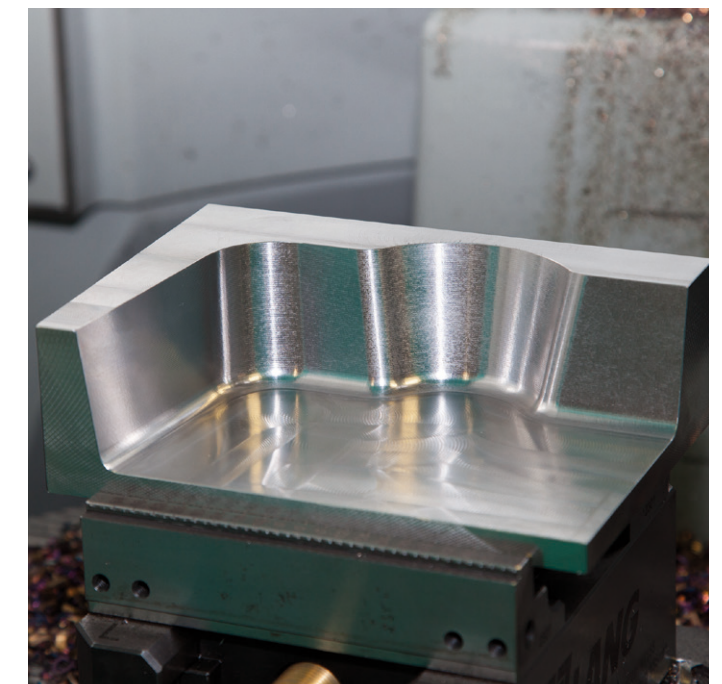
Gentler on the machine

When the maximum teach-in power is exceeded, the feed rate is reduced down to the reference spindle power. As a result, the machine undergoes less strain, and the main spindle is protected from overloading.

* The machine must be adapted by the machine manufacturer for this function.



Workpiece with secondary damage resulting from a broken indexable insert



Fully machined workpiece protected by AFC

dynamic + efficiency

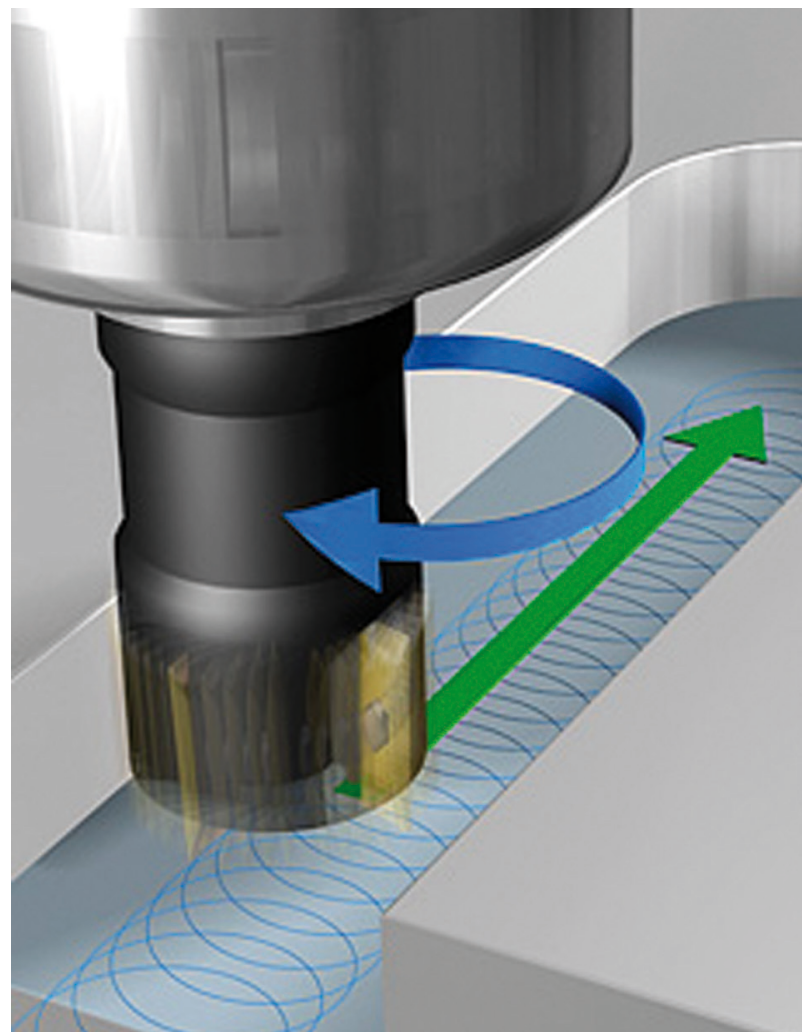
The ability to machine any slot at high efficiency from start to finish is the key benefit of trochoidal milling. In this cycle, roughing is performed with circular movements, onto which a forward linear movement is superimposed. This procedure is referred to as trochoidal milling. It is used particularly for milling high-strength or hardened materials, where the high loads placed on the tool and machine usually only permit small infeeds.

Thanks to the special cutting motion used in trochoidal milling, however, there are no added wear-inducing influences on the tool, and higher infeeds are possible. During hobbing, the entire cutting edge can be used as well. You thereby attain a higher material removal rate per tooth. Circular-motion plunging into the material exerts less radial force on the tool. This reduces the mechanical load on the machine and prevents vibration.

The slot to be machined is described in a contour subprogram as a contour train. You define the dimensions of the slot and the cutting data in a separate cycle. Any residual material can then be easily removed with a subsequent finishing cut.

The benefits include:

- Contact over entire cutter length
- Higher removal rates
- Less strain on the machine
- Less vibration
- Integrated finishing of the side wall
- Superior chip removal



Efficient machining strategies are a key basis for economical NC manufacturing. Roughing processes, in particular, offer great potential for optimization because they usually make up a sizeable portion of the total machining time.

With OCM, you can rough out any pocket and island with high process reliability and lower tool wear thanks to highly consistent process conditions. Simply program the contour as usual in Klartext, or especially easily through the convenient graphical programming function. The control then automatically calculates the complex movements required for maintaining consistent process conditions.

Process reliability and maximum removal rates require optimal adaptation of the cutting data to the characteristics of the tool and workpiece material. OCM gives you a cutting data calculator that draws on a comprehensive integral materials database. You can then adapt the automatically calculated cutting values by taking the specific mechanical and thermal load on the tool into account. Tool service life can be managed with process reliability even at the highest possible removal rates.

Advantages of OCM over conventional machining:

- Reduced tool heating
- Superior chip removal
- Consistent cutting conditions

OCM is an effective, reliable, and convenient way to improve your throughput

- Create programs on the shop floor for any pocket or island
- Significantly higher machining speed
- Considerable reduction in tool wear
- More chips in less time

The OCM option provides practical cycles for roughing, side-wall finishing, and floor finishing.

OCM also permits chamfering and deburring of contours. With this capability, only those areas that can be machined without collisions due to the tool geometry are machined.

Conventional machining

S5000, F1200, a_p : 5.5 mm

Overlap factor: 5 mm

Machining time: 21 min 35 s

*Tool: VHM end mill (Ø 10 mm)
Workpiece material: 1.4104*

Machining with OCM

S8000, F4800, a_p : 22 mm

Overlap factor: 1.4 mm

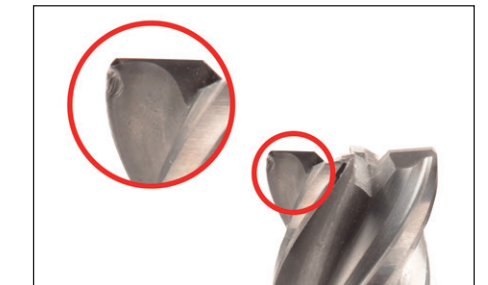
Machining time: 6 min 59 s

*Tool: VHM end mill (Ø 10 mm)
Workpiece material: 1.4104*

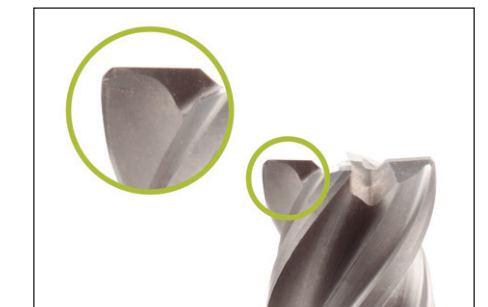
dynamic + efficiency

In order to machine standard shapes, OCM offers various figures that are then used as a pocket, island, or boundary for face milling in conjunction with other OCM cycles.

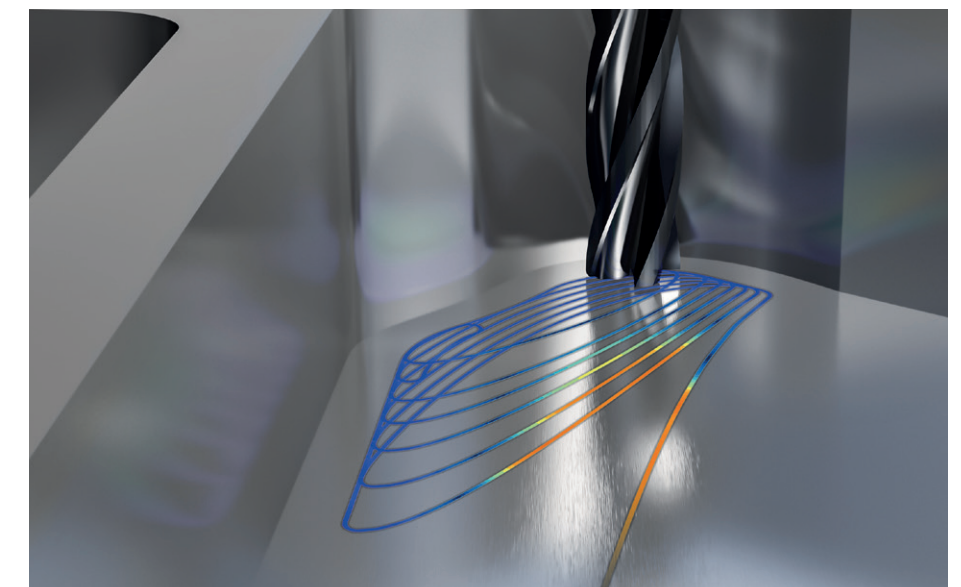
In the machining example illustrated here, both the machining time and tool wear were reduced **by a factor of three**.



Tool after two parts



Tool after six parts



Open for communication

The TNC7 understands CAD files

CAD viewer

With the standardly available CAD viewer software, you can open 3D CAD models and drawings directly on the TNC7. Various view options as well as rotation and zoom capabilities allow for a detailed visual inspection and analysis of your CAD data. You can also use the viewer to ascertain position values from a 3D model. You simply select an arbitrary reference point in your drawing and select the desired contour elements. The CAD viewer then displays the coordinates of the elements in a window. The CAD viewer can depict the following file formats:

- STEP files (.STP and .STEP)
- IGES files (.IGS and .IGES)
- DXF files (.DXF)
- STL files (.STL)

CAD Import (option 42)

Why program complex contours if you already have the drawing as a DXF, STEP, STL or IGES file? After all, you have the ability to extract contours or machining positions from these types of CAD files. This not only saves time otherwise spent on programming and testing, but you can also be sure that the finished contour is exactly in accordance with the design engineer's specifications.

In particular, extracting machining information directly from CAD data provides additional possibilities for creating NC programs with a tilted working plane. You can also define the preset with a 3D basic rotation of the 3D model and set a datum with the appropriate 3D rotation in the desired working plane.

You can easily save the working plane to the clipboard and transfer it to the NC program with the appropriate transformation and the associated PLANE command. On the defined working plane, you can extract contours and machining positions, and transfer them to the NC program.

Selecting contours is very convenient: Start by selecting any element. Once you select a second element, the TNC detects your desired machining direction and initiates automatic contour detection. In doing so, the TNC automatically selects all clearly identifiable contour elements until the contour closes or branches out. In this manner, you can define extensive contours with just a few steps. Then you can simply copy the selected contour to an existing Klartext program using the clipboard.

You can also select **machining positions** and save them as point files, especially in order to apply hole positions or starting points for pocket machining. This can be done very easily by selecting the desired area. In a pop-up window with a filter function, the TNC displays all of the hole diameters within the area you have selected. To select the desired hole diameters and restrict the number of hole positions, simply select the corresponding filter symbol to change the filter limits. A zoom function and various configuration possibilities round out the functionality of CAD Import.

It is also possible to define the contour program's resolution for using it in older TNC controls. You can also define a transition tolerance if the contour elements are not completely connected.

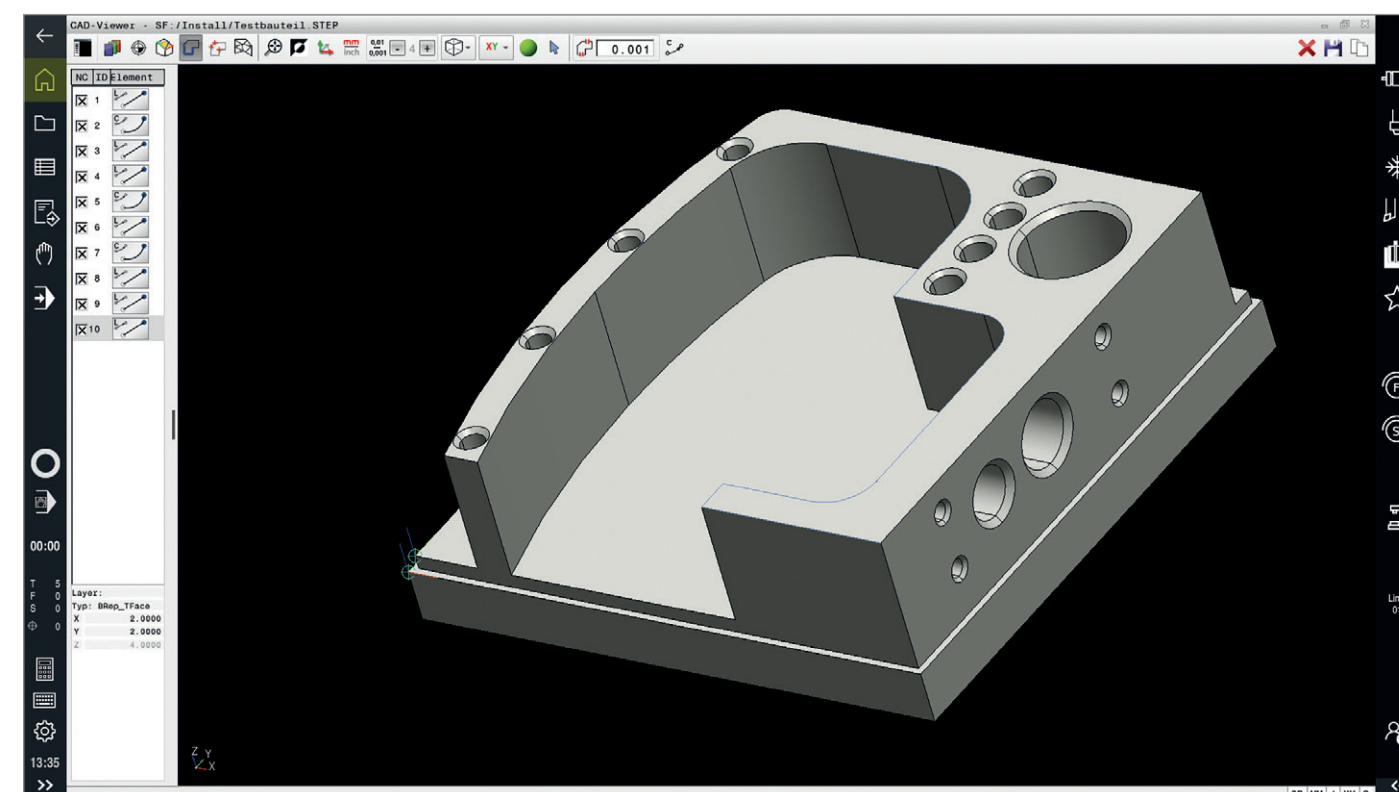
The following positions can be defined as presets:

- The beginning, end, or mid-point of a line
- The beginning, end, or center point of a circular arc
- Quadrant transitions or center point of a circle
- Intersection of two lines, even only in their extension
- Intersection of a line and a circular arc
- Intersection of a line and a circle

If multiple intersections between two elements are possible (e.g., between a straight line and a circle), then you can select the correct intersection with a tap of your finger.

Generating STL files (option)

The CAD Model Optimizer option makes it possible to generate STL files from 3D models. The TNC7 covers the 3D model displayed in the CAD viewer with a mesh of triangles. This simplifies the original model and removes errors, such as small holes in a solid or self-intersections of a surface. The TNC7 then generates an STL file that you can use for various functions of the control. For example, you can then easily repair faulty files of fixtures or tool holders.



Uniformly digital job management with Connected Machining



The smooth exchange of knowledge is crucial for the success of a company. In order for knowledge to be transferred rapidly and without loss, e-mail communication capability is just as important as the continuous availability of electronic production documents or the transfer of data to ERP and production-activity control systems. Tool and raw material inventories, tool data, workholding drawings, CAD data, NC programs and inspection instructions must all be available to machine operators during all shifts. Cost-effective manufacturing therefore requires an efficient process chain and a networked control.

The TNC7, with its **Connected Machining** package of functions, integrates itself flexibly into your process chain and helps you to optimize the transfer of knowledge within your company. So let your shopfloor, as well, benefit from all of the information available within your company. **Connected Machining** makes uniformly digital job management possible within a networked manufacturing environment. You thereby benefit from the following:

- Ease of data usage
- Time-saving procedures
- Transparent processes

The networked TNC7

Integrate the TNC7 with the functions of **Connected Machining** into your corporate network and, via the control, connect the shopfloor to PCs, programming stations, and other data storage media in these areas of the company:

- Design
- Programming
- Simulation
- Production planning
- Production

Even the basic version of the TNC7 is equipped with two Gigabit Ethernet ports of the latest generation. The TNC7 uses the TCP/IP protocol to communicate with NFS servers and Windows networks without requiring additional software. The fast data transfer of up to 1000 Mbit/s ensures very short transmission times. The TNC7 therefore offers the optimal technological platform for **Connected Machining**, the networking of the control in the shop with all production-related areas of your company.

Standard range of functions

For you to be able to use the data that you transfer to the TNC7 over a network, the TNC7 offers attractive applications, even as part of its standard range of functions. The PDF viewer or Mozilla Firefox web browser enable the simplest form of **Connected Machining**: access to production process data directly on the control. In this case, operating web-based documentation systems or ERP systems is just as feasible as accessing your e-mail inbox. For example, the following file formats can also be opened directly on the TNC7:

- Text and PDF files
- Graphic files with the extensions .gif, .bmp, .jpg or .png
- Spreadsheet files with the extensions .xls, .xlsx, .odv or .csv
- html files: .htm, .html, .chm

Data transfer

Another solution for full digital job management from **Connected Machining** is the free-of-charge **TNCremo** PC software. With it, you can transfer remotely stored part programs and pallet tables in both directions over the Ethernet.

With the powerful **TNCremoPlus** PC software, you can also transfer the screen contents from the control to your PC using the live-screen function.

Job-related data

With REMOTE DESKTOP MANAGER (option 133), you can operate a Windows PC from the TNC7. On the control, you gain direct access to EDP systems within the process chain and make your machine setup processes significantly more efficient by reducing inconvenient legwork between the machine and the office. Technical drawings, CAD data, NC programs, tool data, work instructions, parts lists, and warehouse information are digitally available at the machine. E-mails can be sent and received with ease. The Windows PC can be a computer in the local network or an industrial PC (IPC) in the machine's electrical cabinet.

Detailed data for the optimal organization of production processes

HEIDENHAIN DNC enables the connection of existing machine tools to Windows-based industrial applications, meaning that even older TNC controls, like the TNC 426/430 or the iTNC 530, can be connected to modern inventory management systems and production-activity control systems. Use RemoTools SDK to connect your applications to TNC controls.

Monitoring and controlling applications

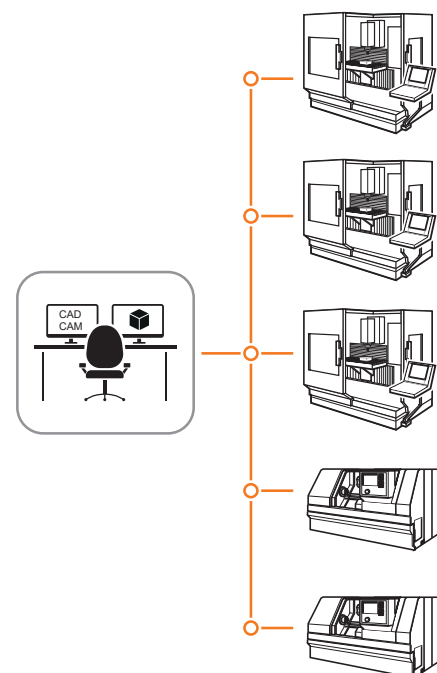
Efficient and secure digital communication in a machine-tool context requires standardized components, application-oriented information models, and adherence to current IT security guidelines.

HEIDENHAIN OPC UA NC Server

OPC UA NC Server offers an interface based on OPC UA for HEIDENHAIN controls. This internationally standardized and widespread communication technology makes it fast and easy to connect machines to your production IT. You also save time when

integrating new functions because the application-oriented presentation of information reduces programming and configuration effort.

- *State-of-the-art IT security:* Authentication, authorization and cryptography
- *Uncomplicated:* Guided connection configuration
- *Application-oriented:* Tailored to the demands of modern industrial applications
- *Standardized:* OPC UA is the communication technology recommended for Industry 4.0
- *Freedom of choice:* Open selection of operating system and toolkit
- *Virtual testing environment:* Free HEIDENHAIN programming station
- *Expandable:* The machine manufacturer can enable access to additional sensors, aggregates or PLC values



StateMonitor collects and visualizes the statuses of production machines. By evaluating important data such as the current machine status, machine messages, override positions, and utilization history, StateMonitor provides in-depth information about the machine's degree of utilization. Based on the data it collects, StateMonitor also reveals machine-specific optimization potential. By entering comments regarding machine downtimes and setup times, the operator can also uncover potential for improvement at the organizational level. Through its messenger function, StateMonitor notifies the appropriate employee by e-mail based on customizable combinations of machine signals and statuses.

StateMonitor collects and visualizes the following information from the networked machines:

- Operating modes
- Override positions (spindle, rapid traverse, feed rate)
- Program status and program name, as well as subprograms if applicable
- Program run time
- SIK number and software number
- Machine messages

Active support for production planning with an extensive range of functions for job data collection:

- Create and assign jobs
- Start and terminate jobs
- Plan setup times and interruptions
- Store additional job data, such as quantities produced

StateMonitor even lets you connect machines with different controls and supports the following protocol types: HEIDENHAIN DNC, OPC UA, MTConnect, and Modbus TCP.

For more information, please contact HEIDENHAIN.

Workpiece measurement

Setup, preset setting and measuring with touch trigger probes

The workpiece touch probes* from HEIDENHAIN help reduce costs in the shop and for serial production. Setup, measurement, and control functions can be automatically executed in conjunction with the touch probe cycles of the TNC7.

Upon contact with the workpiece surface, the stylus of a TS touch trigger probe is deflected. In that instant, the TS generates a triggering signal that, depending on the model, is transmitted either by cable or an infrared beam to the control.

The touch probes are inserted directly into the machine tool spindle and can be equipped with various taper shanks depending on the machine. The ball tips, which are made of ruby, are available in different diameters with various stylus lengths.

* The machine and TNC must be specially adapted by the machine manufacturer.

Cable-bound touch probes

For machines requiring manual tool changes, as well as for grinding machines and lathes:

TS 150/TS 750

- Axial or radial cable connection on its base
- High probing accuracy and repeatability
- Compact dimensions

TS 260

- Axial or radial cable connection
- High probing accuracy

Wireless touch probes

For machines with an automatic tool changer:

TS 460

- Standard touch probe for radio and infrared transmission
- Compact dimensions
- Energy-saving mode
- Optional collision protection
- Thermal decoupling

TS 642

- Activation via switch in taper shank
- Infrared transmission

TS 760

- High probing accuracy
- High reproducibility
- Low probing forces
- Infrared transmission

Transceiver

Radio or infrared transmission is established between the TS or TT touch probe and the SE transceiver:

SE 660

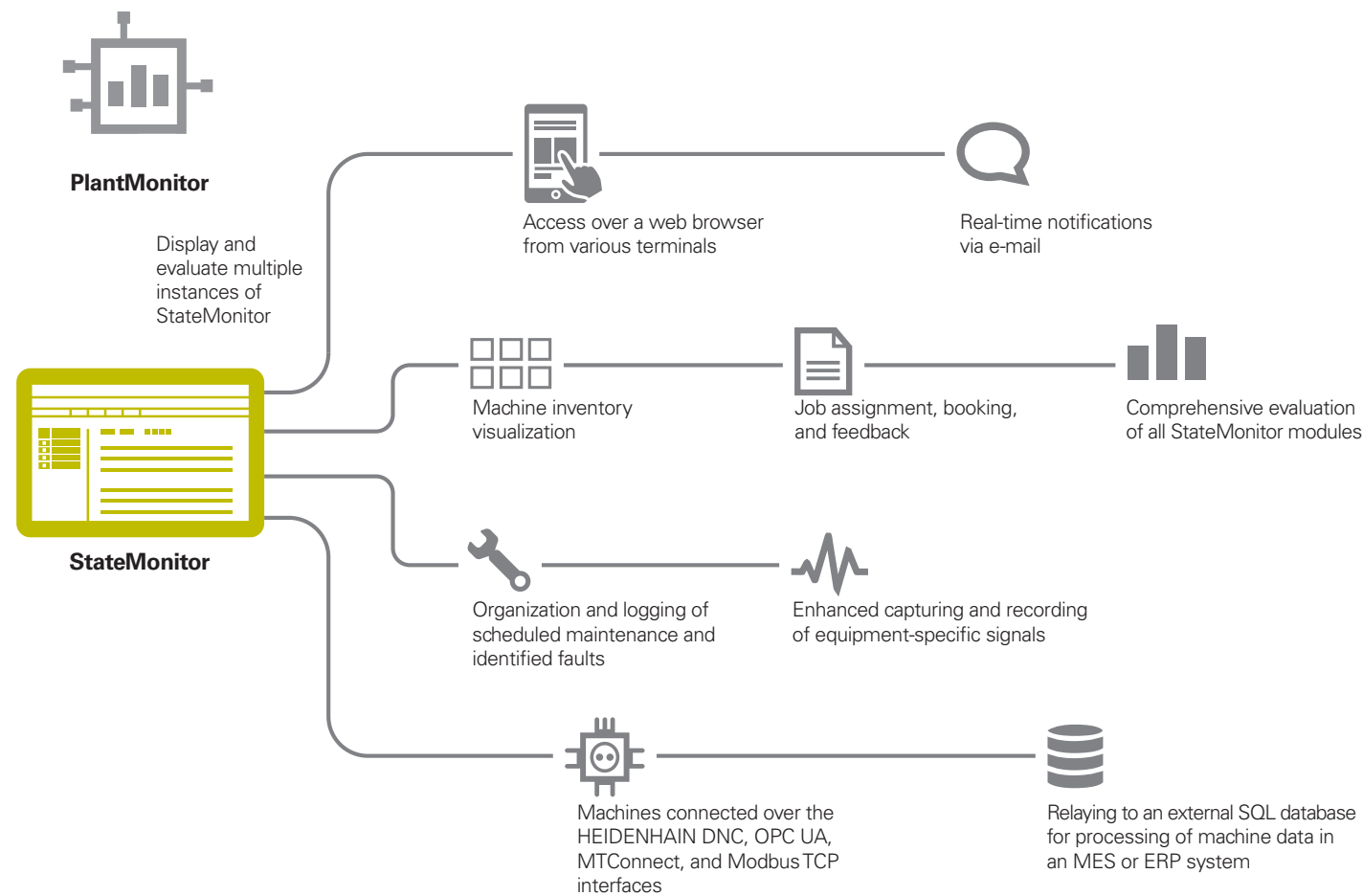
- For radio or infrared transmission (hybrid technology)
- Same SE for TS 460 and TT 460

SE 661

- For radio or infrared transmission (hybrid technology)
- Same SE for TS 460 and TT 460
- EnDat functionality for transmission of the switching state, diagnostics, and additional information



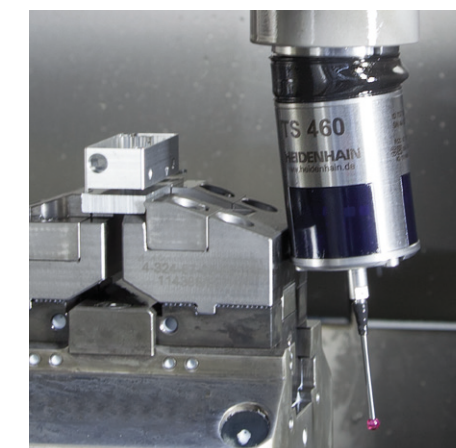
SE 660



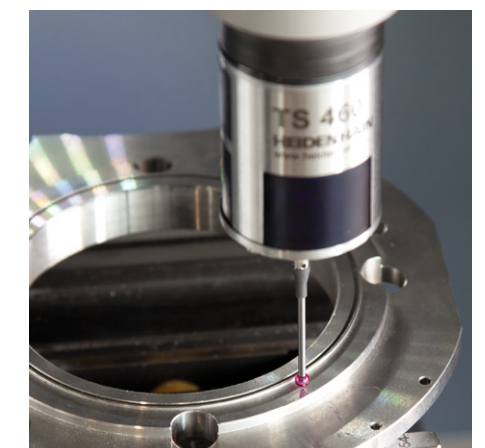
TS 460

Further information:

You can find detailed descriptions of workpiece touch probes on the Internet at www.heidenhain.com or in the *Touch Probes for Machine Tools* brochure.



TS 460 with collision protection



Tool measurement

Measuring length, radius and wear inside the machine

A key factor in obtaining consistently high production quality is, of course, the tool. This requires exact measurement of the tool dimensions and periodic inspection of the tool for breakage, wear, and tooth shape. For tool measurement, HEIDENHAIN offers the TT triggering tool touch probes.

These touch probes are installed directly within the machine's workspace, where they enable tool measurement either before machining or during interruptions.

The **TT tool touch probes** measure the tool length and radius. During probing of a rotating or stationary tool (e.g., for individual tooth measurement), the contact plate is deflected and a triggering signal is transmitted directly to the TNC7.

The **TT 160** uses cable-bound signal transmission, whereas the **TT 460** sends its signals via radio or infrared transmission. It is thus particularly well suited for use on rotary/tilting tables.

To prevent limiting the machining space and avoid collisions, the TT touch probe must occasionally be removed from the machine. The touch probe's new magnetic base features three contact points and a setting screw. As a result, the touch probe requires calibration only during initial installation and can then be re-installed and removed with a quick hand movement. Here are the benefits in a nutshell:

- Fast re-installation without recalibration
- Low-profile base
- Same accuracy as a permanent installation



TT 460



Further information:

You can find detailed descriptions of tool touch probes on the Internet at www.heidenhain.com or in the *Touch Probes for Machine Tools* brochure.

Positioning with an electronic handwheel

Fine motion control of axes

You can set up the workpiece by manually jogging the axes with the axis direction keys, but this task is easier and more finely controllable with the electronic handwheels from HEIDENHAIN.

In this method, the axis slides are moved by the feed motor in accordance with the handwheel's rotation. For particularly high sensitivity, you can incrementally set the amount of traversing distance for each handwheel rotation.

Panel-mounted handwheel

The HR 130 panel-mounted handwheel from HEIDENHAIN can be integrated into the machine operating panel or mounted to a different part of the machine.

Portable handwheels

The HR 510, HR 520, and HR 550 portable handwheels are particularly helpful when you work near the machine's working space. The axis keys and certain function keys are built into the housing. In this way, you can switch axes and set up the machine at any time—regardless of where you happen to be standing. As a wireless handwheel, the HR 550 is ideal for use on large machines. If you no longer need the handwheel, simply attach it to the machine using its built-in magnets.

Expanded range of functions of the HR 520 and HR 550

- Definable traversing distance per revolution
- Display for operating mode, actual position value, programmed feed rate, handwheel offset, spindle speed, and error messages
- Override potentiometers for feed rate, handwheel offset, and spindle speed
- Selection of axes by means of and soft keys
- Keys for continuous traverse of the axes
- Emergency stop button
- Actual position capture
- NC start/stop
- Spindle on/off



HR 550



Overview

User functions

User function	Standard	Option	
Brief description	✓		Basic version: 3 axes plus closed-loop spindle Digital current and speed control
Program entry	✓	42	HEIDENHAIN Klartext Programming of contours graphically, and saving as Klartext program Importing of contours or machining positions from CAD files (STP, IGS, DXF) and saving them as a Klartext contour program or Klartext point table
Position entry	✓		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	✓	9	Tool radius in the working plane, and tool length Radius-compensated contour look-ahead for up to 99 blocks (M120) Three-dimensional tool-radius compensation for changing tool data without having to recalculate an existing program
Tool tables	✓		Multiple tool tables with any number of tools
Cutting data	✓	167	Automatic calculation of spindle speed, cutting speed, feed per tooth, and feed per revolution OCM: automatic calculation of overlap factor, milling feed rate, spindle speed, climb or up-cut milling, lateral infeed, cutting speed, material removal rate, recommended cooling
Constant contour speed	✓		Based on the path of the tool center point Based on the tool's cutting edge
Parallel operation	✓		Program creation with graphical support while another program is running
3D machining	✓	9	Motion control with highly smoothed jerk 3D tool compensation via surface-normal vectors 9 Changing the swivel-head angle with the electronic handwheel during program run without affecting the tool tip position (TCPM = Tool Center Point Management) 9 Keeping the tool perpendicular to the contour 9 Tool radius compensation perpendicular to the tool direction 9 Manual traverse in the active tool-axis system 92 3D radius compensation based on the tool's contact angle
Machining with a rotary table		8	Programming contours on an unrolled cylinder 8 Feed rate in mm/min
Turning		50	Program-controlled switching capability between milling and turning 50 Constant cutting speed 50 Tool-tip radius compensation 50 Cycles for roughing, finishing, recessing, thread turning, and recess turning 50 Blank form updated in contour cycles 50 Turning-specific contour elements for recesses and undercuts 50 Orientation of the turning tool for outside or inside machining 50 Inclined turning 50 Speed limiting 50 Eccentric turning (also requires software option 135) 158 Simultaneous turn finishing
Process monitoring		168	Process Monitoring: detect deviations in a machining process from a reference operation and react accordingly

User function	Standard	Option	
Adaptive feed control		45	AFC adapts the contouring feed rate to the current spindle power
Collision monitoring		40	Dynamic Collision Monitoring (DCM) 40 Graphic depiction of the active collision objects 40 Tool carrier monitoring 140 DCM v2: Dynamic Collision Monitoring Version 2 (expansion of the functions of option 40 (DCM) with graphically supported alignment of workholding equipment)
Contour elements	✓	50 or 158	Straight line Chamfer Circular arc Circle center Circle radius Tangentially connecting circular arc Corner radii Recess Undercut
Contour approach and departure	✓		Via straight line: tangential or perpendicular Via circular arc
Graphical programming	✓		Drawing function for graphical creation and editing of contours; conversion to HEIDENHAIN Klartext format with graphical support for workpiece drawings not dimensioned for NC
Program jumps	✓		Subprograms Program section repeat Any program as a subprogram
Machining cycles	✓	50	Drilling, tapping (with or without floating tap holder), rectangular and circular pockets Peck drilling, reaming, boring, counterboring, centering 50 Area clearance cycles, longitudinal and transverse, paraxial and contour-parallel 50 Recessing cycles, radial/axial 50 Radial/axial recess turning cycles (combined recessing and roughing motion) ✓ Milling internal and external threads 50 Turning internal and external threads 50+ Hobbing 131 Interpolation turning 96 Simultaneous turning (roughing and finishing) for turning operations 50+ Function for grinding operations 156 Gear-system production 157 Clearing level and oblique surfaces ✓ Multi-operation machining of rectangular and circular pockets, rectangular and circular studs ✓ Multi-operation machining of straight and circular slots ✓ Circular and linear point patterns ✓ Point pattern: Data Matrix code ✓ Contour train, contour pocket ✓ Contour slot with trochoidal milling ✓ Engraving cycle: engrave text or numbers in a straight line or on an arc ✓ OEM cycles (special cycles developed by the machine manufacturer) can be integrated 167 Optimized Contour Milling (OCM) cycles: optimization of roughing processes

User functions (continued)

User function	Standard	Option	
Coordinate transformation	✓	8 44	Shifting, rotating, mirroring, scaling (axis-specific) Tilting the working plane, PLANE function <i>Manually definable</i> : shifts, rotations, and handwheel superimpositioning can be manually defined via global program settings
Q parameters Programming with variables	✓ ✓ ✓ ✓ ✓		Mathematical functions =, +, -, *, /, sin α, cos α, tan α, arc sin, arc cos, arc tan, a^n , e^n , ln, log, \sqrt{a} , $\sqrt{a^2 + b^2}$ Logical operations (=, =!, <, >) Calculating with parentheses Absolute value of a number, constant π, negation, truncation of digits before or after the decimal point Functions for calculation of circles Functions for text processing
Programming aids	✓ ✓ ✓ ✓ ✓ ✓		Calculator Complete list of all current error messages Context-sensitive help function for error messages TNCguide: the integrated help system; user information available directly on the TNC7 Graphical support for the programming of cycles Comment and structure blocks in the NC program
Teach-in	✓		Application of actual positions directly in the NC program
CAD Model Optimizer		152	Optimize CAD models
Simulation Display modes	✓ ✓ ✓ ✓		Graphical simulation of the machining operation, even while another program is being executed Plan view / projection in six or more planes / 3D view, also in tilted working plane / 3D line graphics Detail zoom Cutout view
Operating time	✓ ✓		Calculation of machining time in the Editor operating mode and in the Simulation workspace Display of the current machining time in Program Run
Returning to the contour	✓ ✓		Mid-program startup at any block in the program and movement to the calculated nominal position for continuation of the machining operation 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	✓	154	Workpiece-oriented execution of pallet tables (with any number of entries for the selection of pallets, NC programs, and datums) Production process planning with Batch Process Manager
Touch probe cycles*	✓ ✓ ✓ ✓	48 50 or 158	Touch probe calibration Manual or automatic compensation of workpiece misalignment Manual or automatic preset setting Automatic tool and workpiece measurement KinematicsOpt: automatic measurement and optimization of the machine's kinematic model Cycle for measurement of turning tools

User function	Standard	Option	
Parallel secondary axes	✓ ✓ ✓		Compensation of movement in the secondary axes U, V, W through the principal axes X, Y, Z Movements of parallel axes included in the position display of the associated principal axis (sum display) Defining the principal and secondary axes in the NC program enables execution on different machine configurations
Conversational languages	✓		English, German, Czech, French, Italian, Spanish, Portuguese, Swedish, Danish, Finnish, Dutch, Polish, Hungarian, Russian (Cyrillic), Chinese (traditional, simplified), Slovenian, Slovak, Norwegian, Korean, Turkish, Romanian
CAD viewer	✓		Display of standardized CAD file formats on the TNC

* Automatically enabled for HEIDENHAIN touch probes.

Accessories

Accessories	
Electronic handwheels	<ul style="list-style-type: none"> • HR 510/HR 520: portable handwheels • HR 550: portable wireless handwheel • HR 130: panel-mounted handwheel
Workpiece measurement	<ul style="list-style-type: none"> • TS 150/TS 750: compact workpiece touch probes with cable connection • TS 260: workpiece touch probe with cable connection • TS 460/TS 760: workpiece touch probe with radio or infrared transmission • TS 642: workpiece touch probe with infrared transmission
Tool measurement	<ul style="list-style-type: none"> • TT 160: triggering tool touch probe • TT 460: triggering tool touch probe with radio or infrared transmission
Software for PCs	<ul style="list-style-type: none"> • RemoteAccess: software for remote diagnostics, monitoring, and operation • CycleDesign: software for creating your own cycle structure • TNCremo: software for data transfer (free of charge) • TNCremoPlus software for data transfer with live-screen function • State Monitor: software for recording, evaluating, and visualizing machine data

Options

Option number	Option	ID	Remark
0	Additional Axis 1	354540-01	Additional control loops 1 to 8
1	Additional Axis 2	353904-01	
2	Additional Axis 3	353905-01	
3	Additional Axis 4	367867-01	
4	Additional Axis 5	367858-01	
5	Additional Axis 6	370291-01	
6	Additional Axis 7	370292-01	
7	Additional Axis 8	370293-01	
8	Advanced Function Set 1	617920-01	Machining with a rotary table <ul style="list-style-type: none"> • Programming of cylindrical contours as if in two axes • Feed rate in mm/min Interpolation: circular in 3 axes with tilted working plane Coordinate transformation: tilting the working plane, PLANE function
9	Advanced Function Set 2	617921-01	Interpolation: straight line in more than four axes (export license required) 3D machining <ul style="list-style-type: none"> • 3D tool compensation via surface normal vectors • Using the electronic handwheel to change the angle of the swivel head during program run without affecting the position of the tool point (TCPM = Tool Center Point Management) • Keeping the tool perpendicular to the contour • Tool radius compensation perpendicular to the tool direction • Manual traverse in the active tool-axis system
18	HEIDENHAIN DNC	526451-01	Communication with external PC applications over COM component
40	DCM Collision	526452-01	Dynamic Collision Monitoring (DCM) The control monitors the defined collision objects during all machine movements
42	CAD Import	526450-01	Import of contours from 2D and 3D models (e.g., STEP, IGES, DXF)
44	Global PGM Settings	576057-01	Global program settings
45	Adaptive Feed Control (AFC)	579648-01	Adaptive feed control
46	Python OEM Process	579650-01	Execution of Python applications
48	KinematicsOpt	630916-01	Touch-probe cycles for the automatic measurement of rotary axes
49	Double Speed Axes	632223-01	Short control-loop cycle times for a direct drive motor
50	Turning	634608-01	Turning functions (mill-turning): <ul style="list-style-type: none"> • Turning tool management • Tool radius compensation • Switching between milling and turning mode • Turning-specific contour elements • Package of turning cycles
52	KinematicsComp	661879-01	Spatial compensation of error in rotary and linear axes (subject to export permit)

Option number	Option	ID	Remark
56 to 61	HEIDENHAIN OPC UA NC Server	1291434-01 to -06	Reliable and stable interface for the connection of state-of-the-art industry applications; uncomplicated thanks to the use of standardized designs. Each of the six SIK options enables an incoming OPC UA connection via an application certificate
77	4 Additional Axes	634613-01	4 additional control loops
78	8 Additional Axes	634614-01	8 additional control loops
92	3D-Tool Comp	679678-01	33D radius compensation based on the contact angle (only with the Advanced Function Set 2 software option)
93	Extended Tool Management	676938-01	Expanded tool management: <ul style="list-style-type: none"> • Tooling list (list of all tools of the NC program) • T usage sequence (sequence of all tools inserted during the program)
96	Advanced Spindle Interpolation	751653-01	Additional functions for an interpolated spindle <ul style="list-style-type: none"> • Interpolation turning, coupling • Interpolation turning, contour finishing
131	Spindle Synchronism	806270-01	Synchronization of two or more spindles
133	Remote Desk. Manager	894423-01	Display and remote operation of external computer units (e.g., a Windows PC)
135	Synchronizing Functions	1085731-01	Advanced synchronization of axes and spindles
140	DCM v2	1353266-01	Dynamic Collision Monitoring (DCM) Version 2 with graphically supported alignment of workholding equipment <ul style="list-style-type: none"> • Includes all functions of software option 40 (Dynamic Collision Monitoring, DCM)
141	Cross Talk Comp.	800542-01	CTC: compensation of axis couplings
142	Pos. Adapt. Control	800544-01	PAC: position-dependent adaptation of the control parameters
143	Load Adapt. Control	800545-01	LAC: load-dependent adaptation of the control parameters
144	Motion Adapt. Control	800546-01	MAC: motion-dependent adaptation of the control parameters
145	Active Chatter Control	800547-01	ACC: active suppression of chatter during heavy machining
146	Machine Vibration Control	800548-01	Damping of machine oscillations to improve workpiece surfaces. The following functions are part of Machine Vibration Control (MVC): <ul style="list-style-type: none"> • Active Vibration Damping (AVD): active damping of vibrations in the control loop • Frequency Shaping Control (FSC): reduction of vibration inducement by means of frequency-based feedforward control
152	CAD Model Optimizer	1353918-01	Conversion and optimization of CAD models <ul style="list-style-type: none"> • Fixtures • Workpiece blank • Finished part

Option number	Option	ID	Remark
154	Batch Process Manager	1219521-01	Planning and executing multiple machining operations
155	Component Monitoring	1226833-01	Monitoring for component overloading and wear
156	Grinding	1237232-01	Grinding functions: <ul style="list-style-type: none"> • Jig grinding • Ability to switch between normal operation and dressing mode • Reciprocating stroke • Grinding cycles • Tool management for grinding and dressing
157	Gear Cutting	1237235-01	Functions for the machining of gear teeth
158	Turning v2	1359635-01	Turning functions (mill-turning version 2) <ul style="list-style-type: none"> • Includes all functions of software option 50 (Turning) plus cycles for simultaneous roughing and finishing
160	Integrated FS: Basic	1249928-01	Enabling of functional safety and four safe control loops
161	Integrated FS: Full	1249929-01	Enabling of functional safety and maximum number of safe control loops
162	Add. FS Ctrl. Loop 1	1249930-01	Additional FS control loop 1
163	Add. FS Ctrl. Loop 2	1249931-01	Additional FS control loop 2
164	Add. FS Ctrl. Loop 3	1249932-01	Additional FS control loop 3
165	Add. FS Ctrl. Loop 4	1249933-01	Additional FS control loop 4
166	Add. FS Ctrl. Loop 5	1249934-01	Additional FS control loop 5
167	Optimized Contour Milling	1289547-01	OCM: optimize roughing processes and fully utilize milling tools with the integrated cutting data calculator
168	Process Monitoring	1302488-01	Reference-based monitoring of the machining process
169	Add. FS Full	1319091-01	Enabling of all FS axis options or control loops. Options 160 and 162 to 166 must already be set.

Specifications

Specifications	Standard	Option	
Components	✓ ✓ ✓ ✓		MC main computer CC or UxC controller unit Multi-touch operation TE operating panel (suitable for 24-inch screen)
Operating system	✓		HEROS 5 real-time operating system for machine control
Memory	✓ ✓		Main memory: 8 GB RAM NC program memory: 189 GB (with 240 GB SSDR)
Input resolution and display step	✓ ✓		Linear axes: down to 0.01 µm Rotary axes: down to 0.00001°
Input range	✓		Maximum: 999 999 999 mm or 999 999 999°
Interpolation	✓ ✓ ✓	9 8	Linear in 4 axes Linear in up to 6 axes (export license required) Circular in 2 axes Circular in 3 axes with tilted working plane Helical: superimposition of circular and straight paths
Block processing time	✓		≤ 0.5 ms (3D straight line without radius compensation)
Axis feedback control	✓ ✓ ✓ ✓		Position loop resolution: signal period of the position encoder/4096 Position controller cycle time: 200 µs (100 µs with option 49) Speed controller cycle time: 200 µs (100 µs with option 49) Current controller cycle time: minimum 100 µs (minimum 50 µs with option 49)
Error compensation	✓ ✓		Linear and nonlinear axis error, backlash, reversal peaks during circular movements, reversal error, thermal expansion Static friction, sliding friction
Data interfaces	✓ ✓ ✓ ✓	18 56 to 61	One each: RS-232-C/V.24 max. 115 kbit/s Extended data interface with LSV2 protocol for remote operation of the TNC over the data interface with the TNCremo or TNCremoPlus software from HEIDENHAIN 1000BASE-T Gigabit Ethernet interface 4 x USB 3.0 HEIDENHAIN-DNC for communication between a Windows application and the TNC (DCOM interface) HEIDENHAIN OPC UA NC Server Reliable and stable interface for the connection of state-of-the-art industrial applications
Diagnostics	✓		Fast and simple troubleshooting through integrated diagnostic aids
Ambient temperature	✓ ✓		Operation: +5 °C to 40 °C Storage: -20 °C to +60 °C (-31 °F to +149 °F)

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