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Software Function

DCM

Dynamic Collision Monitoring for iTNC 530

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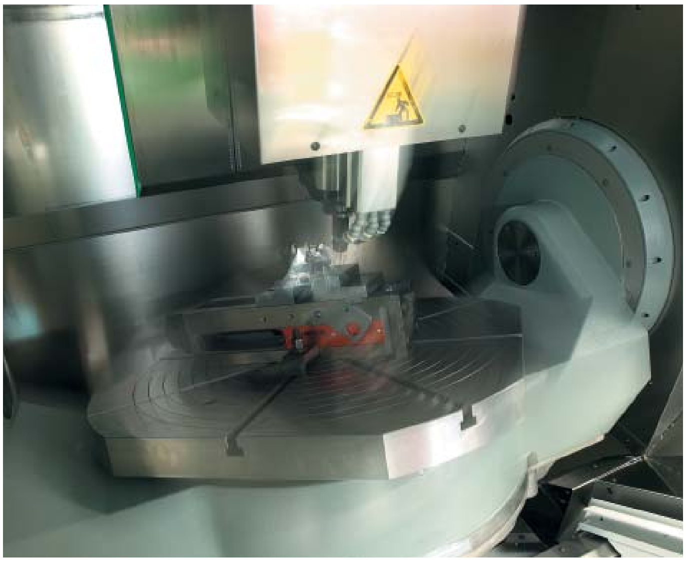
Safe Setup and Machining

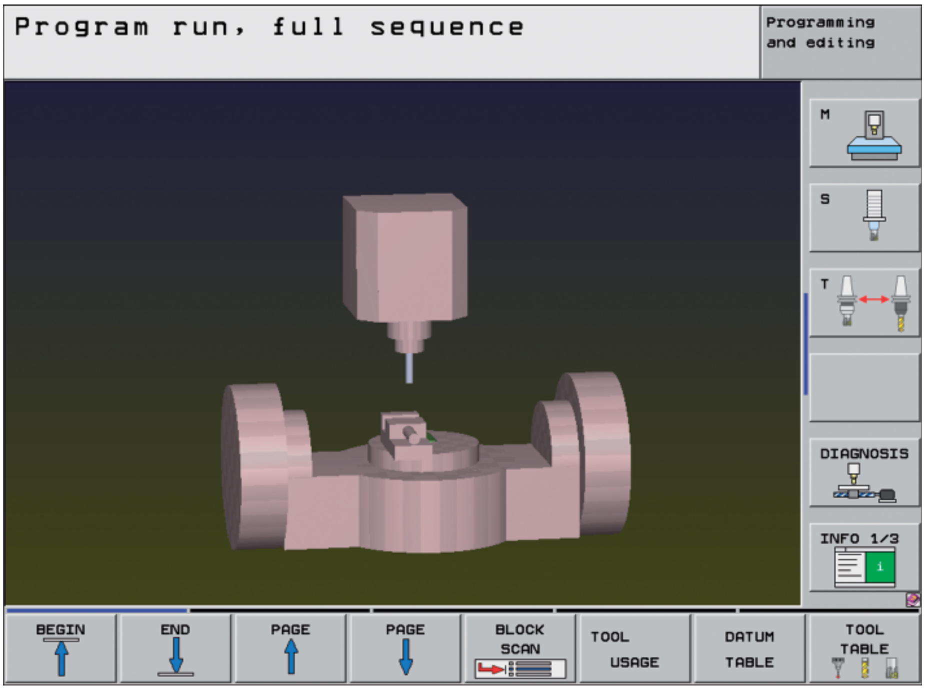
Integrated Dynamic Collision Monitoring (DCM)

Complex machine motions, especially during multiaxis machining, and steadily increasing rapid-traverse and machining speeds make it difficult for the machine operator to foresee axis movements.

Integrated Dynamic Collision Monitoring (DCM) is a powerful function of the iTNC 530 for preventing collisions between the tool and machine components, or between the tool and fixtures. This is possible in both the Program Run modes and set-up mode when the machine axes are moved manually by the operator: The iTNC 530 detects when the tool is in danger of causing a collision and stops the axis movements while issuing an error message. In addition, the machine operator can have the iTNC display all defined collision objects in order to show a simplified depiction of "machine versus tool," including tool carriers and measured fixtures. In this view, the iTNC displays the colliding objects in a different color. This helps to prevent machine damage and costly downtimes. Unattended shifts become safer and more reliable.

Since its introduction at the end of 2005, Dynamic Collision Monitoring (DCM) has been in use on more than 3000 iTNC-controlled machine tools with differing configurations, where it has been providing reliable protection against collision.



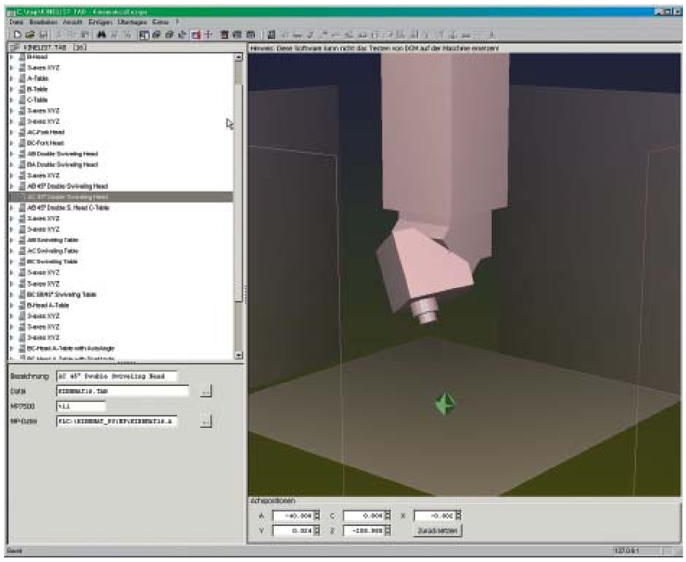


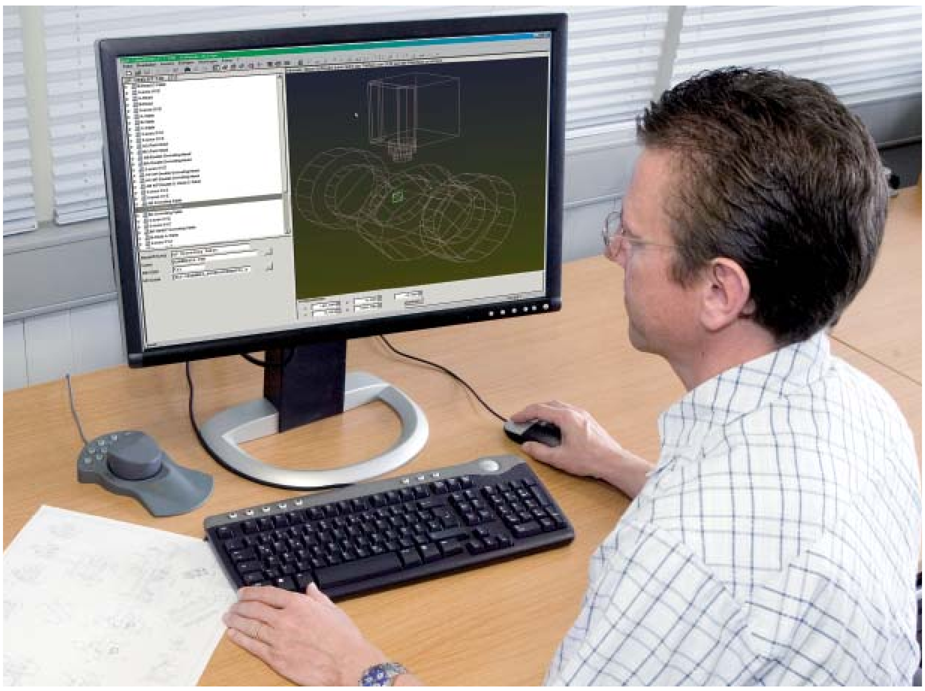
Configuring the Machine

Machine Components Can Be Defined as Collision Objects by the Machine Tool Builder

The machine tool builder must define the machine components to be monitored by the iTNC. The working space and the collision objects are described using geometric bodies such as planes, cuboids and cylinders. Complex machine components can be modeled with multiple geometric bodies. The tool is automatically considered a cylinder of the tool radius (defined in the tool table). For tilting devices, the machine tool builder can use the tables for the machine kinematics also to define the collision objects. This ensures that all components that are attached to the machine are always considered during collision monitoring.

HEIDENHAIN offers the KinematicsDesign software tool to help you create and visually check collision objects quickly and simply. This software tool allows the machine tool builder to use interactive graphics to describe the kinematics and the collision objects that are attached to the machine as early as during the design phase of the machine tool.





Fixture and Tool-Carrier Management

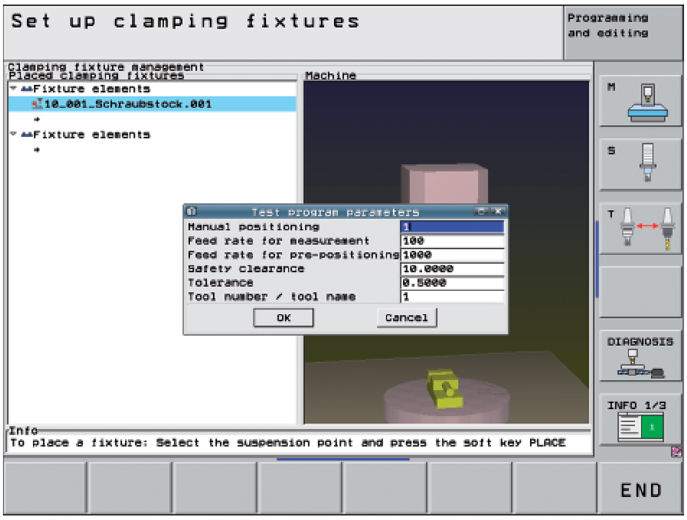
User-Definable Collision Objects

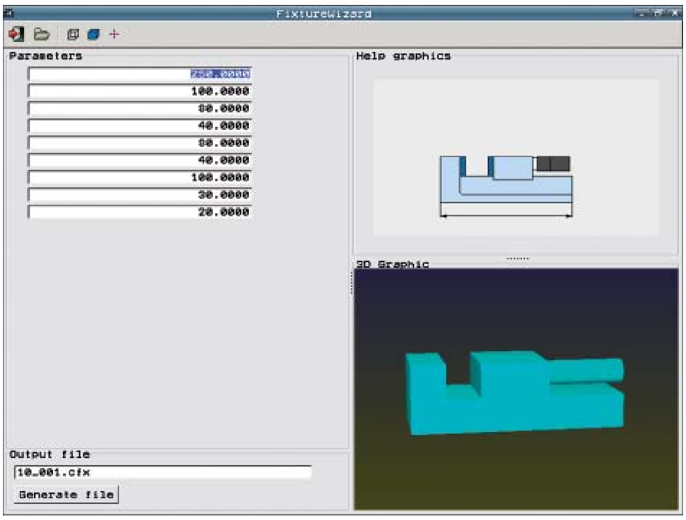
Fixture management
The collision monitoring function of the iTNC 530 also takes into account fixtures that must be measured by the user with a 3-D touch probe according to the requirements of the fixture designer. This enables you to detect collisions between the tool and fixtures in time, so that they can be avoided. HEIDENHAIN or the machine tool builder provides parameterized descriptions of standard fixtures. The FixtureWizard, which is available in set-up mode on the iTNC, enables you to use these standard fixtures for describing your own fixtures.

In the Manual Operation mode, the fixture management function is used to set up the fixtures in the machine's work envelope. The procedure is simple and similar to probing a workpiece. An interactive menu allows you to use the integrated measuring cycles to measure and automatically transfer the fixture data, and to define the variable input values, such as the jaw distance of a vise. The type and sequence of the individual steps depend on the respective fixture and cannot be changed. This prevents unnecessary entries and ensures that the fixture can be set up as quickly and easily as possible.

You can also have the iTNC create a test program after the measuring process. In the Program Run, Full Sequence mode the iTNC moves to defined test points and evaluates them. If the actual values of the test points exceed the tolerance that can be defined for the nominal values, then the iTNC issues corresponding error messages. The measurement result of each test point is displayed on the screen and is also available in a log file.

Tool-carrier management (available as of NC software 34049x-06)
Tool carriers are managed in a way similar to fixtures. Tool-carrier templates can be defined by parameters in the control, which makes it easy to integrate them in collision monitoring. Even angle heads can be defined simply and graphically interactively. In the tool table, you simply assign the associated tool carrier to the respective tool so that the iTNC also considers the tool carrier in the tool call. In this manner, the 3-D touch probes from HEIDENHAIN can also be integrated completely in collision monitoring. HEIDENHAIN naturally provides the corresponding descriptions for the collision objects.





Safe in Any Situation

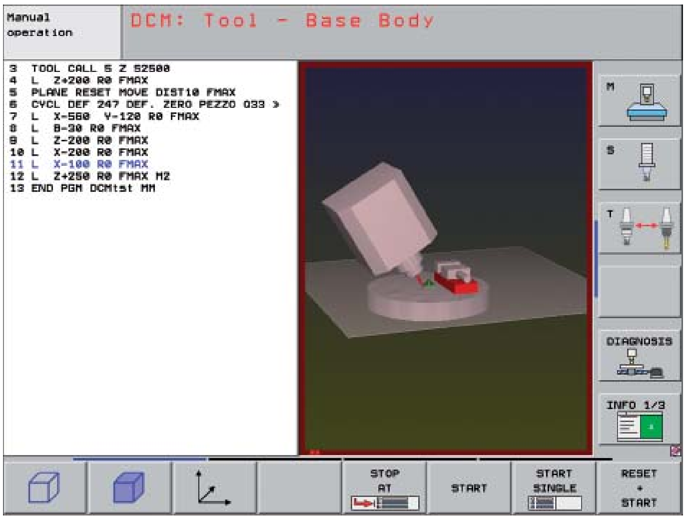
Dynamic Collision Monitoring on the iTNC

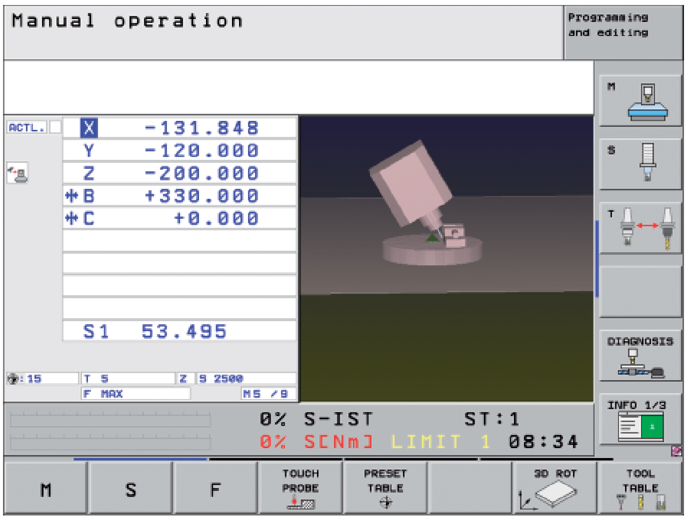
Collision test in Test Run mode
In order to avoid machine downtime, you can check for collisions in the Test Run mode before actually machining a part. The iTNC displays the machine kinematics configuration defined by the machine tool builder with all defined collision objects, including the fixtures if they have already been measured. As usual, the screen layout can be adjusted in such a way that the machine kinematics configuration appears at the right of the NC program, or takes up the whole screen in the same manner as has been possible for workpiece simulation on the iTNCs for many years now. If there is a collision, the iTNC displays an error message and marks the colliding objects in red. By shifting the datum, you can move the workpiece to a position where no collision can occur during machining.

During Test Run, other kinematics models can be activated too, even if a program is being run on the machine at the same time. This is an especially interesting feature for machines with head-changing systems.

Safe manual traverse of the machine axes
Many collisions occur during set-up mode when the wrong axis-direction key is accidentally pressed in the daily hustle and bustle at work. The Dynamic Collision Monitoring function of the iTNC provides excellent protection in such a case, because it monitors the tool and all defined collision objects for collision with each other. If two collision objects move toward each other, the iTNC first reduces the feed rate and then stops machine movement completely if the distance becomes too small. In these cases, it is especially useful that the operator can retract the machine axes only in the direction in which the distance between the collision objects actually increases. This seems to be easily manageable, but five-axis machining with a tilted tool requires complex calculations that are taken care of by the iTNC automatically in real time. Strain on the operator is reduced and safety is considerably increased.

Full control over the machining process
In Automatic mode, the iTNC monitors the movement of all objects with respect to each other. If a collision is impending, the iTNC interrupts the machining process and issues an error message with the names of the colliding objects. In addition, the colliding objects are highlighted in a different color so that they can easily be identified by the machine operator.





DCM Provides Safety in Real Time

Advantages over External Simulation Systems

All common CAM systems already prevent collisions between the tool or tool holder and the workpiece during CAM programming. Some systems also simulate the movement of rotary axes and graphically display the tilting mechanics (swivel head and/or rotary tilting table). CAM systems that are even more powerful can show the complete virtual machine as well as the machining process in the actual (virtual) machine environment.

These systems do not yet simulate the machine-specific NC program that is later run by the NC control, but machine-neutral, CAM-system-internal traverse paths that are converted to an actual NC program by a postprocessor after successful simulation. Only after conversion by the postprocessor does the NC program contain all control-specific and machine-specific commands that are translated into actual axis movements by the NC control during machining. Maximum process reliability is therefore achieved by simulating the actual NC program together with the actual tool-compensation values, actual datums, actual machine settings, and the actual control software, taking into account further machine components in the work envelope of the machine (e.g. vise, tool measuring devices, partitions, etc.).

Process reliability is increased by machine simulation software, especially if the simulation software uses **virtualTNC.** virtualTNC is the software kernel of the iTNC, which can be integrated in the machine simulation software. Please see page 8 for more information on virtualTNC.

Process reliability is increased even more if collision tests can be performed both before actual machining and when the machine operator begins to set up the machine. This is possible in real time with the Dynamic Collision Monitoring (DCM) function that is integrated in the iTNC 530, offering the following benefits in particular:

Manual positioning
In set-up mode, the machine operator moves the machine manually with the axis-direction keys or with the electronic handwheel. External simulation of machine operations, meaning the manual movement of the axes by the machine operator, is not possible beforehand. This is where only **DCM** – as a function that is integrated in the control – provides real protection and considerably reduces the danger of collision.

Actual clamping position
The actual clamping position of the workpiece is unambiguously defined by manually setting the machine datum. The workpiece alignment (basic rotation) is also not exactly defined until the workpiece has been probed. In the worst case, a collision or a violation of a software limit switch is not detected until the part is being machined. This occurs especially when a workpiece takes up the entire work envelope of the machine. Sometimes the workpieces are even measured fully automatically during the machining process by means of touch probe cycles, which do not determine the datum and workpiece position unambiguously until program run has been started. Again, only an integrated system, such as **DCM,** which checks all required positions in real time during the machining process, provides optimum collision protection.

Global program settings
Transformations (shifts, rotations, axis swapping) can be defined in global program settings, which add to and are superimposed over the transformations defined in the NC program. The user can define or cancel transformations at any time during the machining process. This means that only the control is aware of these transformations, and potential collisions can therefore only be prevented by **DCM.**

Actual tool-compensation data
Tool-compensation values sometimes deviate from the value simulated beforehand. The actual values are not entered into the tool table of the iTNC until the tool changer is filled, and do not become effective until a tool is called. Sometimes further compensation values (delta values), which the user can add to the tool call, also apply. It is useful if the external simulation system can access the tool presetter. It is also possible to use tool touch probes or lasers to determine the actual compensation values for length and radius during the machining process and save them in the compensation-value tables of the iTNC. This means that, in the worst case, collisions cannot be detected before program run. Once again, **DCM** puts you on the safe side.

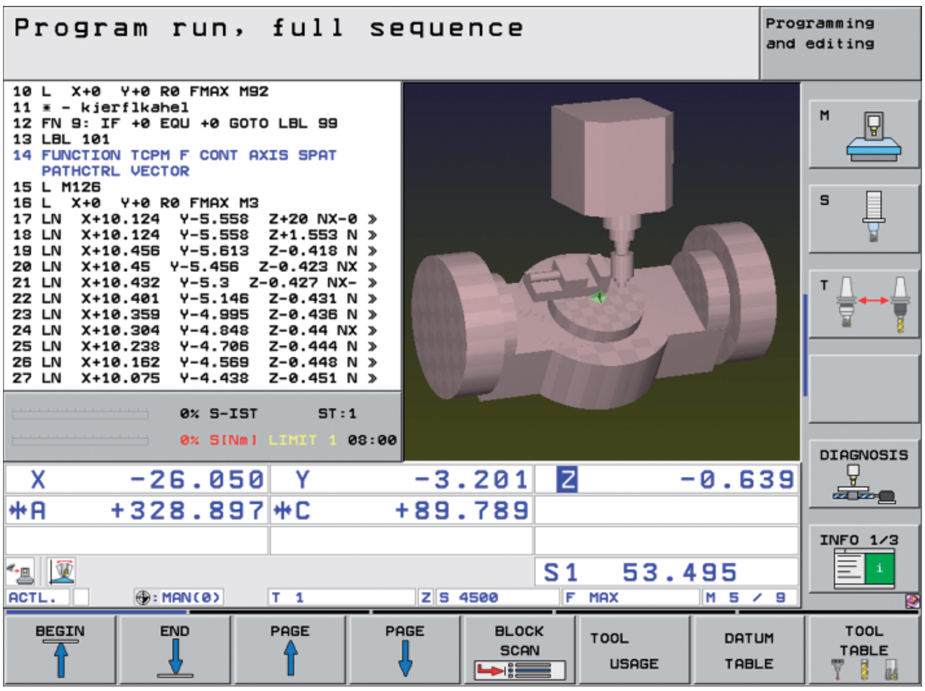
Inserting a replacement tool
When the tool life has expired, fully automated tool changes can take place at any point in the program. The iTNC inserts the replacement tool defined by the user. Especially in five-axis milling, this requires complex traverse motions that are controlled via special macros and cannot be simulated externally. However, **DCM** detects possible collisions in time.

Simulation of complex control functions
Complex control functions that are used, for example, to calculate compensation movements in linear and rotary axes depending on the active kinematics configuration, cannot be simulated exactly by external simulation systems. This can even affect machining operations with a tilted tool that are executed with the PLANE function, i.e. 2.5-D operations. **DCM** also helps you avoid possible collisions if you use other functions that cannot be simulated externally, such as:

- FUNCTION TCPM AXIS SPAT: Inclined-tool machining with 45° swivel heads
- FUNCTION TCPM PATHCTRL VECTOR: Vector interpolation between the starting and end position, independent of kinematics configuration
- M140 MB: Retraction function
- LN blocks: NC programs with surface normal vectors automatically position the rotary axes of a machine according to internal rules.

Configuration-dependent behavior
The machine operator and machine tool builder have numerous possibilities for adapting the control's behavior in various functions to their individual requirements by using machine parameters. For example, different positioning movements within or at the end of cycles, the effect of coordinate transformations, the positioning behavior, etc. can be defined and adapted. Unambiguous external simulation of these settings is also not possible. In addition, these types of settings can temporarily be changed during run time of the NC program. Collisions can therefore only be detected by the **DCM** function in the control.

PLC functions
The machine tool builder uses the PLC (programmable logic controller) to adapt the iTNC to the machine. This makes it possible to realize any machine-dependent functions, such as a tool change, head change or pallet change, and much more. These types of traverse motions defined by the machine tool builder are usually not taken into account by external simulation software, unless **virtualTNC** (see page 8) is used as a control kernel for simulation. The integral solution proves its strength in this area too, because it also monitors these types of movements.



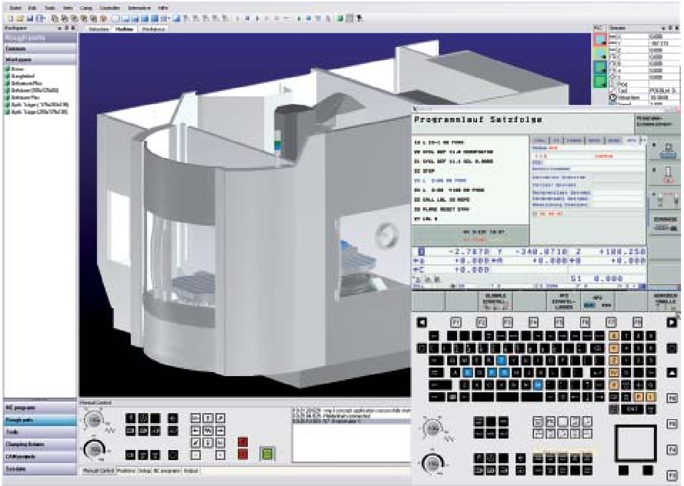
virtualTNC

PC Software for Control of Virtual Machines

The virtualTNC software for PCs makes it possible to use the iTNC 530 as a control component for machine-simulation applications (virtual machines) on external computer systems.

With virtualTNC, machine-simulation applications (virtual machines) are capable of the complete simulation of production units to optimize production processes in the field beforehand. virtualTNC can control the axes of a virtual machine as if it were a real system. Users program and operate the control in the same way as they do an actual HEIDENHAIN iTNC 530.

virtualTNC is the programming station software of the iTNC 530 with a special interface for transmitting the nominal position values of the axes to the machine simulation software. This makes it possible to simulate all control functions just as they will later be executed on an actual machine. The PLC can also be integrated in virtualTNC so that even machine-specific traverse motions (e.g. tool change or pallet change) can be simulated as if they were real.



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For catalogs, brochures and Product Information sheets, visit **www.heidenhain.de/docu**

More information:

- Catalog: *iTNC 530*
- Brochures: *HEIDENHAIN DNC, Remo-Tools SDK, virtualTNC*

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