

HEIDENHAIN



TNC 320

User's Manual ISO programming

NC Software 771851-04 771855-04

English (en) 9/2016

Controls of the TNC

Keys

Controls of the TNC

Keys

Keys on visual display unit

Кеу	Function
0	Selecting the screen layout
0	Toggle the display between machining and programming modes
	Soft keys for selecting functions on screen
	Shifting between soft-key rows

Machine operating modes

Кеу	Function
(m)	Manual operation
	Electronic handwheel
	Positioning with manual data input
	Program run, single block
-	Program run, full sequence

Programming modes

Кеу	Function
\	Programming
- >	Test run

Entering and editing coordinate axes and numbers

Кеу	Function
× v	Select coordinate axes or enter them in a program
0 9	Numbers
-/+	Decimal point / Reverse algebraic sign
ΡΙ	Polar coordinate entry / Incremental values
Q	Q parameter programming / Q parameter status
	Capture actual position
	Skip dialog questions, delete words
ENT	Confirm entry and resume dialog
	Conclude block and exit entry
CE	Clear entries or TNC error message
DEL	Abort dialog, delete program section

Tool functions

Кеу	Function	
TOOL DEF	Define tool data in the program	
TOOL CALL	Call tool data	

Manage programs and files, TNC functions

Кеу	Function
PGM MGT	Select or delete programs and files, external data transfer
PGM CALL	Define program call, select datum and point tables
MOD	Select MOD functions
HELP	Display help text for NC error messages, call TNCguide
ERR	Display all current error messages
CALC	Show calculator
SPEC FCT	Show special functions

Navigation keys

Кеу	Function
1 -	Position the cursor
GOTO	Go directly to blocks, cycles and parameter functions
HOME	Navigate to the program start or table start
END	Navigate to the program end or end of a table line
PG UP	Navigate up one page
PG DN	Navigate down one page
	Select the next tab in forms
	Up/down one dialog box or button

Cycles, subprograms and program section repeats

Кеу		Function
TOUCH PROBE		Define touch probe cycles
CYCL DEF	CYCL CALL	Define and call cycles
LBL SET	LBL CALL	Enter and call labels for subprogramming and program section repeats
STOP		Enter program stop in a program

Programming path movements

Кеу	Function
APPR DEP	Approach/depart contour
FK	FK free contour programming
L	Straight line
CC +	Circle center/pole for polar coordinates
C	Circular arc with center
CR	Circle with radius
CT of	Circular arc with tangential connection
CHF o CHF O CH	Chamfer/rounding arc

Potentiometer for feed rate and spindle speed

Feed r	ate
50 00 150	



About this manual

About this manual

The symbols used in this manual are described below.

	This symbol indicates that important information about the function described must be considered.
!	 This symbol indicates that there is one or more of the following risks when using the described function: Danger to workpiece Danger to fixtures Danger to tool Danger to machine Danger to operator
	This symbol indicates a possibly dangerous situation that may cause injuries if not avoided.
1	This symbol indicates that the described function must be adapted by the machine tool builder. The function described may therefore vary depending on the machine.
	This symbol indicates that you can find detailed information about a function in another manual.

Would you like any changes, or have you found any errors?

We are continuously striving to improve our documentation for you. Please help us by sending your requests to the following e-mail address:

tnc-userdoc@heidenhain.de

TNC model, software and features

This manual describes functions and features provided by controls as of the following NC software numbers.

TNC model	NC software number
TNC 320	771851-04
TNC 320 Programming Station	771855-04

The machine manufacturer adapts the usable features of the TNC to his machine by the setting machine parameters. Some of the functions described in this manual may therefore not be among the features provided by the TNC on your machine.

TNC functions that may not be available on your machine include:

Tool measurement with the TT

In order to find out about the actual features of your machine, please contact the machine manufacturer.

Many machine manufacturers, including HEIDENHAIN, offer programming courses for the TNCs. Participation in one of these courses is recommended to familiarize yourself thoroughly with the TNC functions.



Cycle Programming User's Manual:

All of the cycle functions (touch probe cycles and fixed cycles) are described in the Cycle Programming User's Manual. If you need this user's manual, please contact HEIDENHAIN if required. ID: 1096959-xx

TNC model, software and features

Software options

The TNC 320 features various software options that can be enabled by your machine tool builder. Each option is to be enabled separately and contains the following respective functions:

Additional Axis (option 0 and option	n 1)
Additional axis	Additional control loops 1 and 2
Advanced Function Set 1 (option 8)	
Expanded functions Group 1	Machining with rotary tables
	 Cylindrical contours as if in two axes
	Feed rate in distance per minute
	Coordinate conversions:
	Tilting the working plane
HEIDENHAIN DNC (option 18)	
	Communication with external PC applications over COM component
DXF Converter (option 42)	
DXF converter	 Supported DXF format: AC1009 (AutoCAD R12)
	Adoption of contours and point patterns
	Simple and convenient specification of reference points
	 Selecting graphical features of contour sections from conversational programs

Feature Content Level (upgrade functions)

Along with software options, significant further improvements of the TNC software are managed via the Feature Content Level upgrade functions. If you install a software update on your TNC you do not automatically have the functions available as covered by the FCL.



All upgrade functions are available to you without surcharge when you receive a new machine.

Upgrade functions are identified in the manual as **FCL n**. The **n** signifies the serial number of the development status.

You can purchase a code number in order to permanently enable the FCL functions. For more information, contact your machine tool builder or HEIDENHAIN.

Intended place of operation

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

Legal information

This product uses open source software. Further information is available on the control under:

- Operating mode **Programming**
- MOD function
- LICENSE INFO soft key

TNC model, software and features

New functions

New functions 34055x-06

- The active tool-axis direction can now be activated in manual mode and during handwheel superimposition as a virtual tool axis, see "Superimpose handwheel positioning during program run: M118 ", page 387
- Writing and reading data in freely definable tables, see "Freely definable tables", page 408
- New touch probe Cycle 484 for calibrating the wireless touch probe TT 449, see Cycle Programming User's Manual
- The new HR 520 and HR 550 FS handwheels are supported, see "Traverse with electronic handwheels", page 455
- New operating Cycle 225 Engraving, see Cycle Programming User's Manual
- New manual probing cycle "Center line as datum", see "Setting a center line as datum ", page 502
- New function for rounding corners, see "Rounding corners: M197", page 394
- External access to the TNC can now be blocked with a MOD function, see "External access", page 557

Changed functions 34055x-06

- The maximum number of characters for the NAME and DOC fields in the tool table has been increased from 16 to 32, see "Enter tool data into the table", page 188
- Operation and positioning behavior of the manual probing cycles has been improved, see "Using a 3-D touch probe ", page 477
- Predefined values can now be entered into a cycle parameter with the PREDEF function in cycles, see Cycle Programming User's Manual
- With the KinematicsOpt cycles a new optimization algorithm is now used, see the Cycle Programming User's Manual
- With Cycle 257, CIRCULAR STUD, a parameter is now available with which you can determine the approach position on the stud, see User's Manual for Cycle Programming
- With Cycle 256 RECTANGULAR STUD, a parameter is now available with which you can determine the approach position on the stud, see Cycle Programming User's Manual
- With the manual "Basic Rotation" touch probe cycle, workpiece misalignment can now be compensated for with a table rotation, see "Compensation of workpiece misalignment by rotating the table", page 494

TNC model, software and features

New functions 77185x-01

- New special operating mode RETRACT, see "Retraction after a power interruption", page 542
- New graphic simulation, see "Graphics ", page 520
- New MOD function "tool usage file" within the machine settings group, see "Tool usage file", page 560
- New MOD function "set system time" within the systems settings group, see "Set the system time", page 561
- New MOD group "graphic settings", see "Graphic settings", page 556
- With the new cutting data calculator you can calculate the spindle speed and the feed rate, see "Cutting data calculator", page 166
- With the jump commands new if/then decisions have been introduced, see "Programming if-then decisions", page 322
- The character set of machining Cycle 225 Engraving has been expanded to include more characters and the diameter sign, see Cycle Programming User's Manual
- New machining Cycle 275 Trochoidal Milling, see Cycle Programming User's Manual
- New machining Cycle 233 Face Milling, see Cycle Programming User's Manual
- In drilling Cycles 200, 203 and 205, the parameter Q395 DEPTH REFERENCE has been introduced in order to evaluate the T ANGLE, see Cycle Programming User's Manual
- Probing Cycle 4 MEASURING IN 3-D has been introduced, see Cycle Programming User's Manual

Modified functions 77185x-01

- Up to 4 M functions are now allowed in an NC block, see "Fundamentals", page 374
- New soft keys for transferring values have been introduced in the pocket calculator, see "Operation", page 163
- The distance-to-go display can now also be displayed in the input system, see "Select the position display", page 562
- Several input parameters have been added to Cycle 241 SINGLE-LIP DEEP HOLE DRILLING, see Cycle Programming User's Manual
- Parameter Q305 NUMBER IN TABLE has been added to Cycle 404, see Cycle Programming User's Manual
- In the thread milling Cycles 26x, an approaching feed rate has been introduced, see Cycle Programming User's Manual
- In Cycle 205 Universal Deep Hole Drilling you can now use parameter Q208 to define a feed rate for retraction, see Cycle Programming User's Manual

TNC model, software and features

New functions 77185x-02

- Programs with .HU and .HC extensions can be selected and processed in all operating modes
- The functions SELECT PROGRAM and CALL SELECTED PROGRAM have been introduced, see "Calling any program as a subprogram", page 301
- New FEED DWELL function for programming repeating dwell times, see "Dwell time FUNCTION FEED", page 416
- The control automatically writes upper case letters at the start of a block, see "Programming path functions", page 240
- The D18 functions have been expanded, see "D18 Reading system data", page 335
- USB data carriers can be locked with the SELinux security software, see "SELinux security software", page 94
- The machine parameter **posAfterContPocket** (no. 201007) that influences positioning after an SL cycle has been introduced, see "Machine-specific user parameters", page 586
- Protective zones can be defined in the MOD menu, see "Entering traverse limits", page 559
- Write protection is possible for single lines in the preset table, see "Saving the datums in the preset table", page 468
- New manual probing function for aligning a plane, see "Measuring 3-D basic rotation", page 495
- New function for aligning the machining plane without rotary axes, see "Tilt the working plane without rotary axes", page 444
- CAD files can be opened without option number 42, see "CAD viewer", page 275
- New software option number 93 Extended Tool Management,see "Calling tool management", page 213

Modified functions 77185x-02

- The input range of the DOC column in the pocket table has been expanded to 32 characters, see "Pocket table for tool changer", page 198
- Commands D15, D31 and D32 from predecessor controls no longer generate ERROR blocks during import. When simulating or running an NC program with these commands, the control interrupts the NC program with an error message that helps you to find an alternative implementation
- Miscellaneous functions M104, M105, M112, M114, M124, M134, M142, M150, M200 - M204 from predecessor controls no longer generate ERROR blocks during import. When simulating or running an NC program with these miscellaneous functions, the control interrupts the NC program with an error message that helps you to find an alternative implementation, see "Comparison: Miscellaneous functions", page 624
- The maximum file size of files output with D16 F-Print has been increased from 4 KB to 20 KB
- The Preset.PR preset table is write-protected in Programming operating mode, see "Saving the datums in the preset table", page 468
- The input range of the Q parameter list for defining the QPARA tab on the status display consists of 132 input positions, see "Displaying Q parameters (QPARA tab)", page 87
- Manual calibration of the touch probe with fewer pre-positioning movements, see "Calibrating 3-D touch probes ", page 485
- The position display takes into account the DL oversizes programmed in the T block, selectable as an oversize of the workpiece or tool, see "Delta values for lengths and radii", page 187
- In single block mode the control executes each point individually with point pattern cycles and G79 PAT, see "Program run", page 536
- Rebooting the control is no longer possible with the END key but with the RESTART soft key, see "Switch-off", page 452
- The control displays the contouring feed rate in manual mode, see "Spindle speed S, feed rate F and miscellaneous function M", page 465
- Deactivate tilting in manual mode is only possible via the 3D-ROT menu, see "Activating manual tilting:", page 509
- Machine parameter maxLineGeoSearch (no. 105408) has been increased to max. 50000, see "Machine-specific user parameters", page 586
- The name of software option number 8 has changed, see "Software options", page 8

TNC model, software and features

New and modified cycle functions 77185x-02

- Cycle G270 CONTOUR TRAIN DATA has been added
- Cycle G139 CYL. SURFACE CONTOUR has been added (option 1)
- The character set of Machining Cycle G225 ENGRAVING has been expanded with the CE character, ß, the @ character and system time
- Cycles G252-G254 have been expanded with the optional parameter Q439
- Cycle G122 ROUGH-OUT has been expanded by the optional parameters Q401, Q404
- Cycle G484 CALIBRATE IR TT has been expanded by the optional parameter Q536

Further information: Cycle Programing User's Manual

New functions 77185x-04

- New function FUNCTION DWELL for programming a dwell time, see "Dwell time FUNCTION DWELL", page 418
- New function FUNCTION S-PULSE for programming pulsing shaft speeds, see "Pulsing spindle speed FUNCTION S-PULSE", page 414
- The column KINEMATIC has been added to the tool table, see "Enter tool data into the table", page 188
- The column OVRTIME has been added to the tool table, see "Enter tool data into the table", page 188
- When importing tool data the CSV file may contain additional table columns not recognized by the control. During import a message is displayed indicating the unrecognized columns and informing that these values will not be adopted, see "Import and export tool data", page 219
- Manual probe functions create a line in the preset table that does not yet exist, see "Writing measured values from the touch probe cycles to the preset table", page 484
- Manual probe functions can write in a password-protected line, see "Recording measured values from the touch probe cycles", page 482
- During a manual touch probe cycle, control can be transferred to the handwheel, see "Traverse movements with a handwheel with display", page 478
- Several handwheels can be connected to a control, see "Traverse with electronic handwheels", page 455
- In Electronic handwheel mode of operation, the handwheel axis for an HR 130 can be selected with the orange axis keys
- If the control is set to the INCH unit of measure, the control also includes movements traversed by the handwheel in INCHES, see "Traverse with electronic handwheels", page 455
- The control differentiates between interrupted or stopped NC programs. In the interrupted status, the control offers more intervention options, see "Interrupt, stop or abort machining", page 537
- The software option number 42 DXF Converter now also produces CR circles, see "Basic settings", page 278
- With active structuring the structure block can be edited in the structure window, see "Definition and applications", page 161
- Animated help can be selected with the tilt working plane function, see "Overview", page 422
- The D18 functions have been expanded, see "D18 Reading system data", page 335
- The D16 functions have been expanded, see "D16 Formatted output of text and Q parameter values", page 330
- The file saved with SAVE AS is now also found in the file management under LAST FILES, see "Editing a program", page 123
- If you save files with SAVE AS, you can select the target directory with the SWITCH soft key, see "Editing a program", page 123

TNC model, software and features

- It is possible to search quickly for a file in file management by entering the first letter, see "Selecting drives, directories and files", page 134
- File management displays vertical scrollbars and supports scrolling with the mouse, see "Calling the file manager", page 133
- New machine parameter for recreating M7 and M8, see "Machine-specific user parameters", page 586
- The function STRLEN checks whether a string parameter has been defined, see "Finding the length of a string parameter", page 356
- The function SYSSTR enables the NC software version to be read out, see "Reading system data", page 353
- The function D38 can now be programmed without a code number
- Undefined Q parameters can now be transferred with the function **D00**
- For jumps with D09, QS parameters and texts are permitted as conditions, see "Programming if-then decisions", page 322
- Cylindrical workpiece blanks can now also be defined with a diameter instead of a radius, see "Define the blank: G30/G31", page 117
- The transitional elements G24 and G25 can now also be executed between 3-D contours, i.e. with straight line blocks with three programmed coordinates or a helix
- The control now supports spatial arcs, i.e. circles in 3 axes vertical to the working plane, see "Circular path around circle center ", page 245
- Active kinematics is displayed in the 3D-ROT menu, see "Activating manual tilting:", page 509
- In operating modes Program run, single block and Program run, full sequence the screen layout PROGRAM + SECTS can be specified, see "Structuring programs", page 161
- In operating modes Program run full sequence, Program run single block and Positioning with manl.data input, the font size can be set to the same size as the Programming operating mode, see "Machine-specific user parameters", page 586
- The functions in the **Positioning with manl.data input** mode were expanded and adapted for improved operation, see "Positioning with Manual Data Input", page 513
- Active kinematics is displayed in the operating mode RETRACT, see "Retraction after a power interruption", page 542
- In RETRACT operating mode, feed-rate limitation can be deactivated with the soft key CANCEL THE FEED RATE LIMITATION, see "Retraction after a power interruption", page 542
- In Test run operating mode a tool usage file can also be created without simulation, see "Tool usage test", page 205
- In Test run operating mode the soft keyFMAX PATHS hides the rapid traverse movements, see "3-D view in the Test Run operating mode", page 524

- In Test run operating mode the soft keyRESET THE VOLUME MODEL resets the solid model, see "3-D view in the Test Run operating mode", page 524
- In Test run operating mode the soft keyRESET TOOL PATHS resets the tool paths, see "3-D view in the Test Run operating mode", page 524
- In Test run operating mode the soft key MEASURING displays the coordinates if you position the mouse on the graphics, see "3-D view in the Test Run operating mode", page 524
- In Test run operating mode the soft key STOP AT simulates up to a predefined block, see "Test run up to a certain block ", page 535
- Active basic transformation is shown in the status display on the POS tab, see "Positions and coordinates (POS tab)", page 85
- The status display now also shows the path of the active main program, see "Overview", page 83, see "General program information (PGM tab)", page 83
- In the status display the CYC tab now also shows T-Max and TA-Max
- Mid-program startup can now be continued, see "Any entry into program: Mid-program startup", page 545
- With functions NC/PLC Backup and NC/PLC Restore you can save and restore single directories or the complete TNC drive, see "Backup and restore", page 97

TNC model, software and features

Modified functions 77185x-04

- When editing the tool table or tool management, only the current table line is blocked, see "Editing the tool table", page 192
- When importing tool tables, nonexistent tool types are imported as type undefined, see "Importing tool tables", page 195
- Tool names can now also include the special characters % and ,, see "Tool number, tool name", page 186
- When importing tool tables the numerical values are adopted from the R-OFFS column, see "Importing tool tables", page 195
- In the LIFTOFF column of the tool table the default is now N, see "Enter tool data into the table", page 188
- The L and R columns of the tool table are empty when a new tool is created, see "Editing the tool table", page 192
- In the tool table for the RT and KINEMATIC columns, the SELECT soft key is now available, see "Enter tool data into the table", page 188
- You cannot delete the tool data of tools still stored in the pocket table, see "Editing the tool table", page 192
- The touch probe function Corner as preset has been expanded, see "Corner as datum ", page 498
- In all manual probing functions, quicker selection of the start angle of holes and studs is possible with soft keys (paraxial probing directions), see "Functions in touch probe cycles", page 479
- When probing, after acceptance of the actual value of the 1st point, for the 2nd point the soft key for the axis direction is shown
- In all manual probing functions, the direction of the reference axis is suggested as a default
- The arrangement of soft keys in the manual probing cycle PROBING P has been adapted, see "Corner as datum ", page 498
- In manual probing cycles the hard keys END and ADOPT ACTUAL POSITION may be used
- The display of the machining feed rate has been changed in manual mode, see "Spindle speed S, feed rate F and miscellaneous function M", page 465
- The FMAX soft key in Program Run not only limits the machining feed rate during execution of the program but also the axis feed rate for manual axis movements, see "Feed rate limit F MAX", page 466
- Soft key allocations were adapted for incremental positioning
- The values entered for the traverse limits are checked for validity, see "Entering traverse limits", page 559
- When the preset table is opened the cursor is on the line of the active preset
- The input range in columns SPA, SPB and SPC in the preset table has been expanded to 999,9999, see "Datum management with the preset table", page 467
- New help graphics with PLANE RESET, see "Specifying the positioning behavior of the PLANE function", page 437

- Tilting is permitted in combination with mirroring, see "The PLANE function: Tilting the working plane (software option 8)", page 421
- The behavior of COORD ROT and TABLE ROT in the 3D-ROT menu has been modified, see "Specifying the positioning behavior of the PLANE function", page 437
- Even when the 3D-ROT dialog is active in Manual operation mode, PLANE RESET still functions with active basic transformation, see "Activating manual tilting:", page 509
- When calculating the axis angle in the axes chosen with M138, the control sets the value to 0, see "Selecting tilting axes: M138", page 448
- The feed rate potentiometer only reduces the programmed feed rate and no longer the feed rate calculated by the control, see "Feed rate F", page 184
- The functions APPR LT, APPR LCT, DEP LT and DEP LCT position all three axes at on the auxiliary point at the same time, see "Approaching on a straight line with tangential connection: APPR LT", page 235, see "Approaching on a circular path with tangential connection from a straight line to the contour: APPR LCT", page 237
- The functions APPR CT and DEP CT allow approach to and departure from a helix. This movement is carried out as a helix with an even pitch, see "Overview: Types of paths for contour approach and departure", page 232
- Block editing no longer causes block marking to be canceled. If a block is edited with active block marking and another block is then selected via the syntax search, the marking is expanded to the newly selected block, see "Marking, copying, cutting and inserting program sections", page 126
- The current structure block can be more clearly recognized in the structure window, see "Definition and applications", page 161
- DHCP Lease Time is now also valid following power interruption. When HeROS is shut down, the DHCP server is no longer informed that the IP address is vacant again, see "Configuring the TNC", page 571
- In the status display the fields for the LBL names have been expanded to 32 characters
- The TT status display now also shows values if the user changes to the TT tab later
- Status displays can now also be switched over with the NEXT TAB key, see "Additional status displays", page 82
- If a subprogram called with % ends with M2 or M30 the control outputs a warning
- M124 no longer triggers an error message but only a warning. This enables NC programs with programmed M124 to run through without interruption
- In the file management, the programs or directories at the cursor position are also displayed in a separate field beneath the current path display
- Upper and lower cases for a file name can be modified in the file management

TNC model, software and features

- If a larger file is transferred to a USB device in the file management, the control displays a warning until file transfer is completed, see "USB devices on the TNC", page 154
- In the file management, the control also shows the momentary type filter with the path
- In the file management the SHOW ALL soft key is now displayed in all operating modes
- In the file management the function SELECT DIRECTORY was modified for copying files or directories. The soft keys OK and CANCEL are available on the first two positions
- The colors of the programming graphics were changed, see "Programming graphics", page 168
- In Test run and Programming operating modes the tool data is reset if a program is reselected or restarted with the RESET + START soft key
- In Test run operating mode the control displays the datum of the machine tool table as the reference point with BLANK IN WORK SPACE, see "Show the workpiece blank in the working space ", page 530
- After modification of the active datum, resuming the program is only possible after GOTO or mid-program startup, see "Moving the machine axes during an interruption", page 540
- With mid-program startup an FK sequence can be entered, see "Any entry into program: Mid-program startup", page 545
- Mid-program startup operation and dialog guidance has been improved, also for pallet tables, see "Any entry into program: Mid-program startup", page 545

New and modified cycle functions 77185x-04

- New cycle 258 POLYGON STUD
- Cycles 421, 422 and 427 were expanded by the parameters Q498 and Q531
- For cycle 247: SET DATUM, the datum number from the preset table can be selected with the corresponding parameter
- With cycle 200 and 203 the behavior of the dwell time at top has been adapted
- Cycle 205 performs deburring on the coordinate surface
- With SL cycles, M110 is now taken into account with circles compensated inwards if it is active during machining
- With Cycle 251 Rectangular pocket, M110 is now taken into account with circles compensated inwards if it is active during machining
- Cycle 225 has been expanded with parameters Q516, Q367 and Q574. This enables a datum for the specific text position to be defined or the text length and character height to be scaled
- In cycles 481 to 483 the parameter Q340 was expanded with the input option "2". This enables a tool control without making any change in the tool table
- Cycle 251 has been expanded by parameter Q439. The finishing strategy was also revised
- The finishing strategy was revised with cycle 252
- Cycle 275 has been expanded with parameters Q369 and Q439

Further information: Cycle Programing User's Manual

TNC model, software and features

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Overview 1.1

1.1 **Overview**

This chapter is intended to help TNC beginners quickly learn to handle the most important procedures. For more information on a respective topic, see the section referred to in the text.

The following topics are included in this chapter:

- Machine switch-on
- Programming the first part
- Graphically testing the first part
- Setting up tools
- Workpiece setup
- Running the first program

1.2 Machine switch-on

Acknowledging the power interruption and moving to the reference points



Refer to your machine manual.

Danger exists for the operator when the machine is started up. Read the safety information before switching on the machine.

Switch-on and crossing over the reference points can vary depending on the machine tool. Refer to your machine manual.

Switch on the power supply for control and machine. The TNC starts the operating system. This process may take several minutes. Then the TNC will display the "Power interrupted" message in the screen header.



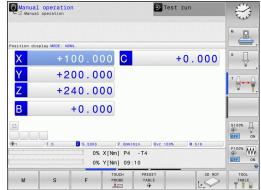
٦Ì,

Press the CE key: The TNC compiles the PLC program

- Switch on the control voltage: The TNC checks operation of the emergency stop circuit and goes into Reference Run mode
- Cross the datums manually in the prescribed sequence: For each axis press the START key. If you have absolute linear and angle encoders on your machine there is no need for a reference run

The TNC is now ready for operation in the Manual operation mode.

- Approaching datums Further Information: "Switch-on", page 450
- Operating modes Further Information: "Programming", page 78





Programming the first part 1.3

1.3 Programming the first part

Selecting the correct operating mode

You can write programs only in **Programming** mode:

(=	
	\sim
	~

Press the Programming operating mode key for the TNC to switch to **Programming**

Further information on this topic

- Operating modes
 - Further Information: "Programming", page 78

The most important TNC keys

Кеу	Functions for conversational guidance
ENT	Confirm entry and activate the next dialog prompt
NO ENT	Ignore the dialog question
END	End the dialog immediately
DEL	Abort dialog, discard entries
	Soft keys on the screen with which you select functions appropriate to the active operating state
Further inform	nation on this tonic

- Writing and editing programs
 Further Information: "Editing a program", page 123
- Overview of keys
 Further Information: "Controls of the TNC", page 2

1.3 Programming the first part

Opening a new program/file management

- Press the PGM MGT key: The TNC opens the file manager The file management of the TNC is arranged much like the file management on a PC with the Windows Explorer. The file management enables you to manage data on the internal memory of the TNC
 - Use the arrow keys to select the folder in which you want to open the new file
 - Enter any desired file name with the extension .I
- ENT

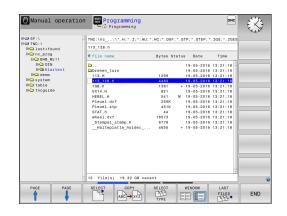
MM

PGM MGT

- Confirm with the ENT key: The control asks you for the unit of measurement for the new program
- Select the unit of measure: Press the MM or INCH soft key

The TNC automatically generates the first and last blocks of the program. Afterwards you can no longer change these blocks.

- File management
 Further Information: "Working with the file manager", page 131
- Creating a new program
 Further Information: "Opening programs and entering", page 116



Defining a workpiece blank

After you have created a new program you can define a workpiece blank. For example, define a cuboid by entering the MIN and MAX points, each with reference to the selected reference point.

After you have selected the desired blank form via soft key, the TNC automatically initiates the workpiece blank definition and asks for the required data:

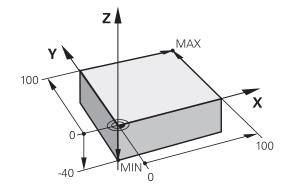
- Spindle axis Z Plane XY: Enter the active spindle axis. G17 is saved as default setting. Accept with the ENT key
- Workpiece blank def.: Minimum X: Enter the smallest X coordinate of the workpiece blank with respect to the reference point, e.g. 0, confirm with the ENT key
- Workpiece blank def.: Minimum Y: Smallest Y coordinate of the workpiece blank with respect to the reference point, e.g. 0. Confirm with the ENT key
- Workpiece blank def.: Minimum Z: Smallest Z coordinate of the workpiece blank with respect to the reference point, e.g. -40, confirm with the ENT key
- Workpiece blank def.: Maximum X: Enter the largest X coordinate of the workpiece blank with respect to the reference point, e.g. 100, confirm with the ENT key
- Workpiece blank def.: Maximum Y: Enter the largest Y coordinate of the workpiece blank with respect to the reference point, e.g. 100. Confirm with the ENT key
- Workpiece blank def.: Maximum Z: Enter the largest Z coordinate of the workpiece blank with respect to the reference point, e.g. 0. Confirm with the ENT key. The TNC concludes the dialog

Example NC blocks

%NEW G71 *	
N10 G30 G17 X+0 Y+0 Z-40*	
N20 G31 X+100 Y+100 Z+0*	
N99999999 %NEW G71 *	

Further information on this topic

 Define workpiece blank
 Further Information: "Opening a new part program", page 120



1.3 Programming the first part

Program layout

NC programs should be arranged consistently in a similar manner. This makes it easier to find your place, accelerates programming and reduces errors.

Recommended program layout for simple, conventional contour machining

- 1 Call tool, define tool axis
- 2 Retract the tool
- 3 Pre-position the tool in the working plane near the contour starting point
- 4 In the tool axis, position the tool above the workpiece, or preposition immediately to workpiece depth. If required, switch on the spindle/coolant
- 5 Contour approach
- 6 Contour machining
- 7 Contour departure
- 8 Retract the tool, end program

Further information on this topic

 Contour programming
 Further Information: "Programming tool movements for workpiece machining", page 226

Recommended program layout for simple cycle programs

- 1 Call tool, define tool axis
- 2 Retract the tool
- 3 Define the fixed cycle
- 4 Move to the machining position
- 5 Call the cycle, switch on the spindle/coolant
- 6 Retract the tool, end program

Further information on this topic

Cycle programming
 Further information: Cycle Programming User's Manual

Layout of contour machining programs %BSPCONT G71 * N10 G30 G71 X... Y... Z...* N20 G31 X... Y... Z...* N30 T5 G17 S5000* N40 G00 G40 G90 Z+250* N50 X... Y...* N60 G01 Z+10 F3000 M13* N70 X... Y... RL F500* ... N160 G40 ... X... Y... F3000 M9*

N170 G00 Z+250 M2* N99999999 BSPCONT G71 *

Cycle program layout

%BSBCYC G71 *
N10 G30 G71 X Y Z*
N20 G31 X Y Z*
N30 T5 G17 S5000*
N40 G00 G40 G90 Z+250*
N50 G200*
N60 X Y*
N70 G79 M13*
N80 G00 Z+250 M2*
N99999999 BSBCYC G71 *

Y

95

Programming a simple contour

The contour shown to the right is to be milled once to a depth of 5 mm You have already defined the workpiece blank. After you have initiated a dialog through a function key, enter all the data requested by the TNC in the screen header.

G00

G90

G40

G00

G40

TOOL CALL

- Call the tool: Enter the tool data. Confirm the entry in each case with the ENT key, and do not forget the G17 tool axis
- Press the L key to open a program block for a linear movement
- Press the left arrow key to switch to the input range for G codes
- Press the G00 soft key if you want to enter a rapid traverse motion
- Press the G90 soft key for absolute values
- Retract tool: Press the orange axis key Z and enter the value for the position to be approached, e.g. 250. Press the ENT key
- Activate no radius compensation: Press the G40 soft key
- Confirm Miscellaneous function M? with the END key: The TNC saves the input positioning block
- Press the L key to open a program block for a linear movement
- Press the left arrow key to switch to the input range for G codes
- Press the G00 soft key if you want to enter a rapid traverse motion
- Preposition the tool in the working plane: Press the orange X axis key and enter the value for the position to be approached, e.g. -20
- Press the orange axis key Y and enter the value for the position to be approached, e.g. -20. Confirm your entry with the ENT key.
- Activate no radius compensation: Press the G40 soft key
- Confirm Miscellaneous function M? with the END key: The TNC saves the input positioning block
- Press the L key to open a program block for a linear movement
- Press the left arrow key to switch to the input range for G codes

approached, e.g. -5. Press the ENT key

Press the G00 soft key if you want to enter a rapid

Move tool to working depth: Press the orange axis key **Z** and enter the value for the position to be

G00

traverse motion

0

0

Х

Programming the first part 1.3

G 4 Ø		Activate no radius compensation: Press the G40 soft key
	•	Miscellaneous function M? Switch on the spindle and coolant, e.g. M13 , confirm with the END key: The TNC saves the entered positioning block
L		Press the L key to open a program block for a linear movement
		Enter the coordinates of the contour starting point 1 in X and Y, e.g. 5/5. Confirm with the ENT key
G 4 1		Activate radius compensation to the left of the path: Press the G41 soft key
		Feed rate F=? Enter the machining feed rate, e.g. 700 mm/min, save your entry with the END key
G	•	Enter 26 to approach the contour: Define Rounding-off radius? for the circular arc, save entries with the END key
Loro		Machine the contour and move to contour point 2: You only need to enter the information that changes. In other words, enter only the Y coordinate 95 and save your entry with the END key
L		Move to contour point 3 : Enter the X coordinate 95 and save your entry with the END key
CHF o		Define chamfer G24 on contour point 3 : Chamfer side length? Enter 10 mm, save with the END key
L		Move to contour point <mark>4</mark> : Enter the Y coordinate 5 and save your entry with the END key
CHF o		Define chamfer G24 on contour point 4 : Chamfer side length? Enter 20 mm, save with the END key
L		Move to contour point 1 : Enter the X coordinate 5 and save your entry with the END key
G		Enter 27 to depart from the contour: Define the Rounding-off radius? of the departing arc
L	•	Depart contour: Enter coordinates outside of the workpiece in X and Y, e.g20/-20, confirm with the ENT key
		Activate no radius compensation: Press the G40 soft key
L		Press the L key to open a program block for a linear movement
		Press the G00 soft key if you want to enter a rapid traverse motion
	•	Retract tool: Press the orange axis key Z to retract in the tool axis, and enter the value for the position to be approached, e.g. 250. Press the ENT key
		Activate no radius compensation: Press the G40 soft key
		MISCELLANEOUS FUNCTION M? Enter M2 to end the program and confirm with the END key: The TNC saves the entered positioning block

1

- Complete example with NC blocks
 Further Information: "Example: Linear movements and chamfers with Cartesian coordinates", page 249
- Creating a new program
 Further Information: "Opening programs and entering", page 116
- Approaching/departing contours
 Further Information: "Approaching and departing a contour", page 229
- Programming contours
 Further Information: "Overview of path functions", page 240
- Tool radius compensation
 Further Information: "Tool radius compensation ", page 209
- Miscellaneous functions M
 Further Information: "Miscellaneous functions for program run inspection, spindle and coolant ", page 376

1.3 Programming the first part

Creating a cycle program

The holes (depth of 20 mm) shown in the figure at right are to be drilled with a standard drilling cycle. You have already defined the workpiece blank.

TOOL CALL

G00

- Call the tool: Enter the tool data. Confirm the entry in each case with the ENT key, do not forget the tool axis
- Press the L key to open a program block for a linear movement
- Press the left arrow key to switch to the input range for G codes
- Press the G00 soft key if you want to enter a rapid traverse motion
- ► Press the **G90** soft key for absolute values
- Retract tool: Press the orange axis key Z and enter the value for the position to be approached, e.g. 250. Press the ENT key
- Activate no radius compensation: Press the G40 soft key
- Miscellaneous function M? Switch on the spindle and coolant, e.g. M13. Confirm with the END key: The TNC saves the entered positioning block
- Call the cycle menu: Press the CYCL DEF key



77

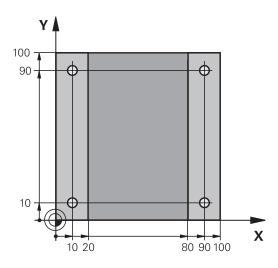
G

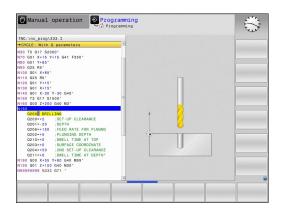
G

G

CYCL DEF

- Display the drilling cycles
- Select the standard drilling cycle 200: The TNC starts the dialog for cycle definition. Enter all parameters requested by the TNC step by step and conclude each entry with the ENT key. In the screen to the right, the TNC also displays a graphic showing the respective cycle parameter
- Enter **0** to approach the first drilling position: Enter the coordinates of the drilling position, call the cycle with M99
- Enter **0** to move to further drilling positions: Enter the **coordinates** of the specific drilling positions, and call the cycle with M99
- Enter **0** to retract the tool: Press the orange axis key Z and enter the value for the position to be approached, e.g. 250. Press the ENT key
- Miscellaneous function M? Enter M2 to end the program and confirm with the END key: The TNC saves the entered positioning block





62

Example NC blocks

%C200 G71 *						
N10 G30 G17 X+0 Y	(+0 Z-40*	Definition of workpiece blank				
N20 G31 X+100 Y+	100 Z+0*					
N30 T5 G17 S4500	*	Tool call				
N40 G00 G90 Z+25	0 G40*	Retract the tool				
N50 G200 DRILLING	3	Define the cycle				
Q200=2	;SET-UP CLEARANCE					
Q201=-20	;DEPTH					
Q206=250	;FEED RATE FOR PLNGNG					
Q202=5 ;PLUNGING DEPTH						
Q210=0 ;DWELL TIME AT TOP						
Q203=-10 ;SURFACE COORDINATE						
Q204=20 ;2ND SET-UP CLEARANCE						
Q211=0.2	;DWELL TIME AT DEPTH					
Q395=0	;DEPTH REFERENCE					
N60 G00 X+10 Y+1	0 M13 M99*	Spindle and coolant on, call the cycle				
N70 G00 X+10 Y+9	0 M99*	Call the cycle				
N80 G00 X+90 Y+1	0 M99*	Call the cycle				
N90 G00 X+90 Y+9	0 M99*	Call the cycle				
N100 G00 Z+250 M	2*	Retract the tool, end program				
N99999999 %C200	G71 *					

Further information on this topic

 Creating a new program
 Further Information: "Opening programs and entering", page 116

Cycle programming
 Further information: Cycle Programming User's Manual

1.4 Graphically testing the first part

1.4 Graphically testing the first part

Selecting the correct operating mode

You can test programs in the Test run mode:

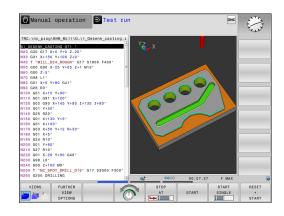


PGM

Press the operating mode key for the TNC to switch to Test Run operating modeTest run

Further information on this topic

- Operating modes of the TNC
 Further Information: "Modes of operation", page 77
- Testing programs
 Further Information: "Test run", page 532



Selecting the tool table for the test run

If you have not yet activated a tool table in **Test run** mode, then you must carry out this step.

▶ Press the **PGM MGT** key: The TNC opens the file

MGT		manager
SELECT TYPE	•	Press the SELECT TYPE soft key: The TNC shows a soft-key menu for selection of the file type to be displayed
DEFAULT		Press the DEFAULT soft key: The TNC shows all saved files in the right-hand window
+		Move the cursor to the left onto the directories
t		Move the cursor to the TNC:\table directory
-		Move the cursor to the right onto the files
Ŧ	•	Move the cursor onto the file TOOL.T (active tool table), confirm with the ${\sf ENT}$ key: TOOL.T contains the status ${\sf S}$ and is therefore active for the test run
END		Press the END key: Exit the file manager

- Tool management
 Further Information: "Enter tool data into the table", page 188
- Testing programs
 Further Information: "Test run", page 532

1

Choosing the program you want to test



- Press the PGM MGT key: The TNC opens the file manager
- Press the LAST FILES soft key: The TNC opens a pop-up window with the most recently selected files
- Use the arrow keys to select the program that you want to test. Load with the ENT key

Further information on this topic

 Program number
 Further Information: "Working with the file manager", page 131

Selecting the screen layout and the view



Press the key for selecting the screen layout. The TNC shows all available alternatives in the soft-key row

PROGRAM + GRAPHICS Press the PROGRAM + GRAPHICS soft key: In the left half of the screen the TNC shows the program; in the right half it shows the workpiece blank

The TNC features the following views:

Soft keys Function Image: Soft keys Volume view and tool paths Image: Soft keys Tool paths

- Graphic functions
 Further Information: "Graphics ", page 520
- Performing a test run
 Further Information: "Test run", page 532

Graphically testing the first part 1.4

Starting the test run



Press the RESET + START soft key

- > The control resets the previously active tool data
- > The control simulates the active program up to a programmed break or to the program end
- While the simulation is running, you can use the soft keys to change views



START

- Press the STOP soft key
- > The TNC interrupts the test run
- Press the START soft key
- > The control resumes the test run after a break

Further information on this topic

- Performing a test run
- Further Information: "Test run", page 532 Graphic functions Further Information: "Graphics ", page 520
- Adjusting the simulation speed Further Information: "Speed of the setting test runs", page 521

HEIDENHAIN | TNC 320 | ISO Programming User's Manual | 9/2016

1.5 Setting up tools

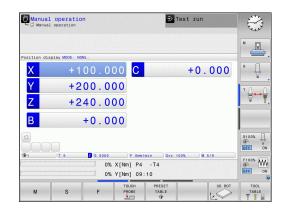
Selecting the correct operating mode

Tools are set up in the $\ensuremath{\textbf{Manual operation}}$ mode:

- M
- Press the operating mode key for the TNC to switch to Manual operation operating mode Manual operation

Further information on this topic

Operating modes of the TNC
 Further Information: "Modes of operation", page 77



Preparing and measuring tools

- Clamp the required tools in their tool holders
- When measuring with an external tool presetter: Measure the tools, note down the length and radius, or transfer them directly to the machine through a transfer program
- When measuring on the machine: store the tools in the tool changer

Further Information: "The pocket table TOOL_P.TCH", page 69

1.5 Setting up tools

The tool table TOOL.T

In the tool table TOOL.T (permanently saved under **TNC:\table**), save the tool data such as length and radius, but also further tool-specific information that the TNC needs to perform its functions.

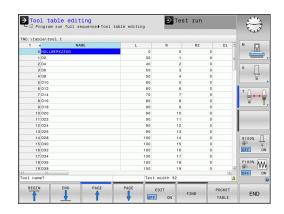
To enter tool data in the tool table TOOL.T, proceed as follows:

TOOL TABLE

OFF ON

- Display the tool table: The TNC shows the tool table
- ► Edit the tool table: Set the EDIT soft key to ON
- With the upward or downward arrow keys you can select the tool number that you want to edit
- With the rightward or leftward arrow keys you can select the tool data that you want to edit
- ▶ To exit the tool table, press the END key

- Operating modes of the TNC
 Further Information: "Modes of operation", page 77
- Working with the tool table
 Further Information: "Enter tool data into the table", page 188



The pocket table TOOL_P.TCH



The function of the pocket table depends on the machine. Refer to your machine manual.

In the pocket table TOOL_P.TCH (permanently saved under **TNC:\table**) you specify which tools your tool magazine contains. To enter data in the pocket table TOOL_P.TCH, proceed as follows:



- Display the tool table: The TNC shows the tool table
- POCKET TABLE
- Display the pocket table: The TNC shows the pocket table
- Edit the pocket table: Set the EDIT soft key to ON
- With the upward or downward arrow keys you can select the pocket number that you want to edit
- With the rightward or leftward arrow keys you can select the data that you want to edit
- ► To leave the pocket table, press the END key

- Operating modes of the TNC
 Further Information: "Modes of operation", page 77
- Working with the pocket table
 Further Information: "Pocket table for tool changer", page 198

TNC:\tabl									
Р.	т	TNAME	RSV	ST	F	L	DOC		M 🖓
0.0		D10							
1.1		D2					Tool 1		
1.2		D4					Tool 2	1	S E
1.3		D6					Tool 3		1° 1
1.4		D8					Tool 4		The second secon
1.5		D10	R						
1.6		D12							τA
1.7		D14							→
1.8		D16							a di
1.9		D18							
1.10		D20							-
1.11		D22							
1.12		D24							
1.13		D26							
1.14	14	D28							\$100% .
1.15	15	D30							(in 1997)
1.16		D32							OFF
1.17	17	D34							
1.18	18	D36							F100% W
1.19	19	D38							<u></u>
< 20 Tool numbe		040		in. 1					OFF

1.6 Workpiece setup

1.6 Workpiece setup

Selecting the correct operating mode

Workpieces are set up in the **Manual operation** or **Electronic handwheel** mode



 Press the operating mode key for the TNC to switch to Manual operation operating modeManual operation

Further information on this topic

The operating mode Manual operation
 Further Information: "Moving the machine axes", page 453

Clamping the workpiece

Mount the workpiece with a fixture on the machine table. If you have a 3-D touch probe on your machine, then you do not need to clamp the workpiece parallel to the axes.

If you do not have a 3-D touch probe available, you have to align the workpiece so that it is fixed with its edges parallel to the machine axes.

- Setting datums with a 3-D touch probe
 Further Information: "Datum setting with a 3-D touch probe ", page 497
- Setting datums without 3-D touch probe
 Further Information: "Datum setting without a 3-D touch probe", page 475

Datum setting with a 3-D touch probe

Insert a 3-D touch probe: In the **Positioning with manl.data** input mode, run a **T** block containing the tool axis and then return to the **Manual operation** mode

_	
	тоцсн
	PROBE
	
	PROBING

P

- Press the probing function soft key: The TNC displays all available functions in the soft key row
- Set the datum at a workpiece corner, for example
- Position the touch probe near the first touch point on the first workpiece edge
- Select the probing direction via soft key
- Press NC START: The touch probe moves in the defined direction until it contacts the workpiece and then automatically returns to its starting point
- Use the axis-direction keys to pre-position the touch probe to a position near the second touch point on the first workpiece edge
- Press NC start: The touch probe moves in the defined direction until it contacts the workpiece and then automatically returns to its starting point
- Use the axis-direction keys to pre-position the touch probe to a position near the first touch point on the second workpiece edge
- Select the probing direction via soft key
- Press NC start: The touch probe moves in the defined direction until it contacts the workpiece and then automatically returns to its starting point
- Use the axis-direction keys to pre-position the touch probe to a position near the second touch point on the second workpiece edge
- Press NC start: The touch probe moves in the defined direction until it contacts the workpiece and then automatically returns to its starting point
- Then the TNC shows the coordinates of the measured corner point
- DATUM
- ► To set to 0: Press the SET DATUM soft key
- Press the END soft key to close the menu

Further information on this topic

 Setting datums
 Further Information: "Datum setting with a 3-D touch probe ", page 497

1.7 Running the first program

1.7 Running the first program

Selecting the correct operating mode

You can run programs either in the **Program run, single block** or the **Program run, full sequence** mode:

- Press the operating mode key: Die TNC changes to operating mode Program run, single block, and the TNC executes the NC program block by block. You have to confirm each block with the NC START KEY
- Press the operating mode key: Die TNC changes to operating mode **Program run, full sequence**, and the TNC runs the program after NC startup to a program interruption or to the end of the program

Further information on this topic

- Operating modes of the TNC
 Further Information: "Modes of operation", page 77
- Executing a program
 Further Information: "Program run", page 536

Choosing the program you want to run

-		_
ſ	DOM	
L	PGIVI	
L.	MGT	
L	in or	

Ð

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- Press the PGM MGT key: The TNC opens the file manager
- LAST
- Press the LAST FILES soft key: The TNC opens a pop-up window with the most recently selected files
- Use the arrow keys if required to select the program you want to run. Load with the ENT key

Further information on this topic

 File management
 Further Information: "Working with the file manager", page 131

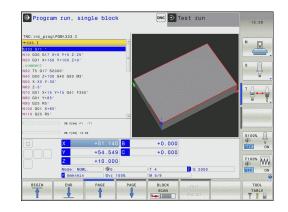
Start the program



Press the NC START key: The TNC runs the active program

Further information on this topic

Executing a program
 Further Information: "Program run", page 536





2

2.1 The TNC 320

HEIDENHAIN TNC controls are workshop-oriented contouring controls that enable you to program conventional milling and drilling operations right at the machine in easy-to-use Klartext conversational language. They are designed for milling, drilling and boring machines, as well as machining centers, with up to 5 axes. You can also change the angular position of the spindle under program control.

Keyboard and screen layout are clearly arranged in such a way that the functions are fast and easy to use.



HEIDENHAIN Klartext and DIN/ISO

HEIDENHAIN Klartext, the dialog-guided TNC programming language for workshops, is an especially easy method of writing programs. Programming graphics illustrate the individual machining steps for programming the contour. If no NC-dimensioned drawing is available, then the FK free contour programming will help. Workpiece machining can be graphically simulated either during a test run or during a program run.

It is also possible to program in ISO format or DNC mode.

You can also enter and test one program while the control is running another.

Compatibility

Machining programs created on HEIDENHAIN contouring controls (starting from the TNC 150 B) may not always run on the TNC 320. If the NC blocks contain invalid elements, the TNC will mark these as ERROR blocks or with error messages when the file is opened.



Please also note the detailed description of the differences between the iTNC 530 and the TNC 320. **Further Information:** "Functions of the TNC 320 and the iTNC 530 compared", page 612.

2.2 Visual display unit and operating panel

Display screen

The TNC is available either as a compact version or with a separate display unit and operating panel. Both TNC variants come with a 15-inch TFT color flat-panel display.

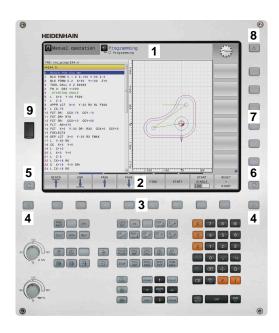
1 Header

When the TNC is on, the screen displays the selected operating modes in the header: The machining mode at the left and the programming mode at right. The currently active mode is displayed in the larger field of the header, where the dialog prompts and TNC messages also appear (exception: If the TNC only displays graphics).

2 Soft keys

In the footer the TNC indicates additional functions in a softkey row. You can select these functions by pressing the keys immediately below them. The thin bars immediately above the soft-key row indicate the number of soft-key rows that can be called with the keys to the right and left that are used to switch the soft keys. The bar representing the active soft-key row is highlighted

- **3** Soft-key selection keys
- 4 Keys for switching the soft keys
- **5** Setting the screen layout
- 6 Shift key for switchover between machining and programming modes
- 7 Soft-key selection keys for machine tool builders
- 8 Keys for switching the soft keys for machine tool builders
- 9 USB connection



2

2.2 Visual display unit and operating panel

Set screen layout

You select the screen layout yourself: In the **Programming** mode, for example, you can have the TNC show program blocks in the left window while the right window displays programming graphics. You could also display the program structure in the right window instead, or display only program blocks in one large window. The available screen windows depend on the selected operating mode.

Set up screen layout:

O

 Press the screen switchover key: The soft key row shows the available layout options
 Further Information: "Modes of operation", page 77



Select the desired screen layout with a soft key

Control panel

The TNC 320 is delivered with an integrated operating panel. As an alternative, the TNC 320 is also available with a separate display unit and an operating panel with an alphabetic keyboard.

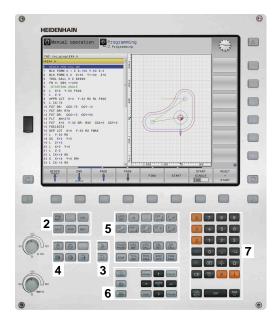
- 1 Alphabetic keyboard for entering texts and file names, as well as for ISO programming
- 2 File management
 - Calculator
 - MOD function
 - HELP function
- **3** Programming modes
- 4 Machine operating modes
- **5** Initiating programming dialogs
- 6 Navigation keys and GOTO jump command
- 7 Numerical input and axis selection
- 10 Machine operating panel More information Machine manual

The functions of the individual keys are described on the inside front cover.



Some machine tool builders do not use the standard HEIDENHAIN operating panel. Refer to your machine manual.

External keys, e.g.**NC START** or **NC STOP**, are described in your machine manual.



2

2.3 Modes of operation

Manual Operation and El. Handwheel

The **Manual operation** mode is required for setting up the machine tool. In this mode of operation, you can position the machine axes manually or by increments, set the datums and tilt the working plane.

The **Electronic handwheel** mode of operation allows you to move the machine axes manually with the HR electronic handwheel.

Soft keys for the screen	n layout (select a	s described above)
--------------------------	--------------------	--------------------

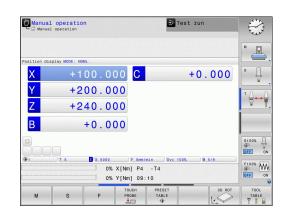
Soft key	Window
POSITION	Positions
POSITION + STATUS	Left: positions, right: status display
POSITION + KINEMATICS	Left: positions, right: collision object

Positioning with Manual Data Input

This mode of operation is used for programming simple traversing movements, such as for face milling or prepositioning.

Soft keys for selecting the screen layout

Soft key	Window
PGM	Program
PROGRAM + STATUS	Left: program, right: status display
POSITION + KINEMATICS	Left: program, right: collision object



		Overview PGM	LBL CYC M	POS TOOL T	T TRANS QPARA	
→\$mdi.i	^	RENOML X	+8.000	c	+0.000	M 🔲
%\$MDI G71 '		Y	+8.000			Let .
N10 G01 X+150 Y+200 Z+100"		z	+0.000			
N20 T500 G17"		Т: 3	MILL_D6_R0			S E
N99999999 %\$MDI G71 *			8.0000	R	+3.0000	8
	-		0.0000	DR-TAB	+0.0000	The second secon
		DL-PGM +	0.0000	DR-PGM	+0.0000	
				M58	MS	TO D
				Px		
		2		ф.		1 1 1
				\$		
		LBL				
		LBL			REP	
0% X (Nn) P1 -T1		PGM CALL				
ON Y [Nn] LINET ?		Active PGM:	TNC:/nc_prog.	/Smdi.i		\$100% []
T × +0.000	С		+0.000			
Y +0.000						
						F100% AA
						(in 1977)
Mode: NOML. 091		(T 3		Z S 3	500	OFF OI
Comm/min Ovr 10		M 5				

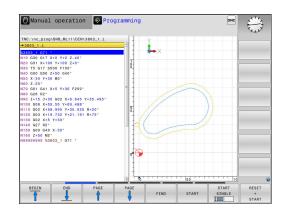
2

Programming

In this operating mode you can write your machining programs. The FK free programming feature, the various cycles and the Q parameter functions help you with programming and add necessary information. If desired, you can have the programming graphics show the programmed paths of traverse.

Soft keys for selecting the screen layout

Soft key	Window			
PGM	Program			
PROGRAM + SECTS	Left: program, right: program structure			
PROGRAM + GRAPHICS	Left: program blocks, right: programming graphics			

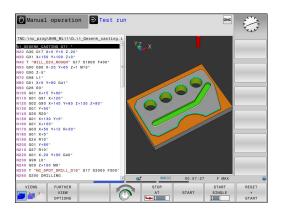


Test Run

In the **Test run** mode of operation, the TNC checks programs and program sections for errors, such as geometrical incompatibilities, missing or incorrect data within the program or violations of the working space. This simulation is supported graphically in different display modes.

Soft keys for selecting the screen layout

Soft key	Window
PGM	Program
PROGRAM + STATUS	Left: program, right: status display
PROGRAM + GRAPHICS	Left: program, right: graphics
GRAPHICS	Graphic

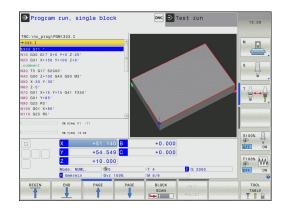


Program Run, Full Sequence and Program Run, Single Block

In the **Program run full sequence** mode, the TNC executes a program continuously to its end or to a manual or programmed stop. You can resume program run after an interruption.

In the **Program run single block** mode, you execute each block separately by pressing the **NC START** key. With point pattern cycles and **CYCL CALL PAT** the controls stops after each point.

Soft key	Window
PGM	Program
PROGRAM + SECTS	Left: program, right: structure
PROGRAM + STATUS	Left: program, right: status display
PROGRAM + GRAPHICS	Left: program, right: graphics
GRAPHICS	Graphic
POSITION + KINEMATICS	Left: program, right: collision object
KINEMATICS	Collision body



2.4 Status displays

2.4 Status displays

General status display

The general status display in the lower part of the screen informs you of the current state of the machine.

It is displayed automatically in the following operating modes:

- Program run, single block
- Program run, full sequence
- Positioning with manl.data input

If the **GRAPHICS** screen layout is selected the status display is not shown.

In the **Manual operation** and **Electronic handwheel** modes the status display appears in the large window.

Information in the status display

lcon	Meaning
ACTL.	Position display: Actual, nominal or distance-to-go coordinates mode
XYZ	Machine axes; the TNC displays auxiliary axes in lower-case letters. The sequence and quantity of displayed axes is determined by the machine tool builder. Refer to your machine manual for more information
(Number of the active presets from the preset table. If the datum was set manually, the TNC displays the text MAN behind the symbol
FSM	The displayed feed rate in inches corresponds to one tenth of the effective value. Spindle speed S, feed rate F and active M functions
*	Axis is clamped
\bigotimes	Axis can be moved with the handwheel
	Axes are moving under a basic rotation
	Axes are moving under a 3-D basic rotation
	Axes are moving in a tilted working plane

	Mode: NOML 6 Omm/min		0%	T 12	Z S 1800		OFF ON
	X Y Z	-6.546 +85.148 -5.000					0FF 0N
	0% X (MN) P1	61 1		e kinemat. X_TOOLDIR_Z			\$100% J
N130 G01 Y+5 N140 G25 R20 N150 G01 X+1 N150 G01 X+1 N170 G03 X+5	30 Y+5' 00'		SPA SPB	transformations +0.00000 X +0.00000 Y +0.00000 Z +3	+8.0000		
N80 G01 X+5 ⁻ N90 G26 R3 ⁺ N100 G01 X+1 N110 G01 G91 N120 G02 G90	5 Y+90"	135 J+80°				_	*
N50 G00 G90 : N60 G00 Z-5" N70 G98 L1"	X-25 Y+65 Z+1 I	413*		Y +85.148 Z -115.000			
TNC:\nc_prog →1 Gesenk ca	m run full seq		0vervi		POS TOOL TT TRA	NS QPARA	

lcon	Meaning
	No program selected, program reselected, program aborted via internal stop or program terminated In this condition the control has no modally effective program information (i.e. the contextual reference), so that all handling is possible, e.g. cursor movements or modification of Q parameters.
	Program started, execution runs For safety reasons, the control permits no handling in this condition
	Program stopped, e.g. in operating mode Program run, full sequence after pressing the NC STOP key
	For safety reasons, the control permits no handling in this condition
	Program interrupted, e.g. in operating mode Positioning with manl.data input following the error-free execution of an NC block
	In this condition the control permits various handling, e.g. cursor movements or the modification of Q parameters. With this handling the control may lose the modally effective program information (i.e. the contextual reference). Loss of this contextual reference may cause undesired tool positions!
	Further Information: "Programming and executing simple machining operations", page 514 and "Program-controlled interruptions", page 538
×	Program aborted or terminated
S %	Pulsing spindle speed function is active

Additional status displays

The additional status displays contain detailed information on the program run. This can be called in all operating modes except for the **Programming** mode.

To switch on the additional status display

Call the soft key row for screen layout





Select the screen layout with additional status ► display: In the right half of the screen, the TNC shows the OVERVIEW status form

To select an additional status display

\triangleright

Toggle through the soft key rows until the STATUS soft keys appear



- Either select the additional status display directly with the soft key, e.g. positions and coordinates; or
- use the switch-over soft keys to select the desired view

Select the status displays described below as follows:

- directly with the corresponding soft key
- via the switchover soft keys
- or by using the **NEXT TAB** key



Please note that some of the status information

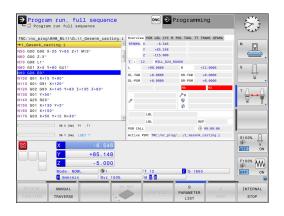
described below is not available unless the

associated software option is enabled on your TNC.

Overview

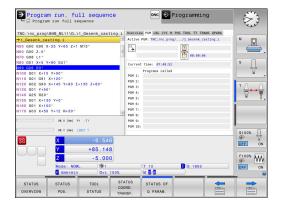
The **Overview** status form is displayed by the TNC following TNC switch-on if you selected the screen layout **PROGRAM + STATUS** (or **POSITION + STATUS**). The overview form contains a summary of the most important status information, which you can also find on the various detail forms.

Soft key	Meaning
STATUS OVERVIEW	Position display
	Tool information
	Active M functions
	Active coordinate transformations
	Active subprogram
	Active program section repeat
	Program called with %
	Current machining time
	Name and path of the active main program



General program	information	(PGM tab)
------------------------	-------------	-----------

Soft key	Meaning
No direct selection possible	Name and path of the active main program
	Circle center CC (pole)
	Dwell time counter
	Machining time when the program was completely simulated in the Test run operating mode
	Current machining time in percent
	Current time
	Active programs



Status displays 2.4

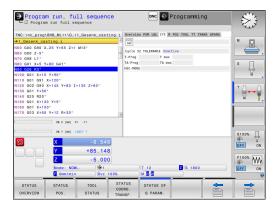
Program section repeat/Subprograms (LBL tab)

Soft key	Meaning
No direct selection possible	Active program section repeats with block number, label number, and number of programmed repeats/repeats yet to be run
	Active subprograms with block number in which the subprogram was called and the label number that was called

	\BHB_ML11\D\1 sting.1	_Gesenk_casting	Subprogr		POS TOOL TT TRA	NS QPARA	
N50 G00 G90 > N50 G00 Z-5° N70 G98 L1° N80 G01 X+5 Y	(-25 Y+65 Z+1)		Blk. no.		LBL no./Name		s
N90 G26 R3* N100 G01 X+15	Y+90"						4
N110 G01 G91			Repetiti				
120 G02 G90	X+145 Y+80 I+1	135 J+80*	Blk. no.		./Nane	REP	т Л Л
130 G01 Y+50 140 G25 R20							 ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
1150 G01 X+13							
160 G01 X+10							1
4170 G03 X+50							
	0% X (Nn) P1						
	0% X [100] P1						\$100% E
	0% X (Mn) P1						\$100%
	0% X (Mn) P1	at 2					6. 8
	0% X (Mn) P1	- 6 . 546 +85. 148					F100% AAA
	08. X (Nn) PT	-6.546 +85.148 -5.000		T 12			0FF 0
	0% X (Mn) P1	- 6 . 546 +85 . 148 - 5 . 000		T 12	2 S 1800		F100% AAA
	OK X (Mr) PT OK Y (Mr) LIX Y Z Mode : NOML	-6.546 +85.148 -5.000			Z S 1800		F100% W

Information on standard cycles (CYC tab)

Soft key	Meaning
No direct selection possible	Active fixed cycle
	Active values of Cycle 32 Tolerance



2

Active miscellaneous functions M (M tab)

Soft key	Meaning
No direct selection possible	List of the active M functions with fixed meaning
	List of the active M functions that are adapted

by your machine manufacturer

	m run, fu n run full se	ll sequenc quence	Ð		Programmin	g	\otimes
TNC:\nc_prog	BHB_ML11\D\	1_Gesenk_casti	ng.i Ove	rview PGM LBL CYC	N POS TOOL TT TRA	NS QPARA	
→1_Gesenk_ca	sting.i		1				M
N50 G00 G90 X	-25 Y+65 Z+1	M13*					T
N60 G00 Z-5*			-				
N70 G98 L1*							
N80 G01 X+5 Y	+80 G41*		_				S
N90 G26 R3*							U U
N100 G01 X+15							
N110 G01 G91							
	X+145 Y+80 I+	135 J+80*			OEM		тл л
N130 G01 Y+50 N140 G25 R20*				MB			
N150 G01 X+13				M3			M 1
N150 G01 X+10				N50			
N170 G03 X+50			-				
			~				
	0% X (Nn) P	1 .71					
	0% Y (Nn) U						
	ON F (Her) C						\$100% J
0	X						
							OFF ON
	Y	+85.148					
	Z	-5.000					F100% W
	Mode: NOM) @ . 1		T 12	Z S 1800		OFF ON
	E Omm/min	0vx 10	10%	M 8/8			OFF ON
10				_			1
STATUS	STATUS	TOOL	STATUS	STATUS OF		-	
OVERVIEW	POS.	STATUS	COORD.	Q PARAM.			
OVERVIEW	ruð.	OTATUS	TRANSF	PAHAN.			

Positions and coordinates (POS tab)

Soft key	Meaning
STATUS POS.	Type of position display, e.g. actual position
	Tilt angle of the working plane
	Angle of basic transformations
	Active kinematics

Program			ce			Programmi	ng	\otimes
TNC:\nc_prog\B	HB_ML11\D\1	_Gesenk_cast	ing.i	Overvi	W PGM LBL CYC M	N POS TOOL TT TR	ANS QPARA	
→1_Gesenk_cast	ing.1		4	RENCH	L X -6.546			M 🗖
N50 G00 G90 X-	25 Y+65 Z+1 I	413*			Y +85.148			
N60 G00 Z-5*			-		z -115.000			_ ,
N70 G98 L1*								
N80 G01 X+5 Y+	80 G41*		_					s
N90 G26 R3*								
N100 G01 X+15								W _
N110 G01 G91 X				Q				
N120 G02 G90 X N130 G01 Y+50*	+145 Y+80 I+	135 J+80°		(entry				тЛ Л
N130 G01 Y+50* N140 G25 R20*				Rasic	transformations			=====
N150 G01 X+130				SPA	0.00000 X	+0.0000		ы Ц
N150 G01 X+100						+8,0000		
N170 G03 X+50					+0.00000 Z +3			
			~		kinemat.			
e	0% X [Nn] P1	-T1			TOOLOIR Z			
e en en en en en en	0% Y (Mn) (D				CIOCOLOGICE			
	3 0% Y [MO] L1							\$100%
0	X	-6.546						
								OFF ON
	Y	+85.148	3					_
eeg .	Z	-5,000	5					F100% WW
					16	Z S 1800		
	Mode: NOML				T 12	S 1800		OFF ON
	0mm/min	0vr ·	00%		M 8/8			۲
STATUS OVERVIEW	STATUS POS.	TOOL STATUS	COO	ATUS DRD. NSF.	STATUS OF Q PARAM.			

Information on tools (TOOL tab)

Soft key	Meaning				
TOOL STATUS	Display of active tool:				
	T: Tool number and tool name				
	 RT: Number and name of a replacement tool 				
	Tool axis				
	Tool length and tool radii				
	Oversizes (delta values) from the tool table (TAB) and the TOOL CALL (PGM)				
	Tool life, maximum tool life (TIME 1) and maximum tool life for TOOL CALL (TIME 2)				
					

Display of programmed tool and replacement tool

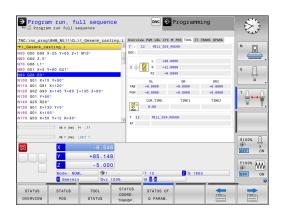
Tool measurement (TT tab)



The TNC displays the TT tab only if the function is active on your machine.

Soft key	Meaning	
No direct selection possible	Active tool	

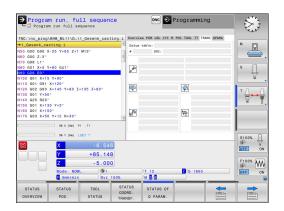
Measured values from tool measurement



	n run, fu n run full se	ll sequen quence	ce		Programmin	g	\geq
TNC:\nc_prog\	BHB_ML11\D\	1_Gesenk_cas1	ing.i Over	view PGM LBL CYC M	POS TOOL TT TRA	NS QPARA	
→1 Gesenk car	sting.i		Ат:	12 NILL 024	ROUGH		M
N50 G00 G90 X N50 G00 Z-5" N70 G98 L1" N80 G01 X+5 Y		M13*	= 00C:	MIN MAX			
N90 G26 R31				DYN			1 U
N100 G01 X+15 N110 G01 G91 N120 G02 G90 N130 G01 Y+50 N140 G25 R20* N150 G01 X+13 N160 G01 X+10 N170 G03 X+50	X+120* X+145 Y+80 I * 0 Y+5* 0* Y+12 R+30*		×				
	X Y Z Mode: NOM	-6.54 +85.14 -5.00	3	T 12	2 S 1800	•	5100%
STATUS OVERVIEW	F Omm/min STATUS POS.	TOOL STATUS	STATUS COORD. TRANSF.	M STATUS OF Q PARAM.			

Coordinate transformations (TRANS tab)

Soft key	Meaning
STATUS COORD. TRANSF.	Name of the active datum table
	Active datum number (#), comment from the active line of the active datum number (DOC) from Cycle G53
	Active datum shift (Cycle G54); The TNC displays an active datum shift in up to 8 axes
	Mirrored axes (Cycle G28)
	Active rotation angle (Cycle G73)
	Active scaling factor/factors (Cycles G72); The TNC displays an active scaling factor in up to 6 axes
	Scaling datum



Further information: Cycle Programming User's Manual

Displaying Q parameters (QPARA tab)

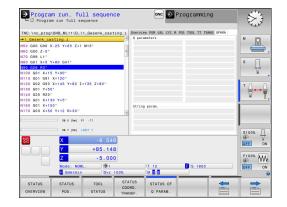
Soft key Meaning

STATUS OF	Display the current values of the defined Q parameters
Q FHRHM.	parameters

Display the character strings of the defined string parameters

Press the **Q PARAMETER LIST** soft key. The TNC opens a pop-up window. For each parameter type (Q, QL, QR, QS) define the parameter numbers you wish to control. Separate single Q parameters with a comma, and connect sequential Q parameters with a hyphen, e.g. 1,3,200-208. The input range per parameter type is 132 characters.

The display in the **QPARA** tab always contains eight decimal places. The result of Q1 = COS 89.999 is shown by the control as 0.00001745, for example. Very large and very small values are displayed by the control in exponential notation. The result of Q1 = COS 89.999 * 0.001 is shown by the control as +1.74532925e-08, whereby e-08 corresponds to the factor of 10^8 .



s 2.4

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2.5 Window manager

2.5 Window manager



The machine tool builder determines the scope of function and behavior of the window manager. Refer to your machine manual.

The TNC features the Xfce window manager. Xfce is a standard application for UNIX-based operating systems, and is used to manage graphical user interfaces. The following functions are possible with the window manager:

- Display a task bar for switching between various applications (user interfaces)
- Manage an additional desktop, on which special applications from your machine manufacturer can run
- Control the focus between NC software applications and those of the machine manufacturer
- You can change the size and position of pop-up windows. It is also possible to close, minimize and restore pop-up windows



The TNC shows a star in the upper left of the screen if an application of the window manager or the window manager itself has caused an error In this case, switch to the window manager and correct the problem. If required, refer to your machine manual.

Overview of the task bar

In the task bar you can choose different workspaces by mouse click.

The control provides the following workspaces:

- Workspace 1: Active operating mode
- Workspace 2: Active programming mode
- Workspace 3: CAD viewer, DXF converter or applications of the machine tool builder (optionally available)
- Workspace 4: Display and remote control of external computer units (option 133) or applications of the machine tool builder (optionally available)

In addition, you can also select other applications from the task bar which you have started in parallel to the control software, e.g. the **TNCguide**.

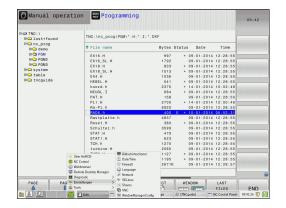


You can randomly move all open applications to the right of the green HEIDENHAIN symbol between the workspaces by pressing and holding the left mouse button.

Click the green HEIDENHAIN symbol to open a menu in which you can get information, make settings or start applications.

The following functions are available:

- About HEROS: Open information about the operating system of the control
- NC Control: Start and stop the control software (for diagnostic purposes only)
- Web Browser: Start the web browser
- Remote Desktop Manager (option 133): Display and remote control external computer units
 Further Information: "Remote Desktop Manager (option 133)", page
- Diagnostic: Diagnostic applications
 - **GSmartControl**: Available only to authorized specialists
 - HE Logging: Define settings for internal diagnostic files
 - **HE Menu**: Available only to authorized specialists
 - perf2: Check processor load and process load
 - Portscan: Test active connections
 Further Information: " Portscan ", page 91
 - Portscan OEM: Available only to authorized specialists
 - RemoteService: Start and stop remote maintenance Further Information: "Remote Service", page 92
 - Terminal: Enter and execute console commands
- Settings: Operating system settings
 - Date/Time: Set date and time
 - Language/Keyboards: Select system dialog language and keyboard version—the control overwrites the setting of the system dialog language when starting with the language setting of the machine parameter CfgDisplayLanguage (no. 101300)
 - **Network**: Define network settings



2.5 Window manager

- Printer: Configure and manage printer
- Screensaver: Define screensaver
- SELinux: Define safety software for Linux-based operating systems
- Shares: Connect and manage external network drives
- VNC: Define the setting for external software accessing the control for e.g. maintenance work (Virtual Network Computing)
 Further Information: "VNC", page 95
- WindowManagerConfig: Available only to authorized specialists
- Firewall: Configure the firewall
 Further Information: "Firewall", page 577
- HePacketManager: Available only to authorized specialists
- HePacketManager Custom: Available only to authorized specialists
- **Tools**: File applications
 - Document Viewer: Display files, e.g. PDF files
 - File Manager: Available only to authorized specialists
 - Geeqie: Open and manage graphics
 - Gnumeric: Open and edit tables
 - Leafpad: Open and edit text files
 - NC/PLC Backup: Create backup file
 Further Information: "Backup and restore", page 97
 - NC/PLC Restore: Restore backup file
 Further Information: "Backup and restore", page 97
 - **Ristretto**: Open graphics
 - Screenshot: Create screenshots
 - **TNCguide**: Call up help system
 - **Xarchiver**: Extract or compress directories
 - Applications: Supplementary applications
 - Orage Calender: Open calendar
 - Real VNC viewer: Define the setting for external software accessing the control for e.g. maintenance work (Virtual Network Computing)

The applications available under tools can be started directly by selecting the corresponding file type in the file management of the control **Further Information:** "Additional tools for management of external file types", page 143

Portscan

The PortScan function enables the cyclic or manual searching for all open, incoming TCP and UDP list ports on the system. All ports found are compared with whitelists. If the control finds a non-listed port it shows a corresponding pop-up window.

The HeROS **Diagnostic** menu contains the **Portscan** and **Portscan OEM** applications for this purpose. **Portscan OEM** is only executable after entering the machine manufacturer password.

The **Portscan** function searches for all open, incoming TCP and UDP ports on the system and compares them to four whitelists stored in the system:

- System-internal whitelists /etc/sysconfig/portscanwhitelist.cfg and /mnt/sys/etc/sysconfig/portscanwhitelist.cfg
- Whitelist for ports with machine manufacturer-specific functions, e.g. for Python and DNC applications: /mnt/plc/etc/ sysconfig/portscan-whitelist.cfg
- Whitelist for ports with customer-specific functions: /mnt/tnc/ etc/sysconfig/portscan-whitelist.cfg

For each entry the whitelist contains the type of port (TCP/UDP), the port number, the offering program and optional comments. If the automatic port scan function is active, only ports listed in the whitelists can be open. Non-listed ports trigger a notification window.

The result of the scan is saved to a log file (LOG:/portscan/scanlog and LOG:/portscan/scanlogevil), and if new ports are found that are not listed in one of the whitelists these are displayed.

Manually starting Portscan

Proceed as follows to manually start the Portscan:

- Open the task bar at the bottom edge of the screen
 Further Information: "Window manager", page 88
- Press the green HEIDENHAIN button to open the JH menu
- Select the **Diagnostic** menu item
- Select the Portscan menu item
- > The control opens the HeRos Portscan pop-up window.
- Press the Start key

Cyclically starting Portscan

Proceed as follows to automatically start the Portscan cyclically:

- Open the task bar at the bottom edge of the screen Further Information: "Window manager", page 88
- Press the green HEIDENHAIN button to open the JH menu
- Select the **Diagnostic** menu item
- Select the Portscan menu item
- > The control opens the **HeRos Portscan** pop-up window.
- Press the Automatic update on key
- Set the time interval with the slider

2

Remote Service

Together with the Remote Service Setup Tool, the TeleService from HEIDENHAIN enables encrypted end-to-end connections to be established between a service computer and the machine tool. To enable the HEIDENHAIN control to communicate with the HEIDENHAIN server it must be connected to the internet.

Further Information: "Configuring the TNC", page 571

In its basic state the firewall of the control blocks all incoming and outgoing connections. For this reason the firewall must be deactivated for the duration of the service session.

Setting up the control

To set up the control, proceed as follows:

- Open the task bar at the bottom edge of the screen Further Information: "Window manager", page 88
- Press the green HEIDENHAIN button to open the JH menu
- Select the Settings menu item
- Select the **Firewall** menu item
- > The control displays the Firewall/SSH settings dialog
- Deactivate the firewall by removing the Active option in the Firewall tab.
- Press the Apply key to save the settings
- ▶ Press the **OK** button
- > The firewall is disabled.



Do not forget to activate the firewall again after the end of the service session.

Automatic installation of a session certificate

With an NC software installation a temporary certificate is automatically installed on the control. An installation, also in the form of an update, may only be carried out by a service technician from the machine tool builder.

Active			Inter	face	eth0
	er inhibited pack P echo answer	ets			
Service	Method	Log	Computer		Description
LSV2	Permit all				for HEIDENHAIN Teleservice ICRemoNT
SMB	Permit all			SMB (CIFS) Server
SSH	Permit all			SSH s	erver
VNC	Permit all	8		VNC s	erver

Manual installation of a session certificate

A new certificate must be installed if no valid session certificate is installed on the control. Clarify which certificate is needed with your service employee. He will then provide you with a valid certificate file if necessary.

To install the certificate on the control proceed as follows:

- Open the task bar at the bottom edge of the screen
 Further Information: "Window manager", page 88
- Press the green HEIDENHAIN button to open the JH menu
- Select the Settings menu item
- Select the Network menu item
- > The control displays the **Network settings** dialog
- Select the Internet tab. The settings in the Remote maintenance field are configured by the machine tool builder.
- Press the Add key and select the file from the selection menu
- Press the Open key
- > The certificate is opened.
- Press the OK soft key
- It may be necessary to restart the control to load the settings

Launching the service session

Proceed as follows to start the service session:

- Open the task bar at the bottom edge of the screen
- Press the green HEIDENHAIN button to open the JH menu
- Select the **Diagnostic** menu item
- Select the **RemoteService** menu item
- Enter the Session key of the machine tool builder

	ettings					n 10
	te intertaci	es internet Hingled	uting NES UID/GID DHCP ser	ver sandbox SMB release		
Proxy	opportion to	o Internet / NAT				
. Direct Ct	unnecourie	o internet.) And	default gatewa	wards internet inquiries to the y and from there they must be ugh network address translation		
O Use prox	cy .					
Addre	-220					
Port:		0				
Telemaintenar						
Use sand	dbox for rer	note maintenance	telemaintenance You should chan	I builder configures servers for before the machine is shipped, ge servers only if you have been so by customer service personn	el.	
🗆 Use own	HTTP user-	agent text				
HTTP user-ag	gent text					
Certificate	Server		Description			
nca2	remotese	rvice.heidenhain.de	Heidenhain Fernwartung NC	1		
			Add		Delete	
				OEM		

2

2.5 Window manager

SELinux security software

SELinux is an extension for Linux-based operating systems. SELinux is an additional security software package based on Mandatory Access Control (MAC) and protects the system against the running of unauthorized processes or functions and therefore protects against viruses and other malware.

MAC means that each action must be specifically permitted otherwise the TNC will not run it. The software is intended as protection in addition to the normal access restriction in Linux. Certain processes and actions can only be executed if the standard functions and access control of SELinux permit it.



The SELinux installation of the TNC is prepared to permit running of only those programs installed with the HEIDENHAIN NC software. Other programs cannot be run with the standard installation.

The access control of SELinux under HEROS 5 is regulated as follows:

- The TNC runs only those applications installed with the HEIDENHAIN NC software
- Files in connection with the security of the software (SELinux system files, HEROS 5 boot files, etc.) may only be changed by programs that are selected explicitly
- New files generated by other programs must never be executed
- USB data carriers cannot be deselected
- There are only two processes that are permitted to execute new files:
 - Starting a software update: A software update from HEIDENHAIN can replace or change system files
 - Starting the SELinux configuration: The configuration of SELinux is usually password-protected by your machine manufacturer; refer here to the relevant machine manual



HEIDENHAIN recommends activating SELinux because it provides additional protection against attacks from outside.

VNC

Use the **VNC** function to configure the behavior of the various VNC clients. This includes, for example, operation via soft keys, mouse and the ASCII keyboard.

The control provides the following options:

- List of permitted clients (IP address or name)
- Password for the connection
- Additional server options
- Additional settings for assigning the focus



For multiple clients or operating units, the focus assignment procedure depends on the design and the operating situation of the machine. This function must be adapted to the TNC by your

machine manufacturer.

Refer to your machine manual.

Opening the VNC settings

Proceed as follows to open the VNC settings:

- Open the task bar at the bottom edge of the screen
 Further Information: "Window manager", page 88
- ▶ Press the green HEIDENHAIN button to open the JH menu
- Select the **Settings** menu item
- Select the VNC menu item
- > The control opens the VNC Settings pop-up window.
- The control provides the following options:
- Add: Add new VNC viewer/client
- Remove: Deletes the selected client Only possible with manually entered clients.
- Edit: Edit the configuration of the selected client
- Update: Updates the display. Required with connection attempts during which the dialog is open.

VNC settings

Dialog	Option	Meaning
VNC participant settings	Computer name:	IP address or computer name
	VNC:	Connection of the client to the VNC viewer
	VNC Focus	The client participates in the focus assignment
	Model	 Manual Manually entered client Denied This client is not permitted to connect
		 TeleService/IPC 61xx Client via TeleService connection
		 DHCP Other computer that obtains an IP address from this computer

- 🔂 Manual oper	ation					
						- E
osition display	MODE: ACTL.	Ov	erview PGM LBL CYC	M POS TOOL TT	TRANS OPARA AFC	8
x	-490.000	C) RC	FDST X +0.000	n	+0.000	V V
V	+0.000		Y +0.000 Z +0.000	C \$17	+0.000	
Z	+0.000	*	2 +0.000	517	+0.000	
	+0.000	i.	+0.0000	R	+0.0000	
+m	+10.001	DL	-TAB +0.0000	DR-TAB	+0.0000	
C	+90.000	DL	-PGM +0.0000	DR-PGM	+0.0000	
		Preferred awner of the focus				
VNC settings VNC parkgarisetings Camputername IP addres	s VMC VMCFacas Tape					
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2.5 Window manager

Option	Meaning
	Warnings and information about if the VNC protocol has not been authorized for all VNC clients due to firewall settings on the control.
	Further Information: "Firewall", page 577.
Enabling TeleService/ IPC 61xx	Connection via TeleService/IPC 61xx is always permitted
Password verification	The client must enter a password for verification. If this option is active, the password must be entered when the connection is established.
Deny	Access generally denied to all other VNC clients.
Inquire	During connection attempts a corresponding dialog is opened.
Permitted	Access is generally granted to all other VNC clients.
Enabling VNC focus	Enable focus assignment for this system. Otherwise there is no central focus assignment. In the default setting, the focus is actively reassigned by the owner of the focus by clicking the focus symbol. This means that the owner of the focus must first release the focus by clicking the focus symbol before any other client can retrieve the focus.
Enabling concurrency VNC focus	In the default setting, the focus is actively reassigned by the owner of the focus by clicking the focus symbol. This means that the owner of the focus must first release the focus by clicking the focus symbol before any other client can retrieve the focus. If concurrency focus is selected, any client can retrieve the focus at any time without having to wait for the current owner of the focus to release it.
Timeout Concurrency VNC Focus	Time period within which the current owner of the focus can object to the focus being withdrawn or can prevent the reassignment of the focus. If a client requests the focus, a dialog in which the reassignment of focus can be refused appears on all clients' screens.
	Current status of VNC focus on the respective client: Focus is owned by other client. Mouse and keyboard are disabled.
	Current status of VNC focus on respective client: Focus is owned by current client. Entries can be made.
⊒ ≈? !	Current status of VNC focus on the respective client: Request by the owner of the focus to give the focus to another client. Mouse and keyboard are disabled until the focus is assigned unambiguously.
	TeleService/ IPC 61xx Password verification Deny Inquire Permitted Enabling VNC focus Enabling Concurrency VNC focus Timeout Concurrency VNC Focus

If **Enable concurrency VNC focus** is selected, a pop-up window appears. This dialog makes it possible to refuse that the focus be given to the requesting client. If this does not occur, the focus changes to the requesting client after the set time limit.

Backup and restore

With functions **NC/PLC Backup** and **NC/PLC Restore** you can save and restore single directories or the complete TNC drive. You can save the backup files locally on a network drive or to USB data carriers.

The backup program generates a *****. **tncbck** file that can also be processed by the PC tool TNCbackup (part of TNCremo). The restore program can restore these files as well as those from existing TNCbackup programs. If a *****. tncbck file is selected in the file manager of the control, the program **NC/PLC Restore** is automatically launched.

Backup and restore is subdivided into several steps. Navigate between these steps with the **FORWARD** and **BACK** soft keys. Specific actions for steps are selectively displayed as soft keys.

Open NC/PLC Backup or NC/PLC Restore

Proceed as follows to open the functions:

- Open the task bar at the bottom edge of the screen Further Information: "Window manager", page 88
- Press the green HEIDENHAIN button to open the JH menu
- Select the **Tools** menu item
- Open the NC/PLC Backup or NC/PLC Restore menu item
- > The control opens the pop-up window.

Backing up data

To backup data from the control, proceed as follows:

- Select NC/PLC Backup
- Select the type
 - Back up the **TNC** partition
 - Back up the directory tree: Select the directory for backup in the file management
 - Backup machine configuration (for machine tool builders only)
 - Complete backup (for machine tool builders only)
 - Comment: Freely configurable comment for the backup
- Select the next step with the **FORWARD** soft key
- Stop the control if required with the STOP NC SOFTWARE soft key
- Define the exclusion rules
 - User preset rules
 - Write own rules to the table
- Select the next step with the FORWARD soft key
- > The control generates a list of files for backing up.
- Check the list. Deselect files if necessary.
- Select the next step with the FORWARD soft key
- Enter the name of the backup file
- Select the storage path
- Select the next step with the FORWARD soft key
- > The control generates the backup file.
- Confirm with the **OK** soft key
- The control concludes the backup process and restarts the NC software.

2.5 Window manager

Restore data



Caution: Data may be lost!

The control overwrites existing files without a confirmation prompt.

To restore the data proceed as follows:

- Select NC/PLC Restore
- Select the archive to be restored
- Select the next step with the FORWARD soft key
- > The control generates a list of files for restoring.
- Check the list. Deselect files if necessary.
- Select the next step with the FORWARD soft key
- Stop the control if required with the STOP NC SOFTWARE soft key
- Extract the archive
- > The control restores the files.
- Confirm with the **OK** soft key
- > The control restarts the NC software.

2.6 Accessories: HEIDENHAIN 3-D touch probes and electronic handwheels

3-D touch probes

The various HEIDENHAIN 3-D touch probes enable you to:

- Automatically align workpieces
- Quickly and precisely set datums
- Measure the workpiece during program run
- Measure and inspect tools

All of the cycle functions (touch probe cycles and fixed cycles) are described in the Cycle Programming User's Manual. If you need this user's manual, please contact HEIDENHAIN if required. ID: 1096959-xx

The triggering touch probes TS 220, TS 440, TS 444, TS 640 and TS 740

These touch probes are particularly effective for automatic workpiece alignment, datum setting and workpiece measurements. The TS 220 transfers the trigger signal via a cable and is also a cost-effective alternative if you have to carry out digitizing occasionally.

The TS 640 and the smaller TS 440 feature wireless infrared transmission of the triggering signals to the TNC. This makes them highly convenient for use on machines with automatic tool changers.

Principle of operation: HEIDENHAIN triggering touch probes feature a wear resisting optical switch that generates an electrical signal as soon as the stylus is deflected. The signal produced is transmitted to the control, which stores the current position of the touch probe as the actual value.

TT 140 tool touch probe for tool measurement

The TT 140 is a triggering 3-D touch probe for tool measurement and inspection. The TNC provides three cycles for this touch probe with which you can measure the tool length and radius either with the spindle rotating or stationary. The TT 140 features a particularly rugged design and a high degree of protection, which make it insensitive to coolants and swarf. The triggering signal is generated by a wear-resistant and highly reliable optical switch.





2.6 Accessories: HEIDENHAIN 3-D touch probes and electronic handwheels

HR electronic handwheels

Electronic handwheels facilitate moving the axis slides precisely by hand. A wide range of traverses per handwheel revolution is available. Apart from the HR130 and HR150 integral handwheels, HEIDENHAIN also offers the HR 410, HR 520 and HR 550FS portable handwheels.





Fundamentals, file management

Fundamentals, file management

3.1 Fundamentals

3

3.1 Fundamentals

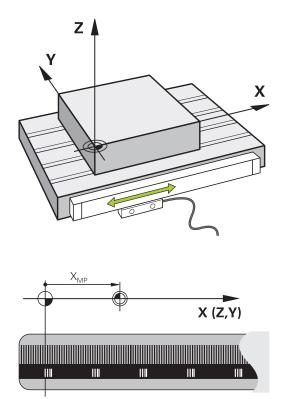
Position encoders and reference marks

The machine axes are equipped with position encoders that register the positions of the machine table or tool. Linear axes are usually equipped with linear encoders, rotary tables and tilting axes with angle encoders.

When a machine axis moves, the corresponding position encoder generates an electrical signal. The TNC evaluates this signal and calculates the precise actual position of the machine axis.

If there is a power interruption, the calculated position will no longer correspond to the actual position of the machine slide. To recover this association, incremental position encoders are provided with reference marks. The scales of the position encoders contain one or more reference marks that transmit a signal to the TNC when they are crossed over. From that signal the TNC can re-establish the assignment of displayed positions to machine positions. For linear encoders with distance-coded reference marks, the machine axes need to move by no more than 20 mm, for angle encoders by no more than 20°.

With absolute encoders, an absolute position value is transmitted to the control immediately upon switch-on. In this way the assignment of the actual position to the machine slide position is re-established directly after switch-on.



reference systems

For the control to traverse an axis according to a defined path it requires a **reference system**.

A paraxially mounted linear encoder on a machine tool serves as a simple reference system for linear axes. The linear encoder represents a **number ray**, a unidimensional coordinate system.

To approach a point on the **plane**, the control requires two axes and therefore a reference system with two dimensions.

To approach a point in the **space**, the control requires three axes and therefore a reference system with three dimensions. If these three axes are configured perpendicular to each other this creates a so-called **three-dimensional Cartesian coordinate system**.



According to the right-hand rule the fingertips point in the positive directions of the three main axes.

For a point to be uniquely determined in space, a **coordinate origin** is needed in addition to the configuration of the three dimensions. The common intersection serves as the coordinate origin in a 3-D coordinate system. This intersection has the coordinates **X+0**, **Y+0** and **Z+0**.

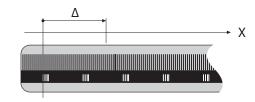
The control must differentiate between various reference systems for it to always perform a tool change at the same position for example, or carry out a machining operation always related to the current workpiece position.

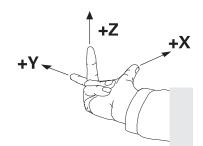
The control differentiates between the following reference systems:

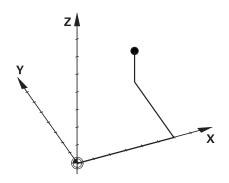
- Machine coordinate system M-CS: Machine Coordinate System
- Basic coordinate system B-CS:
 Basic Coordinate System
- Workpiece coordinate system W-CS:
 Workpiece Coordinate System
- Working plane coordinate system WPL-CS:
 Working Plane Coordinate System
- Input coordinate system I-CS: Input Coordinate System
- Tool coordinate system T-CS: Tool Coordinate System

All reference systems build up on each other. They are subject to the kinematic chain of the specific machine tool.

The machine coordinate system is the reference system.







Fundamentals, file management

3.1 Fundamentals

3

Machine coordinate system M-CS

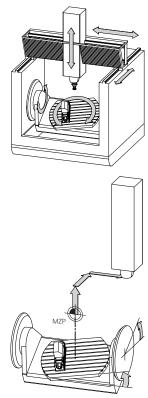
The machine coordinate system corresponds to the description of kinematics and therefore to the actual mechanical design of the machine tool.

Because the mechanics of a machine tool never precisely correspond to a Cartesian coordinate system, the machine coordinate system consists of several one-dimensional coordinate systems. These one-dimensional coordinate systems correspond to the physical machine axes that are not obligatorily perpendicular to each other.

The position and orientation of the one-dimensional coordinate systems are defined with the aid of translations and rotations based on the spindle tip in the description of kinematics.

The position of the coordinate origin, the so-called machine datum, is defined by the machine manufacturer during machine configuration. The values in the machine configuration define the zero positions of the encoders and the corresponding machine axes. The machine zero point is not obligatorily located in the theoretical intersection of the physical axes. It can therefore also be located outside of the traverse range.

Because the machine configuration values cannot be modified by the user, the machine coordinate system is used for determining constant positions, e.g. the tool change point.



Machine zero point MZP: Machine Zero Point

The control converts all movements in the machine coordinate system, independent of the reference system used for value input.

Example of a 3-axis machine tool with a Y axis as oblique axis, not arranged perpendicularly to the ZX plane:

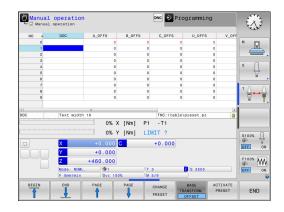
- In the Positioning with manl.data input operating mode, run an NC block with L IY+10
- > The control determines the required axis nominal values from the defined values.
- > During positioning the control moves the ${\bf Y}~{\bf and}~{\bf Z}$ machine axes.
- The RFACTL and REF NOML displays show movements of the Y axis and Z axis in the machine coordinate system.
- > The **ACTL.** and **NOML.** displays only show one movement of the Y axis in the input coordinate system.
- In the Positioning with manl.data input operating mode run an NC block with L IY-10 M91
- The control determines the required axis nominal values from the defined values.
- > During positioning the control only moves the ${\bf Y}$ machine axis.
- > The **RFACTL** and **REF NOML** displays only show one movement of the Y axis in the machine coordinate system.
- > The **ACTL.** and **NOML.** displays show movements of the Y axis and Z axis in the input coordinate system.

The user can program positions related to the machine zero point, e.g. by using the miscellaneous function **M91**.

Soft key	Application
BASE TRANSFORM. OFFSET	The user can define shifts in the machine coordinate system according to the specific axis with use of the OFFSET values of the preset table.

The machine manufacturer configures the **OFFSET** columns of the preset table in accordance with the machine.

Further Information: "Datum management with the preset table", page 467



Fundamentals, file management

3.1 Fundamentals

3

Basic coordinate system B-CS

The basic coordinate system is a 3-D Cartesian coordinate system. Its coordinate origin is the end of the kinematics model.

The orientation of the basic coordinate system in most cases corresponds to that of the machine coordinate system. There may be exceptions to this if a machine manufacturer uses additional kinematic transformations.

The kinematic model and thus the position of the coordinate origin for the basic coordinate system is defined by the machine manufacturer in the machine configuration. The user cannot modify the machine configuration values.

The basic coordinate system serves to determine the position and orientation of the workpiece coordinate system.



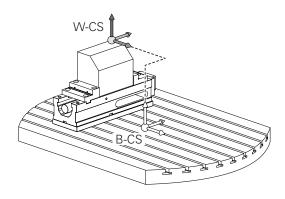
Soft key Application

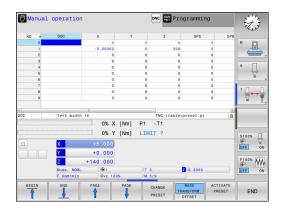
The user determines the position and orientation of the workpiece coordinate system by using a 3-D touch probe for example. The control saves the values determined related to the basic coordinate system as **BASE TRANSFORM.** values in the preset table.



The machine manufacturer configures the **BASE TRANSFORM.** columns of the preset table in accordance with the machine.

Further Information: "Datum management with the preset table", page 467





Workpiece coordinate system W-CS

The workpiece coordinate system is a 3-D Cartesian coordinate system. Its coordinate origin is the active reference point.

The position and orientation of the workpiece coordinate system depend on the **BASE TRANSFORM.** values of the active preset line.

Soft key	Application
BASE TRANSFORM. OFFSET	The user determines the position and orientation of the workpiece coordinate system by using a 3- D touch probe for example. The control saves the values determined related to the basic coordinate system as BASE TRANSFORM. values in the preset table.

Further Information: "Datum management with the preset table", page 467

In the workpiece coordinate system the user defines the position and orientation of the working plane coordinate system with use of transformations.

Transformations in the workpiece coordinate system:

- **3D ROT** functions
 - PLANE functions
 - Cycle 19 WORKING PLANE
- Cycle 7 DATUM SHIFT (shifting before tilting the working plane)
- Cycle 8 MIRRORING (mirroring before tilting the working plane)

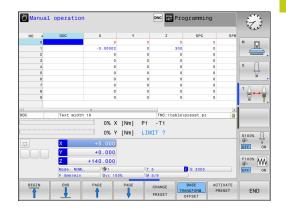
The result of transformations built up on each other depends on the programming sequence.

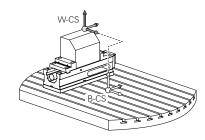
 \Rightarrow

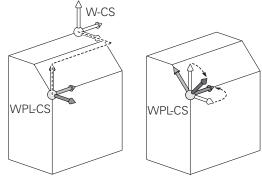
Without active transformations in the workpiece coordinate system, the position and orientation of the working plane coordinate system and workpiece coordinate system are identical.

There are no transformations in the workpiece coordinate system on 3-axis machine tools or with pure 3-axis machining. The **BASE TRANSFORM.** values of the active preset line are directly affective on the working plane coordinate system with this assumption.

Other transformations are of course possible in the working plane coordinate system. **Further Information:** "Working plane coordinate system WPL-CS", page 108







Fundamentals, file management

3.1 Fundamentals

Working plane coordinate system WPL-CS

The working plane coordinate system is a 3-D Cartesian coordinate system.

The position and orientation of the working plane coordinate system depend on the active transformations in the workpiece coordinate system.



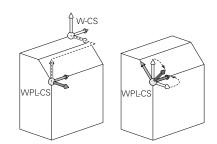
Without active transformations in the workpiece coordinate system, the position and orientation of the working plane coordinate system and workpiece coordinate system are identical.

There are no transformations in the workpiece coordinate system on 3-axis machine tools or with pure 3-axis machining. The **BASE TRANSFORM.** values of the active preset line are directly affective on the working plane coordinate system with this assumption.

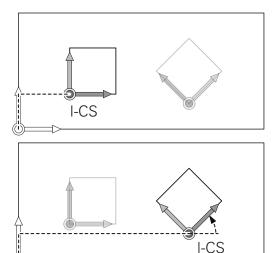
In the working plane coordinate system the user defines the position and orientation of the input coordinate system with use of transformations.

Transformations in the working plane coordinate system:

- Cycle 7 DATUM SHIFT
- Cycle 8 MIRRORING
- Cycle 10 ROTATION
- Cycle 11 SCALING FACTOR
- Cycle 26 AXIS-SPECIFIC SCALING
- PLANE RELATIVE







3

\Rightarrow

As a **PLANE** function, the **PLANE RELATIVE** is

effective in the workpiece coordinate system and aligns the working plane coordinate system.

The values of additive tilting always relate to the current working plane coordinate system.

 \Rightarrow

The result of transformations built up on each other depends on the programming sequence.

Without active transformations in the working plane coordinate system, the position and orientation of the input coordinate system and working plane coordinate system are identical.

There are also no transformations in the workpiece coordinate system on 3-axis machine tools or with pure 3-axis machining. The **BASE TRANSFORM.** values of the active preset line are directly affective on the input coordinate system with this assumption.

3.1 Fundamentals

Input coordinate system I-CS

The input coordinate system is a 3-D Cartesian coordinate system.

The position and orientation of the input coordinate system depend on the active transformations in the working plane coordinate system.



Without active transformations in the working plane coordinate system, the position and orientation of the input coordinate system and working plane coordinate system are identical.

There are also no transformations in the workpiece coordinate system on 3-axis machine tools or with pure 3-axis machining. The **BASE TRANSFORM.** values of the active preset line are directly affective on the input coordinate system with this assumption.

With the aid of positioning blocks in the input coordinate system, the user defines the position of the tool and therefore the position of the tool coordinate system.

Positioning blocks in input coordinate system:

- Paraxial positioning blocks
- Positioning blocks with Cartesian or polar coordinates
- Positioning blocks with Cartesian coordinates and surface normal vectors

7 X+48 R+

7 L X+48 Y+102 Z-1.5 R0

7 LN X+48 Y+102 Z-1.5 NX-0.04658107 NY0.00045007 NZ0.8848844 R0



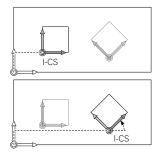
The position of the tool coordinate system is determined by the Cartesian coordinates X, Y and Z also for positioning blocks with surface normal vectors.

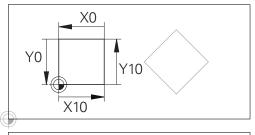
In conjunction with 3-D tool compensation, the position of the tool coordinate system can be shifted along the surface normal vectors.

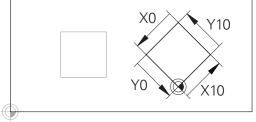
Orientation of the tool coordinate system can be performed in various reference systems. **Further Information:** "Tool coordinate system T-CS",

page 111









A contour referencing the input coordinate system origin can be simply transformed at random.

Tool coordinate system T-CS

The tool coordinate system is a 3-D Cartesian coordinate system. Its coordinate origin is the tool reference point. The values of the tool table, **L** and **R** with milling tools and **ZL**, **XL** and **YL** with turning tools, reference this point.

Further Information: "Enter tool data into the table", page 188 and "Tool data"



For dynamic collision monitoring (option 40) to correctly monitor the tool, the values in the tool table must correspond to the actual dimensions of the tool.

In accordance with the values from the tool table, the coordinate origin of the tool coordinate system is shifted to the tool center point TCP. TCP stands for **T**ool **C**enter **P**oint.

If the NC program does not reference the tool tip, the tool center point must be shifted. The required shift is implemented in the NC program using the delta values during a tool call.



The position of the TCP as shown in the diagram is obligatory in conjunction with the 3-D tool compensation.

With the aid of positioning blocks in the input coordinate system, the user defines the position of the tool and therefore the position of the tool coordinate system.

With active **TCPM** function or active miscellaneous function **M128** the orientation of the tool coordinate system depends on the current tool angle of inclination.

The user defines the tool's angle of inclination either in the machine coordinate system or in the working plane coordinate system.

Tool angle of inclination in the machine coordinate system:

7 L X+10 Y+45 A+10 C+5 R0 M128

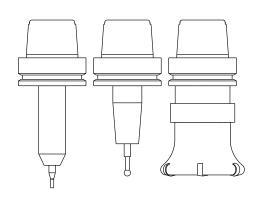
Tool angle of inclination in the working plane coordinate system:

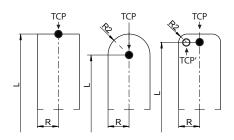
6 FUNCTION TCPM F TCP AXIS SPAT PATHCTRL AXIS

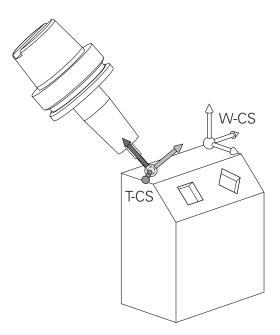
7 L A+0 B+45 C+0 R0 F2500

```
7 LN X+48 Y+102 Z-1.5 NX-0.04658107 NY0.00045007
NZ0.8848844 TX-0.08076201 TY-0.34090025 TZ0.93600126
R0 M128
```

7 LN X+48 Y+102 Z-1.5 NX-0.04658107 NY0.00045007 NZ0.8848844 R0 M128







3.1 Fundamentals

With the shown positioning blocks with vectors, 3-D tool compensation is possible with compensation values **DL**, **DR** and **DR2** from the **TOOL CALL** block. The methods of function of the compensation values

depend on the type of tool.

The control detects the various tool types with the columns **L**, **R** and **R2** of the tool table:

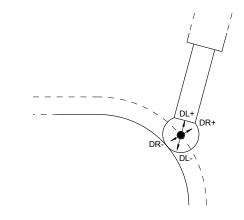
■ $R2_{TAB} + DR2_{TAB} + DR2_{PROG} = 0$ → end mill

 $R2_{TAB} + DR2_{TAB} + DR2_{PROG} = R_{TAB} + DR_{TAB} + DR_{PROG}$

 \rightarrow radius cutter or ball cutter

- $0 < R2_{TAB} + DR2_{TAB} + DR2_{PROG} < R_{TAB} + DR_{TAB} + DR_{PROG}$
 - \rightarrow toroid cutter or toroidal cutter

Without the **TCPM** function or miscellaneous function **M128**, orientation of the tool coordinate system and input coordinate system is identical.



3

Designation of the axes on milling machines

The X, Y and Z axes on your milling machine are also referred to as tool axis, principal axis (1st axis) and secondary axis (2nd axis). The assignment of the tool axis is decisive for the assignment of the principal and secondary axes.

Tool axis	Principal axis	Secondary axis
Х	Y	Z
Y	Z	Х
Z	Х	Y

Polar coordinates

If the production drawing is dimensioned in Cartesian coordinates, you also write the NC program using Cartesian coordinates. For parts containing circular arcs or angles it is often simpler to give the dimensions in polar coordinates.

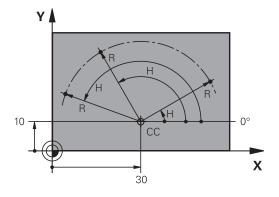
While the Cartesian coordinates X, Y and Z are three-dimensional and can describe points in space, polar coordinates are twodimensional and describe points in a plane. Polar coordinates have their datum at a circle center (CC), or pole. A position in a plane can be clearly defined by the:

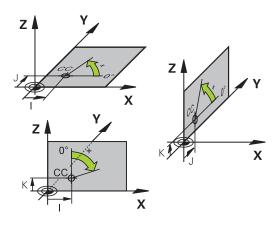
- Polar Radius, the distance from the circle center CC to the position, and the
- Polar Angle, the value of the angle between the angle reference axis and the line that connects the circle center CC with the position.

Setting the pole and the angle reference axis

The pole is set by entering two Cartesian coordinates in one of the three planes. These coordinates also set the reference axis for the polar angle H.

Coordinates of the pole (plane)	Reference axis of the angle
X/Y	+X
Y/Z	+Y
Z/X	+Z





3.1 Fundamentals

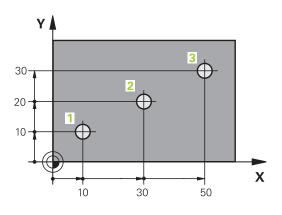
Absolute and incremental workpiece positions

Absolute workpiece positions

Absolute coordinates are position coordinates that are referenced to the datum of the coordinate system (origin). Each position on the workpiece is unambiguously defined by its absolute coordinates.

Example 1: Holes dimensioned in absolute coordinates

Hole 1	Hole 2	Hole 3
X = 10 mm	X = 30 mm	X = 50 mm
Y = 10 mm	Y = 20 mm	Y = 30 mm



Incremental workpiece positions

Incremental coordinates are referenced to the last programmed nominal position of the tool, which serves as the relative (imaginary) datum. When you write an NC program in incremental coordinates, you thus program the tool to move by the distance between the previous and the subsequent nominal positions. This is why they are also referred to as chain dimensions.

To program a position in incremental coordinates, enter the function G91 before the axis.

Example 2: Holes dimensioned in incremental coordinates

Absolute coordinates of hole 4

X = 10	mm

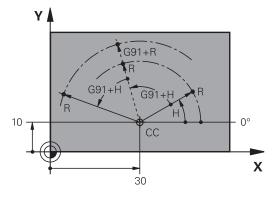
Y = 10 mm

Hole 5, with respect to 4	Hole 6, with respect to 5
G91 X = 20 mm	G91 X = 20 mm
G91 Y = 10 mm	G91 Y = 10 mm

Absolute and incremental polar coordinates

Absolute coordinates always refer to the pole and the angle reference axis.

Incremental polar coordinates always refer to the last programmed nominal position of the tool.



Fundamentals

Selecting the datum

A production drawing identifies a certain form element of the workpiece, usually a corner, as the absolute datum. When setting the datum, you first align the workpiece along the machine axes, and then move the tool in each axis to a defined position relative to the workpiece. Set the display of the TNC either to zero or to a known position value for each position. This establishes the reference system for the workpiece, which will be used for the TNC display or your machining program.

If the production drawing is dimensioned in relative datums, simply use the coordinate transformation cycles.

Further information: Cycle Programing User's Manual

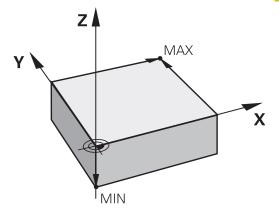
If the production drawing is not dimensioned for NC, set the datum at a position or corner on the workpiece from which the dimensions of the remaining workpiece positions can be measured.

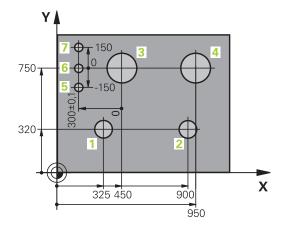
The fastest, easiest and most accurate way of setting the datum is by using a 3-D touch probe from HEIDENHAIN.

Further Information: "Datum setting with a 3-D touch probe ", page 497

Example

The workpiece drawing shows holes (1 to 4), whose dimensions are shown with respect to an absolute datum with the coordinates X=0 Y=0. The coordinates of holes 5 to 7 refer to the relative datum with the absolute coordinates X=450 Y=750. By using the **ZERO POINT DISPL.** cycle you can shift the datum temporarily to the position X=450, Y=750 and program the holes (5 to 7) without further calculations.





3.1

3.2 Opening programs and entering

3.2 Opening programs and entering

Structure of an NC program in DIN/ISO format

A machining program consists of a series of NC blocks. The illustration on the right shows the elements of a block.

The TNC numbers the blocks of a part program automatically depending on machine parameter **blockIncrement** (105409). The machine parameter **blockIncrement** (105409) defines the block number increment.

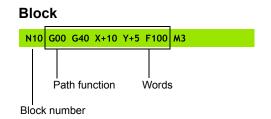
The first block of a program is identified by %, the program name and the active unit of measure.

The subsequent blocks contain information on:

- The workpiece blank
- Tool calls
- Approaching a safe position
- Feed rates and spindle speeds, as well as
- Path contours, cycles and other functions

The last block of a program is identified by **N99999999**, the program name and the active unit of measure.

After each tool call, HEIDENHAIN recommends always traversing to a safe position from which the TNC can position the tool for machining without causing a collision!



3

Define the blank: G30/G31

Immediately after initiating a new program, you define a cuboid, unmachined workpiece blank. If you wish to define the blank at a later stage, press the **SPEC FCT** key, the **PROGRAM DEFAULTS** soft key, and then the **BLK FORM** soft key. The TNC needs this definition for graphic simulation.

_	

You only need to define the workpiece blank if you wish to run a graphic test for the program!

The TNC can depict various types of blank forms.

Soft key	Function
	Define a rectangular blank
	Define a cylindrical blank
	Define a rotationally symmetric blank of any shape

Rectangular blank

The sides of the cuboid lie parallel to the X, Y and Z axes. This blank is defined by two of its corner points:

- MIN point G30: the smallest X, Y and Z coordinates of the blank form, entered as absolute values.
- MAX point G31: the largest X, Y and Z coordinates of the blank form, entered as absolute or incremental values

Example: Display the BLK FORM in the NC program

%NEW G71 *	Program begin, name, unit of measure
N10 G30 G17 X+0 Y+0 Z-40*	Spindle axis, MIN point coordinates
N20 G31 X+100 Y+100 Z+0*	MAX point coordinates
N99999999 %NEW G71 *	Program end, name, unit of measure

3.2 Opening programs and entering

Cylindrical blank

3

The cylindrical blank form is defined by the dimensions of the cylinder:

- X, Y or Z: Rotation axis
- D, R: Diameter or radius of the cylinder (with positive algebraic sign)
- L: Length of the cylinder (with positive algebraic sign)
- DIST: Shifting along the rotational axis
- DI, RI: Inside diameter or inside radius for a hollow cylinder



The parameters **DIST** and **RI** or **DI** are optional and need not be programmed.

Example: Display the BLK FORM CYLINDER in the NC program

%NEW G71 *	Program begin, name, unit of measure
N10 BLK FORM CYLINDER Z R50 L105 DIST+5 RI10*	Spindle axis, radius, length, distance, inside radius
N99999999 %NEW G71 *	Program end, name, unit of measure

Rotationally symmetric blank of any shape

You define the contour of the rotationally symmetric blank in a subprogram. Use X, Y or Z as the rotation axis.

In the workpiece blank definition you refer to the contour description:

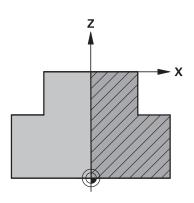
- DIM_D, DIM-R: Diameter or radius of the rotationally symmetrical blank form
- LBL: Subprogram with the contour description

The contour description may contain negative values in the rotation axis but only positive values in the reference axis. The contour must be closed, i.e. the contour beginning corresponds to the contour end.

If you define a rotationally symmetric blank with incremental coordinates, the dimensions are then independent of the diameter programming.



The subprogram can be designated with a number, an alphanumeric name, or a QS parameter.



3

Example: Display the BLK FORM ROTATION in the NC program

%NEW G71 *	Program begin, name, unit of measure
N10 BLK FORM ROTATION Z DIM_R LBL1*	Spindle axis, manner of interpretation, subprogram number
N20 M30*	End of main program
N30 G98 L1*	Beginning of subprogram
N40 G01 X+0 Z+1*	Starting point of contour
N50 G01 X+50*	Programming in the positive direction of the principal axis
N60 G01 Z-20*	
N70 G01 X+70*	
N80 G01 Z-100*	
N90 G01 X+0*	
N100 G01 Z+1*	Contour end
N110 G98 L0 *	End of subprogram
N99999999 %NEW G71 *	Program end, name, unit of measure

3.2 Opening programs and entering

Opening a new part program

You always enter a machining program in **Programming** mode. An example of program initiation:



3

Operating mode: Press the Programming key



► To call the file manager, press the **PGM MGT** key.

Select the directory in which you wish to store the new program: **FILE NAME = NEW.I**

FILE NAME = N

- Enter the new program name and confirm your entry with the ENT key
- Select the unit of measure: Press the MM or INCH soft key. The TNC switches the screen layout and initiates the dialog for defining the BLK FORM



MM

 Select a rectangular workpiece blank: Press the soft key for a rectangular blank form

WORKING PLANE IN GRAPHIC: XY



ENT

Enter the spindle axis, e.g. G17

(workpiece blank)

WORKPIECE BLANK DEF .: MINIMUM

Enter in sequence the X, Y and Z coordinates of the MIN point and confirm each of your entries with the ENT key

WORKPIECE BLANK DEF.: MAXIMUM

ENT

Enter in sequence the X, Y and Z coordinates of the MAX point and confirm each of your entries with the ENT key

Example: Display the BLK form in the NC program

%NEW G71 *	Program begin, name, unit of measure
N10 G30 G17 X+0 Y+0 Z-40*	Spindle axis, MIN point coordinates
N20 G31 X+100 Y+100 Z+0*	MAX point coordinates
N99999999 %NEW G71 *	Program end, name, unit of measure

The TNC automatically generates the first and last blocks of the program.



If you do not wish to define a blank form, cancel the dialog at **Working plane in graphic: XY** using the **DEL** key.



Programming tool movements in DIN/ISO

Press the SPEC FCT key to program a block. Press the PROGRAM FUNCTIONS soft key, and then the DIN/ISO soft key. You can also use the gray path function keys to get the corresponding G code.



If you enter DIN/ISO functions via a connected USB keyboard, make sure that capitalization is active.

Example of a positioning block



Enter 1 and press the ENT key to



COORDINATES ?



10 (enter the target coordinate for the X axis)



20 (enter the target coordinate for the Y axis)



Go to the next question with ENT.

MILLINGDEFINITIONPOINTPATH



Enter 40 and confirm with ENT to traverse without tool radius compensation, or



ENT

Move the tool to the left or to the right of the programmed contour: Press the G41 or G42 soft key

FEED RATE F=?

- ► **100** (enter a feed rate of 100 mm/min for this path contour)
 - ▶ Go to the next question with **ENT**.

MISCELLANEOUS FUNCTION M ?

► Enter 3 (miscellaneous function M3 "Spindle ON").



▶ With the **END** key, the TNC ends this dialog.

The program-block window displays the following line:

N30 G01 G40 X+10 Y+5 F100 M3*

3

3.2 Opening programs and entering

Actual position capture

The TNC enables you to transfer the current tool position into the program, for example during

- Positioning-block programming
- Cycle programming

To transfer the correct position values, proceed as follows:

Place the input box at the position in the block where you want to insert a position value



 Select the actual-position-capture function: In the soft-key row the TNC displays the axes whose positions can be transferred



 Select the axis: The TNC writes the current position of the selected axis into the active input box

In the working plane the TNC always captures the coordinates of the tool center, even though tool radius compensation is active.

In the tool axis the TNC always captures the coordinates of the tool tip and thus always takes the active tool length compensation into account.

The TNC keeps the soft-key row for axis selection active until you deactivate it by pressing the actualposition-capture key again. This behavior remains in effect even if you save the current block and open a new one with a path function key. If you select a block element in which you must choose an input alternative via soft key (e.g. for radius compensation), then the TNC also closes the soft-key row for axis selection.

The actual-position-capture function is not allowed if the tilted working plane function is active.

3

Editing a program



You cannot edit a program while it is being run by the TNC in a machine operating mode.

While you are creating or editing a part program, you can select any desired line in the program or individual words in a block with the arrow keys or the soft keys:

Soft key/key	Function
PAGE	Go to previous page
PAGE	Go to next page
BEGIN	Go to beginning of program
END	Go to end of program
I	Change the position of the current block on the screen. Press this soft key to display additional NC blocks that are programmed before the current block
	Change the position of the current block on the screen. Press this soft key to display additional NC blocks that are programmed after the current block
<u>↑</u>	Move from one block to the next
	Select individual words in a block
	To select a certain block, press the GOTO key, enter the desired block number, and confirm with the ENT key. Or: Press the GOTO key, enter the block number step and jump up or down the number of entered lines by pressing the N LINES soft key

3.2 **Opening programs and entering**

Soft key/key	Function
CE	Set the selected word to zero
	Erase an incorrect number
	Delete the (clearable) error message
NO ENT	Delete the selected word
DEL	Delete the selected block
	Erase cycles and program sections
INSERT LAST NC BLOCK	Insert the block that you last edited or deleted

Inserting blocks at any desired location

Select the block after which you want to insert a new block and initiate the dialog

Save changes

The control normally saves changes automatically if you switch the operating mode or if you select the file manager. If you deliberately want to save changes to the program, proceed as follows:

Select the soft-key row with the saving functions



Press the STORE soft key for the TNC to save all changes made since the last time you saved the program

Saving a program to a new file

You can save the contents of the currently active program under a different program name. Proceed as follows: ►

- Select the soft-key row with the saving functions
- SAVE AS
- Press the SAVE AS soft key: The TNC opens a window in which you can enter the directory and the new file name
- Select the target directory if required with the SWITCH soft key
- Enter the file name
- Confirm with the OK soft key or the ENT key, or press the CANCEL soft key to abort



The file saved with SAVE AS is now also found in the file management under LAST FILES.

Undoing changes

You can undo all changes made since the last time you saved the program. Proceed as follows:

Select the soft-key row with the saving functions



- Press the CANCEL CHANGE soft key: The TNC opens a window in which you can confirm or cancel this action
- Confirm with the YES key or cancel with the ENT key, or press the NO key to abort

Editing and inserting words

- Select a word in a block and overwrite it with the new one. The dialog is available while the word is highlighted
- To accept the change, press the END key

If you want to insert a word, press the horizontal arrow key repeatedly until the desired dialog appears. You can then enter the desired value.

Looking for the same words in different blocks

- Select a word in a block: Press the arrow key repeatedly until the desired word is highlighted
- Select a block with the arrow keys Arrow down: search forwards

 - Arrow up: search backwards

The word that is highlighted in the new block is the same as the one you selected previously.



If you have started a search in a very long program, the TNC shows a progress display window. You then have the option of canceling the search via soft key.

3.2 Opening programs and entering

Marking, copying, cutting and inserting program sections

The TNC provides the following functions for copying program sections within an NC program or into another NC program:

Soft key	Function
SELECT BLOCK	Switch the marking function on
CANCEL SELECTION	Switch the marking function off
CUT OUT BLOCK	Cut the marked block
INSERT BLOCK	Insert the block that is stored in the buffer memory
COPY BLOCK	Copy the marked block

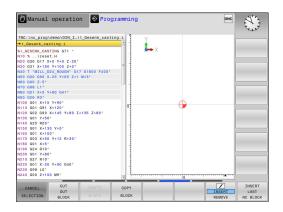
To copy a program section, proceed as follows:

- Select the soft key row containing the marking functions
- Select the first block of the section you wish to copy
- Mark the first block: Press the SELECT BLOCK soft key. The TNC highlights the block in color and displays the CANCEL SELECTION soft key
- Move the highlight to the last block of the program section you wish to copy or cut. The TNC shows the marked blocks in a different color. You can end the marking function at any time by pressing the CANCEL SELECTION soft key
- Copy the selected program section: Press the COPY BLOCK soft key. Cut the selected program section: Press the CUT OUT BLOCK soft key. The TNC stores the selected block
- Using the arrow keys, select the block after which you wish to insert the copied (cut) program section



To insert the section into another program, select the corresponding program using the file manager and then mark the block after which you wish to insert the program section.

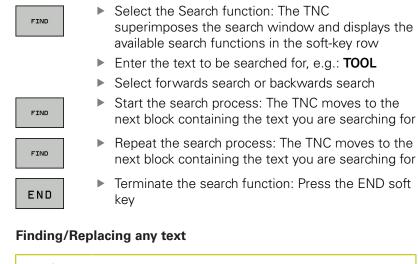
- Insert the saved program section: Press the INSERT BLOCK soft key
- To end the marking function, press the CANCEL SELECTION soft key

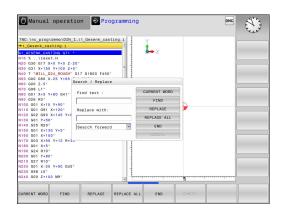


The TNC search function

The search function of the TNC enables you to search for any text within a program and replace it by a new text, if required.

Finding any text





	 The find/replace function is not possible if a program is protected the program is currently being run by the TNC When using the REPLACE ALL function, ensure that you do not accidentally replace text that you do not want to change. Once replaced, such text cannot be restored.
Selec	t the block containing the word you wish to find
FIND	Select the Search function: The TNC superimposes the search window and displays the available search functions in the soft-key row
	Press the CURRENT WORD soft key: The TNC loads the first word of the current block. If required, press the info key again to load the desired word.
FIND	 Start the search process: The TNC moves to the next occurrence of the text you are searching for
REPLACE	To replace the text and then move to the next occurrence of the text, press the REPLACE soft key. To replace all text occurrences, press the REPLACE ALL soft key. To skip the text and move to its next occurrence press the FIND soft key
END	 Terminate the search function: Press the END soft key

3.3 File management: Basics

3.3 File management: Basics

Files

3

Files in the TNC	Туре
Programs in HEIDENHAIN format in DIN/ISO format	.H .I
Compatible Programs HEIDENHAIN Unit Programs HEIDENHAIN Contour Programs	.HU .HC
Tables for toolsTool changersDatumsPointsReference pointsTouch probesBackup filesDependent data (e.g. Structure items)Freely definable tables	.T .TCH .D .PNT .PR .TP .BAK .DEP .TAB
Text as ASCII files Log files Help files	.A .TXT .CHM
CAD files as ASCII files	.DXF .IGES .STEP

When you write a part program on the TNC, you must first enter a program name. The TNC saves the program to the internal memory as a file with the same name. The TNC can also save texts and tables as files.

The TNC provides a special file management window in which you can easily find and manage your files. Here you can call, copy, rename and erase files.

With the TNC you can manage and save files up to a total size of **2 GB**.



Depending on the setting, the TNC generates a backup file (*.bak) after editing and saving of NC programs. This can reduce the memory space available to you.

3

File names

When you store programs, tables and texts as files, the TNC adds an extension to the file name, separated by a point. This extension indicates the file type.

File name	File type	
PROG20	.	

File names on the TNC must comply with this standard: The Open Group Base Specifications Issue 6 IEEE Std 1003.1, 2004 Edition (Posix-Standard). Accordingly, the file names may include the characters below:

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z a b c d e f g h i j k l m n o p q r s t u v w x y z 0 1 2 3 4 5 6 7 8 9 . _ -

You should not use any other characters in file names in order to prevent any file transfer problems. Table names must start with a letter.



The maximum permitted path length is 255 characters. All drive characters, directory and the file name, including the extension, must not exceed 255 characters.

Further Information: "Paths", page 131

3.3 File management: Basics

Displaying externally generated files on the TNC

The TNC features several additional tools which you can use to display the files shown in the table below. Some of the files can also be edited.

File types	Туре
PDF files	pdf
Excel tables	xls
	CSV
Internet files	html
Text files	t×t
	ini
Graphics files	bmp
	gif
	jpg
	png

Further Information: "Additional tools for management of external file types", page 143

Data Backup

We recommend saving newly written programs and files on a PC at regular intervals.

The **TNCremo** data transmission freeware from HEIDENHAIN is a simple and convenient method for backing up data stored on the TNC.

You can also backup files directly from the control. **Further Information:** "Backup and restore", page 97

You additionally need a data medium on which all machinespecific data, such as the PLC program, machine parameters, etc., are stored. Ask your machine manufacturer for assistance, if necessary.



Take the time occasionally to delete any unneeded files so that the TNC always has enough hard-disk space for system files (such as the tool table).

3.4 Working with the file manager

Directories

To ensure that you can easily find your programs and files, we recommend that you organize your internal memory into directories. You can divide a directory into further directories, which are called subdirectories. With the -/+ key or **ENT** you can show or hide the subdirectories.

Paths

A path indicates the drive and all directories and subdirectories under which a file is saved. The individual names are separated by a backslash " $\$ ".



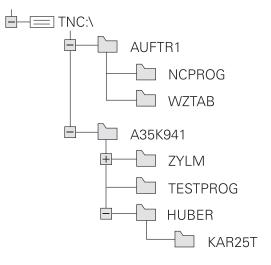
The maximum permitted path length is 255 characters. All drive characters, directory and the file name, including the extension, must not exceed 255 characters.

Example

The directory AUFTR1 was created on the TNC drive. Then, in the AUFTR1 directory, the directory NCPROG was created and the part program PROG1.H was copied into it. The part program now has the following path:

TNC:\AUFTR1\NCPROG\PROG1.I

The chart at right illustrates an example of a directory display with different paths.



3

3.4 Working with the file manager

Overview: Functions of the file manager

Soft key	Function	Page
	Copy a single file	136
SELECT TYPE	Display a specific file type	134
NEW FILE	Create new file	136
	Display the last 10 files that were selected	139
DELETE	Delete a file	140
TAG	Tag a file	141
RENAME ABC = XYZ	Rename file	141
PROTECT	Protect a file against editing and erasure	142
	Cancel file protection	142
IMPORT TABLE	Import tool table of an iTNC 530	195
ADAPT THE TABLE FORMAT	Customize table view	413
NET	Manage network drives	153
SELECT EDITOR	Select the editor	142
SORT	Sort files by properties	142
COPY DIR	Copy a directory	139
DELETE ALL	Delete directory with all its subdirectories	
	Refresh directory	
	Rename a directory	
	Create a new directory	

parameter dependentFiles (no. 122101) to MANUAL.

Working with the file manager

Calling the file manager

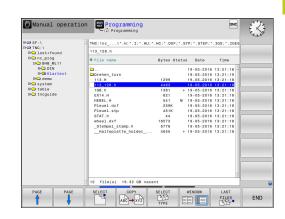
PGM MGT Press the PGM MGT key: The TNC displays the file management window (see figure for default setting. If the TNC displays a different screen layout, press the WINDOW soft key.)

The narrow window on the left shows the available drives and directories. Drives designate devices with which data are stored or transferred. A drive is the internal memory of the TNC. Other drives are the interfaces (RS232, Ethernet) to which you can connect a PC for example. A directory is always identified by a folder symbol to the left and the directory name to the right. Subdirectories are shown to the right of and below their parent directories. If there are subdirectories, you can show or hide them using the **-/+** key.

If the directory tree is longer than the screen, navigate using the scroll bar or a connected mouse.

The wide window on the right shows you all files that are stored in the selected directory. Each file is shown with additional information, illustrated in the table below.

Display	Meaning
File name	File name and file type
Bytes	File size in bytes
Status	File properties:
E	Program is selected in the Programming mode of operation
S	Program is selected in the Test run mode of operation
М	Program is selected in a Program Run mode of operation
+	Program has non-displayed dependent files with the extension DEP, e.g. with use of the tool usage test
f	File is protected against erasing and editing
⊕	File is protected against erasing and editing, because it is being run
Date	Date that the file was last edited
Time	Time that the file was last edited
	o display the dependent files, set the machine



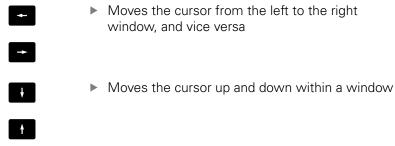
3.4

3.4 Working with the file manager

Selecting drives, directories and files



Navigate with a connected mouse or use the arrow keys or the soft keys to move the cursor to the desired position on the screen:



Moves the cursor one page up or down within a window

Step 1: Select drive

Move the highlight to the desired drive in the left window



- To select a drive, press the SELECT soft key, or
- Press the ENT key

Step 2: Select a directory

Move the highlight to the desired directory in the left-hand window—the right-hand window automatically shows all files stored in the highlighted directory

Step 3: Select a file



Press the SELECT TYPE soft key

Press the soft key for the desired file type, or



▶ Press the **SHOW ALL** soft key to display all files, or



►

Use wildcards, e.g. 4*.h: Show all files of type .h starting with a 4

Move the highlight to the desired file in the right window



Press the SELECT soft key, or

Press the ENT key

The TNC opens the selected file in the operating mode from which you called the file manager.



If you enter the first letter of the file you are looking for in file management, the cursor automatically jumps to the first program with the same letter.

Working with the file manager 3.4

Creating a new directory

Move the highlight in the left window to the directory in which ► you want to create a subdirectory



- Press the NEW DIRECTORY soft key
- Enter a directory name Press the ENT key



Press the OK soft key to confirm or

Press the CANCEL soft key to abort

Create new file

- Select the directory in the left window in which you wish to ► create the new file
- Position the cursor in the right window ►
 - Press the NEW FILE soft key
 - Enter the file name with extension

NEW FILE

Press the ENT key

Copying a single file

Move the cursor to the file you wish to copy ►

Press the COPY soft key to select the copying function. The TNC opens a pop-up window

Copying files into the current directory

▶ Enter the name of the destination file.



COP АВС→ХҮΖ

> Press the**ENT** key or **OK** soft key: The TNC copies the file into the current directory. The original file is retained.

Copying files into another directory



Press the TARGET DIRECTORY soft key to select the target directory from a pop-up window



Press the ENT key or OK soft key: The TNC copies the file with the same name into the chosen directory. The original file is retained.



When you start the copying process with ENT or the OK soft key, the TNC displays a pop-up window with a progress indicator.

Copying files into another directory

- Select a screen layout with two equally sized windows
- In the right window
- Press the SHOW TREE soft key
- Move the cursor to the directory into which you wish to copy the files, and display the files in this directory with the ENT key
- In the left window
- Press the SHOW TREE soft key
- Select the directory with the files to copy and press the SHOW
 FILES soft key to display them

TAG	
TAG	
FILE	

- Press the Tag soft key: Call the file tagging functions
- Press the Tag soft key: Position the cursor on the file you wish to copy and tag. You can tag several files in this way, if desired
- Press the Copy soft key: Copy the tagged files into the target directory

Further Information: "Tag files", page 141

If you have tagged files in both the left and right windows, the TNC copies from the directory in which the cursor is located.

Overwriting files

If you copy files into a directory in which other files are stored under the same name, the TNC will ask whether the files in the target directory should be overwritten:

- Overwrite all files (Existing files field selected): Press the OK soft key, or
- ▶ To leave the files as they are, press the CANCEL soft key

If you want to overwrite a protected file, select the **Protected files** field or cancel the process.

3.4 Working with the file manager

Copying a table

3

Importing lines to a table

If you are copying a table into an existing table, you can overwrite individual lines with the **REPLACE FIELDS** soft key. Prerequisites:

- The target table must exist
- The file to be copied must only contain the lines you want to replace
- Both tables must have the same file extension

The **REPLACE FIELDS** function is used to overwrite lines in the target table. To avoid losing data, create a backup copy of the original table.

Example

With a tool presetter you have measured the length and radius of ten new tools. The tool presetter then generates the TOOL_Import.T tool table with 10 lines (for the 10 tools).

- Copy this table from the external data medium to any directory
- Copy the externally created table to the existing table TOOL.T using the TNC file manager. The TNC asks if you wish to overwrite the existing TOOL.T tool table:
- If you press the REPLACE FIELDS soft key, the TNC will completely overwrite the current TOOL.T tool table. After the copying process the new TOOL.T table consists of 10 lines.
- Or press the REPLACE FIELDS soft key for the TNC to overwrite the 10 lines in the TOOL.T file. The data of the other lines is not changed

Extracting lines from a table

You can select one or more lines in a table and save them in a separate table.

- Open the table from which you want to copy lines
- Use the arrow keys to select the first line to be copied
- Press the MORE FUNCTIONS soft key
- Press the TAG soft keyTAG
- Select additional lines, if required
- Press the SAVE AS soft keySAVE AS
- Enter a name for the table in which the selected lines are to be saved

Copying a directory

- Move the highlight in the right window onto the directory you want to copy
- Press the COPY soft key: The TNC opens the window for selecting the target directory
- Select the target directory and confirm with ENT or the OK soft key: The TNC copies the selected directory and all its subdirectories to the selected target directory

Choose one of the last files selected



To call the file manager, press the PGM MGT key.



 To display the last ten files selected: press the LAST FILES soft key

Press the arrow keys to move the cursor to the file you wish to select:

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Moves the cursor up and down within a window

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▶ To select the file, press the **OK** soft key, or



Press the ENT key

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The **COPY FIELD** soft key allows you to copy the path of a marked file. You can reuse the copied path later, e.g. when calling a program with the **PGM CALL** key.

B	TNC:\nc*.H;*.I;*.	.HU;*.HC;*.DXF;*.STP;*.STEF	; *. IGS; *. IGES	
	1_Gesenk_casting.1			
DO nc_prog	✿ File name	Bytes Status Dat	e Time	
B-Cast B-Cast	e_component lles %2\nc_prog\demo\DIN_TGO\I_Gesen %2\nc_prog\demo\DIN_ISO\Heben.1		5 08:59:12 5 01:47:42 5 01:47:42 5 08:59:12 5 01:47:42 5 01:47:42	

3.4 Working with the file manager

Deleting a file



3

Caution: Data may be lost!

Once you delete files they cannot be restored!

Move the cursor to the file you want to delete



- To select the erasing function, press the DELETE soft key. The TNC asks whether you really want to delete the file
- ► To confirm the deletion, press the **OK** soft key; or
- ► To cancel deletion, press the **CANCEL** soft key

Deleting a directory



Caution: Data may be lost!

Once you delete files they cannot be restored!

Move the cursor to the directory you want to delete



- To select the erasing function, press the DELETE soft key. The TNC inquires whether you really intend to delete the directory and all its subdirectories and files
- ▶ To confirm the deletion, press the **OK** soft key; or
- ▶ To cancel deletion, press the **CANCEL** soft key

Tag files

Soft key	Tagging function
TAG FILE	Tag a single file
TAG ALL FILES	Tag all files in the directory
UNTAG FILE	Untag a single file
UNTAG ALL FILES	Untag all files
COPY TAG	Copy all tagged files

Some functions, such as copying or erasing files, can not only be used for individual files, but also for several files at once. To tag several files, proceed as follows:

Move the cursor to other files

Move the cursor to the first file

TAG
TAG FILE
Î

soft keyTo tag the file, press the TAG FILE soft key

▶ To display the tagging functions, press the **TAG**

- To select the next file, press the TAG FILE soft key. Repeat this process for all files you want to tag.
- Copy the tagged files: Press the COPY soft key; or

RENAME ABC = XYZ

TAG

FILE

- Delete tagged files: leave active soft key row
- Press the **DELETE** soft key to delete tagged files

Renaming a file

- Move the cursor to the file you wish to rename
 - To select the function for renaming press the RENAME soft key
 - Enter the new file name; the file type cannot be changed
 - ▶ To rename: Press the **OK** soft key or the **ENT** key

Sort files

3

Select the folder in which you wish to sort the files

- Press the SORT soft key
- SORT
- Select the soft key with the corresponding display criterion

Additional functions

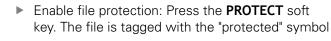
Protecting a file / Canceling file protection

Move the cursor to the file you want to protect



MORE

To select the additional functions, press the MORE FUNCTIONS soft key





To cancel file protection, press the UNPROTECT soft key

Selecting the editor

Move the cursor in the right-hand window onto the file you want to open



- To select the additional functions, press the MORE FUNCTIONS soft key.
- SELECT
- To select the editor with which to open the selected file, press the SELECT EDITOR soft key
- Mark the desired editor
- Press the **OK** soft key to open the file

Connecting/removing a USB device

- Move the cursor to the left-hand window
- MORE FUNCTIONS
- To select the additional functions, press the MORE FUNCTIONS soft key.
- 1 Ali
- Shift the soft-key rowSearch for a USB device
- To remove the USB device, move the cursor to the USB device in the directory tree
- Remove the USB device

Further Information: "USB devices on the TNC", page 154

3

Additional tools for management of external file

types

The additional tools enable you to display or edit various externally created file types on the TNC.

File types	Description
PDF files (pdf)	page 144
Excel spreadsheets (xls, csv)	page 145
Internet files (htm, html)	page 146
ZIP archives (zip)	page 147
Text files (ASCII files, e.g. txt, ini)	page 148
Video files	page 148
Graphics files (bmp, jpg, gif, png)	page 149



If you transfer files from a PC to the control by means of TNCremo, you must have entered the file name extension pdf, xls, zip, bmp gif, jpg and png in the list of the file types for binary transmission (menu item >**Extras >Configuration >Mode** in TNCremo).

3.4 Working with the file manager

Displaying PDF files

PGM MGT

ENT

To open PDF files directly on the TNC, proceed as follows:

- ► To call the file manager, press the **PGM MGT** key.
- Select the directory in which the PDF file is saved
- Move the cursor to the PDF file
- Press ENT: The TNC opens the PDF file in its own application using the PDF viewer additional tool

With the key combination ALT+TAB you can always return to the TNC user interface while leaving the PDF file open. Alternatively, you can also click the corresponding symbol in the task bar to switch back to the TNC interface.

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If you position the mouse pointer over a button, a brief tool tip explaining the function of this button will be displayed. More information on how to use the **PDF viewer** is provided under **Help**.

Proceed as follows to exit the **PDF viewer**:

- Use the mouse to select the File menu item
- Select the menu item Close: The TNC returns to the file manager

If you are not using a mouse, proceed as follows to close the **PDF** viewer:



- Press the key for switching the soft keys: The PDF viewer opens the File pull-down menu
- ŧ

ENT

Select the menu item Close: The TNC returns to the file manager and confirm with the ENT key: The TNC returns to the file manager



Displaying and editing Excel files

Proceed as follows to open and edit Excel files with the extension **xls**, **xlsx** or **csv** directly on the TNC:



- ► To call the file manager, press the **PGM MGT** key.
- Select the directory in which the Excel file is saved
- Move the cursor to the Excel file
- Press ENT: The TNC opens the Excel file in its own application using the Gnumeric additional tool



With the key combination ALT+TAB you can always return to the TNC user interface while leaving the Excel file open. Alternatively, you can also click the corresponding symbol in the task bar to switch back to the TNC interface.



If you position the mouse pointer over a button, a brief tool tip explaining the function of this button will be displayed. More information on how to use the **Gnumeric** function is provided under **Help**.

Proceed as follows to exit Gnumeric:

- Use the mouse to select the File menu item
- Select the menu item Close: The TNC returns to the file manager

If you are not using a mouse, proceed as follows to close the additional **Gnumeric** tool:



- Press the key for switching the soft keys: The Gnumeric additional tool opens the File pull-down menu
- Select the Close menu item and confirm with the ENT key: The TNC returns to the file manager



Fundamentals, file management

3.4 Working with the file manager

Displaying Internet files

To open Internet files with the extension $\ensuremath{\textbf{htm}}$ or $\ensuremath{\textbf{htm}}$ directly on the TNC, proceed as follows:



- ► To call the file manager, press the **PGM MGT** key.
- Select the directory in which the Internet file is saved
- Move the cursor to the Internet file
- Press ENT: The TNC opens the Internet file in its own application using the additional Web Browser tool

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With the key combination ALT+TAB you can always return to the TNC user interface while leaving the PDF file open. Alternatively, you can also click the corresponding symbol in the task bar to switch back to the TNC interface.



If you position the mouse pointer over a button, a brief tool tip explaining the function of this button will be displayed. More information on how to use **Web Browser** is available in **Help**.

Proceed as follows to exit the Web Browser:

- Use the mouse to select the File menu item
- Select the menu item Quit: The TNC returns to the file manager

If you are not using a mouse, proceed as follows to close the **Web Browser**:

- \triangleright
- Press the key for switching the soft keys: The Web Browser opens the File pull-down menu
- Ť

ENT

Select the Quit menu item and confirm with the ENT key: The TNC returns to the file manager



Working with ZIP archives

Proceed as follows to open ZIP archives with the extension \boldsymbol{zip} directly on the TNC:



- ► To call the file manager, press the **PGM MGT** key.
- Select the directory in which the archive file is saved
- Move the cursor to the archive file
- Press ENT: The TNC opens the archive file in its own application using the additional Xarchiver tool

 \Rightarrow

With the key combination ALT+TAB you can always return to the TNC user interface while leaving the archive file open. Alternatively, you can also click the corresponding symbol in the task bar to switch back to the TNC interface.

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If you position the mouse pointer over a button, a brief tool tip explaining the function of this button will be displayed. More information on how to use the **Xarchiver** function is provided under **Help**.

Please note that the TNC does not carry out any binary-to-ASCII conversion or vice versa when compressing or decompressing NC programs and NC tables. When such files are transferred to TNC controls using other software versions, the TNC may not be able to read them.

Proceed as follows to exit Xarchiver:

- Use the mouse to select the ARCHIVE menu item
- Select the menu item **Exit**: The TNC returns to the file manager

If you are not using a mouse, proceed as follows to close the **Xarchiver**:



Press the key for switching the soft keys: The Xarchiver opens the ARCHIVE pull-down menuARCHIVE

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ENT

Select the Exit menu item and confirm with the ENT key: The TNC returns to the file manager

K FKPROG.ZIP - Xarchiver 0.5.2							* . Ø X				
Archive Agtion Help											And a second second
	を留し				_						
Location											
Archive tree	R	ename	Permissions				Compressed		Date	Time	^
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		FK-SL-KOMBLH	-04-2	2.0	fat	2268	744	defX	16-May-01	13:50	
		femus.c	-14-2	2.0	fat	2643	1012	detX	6-Apr-99	16:31	-
		ficth	-64-30-	2.0	fat	605869	94167	defX	5-Mar-99	10:55	
		6.h	-08-2	2.0	fat	\$\$9265	83261	defX	S-Mar-99	10:41	
		PKS.H	-14-12	2.0	fat	655	309	detX	16-May-01	13:50	1000
	I	FK4.H	-04-2	2.0	fat .	948	394	defX	16-May-01	13:50	
		FK3.H	-141-2	2.0	fat	449	241	deDX	16-May-01	13:50	
		RLH	-64-8	2.0	tat	348	189	detX	18-Sep-03	13:39	
		faresa.h	-04-2	2.0	fat	266	169	defx	16-May-01	13.50	
		country.h	-14-2	2.0	fat	509	252	defX	16-May-01	13:50	1
		bsplk1.h	-8-80-	2.0	fat	383	239	defX	16-May-01	13:50	1000
		brite	-04-2	2.0	fat	538	261	defX	27-Apr-01	10:36	
		appricth	-10-2	2.0	tat	601	325	detX	13-Jun-97	13.96	1000
		appr2.h	-64-20-	2.0	fat.	600	327	defX	30-Jul-99	08-49	
		ANKER.H	-14-2	2.0	fat	580	310	deDX	16-May-01	13:50	100000000
		ANKER2.H	-04-1	2.0	-	1253	601	d+fX	16-May-01	1150	

Fundamentals, file management

3.4 Working with the file manager

Displaying and editing text files

Use the internal text editor to open and edit text files (ASCII files, e.g. with the extension txt). Proceed as follows:



- ▶ To call the file manager, press the PGM MGT key.
- Select the drive and the directory in which the text file is saved
- ► Move the cursor to the text file
- Press the ENT key: The TNC opens the text file ► with the internal text editor

Alternatively, you can also open the ASCII files using the Leafpad additional tool. The shortcuts you are familiar with from Windows, which you can use to edit texts quickly (CTRL+C, CTRL+V,...), are available within Leafpad.



With the key combination ALT+TAB you can always return to the TNC user interface while leaving the text file open. Alternatively, you can also click the corresponding symbol in the task bar to switch back to the TNC interface.

Proceed as follows to open Leafpad:

- Use the mouse to select the Menu HEIDENHAIN icon from the ► task bar
- Select the Tools and Leafpad menu items in the pull-down ► menu

Proceed as follows to exit Leafpad:

- Use the mouse to select the File menu item
- Select the menu item Exit: The TNC returns to the file manager

Displaying video files



Refer to your machine manual.

This feature must be enabled and adapted by the machine tool builder.

Proceed as follows to open video files directly on the TNC:

- PGM MGT
- ► To call the file manager, press the **PGM MGT** key.
- Select the directory in which the video file is saved
- Move the cursor to the video file
- ENT
- Press ENT: The TNC opens the video file in its own application

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Displaying graphic files

Proceed as follows to open graphics files with the extension bmp, gif, jpg or png directly on the TNC:



- ► To call the file manager, press the **PGM MGT** key.
- Select the directory in which the graphics file is saved
- Move the cursor to the graphics file
- Press the ENT key The TNC opens the graphics file in its own application using the additional ristretto tool

With the key combination ALT+TAB you can always return to the TNC user interface while leaving the graphics file open. Alternatively, you can also click the corresponding symbol in the task bar to switch back to the TNC interface.



More information on how to use the **ristretto** function is provided under **Help**.

Proceed as follows to exit ristretto:

- Use the mouse to select the File menu item
- Select the menu item Exit: The TNC returns to the file manager

If you are not using a mouse, proceed as follows to close the additional **ristretto** tool:



- Press the key for switching the soft keys: The ristretto additional tool opens the File pull-down menu
- ŧ

ENT

Select the Exit menu item and confirm with the ENT key: The TNC returns to the file manager



Fundamentals, file management

3.4 Working with the file manager

Additional tools for ITCs

The following additional tools allow you to apply various settings for the touch screens on connected ITCs.

ITCs are industrial PCs without their own memory media, and therefore they do not have their own operating system. This feature is what makes ITCs different from IPCs.

ITCs are frequently used with large machinery, e.g. as a clone of the actual control system.



The machine manufacturer defines and configures the display and function of the connected ITCs and IPCs.

Additional tool	Application
ITC Calibration	4-point calibration
ITC Gestures	Configuration of gesture control
ITC touchscreen configuration	Selection of touch sensitivity



The additional tools for the ITCs are only provided by the control in the taskbar with connected ITCs.

ITC Calibration

Using the additional tool **ITC Calibration,** you align the position for the mouse cursor displayed with the actual movement position of your finger.

Calibration using the additional **ITC Calibration** tool is recommended in the following cases:

- After replacing the touchscreen
- When changing the touch screen position (parallel axis error due to amended viewing angle)

Calibration involves the following steps:

- Start the tool in control using the task bar
- The ITC opens the calibration screen with four touch points in the corners of the screen
- Touch the four touch points shown one after the other
- The ITC closes the calibration screen once calibration has been successfully completed

ITC Gestures

Using the additional **ITC Gestures** tool, the machine manufacturer configures the gesture control on the touch screen.



This function may only be used with the permission of your machine manufacturer.

3

ITC touchscreen configuration

Using the additional **ITC Touchscreen Configuration** tool, you can select the touch sensitivity of the touch screen. The ITC gives you the following options:

Normal Sensitivity (Cfg 0)

- High Sensitivity (Cfg 1)
- Low Sensitivity (Cfg 2)

Use the **Normal Sensitivity (Cfg 0)** setting as standard. If you find it difficult to operate the equipment while wearing gloves in this setting, select the **High Sensitivity (Cfg 1)** setting.



If the ITC touch screen is not splash-proof, select the **Low Sensitivity (Cfg 2)** setting. This stops the ITC interpreting drops of water as touches.

Calibration involves the following steps:

- Start the tool in control using the task bar
- > The ITC opens a pop-up window with three options
- Select Touch Sensitivity
- ▶ Press the **OK** button
- > The ITC closes the pop-up window

Fundamentals, file management

3.4 Working with the file manager

Data transfer to or from an external data carrier



Before you can transfer data to an external data medium, you must set up the data interface.

Further Information: "Setting up data interfaces", page 565

Depending on the data transfer software you use, problems can occur occasionally when you transmit data over a serial interface. They can be overcome by repeating the transmission.



► To call the file manager, press the **PGM MGT** key.



 Select the screen layout for data transfer: press the WINDOW soft key.

Use the arrow keys to move the cursor to the file you wish to transfer:



Moves the cursor up and down within a window

ţ

 Moves the cursor from the right to the left window, and vice versa

If you wish to copy from the TNC to the external data medium, move the highlight in the left window to the file to be transferred. If you wish to copy from the external data medium to the TNC, move the highlight in the right window to the file to be transferred

move the highlight in the right window to the file to be transferred.

sнои
TREE

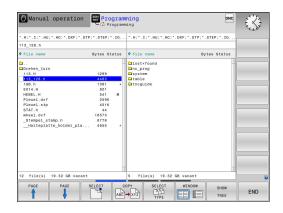
- Select another drive or directory: Press the SHOW TREE soft key
- Use the arrow keys to select the desired directory

Select the desired file: Press the SHOW FILES soft



 key

- ► Use the arrow keys to select the file
- ► Transfer a single file: Press the **COPY** soft key
- Confirm with the OK soft key or with the ENT key. A status window appears on the TNC, informing about the copying progress, or
 - Stop transfer: Press the WINDOW soft key. The TNC displays the standard file manager window again



The TNC in a network

You must connect the Ethernet card to the network.
 Further Information: "Ethernet interface ", page 571
 The TNC logs error messages during network operation.
 Further Information: "Ethernet interface ", page 571

If the TNC is connected to a network, the left directory window displays additional drives. All the functions described above (selecting a drive, copying files, etc.) also apply to network drives, provided that you have been granted the corresponding rights.

Connecting and disconnecting a network drive

I PGM
MGT
INIGI

► To call the file manager, press the **PGM MGT** key

NET

 Select network settings: Press the NET soft key (soft-key row 2)

To manage the network drives: Press the DEFINE NETWORK CONNECTN. soft key. In a window the TNC shows the network drives available for access. With the soft keys described below you can define the connection for each drive.

Soft key	Function
Connect	Establish the network connection. If the connection is active, the TNC marks the Mount column.
Separate	End network connection
Auto	Automatically establish network connection whenever the TNC is switched on. The TNC marks the Auto column if the connection is established automatically
Add	Set up new network connection
Remove	Delete existing network connection
Сору	Copy network connection
Edit	Edit network connection
Clear	Delete the status window

🖑 Manua	l op	eratio	'n	Hot Pro	ogramm	ing				09:24
B-C Inc:\ B-C lost+ B-C nc pr			TN	IC:\nc_pi	rog\PGM*	.H;•.I;	. DXF			
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Status log										
OK						Qlear Apply				Cancel
QK		Apply		Cancel	1	-	Mount	Auto		- Zurra

Fundamentals, file management

3.4 Working with the file manager

USB devices on the TNC

3

Caution: Data may be lost!

Only use the USB interface for transferring and saving, not for processing or running programs.

Backing up data from or loading onto the TNC is especially easy with USB devices. The TNC supports the following USB block devices:

- Floppy disk drives with FAT/VFAT file system
- Memory sticks with the FAT/VFAT file system
- Hard disks with the FAT/VFAT file system
- CD-ROM drives with the Joliet (ISO 9660) file system

The TNC automatically detects these types of USB devices when connected. The TNC does not support USB devices with other file systems (such as NTFS). The TNC displays the **USB: TNC does not support device** error message when such a device is connected.



If an error message is displayed when connecting a USB data medium, check the setting in the SELinux security software.

Further Information: "SELinux security software", page 94

The TNC also displays the **USB: TNC does not support device** error message if you connect a USB hub. In this case, simply acknowledge the message with the **CE** key.

In theory, you should be able to connect all USB devices with the file systems mentioned above to the TNC. It may occur that a USB device is not correctly detected by the control. In such cases, use another USB device.

Working with USB devices



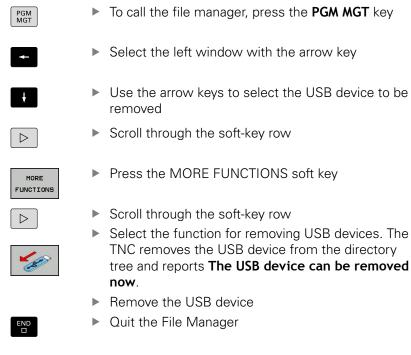
Your machine tool builder can assign permanent names for USB devices. The machine manual provides further information.

The USB devices appear as separate drives in the directory tree, so you can use the file management functions described in the earlier chapters.

If a larger file is transferred to a USB device in the file management, the control displays a dialog **Write access on USB device** until file transfer is completed. The dialog is closed with the soft key **VERBERGEN** and file transfer is continued in the background. The control displays a warning until file transfer is completed.

Remove the USB device

Proceed as follows to remove a USB device:



In order to re-establish a connection with a USB device that has been removed, press the following soft key:



Select the function for reconnection of USB devices

3

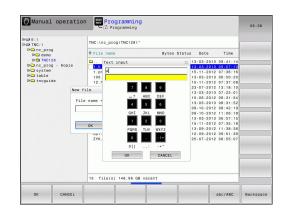
Programming aids

4

4.1 Screen keyboard

4.1 Screen keyboard

If you are using the compact version (without an alphabetic keyboard) TNC 320, you can enter letters and special characters with the screen keyboard or with a PC keyboard connected over the USB port.



Entering text with the screen keyboard

- Press the GOTO key if you want to enter letters, e.g. a program name or directory name, using the screen keyboard
- The TNC opens a window in which the numeric entry field of the TNC is displayed with the corresponding letters assigned
- You can move the cursor to the desired character by repeatedly pressing the respective key
- Wait until the TNC transfers the selected character to the entry field before you enter the next character
- ▶ Use the **OK** soft key to load the text into the open dialog field

Use the **ABC/ABC** soft key to select upper or lower case. If your machine manufacturer has defined additional special characters, you can call them with the **SPECIAL CHARACTERS** soft key and insert them. Use the **BACKSPACE** soft key to delete individual characters.

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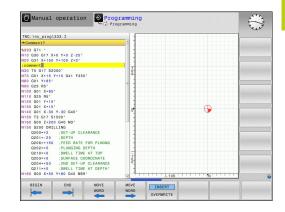
4.2 Adding comments

Application

You can add comments to a part program to explain program steps or make general notes.

Depending on the machine parameter **lineBreak** (no. 105404), the TNC displays comments that can no longer be shown entirely on the screen, shows these in several lines or the character >> appears on the screen.

The last character in a comment block must not have any tilde(~).



Entering a comment in a separate block

- Select the block after which the comment is to be inserted
- Initiate the programming dialog with the semicolon key (;) on the alphabetic keyboard
- Enter your comment and conclude the block by pressing the END key

Functions for editing of the comment

Soft key	Function
BEGIN	Jump to beginning of comment
END	Jump to end of comment
MOVE WORD	Jump to the beginning of a word. Words must be separated by a space
MOVE WORD	Jump to the end of a word. Words must be separated by a space
INSERT OVERWRITE	Switch between paste and overwrite mode

4

4.3 Display of NC programs

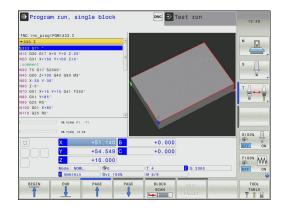
4.3 Display of NC programs

Syntax highlighting

The TNC displays syntax elements with various colors according to their meaning. Programs are made more legible and clear with color-highlighting.

Color highlighting of syntax elements

Use	Color
Standard color	Black
Display of comments	Green
Display of numerical values	Blue
Block number	Violet



Scrollbar

Screen content can be shifted with the mouse using the scroll bar at the right edge of the program window. In addition, the size and position of the scrollbar indicates program length and cursor position.

4.4 Structuring programs

Definition and applications

This TNC function enables you to comment part programs in structuring blocks. Structuring blocks are short texts with up to 252 characters and are used as comments or headlines for the subsequent program lines.

With the aid of appropriate structuring blocks, you can organize long and complex programs in a clear and comprehensible manner.

This function is particularly convenient if you want to change the program later. Structuring blocks can be inserted into the part program at any point.

Structure blocks can also be displayed in a separate window, and be edited or added to, as desired. Use the appropriate screen layout for this.

The inserted structure items are managed by the TNC in a separate file (extension: .SEC.DEP). This speeds navigation in the program structure window.

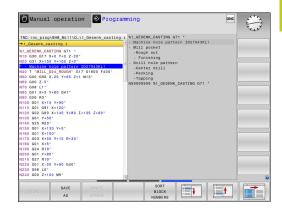
The **PROGRAM + SECTS** screen layout can be selected in the following operating modes:

- Program run, single block
- Program run, full sequence
- Programming

Displaying the program structure window / Changing the active window

PROGRAM
+
SECTS

- Display structure window: For this screen layout press the PROGRAM + STRUCTURE soft key
- Change the active window: Press the CHANGE WINDOW soft key



4.4 Structuring programs

Inserting a structure block in the program window

- Select the block after which the structuring block is to be inserted
- SPEC FCT
- Press the SPEC FCT key



Press the PROGRAMMING AIDS soft key



- Press the INSERT SECTION soft key
- Enter the structuring text
- If necessary, change the structure depth with the soft key

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	_>
	V

You can also insert structure blocks with the key combination **Shift + 8**.

Selecting blocks in the program structure window

If you are scrolling through the program structure window block by block, the TNC at the same time automatically moves the corresponding NC blocks in the program window. This way you can quickly skip large program sections.

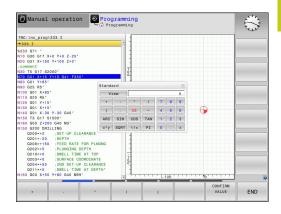
4.5 Calculator

Operation

The TNC features an integrated calculator with the basic mathematical functions.

- ▶ Use the CALC key to show and hide the on-line calculator
- Select the arithmetical functions: The calculator is operated with short commands via soft key or through the alphabetic keyboard.

Calculate function	Shortcut (soft key)
Addition	+
Subtraction	_
Multiplication	*
Division	/
Calculations in parentheses	()
Arc cosine	ARC
Sine	SIN
Cosine	COS
Tangent	TAN
Powers of values	Х^Ү
Square root	SQRT
Inversion	1/x
pi (3.14159265359)	PI
Add value to buffer memory	M+
Save the value to buffer memory	MS
Recall from buffer memory	MR
Delete buffer memory contents	MC
Natural logarithm	LN
Logarithm	LOG
Exponential function	e^x
Check the algebraic sign	SGN
Form the absolute value	ABS



4.5 Calculator

Calculate function	Shortcut (soft key)
Truncate decimal places	INT
Truncate integers	FRAC
Modulus operator	MOD
Select view	View
Delete value	CE
Unit of measure	MM or INCH
Show angle values in radians (standard: angle in degrees)	RAD
Select the display mode of the numerical value	DEC (decimal) or HEX (hexadecimal)

Transferring the calculated value into the program

- Use the arrow keys to select the word into which the calculated value is to be transferred
- Superimpose the on-line calculator by pressing the CALC key and perform the desired calculation
- Press the CONFIRM VALUE soft key for the TNC to transfer the value into the active input box and close the calculator



You can also transfer values from a program into the calculator. When you press the **GET CURRENT VALUE** soft key or the **GOTO** key, the TNC transfers the value from the active input field to the calculator. The calculator remains in effect even after a change in operating modes. Press the **END** soft key to close the calculator.

Functions in the pocket calculator

Soft key	Function
AX. VALUES	Load the nominal or reference value of the respective axis position into the calculator
GET CURRENT VALUE	Load the numerical value from the active input field into the calculator
CONFIRM VALUE	Load the numerical value from the calculator field into the active input field
COPY FIELD	Copy the numerical value from the calculator
PASTE	Insert the copied numerical value into the calculator
CUTTING DATA CALCULATOR	Open the cutting data calculator
	You can also shift the calculator with the arrow keys on your keyboard. If you have connected a mouse

you can also position the calculator with this.

4.6 Cutting data calculator

4.6 Cutting data calculator

Application

With the cutting data calculator you can calculate the spindle speed and the feed rate for a machining process. Then you can load the calculated values into an opened feed rate or spindle speed dialog box in the NC program.

To open the cutting data calculator, press the **CUTTING DATA CALCULATOR** soft key. The TNC shows the soft key if you

- open the on-line calculator (press the CALC soft key)
- open the dialog field for spindle speed input in the T block
- open the dialog field for feed rate input in positioning blocks or cycles
- enter a feed rate in manual mode (press the **F** soft key)
- enter a spindle speed in manual mode (press the **S** soft key)

The cutting data calculator is displayed with different input fields depending on whether you calculate a spindle speed or a feed rate:

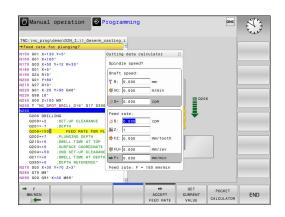
Window or spindle speed calculation:

Code letter	Meaning
R:	Tool radius (mm)
VC:	Cutting speed (m/min)
S=	Result for spindle speed (rev/min)

Window for feed rate calculation:

Code letter	Meaning
S:	Spindle speed (rpm)
Z:	Number of teeth on the tool (n)
FZ:	Feed per tooth (mm/tooth)
FU:	Feed rate per revolution (mm/1)
F=	Result for feed rate (mm/min)

You can also calculate the feed rate in the T block and automatically transfer it to the subsequent positioning blocks and cycles. For this purpose, with feed rate input in positioning blocks and cycles, press the **F AUTO** soft key. The TNC then uses the feed rate defined in the T block. If you have to change the feed rate later, you only need to adjust the feed-rate value in the T block.



Functions in the cutting data calculator:

Soft key	Function
US RPM B	Load the spindle speed from the cutting data calculator form into an open dialog field.
■ F MM/MIN	Load the feed rate from the cutting data calculator form into an open dialog field.
∜ VC M/MIN	Load the cutting speed from the cutting data calculator form into an open dialog field.
♦ FZ MM/TOOTH E	Load the feed per tooth from the cutting data calculator form into an open dialog field.
≝ FU MM∕REV ≣	Load the feed per revolution from the cutting data calculator form into an open dialog field.
ACCEPT TOOL RADIUS	Load the tool radius into the cutting data calculator form
لع CONFIRM RPM	Load the spindle speed from the open dialog field into the cutting data calculator form
ACCEPT FEED RATE	Load the feed rate from the open dialog field into the cutting data calculator form
ACCEPT FEED RATE	Load the feed per tooth from the open dialog field into the cutting data calculator form
GET CURRENT VALUE	Load the value from an open dialog field into the cutting data calculator form
POCKET CALCULATOR	Switch to the pocket calculator
ţ	Move the cutting data calculator in the direction of the arrow
INCH	Use inch values in the cutting data calculator
END	Close the cutting data calculator

4

4.7 **Programming graphics**

4.7 **Programming graphics**

Generate/do not generate graphics during programming

While you are writing the part program, you can have the TNC generate a 2-D pencil-trace graphic of the programmed contour.

Switch the screen layout to displaying program blocks to the left and graphics to the right: Press the screen layout key and the DDOCRAM - CDADING of them.

PROGRAM + GRAPHICS soft key



Set the AUTO DRAW soft key to ON. While you are entering the program lines, the TNC generates each programmed path contour in the graphics window in the right screen half

If you do not wish to have the TNC generate graphics during programming, set the **AUTO DRAW** soft key to **OFF**.



If **AUTO DRAW** is set to **ON**, with creation of 2-D line graphics the control does not consider: Program section repetitions Jump commands M functions, such as M2 or M30 Cycle calls

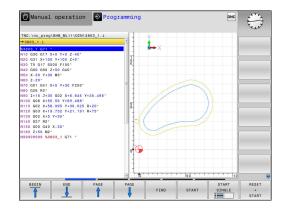
Only use automatic drawing during contour programming.

The control resets the tool data if you reopen a program or press the **RESET + START** soft key.

The control uses various colors in the programming graphics:

- **blue:** uniquely specified contour element
- violet: not yet uniquely specified contour element, can still be modified by e.g. an RND
- ocher: tool midpoint path
- red: rapid traverse

Further Information: "FK programming graphics", page 261



4

Generating a graphic for an existing program

Use the arrow keys to select the block up to which you want the graphic to be generated, or press GOTO and enter the desired block number

RESET
+
START

Reset previously active tool data and generate graphics: Press the RESET + START soft key

Additional functions:

Soft key	Function
RESET + START	Reset previously active tool data. Generate programming graphics
START SINGLE	Generate programming graphic blockwise
START	Generate a complete graphic or complete it after RESET + START
STOP	Stop the programming graphics. This soft key only appears while the TNC is generating the programming graphics
VIEWS	Selecting views Plan view Front view Page view
TOOL PATH: SHOW HIDE	Display or hide tool paths
FMAX PATHS DISPLAY HIDE	Display or hide tool paths in rapid traverse

4.7 **Programming graphics**

Block number display ON/OFF



Shift the soft-key row



- Display block numbers: BLOCK NO. soft keySet BLOCK NO. SHOW OMIT to SHOW
- Hide block numbers: BLOCK NO. soft keySet BLOCK NO. SHOW OMIT to HIDE

Erasing the graphic



Shift the soft-key row



Erase the graphics: Press the CLEAR GRAPHICS soft key

Showing grid lines



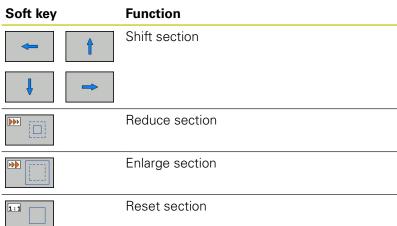
OFF ON

- ► Shift the soft-key row
- Show grid lines: Press the SHOW GRID LINES soft key

Magnification or reduction of details

- You can select the graphics display
- Shift the soft-key row

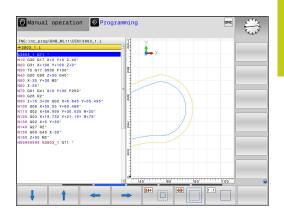
The following functions are available:



With the **RESET BLK FORM** soft key, you can restore the original section.

You can also use the mouse to change the graphic display. The following functions are available:

- To shift the model shown: Hold the center mouse button or mouse wheel down and move the mouse. If you simultaneously press the shift key, you can only shift the model horizontally or vertically
- To zoom in on a certain area: Mark a zoom area by holding the left mouse button down. After you release the left mouse button, the TNC zooms in on the defined area
- To rapidly magnify or reduce any area: Rotate the mouse wheel backwards or forwards



4

4.8 Error messages

4.8 Error messages

Display of errors

The TNC displays errors with e.g.:

- Incorrect data input
- Logical errors in the program
- Contour elements that are impossible to machine
- Incorrect use of touch probes

When an error occurs, it is displayed in red type in the header.

The control uses different colors for different dialogs:

- red for errors
- yellow for warnings
- green for notes
- blue for information

Long and multi-line error messages are displayed in abbreviated form. Complete information on all pending errors is shown in the error window.

If a rare "processor check error" should occur, the TNC automatically opens the error window. You cannot correct such an error. Shut down the system and restart the TNC.

The error message is displayed in the header until it is cleared or replaced by a higher-priority error.

An error message that contains an NC block number was caused by an error in the indicated block or in the preceding block.

Open the error window



Press the ERR key. The TNC opens the error window and displays all accumulated error messages.

Closing the error window



ERR

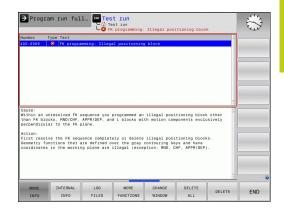
- Press the END soft key; or
- Press the ERR key. The TNC closes the error window.

Detailed error messages

The TNC displays possible causes of the error and suggestions for solving the problem:

Open the error window

- MORE INFO
- Information on the error cause and corrective action: Position the cursor on the error message and press the **MORE INFO** soft key. The TNC opens a window with information on the error cause and corrective action.
- Leave Info: Press the **MORE INFO** soft key again



Soft key: INTERNAL INFO

The **INTERNAL INFO** soft key supplies information on the error message. This information is only required if servicing is needed.

Open the error window



- Detailed information about the error message: Position the cursor on the error message and press the INTERNAL INFO soft key. The TNC opens a window with internal information about the error
- To exit Details, press the INTERNAL INFO soft key again

Soft key FILTER

The **FILTER** soft key enables you to filter identical warnings listed immediately in succession.

Open the error window



Press the MORE FUNCTIONS soft key



- Press the FILTER soft key The control filters the identical warnings
- Leave Filter: Press the GO BACK soft key

Clearing errors

Clearing errors outside of the error window



4

 Clear the errors/messages in the header: Press the CE key



In certain situations you cannot use the **CE** key for deleting the errors because the key is used for other functions.

Deleting errors

Open the error window



Clear individual errors: Position the cursor on the error message and press the DELETE soft key.



Delete all error messages: Press the DELETE ALL soft key.



If the cause of the error has not been corrected for that error it cannot be deleted. In this case, the error message remains in the window.

Error log

The TNC stores errors occurred and important events (e.g. system start) in an error log. The capacity of the error log is limited. If the log is full, the TNC uses a second file. If this is also full, the first error log is deleted and newly written etc. If required, switch from **CURRENT FILE** to **PREVIOUS FILE** to view the history.

Open the error window.



- Press the LOG FILES soft key.
- Open the error log file: Press the ERROR LOG soft key.
- Set the previous error log if required: Press the PREVIOUS FILE soft key.
- Set the current error log if required: Press the CURRENT FILE soft key.

The oldest entry is at the beginning of the log file, and the most recent entry is at the end.

Keystroke log

The TNC stores each key pressed and important events (e.g. system start) in a keystroke log. The capacity of the keystroke log is limited. If the keystroke log is full, the control switches to a second keystroke log. If this is also full, the first keystroke log is deleted and newly written etc. If required, switch from **CURRENT FILE** to **PREVIOUS FILE** to view the history of the inputs.

LOG FILES	Press the LOG FILES soft key
KEYSTROKE	 Open the keystroke log file: Press the KEYSTROKE
LOG	LOG soft key
PREVIOUS	 Set the previous keystroke log if required: Press
FILE	the PREVIOUS FILE soft key
CURRENT	 Set the current keystroke log if required: Press the CURRENT FILE soft key

The TNC saves each key pressed during operation in a keystroke log. The oldest entry is at the beginning, and the most recent entry is at the end of the file.

Overview of the keys and soft keys for viewing the log

Soft key/ Keys	Function
BEGIN	Go to beginning of keystroke log
END	Go to end of keystroke log
FIND	Find text
CURRENT	Current keystroke log
PREVIOUS FILE	Previous keystroke log
t	Up/down one line
+	



Return to main menu

4.8 Error messages

Informational texts

With an operating error, e.g. pressing an impermissible key or entering a value outside of a validity range, the TNC notifies you of this with an information text in the header of the operating error. The TNC deletes this information text with the next valid entry.

Save service files

If necessary, you can save the "Current status of the TNC," and make it available to a service technician for evaluation. A group of service files is saved (error and keystroke logs, as well as other files that contain information about the current status of the machine and the machining operation).

If you repeat the **Save service files** function with the same file name, the previously saved group of service data files is overwritten. To avoid this, use another file name when you repeat the function.

Saving service files

► Open the error window.



FILES

ок

Press the LOG FILES soft key

- Press the SAVE SERVICE FILES soft key: The TNC opens a pop-up window in which you can enter a file name or a complete path for the service file
- Save the service files: Press the **OK** soft key

Calling the TNCguide help system

You can call the TNC's help system via soft key. Immediately the help system shows you the same error explanation that you receive by pressing the **HELP** soft key.



If your machine manufacturer also provides a help system, the TNC shows an additional **MACHINE MANUFACTURER (OEM)** soft key with which you can call this separate help system. There you will find further, more detailed information on the error message concerned.



MFR.

Call the help for HEIDENHAIN error messages

 Call the help for HEIDENHAIN machine-specific error messages, if available

4

4.9 TNCguide context-sensitive help system

Application

Before you can use the TNCguide, you need to download the help files from the HEIDENHAIN home page.

Further Information: "Downloading current help files", page 181

The **TNCguide** context-sensitive help system contains the user documentation in HTML format. The TNCguide is called with the **HELP** key, and the TNC sometimes immediately displays the information specific to the situation from which the help was called (context-sensitive call). Even if you are editing an NC block and press the **HELP** key, you are usually brought to the exact place in the documentation that describes the corresponding function.



The TNC always tries to start TNCguide in the language that you have selected as the conversational language on your TNC. If the files with this language are not yet available on your TNC, it automatically opens the English version.

The following user documentation is available in TNCguide:

- Conversational Programming User's Manual (BHBKlartext.chm)
- ISO User's Manual (BHBIso.chm)
- Cycle Programming User's Manual (BHBtchprobe.chm)
- List of All Error Messages (errors.chm)

In addition, the **main.chm** "book" file is available, with the contents of all existing .chm files.



As an option, your machine tool builder can embed machine-specific documentation in the **TNCguide**. These documents then appear as a separate book in the **main.chm** file.

Contents	- main.chm	8 - N
contents	Index Find	Switch-on
 Contro Fundar Conter 		Switch-on and clossing over the reference points can vary depending on the machine tool. Refer to your machine manual.
 First S Introdu 	teps with the TNC 320 action	Switch on the power supply for TNC and machine. The TNC then displays the following dialog: SYSTEM STARTUP
Progra	mming: Fundamenta	> TNC is started
+ Progra	mming: Programmin	POWER INTERRUPTED
Progra	mming: Tools	CE TNC message that the power was interrupted—clear the message
 Progra 	mming: Programmin	COMPILE A PLC PROGRAM
 Progra 	mming: Data transfe	The PLC program of the TNC is automatically compiled
 Progra 	mming: Subprogram	RELAVENT DO VOLTAGE MISSING
	mming: Q Parameters	Switch on external dc voltage. The TNC checks the functioning of the EMERGENCY
 Progra 	mming: Special func	STOP crost
	l operation and setup h-on, switch-off	Closs the reference points manually in the displayed sequence: For each axis press the machine START button, or
Swit	shron sch-off ng the machine axes	Cross the wiference points in any sequence. Press and hold the machine axis direction button for each axis until the reference point has been traversed Y
BAC	C FORWARD	PAGE PAGE DIRECTORY WINDOW SWITCH
-		

4.9 TNCguide context-sensitive help system

Working with TNCguide

Call TNCguide

There are several ways to start the TNCguide:

- Press the HELP key.
- Click the help symbol at the lower right of the screen beforehand, then click the appropriate soft keys
- Open a help file (CHM file) via the file management. The TNC can open any .chm file, even if it is not saved on the TNC's internal memory

 \Rightarrow

When the help system is called on the programming station, the TNC starts the internally defined standard browser.

For many soft keys there is a context-sensitive call through which you can go directly to the description of the soft key's function. This functionality requires using a mouse. Proceed as follows:

- Select the soft-key row containing the desired soft key
- Click with the mouse on the help symbol that the TNC displays just above the soft-key row: The mouse pointer turns into a question mark
- Move the question mark to the soft key for which you want an explanation, and click: The TNC opens TNCguide. If there is no entry point for the selected soft key, then the TNC opens the book file **main.chm**. You can search for the desired explanation using full text search or by using the navigation

Even if you are editing an NC block, context-sensitive help is available:

- Select any NC block
- Select the desired word
- Press the HELP button: The TNC opens the Help system and shows the description of the active function. This does not apply for miscellaneous functions or cycles from your machine manufacturer

Contents Index Find	Switch-on
Controls of the TNC Fundamentals Controls	Switch-on and crossing over the reference points can vary depending on the machine tool. Roter to your machine manual.
First Steps with the TNC 320 Introduction	Switch on the power supply for TNC and machine. The TNC then displays the following dialog: SYSTEM STARTUP
Programming: Fundamenta	> TNC is started
Programming: Programmin	POWER INTERRUPTED
Programming: Tools	CE TNC message that the power was interrupted—clear the message
Programming: Programmin	 The meaning one on power was memoried—does no meaning
Programming: Data transfe	COMPILE A PLC PROGRAM
Programming: Subprogram	The PLC program of the TNC is automatically compiled
Programming: Q Parameters	RELAY EXT. DC VOLTAGE MISSING
Programming: Miscellaneo	Switch on external dc voltage. The TNC checks the functioning of the EMERGENCY STOP circuit
Programming: Special func	MANUAL OPERATION TRAVERSE REFERENCE POINTS
Programming: Multiple Axis	TRAVERSE REPERENCE POINTS
 Nanual operation and setup 	Cross the reference points manually in the displayed sequence: For each axis press the machine START button, or
· Switch-on, switch-off	THE THE STREET BASIN, M
Switch-on	X Eross the reference points in any sequence: Press and hold the machine axis direction button for each axis until the reference point has been towerved.
Switch-off	
Noving the machine axes	(Y)
BACK FORWARD	PAGE PAGE DIRECTORY WINDOW SWITCH

4

Navigating in the TNCguide

It's easiest to use the mouse to navigate in TNCguide. A table of contents appears on the left side of the screen. By clicking the rightward pointing triangle you open subordinate sections, and by clicking the respective entry you open the individual pages. It is operated in the same manner as the Windows Explorer.

Linked text positions (cross references) are shown underlined and in blue. Clicking the link opens the associated page.

Of course you can also operate TNCguide through keys and soft keys. The following table contains an overview of the corresponding key functions.

Soft key	Function
t	If the table of contents at left is active: Select the entry above it or below it
•	 If the text window on the right is active: Move the page downward or upward if texts or graphics are not shown completely
-	If the table of contents at left is active: Open up the table of contents
	If the text window at right is active: No function
+	If the table of contents at left is active: Close the table of contents
	If the text window at right is active: No function
ENT	If the table of contents at left is active: Use the cursor key to show the selected page
	If the text window at right is active: If the cursor is on a link, jump to the linked page
	 If the table of contents at left is active: Switch the tab between the display of the table of contents, display of the subject index, and the full-text search function and switching to the screen half at right
	If the text window at right is active: Jump back to the window at left
	If the table of contents at left is active: Select the entry above it or below it
ŧ	 If the text window at right is active: Jump to next link
BRCK	Select the page last shown
FORWARD	Page forward if you have used the "Select page last shown" function
PAGE	Move up by one page
PAGE	Move down by one page

4.9 TNCguide context-sensitive help system

Soft key	Function
	Display or hide table of contents
WINDOW	Switch between full-screen display and reduced display. With the reduced display you can see some of the rest of the TNC window
SWITCH	The focus is switched internally to the TNC application so that you can operate the control when the TNCguide is open. If the full screen is active, the TNC reduces the window size automatically before the change of focus
	E IN THIS IN



Exit TNCguide

Subject index

The most important subjects in the Manual are listed in the subject index (**Index** tab). You can select them directly by mouse or with the arrow keys.

The left side is active.



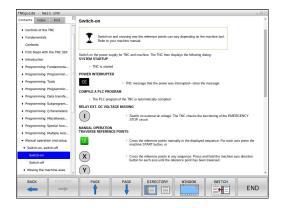
- Select the Index tab
- Activate the Keyword entry field
- Enter the search word and the TNC synchronizes the subject index and creates a list in which you can find the subject more easily; or
- Use the arrow key to highlight the desired keyword
- Use the ENT key to call the information on the selected keyword

Full-text search

In the **Find** tab you can search all of TNCguide for a specific word. The left side is active.

- Select the Find tab
- Activate the Find: entry field
- Enter the desired word and confirm with the ENT key: The TNC lists all sources containing the word
- Use the arrow key to highlight the desired source
- Press the ENT key to go to the selected source

The full-text search only works for single words. If you activate the **Search only in titles** function (by mouse or by using the cursor and the space key), the TNC searches only through headings and ignores the body text.



4

Downloading current help files

You'll find the help files for your TNC software on the HEIDENHAIN homepage:

http://content.heidenhain.de/doku/tnc_guide/html/en/ index.html

Navigate to the suitable help file as follows:

- TNC Controls
- ▶ Series, e.g. TNC 300
- Desired NC software number, e.g.TNC 320 (77185x-04)
- Select the desired language version from the TNCguide online help table
- Download the ZIP file and unpack it
- Move the unzipped CHM files to the TNC in the TNC:\tncguide-\en directory or to the respective language subdirectory



If you want to use TNCremo to transfer the CHM files to the TNC, then in the **Extras** >**Configuration** >**Mode** >**Transfer in binary format** menu item you have to enter the extension **.CHM**.

Programming aids

4

4.9 **TNCguide context-sensitive help system**

Language	TNC directory
German	TNC:\tncguide\de
English	TNC:\tncguide\en
Czech	TNC:\tncguide\cs
French	TNC:\tncguide\fr
Italian	TNC:\tncguide\it
Spanish	TNC:\tncguide\es
Portuguese	TNC:\tncguide\pt
Swedish	TNC:\tncguide\sv
Danish	TNC:\tncguide\da
Finnish	TNC:\tncguide\fi
Dutch	TNC:\tncguide\nl
Polish	TNC:\tncguide\pl
Hungarian	TNC:\tncguide\hu
Russian	TNC:\tncguide\ru
Chinese (simplified)	TNC:\tncguide\zh
Chinese (traditional)	TNC:\tncguide\zh-tw
Slovenian	TNC:\tncguide\sl
Norwegian	TNC:\tncguide\no
Slovak	TNC:\tncguide\sk
Korean	TNC:\tncguide\kr
Turkish	TNC:\tncguide\tr
Romanian	TNC:\tncguide\ro



Tools

Tools

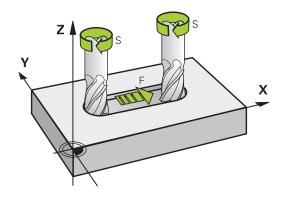
5

5.1 Entering tool-related data

5.1 Entering tool-related data

Feed rate F

The feed rate \mathbf{F} is the speed at which the tool center point moves. The maximum feed rates can be different for the individual axes and are set in machine parameters.



Input

You can enter the feed rate in the ${\bf T}$ block and in every positioning block.

Further Information: "Programming tool movements in DIN/ISO", page 121

You enter the feed rate **F** in mm/min in millimeter programs, and in 1/10 inch/min in inch-programs, for resolution reasons.

Rapid traverse

If you wish to program rapid traverse, enter G00.



To move your machine at rapid traverse, you can also program the corresponding numerical value, e.g. **G01 F30000**. Unlike **G00**, this rapid traverse remains in effect not only in the individual block but in all blocks until you program a new feed rate.

Duration of effect

A feed rate entered as a numerical value remains in effect until a block with a different feed rate is reached. **G00** is only effective in the block in which it is programmed. After the block with **G00** is executed, the feed rate will return to the last feed rate entered as a numerical value.

Changing during program run

You can adjust the feed rate during the program run with the feed rate potentiometer $\ensuremath{\mathsf{F}}$

The feed rate potentiometer lowers the programmed feed rate, not the feed rate calculated by the control.

5

Spindle speed S

The spindle speed S is entered in revolutions per minute (rpm) in a T block (tool call). Instead, you can also define the cutting speed Vc in meters per minute (m/min).

Programmed change

In the part program, you can change the spindle speed in a **T** block by entering the new spindle speed only:

- S
- To program the spindle speed, press the **S** key on the alphabetic keyboard.
- Enter the new spindle speed

Changing during program run

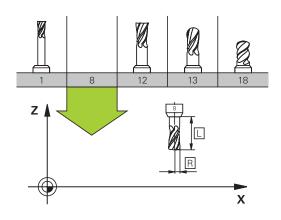
You can adjust the spindle speed during program run with the spindle speed potentiometer S.

5.2 Tool data

Requirements for tool compensation

You usually program the coordinates of path contours as they are dimensioned in the workpiece drawing. To allow the TNC to calculate the tool center path i.e. the tool compensation you must also enter the length and radius of each tool you are using.

Tool data can be entered either directly in the part program with **G99** or separately in a tool table. In a tool table, you can also enter additional data for the specific tool. The TNC will consider all the data entered for the tool when executing the part program.



Tool number, tool name

Each tool is identified by a number between 0 and 32767. If you are working with tool tables, you can also enter a tool name for each tool. Tool names can have up to 32 characters.

Permitted special characters: #\$% & , - _ . 0 1 2 3 4 5 6 7 8 9 @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z The control automatically replaces lowercase letters

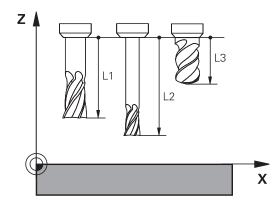
The control automatically replaces lowercase letters with corresponding uppercase letters during saving. **Impermissible characters**: <Leerzeichen> ! " ' () *

 $+ \; : \; ; \; < \; = \; > \; ? \; [\; / \;] \; \land \; ` \; \{ \; | \; \} \; \sim \;$

The tool number 0 is automatically defined as the zero tool with the length L=0 and the radius R=0. In tool tables, tool T0 should also be defined with L=0 and R=0.

Tool length L

You should always enter the tool length L as an absolute value based on the tool reference point. The entire tool length is essential for the TNC in order to perform numerous functions involving multi-axis machining.



Tool radius R

You can enter the tool radius R directly.

Delta values for lengths and radii

Delta values are offsets in the length and radius of a tool.

A positive delta value describes a tool oversize (**DL**, **DR**>0). If you are programming the machining data with an allowance, enter the oversize value in the **T**.

A negative delta value describes a tool undersize (**DL**, **DR**<0). An undersize is entered in the tool table for wear.

Delta values are usually entered as numerical values. In a ${\bf T}$ block, you can also assign the values to Q parameters.

Input range: You can enter a delta value with up to \pm 99.999 mm.



Delta values from the tool table influence the graphical representation of the clearing simulation.

Delta values from the **T** block do not change the represented size of the **tool** during the simulation. However, the programmed delta values move the **tool** by the defined value in the simulation.



Delta values from the **T** block influence the position display depending on the optional machine parameter **progToolCalIDL** (no. 124501).

Entering tool data into the program



TOOL DEF The machine tool builder determines the scope of function of the **G99** function. Refer to your machine manual.

The number, length and radius of a specific tool is defined in the **G99** block of the part program:

Select the tool definition: Press the TOOL DEF key

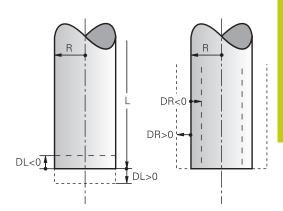
- Tool number: Each tool is uniquely identified by its tool number
 - Tool length: Compensation value for the tool length
 - Tool radius: Compensation value for the tool radius



In the programming dialog, you can transfer the value for tool length and tool radius directly into the input line by pressing the desired axis soft key.

Example

N40 G99 T5 L+10 R+5*



Enter tool data into the table

You can define and store up to 767 tools and their tool data in a tool table. Also see the editing functions later in this chapter. In order to be able to assign various compensation data to a tool(indexing the tool number), insert a line and extend the tool number by a dot and a number from 1 to 9 (e.g. **T 5.2**).

You must use tool tables if:

- you wish to use indexed tools such as stepped drills with more than one length compensation value
- your machine tool has an automatic tool changer
- If you want to work with the machining cycle G122,
 Further information: Cycle Programming User's Manual
- If you want to work with machining Cycles 251 to 254,
 Further information: Cycle Programming User's Manual



if you create or manage further tool tables, the file name has to start with a letter.

You can select either list view or form view for tables via the "Screen layout" key.

when you open the tool table you can also change its layout

Tool table: Standard tool data

Abbr.	Inputs	Dialog
Т	Number by which the tool is called in the program (e.g. 5, indexed: 5.2).	-
NAME	Name by which the tool is called in the program (max. 32characters, all capitals, no spaces)	Tool name?
L	Compensation value for tool length L	Tool length?
R	Compensation value for the tool radius R	Tool radius?
R2	Tool radius R2 for toroid cutters (only for 3-D radius compensation or graphical representation of a machining operation with spherical or toroid cutters)	Tool radius 2?
DL	Delta value for tool length L	Tool length oversize?
DR	Delta value for tool radius R	Tool radius oversize?
DR2	Delta value for tool radius R2	Tool radius oversize 2?
TL	Set tool lock (TL for ToolLocked	Tool locked? Yes=ENT/ No=NOENT
RT	Number of a replacement tool – if available – asreplacement tool (RT : for R eplacement T ool) An empty field or input 0 means no replacement tool has been defined.	Replacement tool?
TIME1	Maximum tool life in minutes. This function can vary depending on the individual machine tool. Your machine manual provides more information	Maximum tool age?
TIME2	Maximum tool life in minutes during a tool call: If the current tool age reaches or exceeds this value, the TNC inserts the replacement tool during the next T block	Max. tool age for TOOL CALL?
CUR_TIME	Current age of the tool in minutes: The TNC automatically counts the current tool life (CUR_TIME : For CUR rent TIME) A starting value can be entered for used tools	Current tool age?
ТҮРЕ	Tool type: Press the ENT key to edit the field; the GOTO key opens a window in which you can select the tool type. You can assign tool types to specify the display filter settings such that only the selected type is visible in the table	Tool type?
DOC	Comment on tool (max. 32 characters)	Tool description
PLC	Information on this tool that is to be sent to the PLC	PLC status?
LCUTS	Tooth length of the tool for Cycle 22	Tooth length in the tool axis?
ANGLE	Maximum plunge angle of the tool for reciprocating plunge-cut in Cycles 22 and 208	Maximum plunge angle?
NMAX	Limit the spindle speed for this tool. The programmed value is monitored (error message) as well as an increase in the shaft speed via the potentiometer. Function inactive: Enter	Maximum speed [rpm]
	Input range: 0 to +999, if function not active: enter -	

5 Tools

5.2 Tool data

Abbr.	Inputs	Dialog
LIFTOFF	Definition of whether the TNC should retract the tool inthe direction of the positive tool axis at an NC stop inorder to avoid leaving dwell marks on the contour. If Y is defined, the TNC retracts the tool from the contour, provided M148 has been activated.	Retract allowed? Yes=ENT/ No=NOENT
	Further Information: "Automatically retract tool from the contour at an NC stop: M148", page 393	
TP_NO	Reference to the number of the touch probe in the touch- probe table	Number of the touch probe
T-ANGLE	Point angle of the tool. Is used by the Centering cycle(Cycle 240) in order to calculate the centering depth fromthe diameter entry	Point angle
РІТСН	Thread pitch of the tool. Used by tapping cycles (Cycle 206, Cycle 207 and Cycle 209). A positive algebraic sign means a right-hand thread.	Tool thread pitch?
LAST_USE	Date and time that the tool was last inserted via T block	Date/time of last tool call
РТҮР	Tool type for evaluation in the pocket table Function is defined by the machine manufacturer. Refer to your machine manual.	Tool type for pocket table?
KINEMATIC	Display tool carrier kinematics using the SELECT softkey and confirm file name and path with the OK (in tool management, display using the GOTO key andconfirm with the SELECT soft key). Further Information: "Allocate parameterized tool carriers", page 402	Tool-carrier kinematics
OVRTIME	Time for exceeding the tool life in minutes	Tool life expired
	Further Information: "Overtime for tool life", page 205	
	Function is defined by the machine manufacturer. Refer to your machine manual.	

Tool table: Tool data required for automatic tool measurement

	For a description of the cycles governing automatic tool measurement,
ŗ	Further information: Cycle Programming User's Manual

Abbr.	Inputs	Dialog
CUT	Number of teeth (99 teeth maximum)	Number of teeth?
LTOL	Permissible deviation from tool length L for wear detection. If the entered value is exceeded, the TNC locks the tool (status L). Input range: 0 to 0.9999 mm	Wear tolerance: length?
RTOL	Permissible deviation from tool radius R for wear detection. If the entered value is exceeded, the TNC locks the tool (status L). Input range: 0 to 0.9999 mm	Wear tolerance: radius?
R2TOL	Permissible deviation from tool radius R2 for wear detection. If the entered value is exceeded, the TNC locks the tool (status L). Input range: 0 to 0.9999 mm	Wear tolerance: Radius 2?
DIRECT	Cutting direction of the tool for measuring the tool during rotation	Cutting direction? M4=ENT/ M3=NOENT
R-OFFS	Tool length measurement: Tool offset between stylus center and tool center. Default setting: No value entered (offset = tool radius)	Tool offset: radius?
L-OFFS	Tool radius measurement: tool offset in addition to offsetToolAxis between upper surface of stylus and lower surface of tool. Default: 0	Tool offset: length?
LBREAK	Permissible deviation from tool length L for breakage detection. If the entered value is exceeded, the TNC locks the tool (status L). Input range: 0 to 3.2767 mm	Breakage tolerance: length?
RBREAK	Permissible deviation from tool radius R for breakage detection. If the entered value is exceeded, the TNC locks the tool (status L). Input range: 0 to 0.9999 mm	Breakage tolerance: radius?

Editing the tool table

The tool table that is active during execution of the part program is designated TOOL.T and must be saved in the **TNC:\table** directory.

Other tool tables that are to be archived or used for test runs are given different file names with the extension .T. By default, for the **Test run** and **Programming** modes the TNC also uses the TOOL.T tool table. In the **Test run** mode, press the **TOOL TABLE** soft key to edit it.

To open the tool table TOOL.T:

Select any machine operating mode



Select the tool table: Press the TOOL TABLE soft key



Set the **EDIT** soft key to **ON**



If you edit the tool table, the selected tool is locked. If this tool is required in the NC program being used, the TNC shows the message: **Tool table locked**.

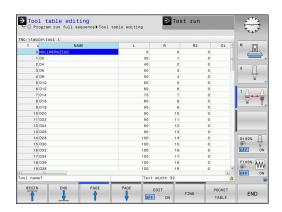
If a new tool is created the length and radius columns remain empty until you enter values. If it is attempted to insert such a newly created tool, the control aborts with an error message. This means you cannot insert a tool for which no data has been entered.

Displaying only specific tool types (filter setting)

- Press the TABLE FILTER soft key
- Select the tool type by pressing a soft key: The TNC only shows tools of the type selected
- Cancel the filter: Press the SHOW ALL soft key



The machine tool builder adapts the features of the filter function to the requirements of your machine. Refer to your machine manual.



Hiding or sorting the tool table columns

You can adapt the layout of the tool table to your needs. Columns that are not to be displayed can be simply hidden:

- Press the HIDE/ SORT/ COLUMNS soft key
- Select the appropriate column name with the arrow key
- Press the HIDE COLUMN soft key to remove this column from the table view

You can also modify the sequence of columns in the table:

You can also modify the sequence of columns in the table with the Move before: dialog. The entry highlighted in Displayed columns: is moved in front of this column

You can use a connected mouse or the TNC keyboard to navigate in the form. Navigation using the TNC keyboard:



Press the navigation keys to go to the input fields. Use the arrow keys to navigate within an input field. To open pop-down menus, press the GOTO key.

	ト	>

PGM MGT The function **freeze number of columns** enables you to determine how many columns (0-3) the control will freeze to the left border of the screen. These columns are also displayed if you navigate in the table to the right.

Opening any other tool table

Select the **Programming** operating mode

- ► To call the file manager, press the PGM MGT key
 - Select a file or enter a new file name. Confirm your entry with the ENT key or the soft key SELECT

When you have opened the tool table, you can edit the tool data by moving the cursor to the desired position in the table with the arrow keys or the soft keys. You can overwrite the stored values, or enter new values at any position. Additional functions are illustrated in the table below.

5 Tools

5.2 Tool data

Soft key	Editing functions for tool tables
BEGIN	Select the table start
	Select the table end
PAGE	Select the previous page in the table
PAGE	Select the next page in the table
FIND	Find the text or number
BEGIN LINE	Move to beginning of line
	Move to end of line
COPY FIELD	Copy highlighted field
PASTE FIELD	Insert copied field
APPEND N LINES	Add the entered number of lines (tools) at the end of the table
INSERT LINE	Adding a row with tool number for entering
DELETE	Delete the current line (tool)
SORT	Sort the tools according to the content of a column
SELECT	Select possible entries from a pop-up window
DRILL	Show all drills in the tool table
CUTTER	Show all cutters in the tool table
TAP/ THREAD CUTTER	Show all taps/thread cutters in the tool table
TOUCH PROBE	Show all touch probes in the tool table

Exiting any other tool table

 Call the file manager and select a file of a different type, such as a part program

Importing tool tables



Refer to your machine manual. The machine manufacturer can adapt the IMPORT TABLE function.

If you export a tool table from an iTNC 530 and import it into a TNC 320, you have to adapt its format and content before you can use the tool table. On the TNC 320, you can adapt the tool table conveniently with the IMPORT TABLE function. The TNC converts the contents of the imported tool table to a format valid for the TNC 320 and saves the changes to the selected file.

Follow this procedure:

 Save the t Save the t 		table of the iTNC 530 to the TNC:\table directory Select the operating mode: Press the Programming key		
PGM MGT		Call the file manager: Press the PGM MGT key		
t		Move the cursor to the tool table you want to import		
MORE FUNCTIONS		Press the MORE FUNCTIONS soft keyMORE FUNCTIONS		
\bigcirc		Shift the soft key row		
IMPORT TABLE		Press the IMPORT TABLE soft key: The TNC inquires whether you really want to overwrite the selected tool table		
 Do not overwrite the file: Press the CANCEL soft key; or Overwrite the file: Press the OK soft key Open the converted table and check its contents New columns in the tool table are highlighted green 				

Press the **REMOVE UPDATE INFORMATION** soft key: The green ► columns are displayed in white again

5.2 Tool data



The following characters are permitted in the **Name** column of the tool table: # \$ % & , - . 0 1 2 3 4 5 6 7 8 9 @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z _

The TNC changes a comma in the tool name to a period during import.

The TNC overwrites the selected tool table when running the **IMPORT TABLE** function. To avoid losing data, be sure to make a backup copy of your original tool table before importing it!

The procedure for copying tool tables using the TNC file manager is described in the section on file management.

Further Information: "Copying a table", page 138 When tool tables are imported from an iTNC 530, all existing tools are imported along with their corresponding tool type. Tool types not present areimported as type **Undefined**. Check the tool table after the import.

Overwriting tool data from an external PC

Application

The HEIDENHAIN data transfer software TNCremo provides an especially convenient way to use an external PC to overwrite tool data.

Further Information: "Software for data transfer", page 569

This application case occurs e.g. if you wish to determine tool data on an external tool presetter and then transfer this to the TNC.

Requirements

In addition to option 18 HEIDENHAIN DNC, TNCremo (from version 3.1) is required with TNCremoPlus functions.

Procedure

- Copy the tool table TOOL.T to the TNC, for example to TST.T
- Start the data transfer software TNCremo on the PC
- Establish a connection with the TNC
- Transfer the copied tool table TST.T to the PC
- Use any text editor to reduce TST.T to the lines and columns to be changed (see figure). Make sure that the header is not changed and the data is always flush in the column. The tool number (column T) need not be consecutive
- In TNCremo, select the menu item <Extras> and <TNCcmd>: This starts TNCcmd.
- To transfer TST.T to the TNC, enter the following command and confirm with the return key (see figure): put tst.t tool.t /m

During transfer, only the tool data defined in the subfile (e.g. TST.T) is overwritten. All other tool data of the table TOOL.T remains unchanged.

The procedure for copying tool tables using the TNC file manager is described in the file management.

Further Information: "Copying a table", page 138

BEGIN	TST	.T MM		
Г	NAME		L	R
1			+12.5	+9
3			+23.15	+3.5
[END]				

TNCcmdPlus - WIN32 Command Line Client for HEIDENHAIN Controls - Ver	ion: 5.92 🔺
Connecting with TNC640(340594) (192.168.56.101)	=
Connection established with TNC640, NC Software 340595 07 Dev	
TNC:\nc_prog\> put tst.t tool.t /m_	

5.2 Tool data

Pocket table for tool changer



Refer to your machine manual. The machine tool builder adapts the features of the pocket table to the requirements of your machine.

For automatic tool changing you need the a pocket table. You manage the assignment of your tool changer in the pocket table. The pocket table is in the **TNC:\TABLE** directory. The machine manufacturer can amend the name, path and content of the pocket table. If you wish, you can select different views using the soft keys in the **TABLE FILTER** menu.

Editing a pocket table in a Program Run operating mode



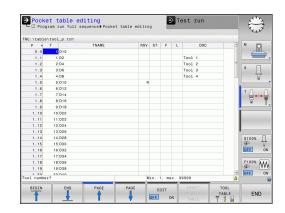
POCKET

TABLE

EDIT

OFF ON

- Select the tool table: Press the TOOL TABLE soft key
- Select the pocket table: Press the POCKET TABLE soft key
- Set the EDIT soft key to ON. On your machine this might not be necessary or even possible. Refer to your machine manual



Selecting a pocket table in Programming mode

- PGM MGT
- ► To call the file manager, press the **PGM MGT** key.
- Display the file types: Press the SHOW ALL soft key
- Select a file or enter a new file name. Confirm your entry with the ENT key or the soft key SELECT

Abbr.	Inputs	Dialog
Р	Pocket number of the tool in the tool magazine	-
Т	Tool number	Tool number?
RSV	Pocket reservation for box magazines	Pocket reserv.: Yes = ENT / No = NOENT
ST	Special tool (ST); If your special tool blocks pockets in front of and behind its actual pocket, these additional pockets need to be locked in column L (status L).	Special tool?
F	The tool is always returned to the same pocket in the tool magazine	Fixed pocket? Yes = ENT / No = NO ENT
L	Locked pocket (L: for Locked)	Pocket locked Yes = ENT / No = NO ENT
DOC	Display of the comment to the tool from TOOL.T	-
PLC	Information on this tool pocket that is to be sent to the PLC	PLC status?
P1 P5	Function is defined by the machine tool builder. The machine tool documentation provides further information	Value?
РТҮР	Tool type. Function is defined by the machine tool builder. The machine tool documentation provides further information	Tool type for pocket table?
LOCKED_ABOVE	Box magazine: Lock the pocket above	Lock the pocket above?
LOCKED_BELOW	Box magazine: Lock the pocket below	Lock the pocket below?
LOCKED_LEFT	Box magazine: Lock the pocket at left	Lock the pocket at left?
LOCKED_RIGHT	Box magazine: Lock the pocket at right	Lock the pocket at right?

Tools

5.2 Tool data

Soft key	Editing functions for pocket tables
	Select the table start
	Select the table end
	Select the previous page in the table
PAGE	Select the next page in the table
RESET POCKET TABLE	Reset pocket table
RESET COLUMN T	Reset tool number T column
BEGIN LINE	Go to beginning of the line
END LINE	Go to end of the line
SIMULATED TOOL CHANGE	Simulate a tool change
SELECT	Select a tool from the tool table: The TNC shows the contents of the tool table. Use the arrow keys to select a tool, press OK to transfer it to the pocket table
EDIT CURRENT FIELD	Edit the current field
SORT	Sort the view
1	The machine manufacturer defines the features, properties and designations of the various display filters. Refer to your machine manual.

Call tool data

A **T** in the part program is defined with the following data:

- Select the tool call function with the TOOL CALL key
- **Tool number**: Enter the number or name of the TOOL CALL tool. The tool must already be defined in a G99 block or in the tool table. With the TOOL NAME soft key you can enter a name. With the QS soft key you enter a string parameter. The TNC automatically places the tool name in quotation marks. You have to assign a tool name to a string parameter first. Names always refer to an entry in the active tool table TOOL .T. If you wish to call a tool with other compensation values, also enter the index you defined in the tool table after the decimal point. There is a SELECT soft key for calling a window from which you can select a tool defined in the tool table TOOL.T directly without having to enter the number or name
 - Working spindle axis X/Y/Z: Enter the tool axis
 - **Spindle speed S**: Enter the spindle speed S in revolutions per minute (rpm). Instead, you can define the cutting speed Vc in meters per minute (m/min). Press the VC soft key
 - **Feed rate F**: Enter feed rate **F** in millimeters per minute (mm/min). The feed rate is effective until you program a new feed rate in a positioning block or in a **T** block
 - **Tool length oversize DL**: Enter the delta value for the tool length
 - **Tool radius oversize DR**: Enter the delta value for ► the tool radius
 - **Tool radius oversize DR2**: Enter the delta value for tool radius 2



If you open a pop-up window for tool selection, the TNC marks all tools available in the tool magazine green.

You can also search for a tool in the pop-up window. To do so, press the **GOTO** or **FIND** soft key and enter the tool number or tool name. With the **OK** soft key you can load the tool into the dialog box.

Example: Tool call

Call tool number 5 in the tool axis Z with a spindle speed 2500 rpm and a feed rate of 350 mm/min. The tool length and tool radius 2 are to be programmed with an oversize of 0.2 and 0.05 mm, the tool radius with an undersize of 1 mm.

N20 T 5.2 G17 S2500 DL+0.2 DR-1*

The character ${\bf D}$ preceding ${\bf L},\, {\bf R}$ and ${\bf R2}$ designates delta values.

Preselection of tools



The preselection of tools with **G51** can vary depending on the individual machine. Refer to your machine manual.

If you are working with tool tables, use a **G51** block to preselect the next tool. Simply enter the tool number or a corresponding Q parameter, or type the tool name in quotation marks.

Tool change

Automatic tool change



The tool change function can vary depending on the individual machine tool. Refer to your machine manual.

If your machine tool has automatic tool changing capability, the program run is not interrupted. When the TNC reaches a tool call with \mathbf{T} , it replaces the inserted tool by another from the tool magazine.

Automatic tool change if the tool life expires: M101



The function of **M101** can vary depending on the individual machine tool. Refer to your machine manual.

When the specified tool life has expired, the TNC can automatically insert a replacement tool and continue machining with it. Activate the miscellaneous function **M101** for this. **M101** is reset with **M102.**

Enter the respective tool life after which machining is to be continued with a replacement tool in the **TIME2** column of the tool table. In the **CUR_TIME** column the TNC enters the current tool life. If the current tool life is higher than the value entered in the **TIME2** column, a replacement tool will be inserted at the next possible point in the program no later than one minute after expiration of the tool life. The change is made only after the NC block has been completed.

The TNC performs the automatic tool change at a suitable point in the program. The automatic tool change is not performed:

- During execution of machining cycles
- While radius compensation (G41/G42) is active
- Directly after an approach function **APPR**
- Directly before a departure function **DEP**
- Directly before and after G24 and G25
- During execution of macros
- During execution of a tool change
- Directly after a T block or G99
- During execution of SL cycles



Caution: Danger to the workpiece and tool!

Switch off the automatic tool change with **M102** if you are working with special tools (e.g. side mill cutter) because the TNC at first always moves the tool away from the workpiece in tool axis direction.

Depending on the NC program, the machining time can increase as a result of the tool life verification and calculation of the automatic tool change. You can influence this with the optional entry element **BT** (block tolerance).

If you enter the **M101** function, the TNC continues the dialog by requesting the **BT**. Here you define the number of NC blocks (1 - 100) by which the automatic tool change may be delayed. The resulting time period by which the tool change is delayed depends on the content of the NC blocks (e.g. feed rate, path). If you do not define **BT**, the TNC uses the value 1 or, if applicable, a default value defined by the machine manufacturer.



The more you increase the value of **BT**, the smaller will be the effect of an extended program duration through **M101**. Please note that this will delay the automatic tool change!

Use the formula **BT = 10: Average machining time of an NC block in seconds** to calculate a suitable starting value for **BT**. Round up to the next odd integer. If the calculated result is greater than 100, use the maximum input value of 100.

If you want to reset the current age of a tool (e.g. after changing the indexable inserts), enter the value 0 in the CUR_TIME column.

Overtime for tool life



Refer to your machine manual.

This feature must be enabled and adapted by the machine tool builder.

The tool condition at the end of planned tool life depends on e.g. the tool type, machining method and workpiece material. In the **OVRTIME** column of the tool table, enter the time in minutes for which the tool is permitted to be used beyond the tool life.

The machine manufacturer specifies whether this column is enabled and how it is used during tool search.

Tool usage test

Requirements



The tool usage test function must be enabled by your machine manufacturer.

Refer to your machine manual.

To conduct a tool usage test, you must activate **Create tool usage files** in the MOD menu.

Further Information: "Tool usage file", page 560

Generate a tool usage file

Depending on the setting in the MOD menu, you have the following options for generating the tool usage file:

- Completely simulate the NC program in the Test run operating mode
- Completely run the NC program in the Program Run, Full Sequence/Single Block operating modes
- In the Test run operating mode press the GENERATE TOOL USAGE FILE soft key (also possible without simulation)

The tool usage file generated is in the same directory as the NC program. It contains the following information:

Tools

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5.2 Tool data

Column	Meaning				
TOKEN	 TOOL: Tool usage time per tool call. The entries are listed in chronological order. 				
	TTOTAL: Total usage time of a tool				
	STOTAL : Call of a subprogram. The				
	entries are listed in chronological order.				
	TIMETOTAL: The total machining time of the NC program is entered in the WTIME column. In the PATH column the TNC saves the path name of the corresponding NC programs. The TIME column shows the sum of all TIME entries (feed time without rapid traverse movements). The TNC sets all other columns to 0				
	TOOLFILE: In the PATH column, the TNC saves the path name of the tool table with which you conducted the test run. This enables the TNC during the actual tool usage test to detect whether you performed the test run with the TOOL.T				
TNR	Tool number (-1 : Tool not inserted yet)				
IDX	Tool index				
NAME	Tool name from the tool table				
TIME	Tool usage time in seconds (feed time without rapid traverse movements)				
WTIME	Tool-usage time in seconds (total usage time between tool changes)				
RAD	Tool radius R + Oversize of tool radius DR from the tool table. (in mm)				
BLOCK	Block number in which the T block was programmed				
PATH	TOKEN = TOOL : Path name of the active				
	main program or subprogram				
	TOKEN = STOTAL: Path name of the subprogram				
Т	Tool number with tool index				
OVRMAX	Maximum feed rate override that occurred during machining. The TNC enters the value 100 (%) during the test run				
OVRMIN	Minimum feed rate override that occurred during machining. During Test Run the TNC enters the value –1				
NAMEPROG	0: The tool number is programmed1: The tool name is programmed				

The TNC saves the tool usage times in a separate file with the extension **pgmname.I.T.DEP**. This file is not visible unless the machine parameter **dependentFiles** (no. 122101) is set to **MANUAL**

There are two ways to run a tool usage test for a pallet file:

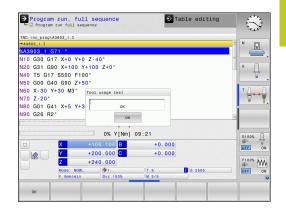
- The highlight in the pallet file is on a pallet entry: The TNC runs the tool usage test for the entire pallet
- The highlight in the pallet file is on a pallet entry: The TNC runs the tool usage test for the entire pallet

Using a tool usage test

Before starting a program in the **Program Run, Full Sequence/ Single Block** operating modes, you can use the **TOOL USAGE** and **TOOL USAGE TEST** soft keys to check whether the tools being used in the selected program are available and have sufficient remaining service life. The TNC then compares the actual service-life values in the tool table with the nominal values from the tool usage file.

After you have pressed the **TOOL USAGE TEST** soft key, the TNC displays the result of the tool usage test in a pop-up window. To close the pop-up window, press the **ENT** key.

You can query the tool usage test with the **D18 ID975 NR1** function.



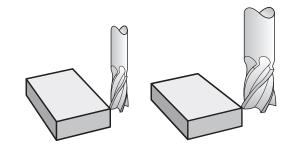
5.3 Tool compensation

Introduction

The TNC adjusts the tool path by the compensation value for the tool length in the spindle axis. In the machining plane, it compensates the tool radius.

If you are writing the part program directly on the TNC, the tool radius compensation is effective only in the working plane.

The TNC accounts for the compensation value in up to five axes including the rotary axes.



Tool length compensation

Length compensation becomes effective automatically as soon as a tool is called. To cancel length compensation, call a tool with the length L=0 (e.g. T 0).

Danger of collision!

If you cancel a positive length compensation with **T 0** the distance between tool and workpiece will be reduced.

After **T** the path of the tool in the spindle axis, as entered in the part program, is adjusted by the difference between the length of the previous tool and that of the new one.

For tool length compensation, the control takes the delta values from both the ${\bf T}$ block and the tool table into account:

Compensation value = L + $DL_{CALL\ T\ block}$ + DL_{TAB} with

L: Tool length L from G99 block or tool table

 $\textbf{DL}_{\text{CALL T block}}:$ Oversize for length DL in the T block

DL TAB: Oversize for length **DL** in the tool table

Tool radius compensation

The block for programming a tool movement contains:

- G41 or G42 for radius compensation
- **G40**, if there is no radius compensation

The radius compensation is effective as soon as a tool is called and traversed with a straight line block in the working plane with G41 or G42.



The TNC automatically cancels radius compensation if you:

- program a straight line block with G40
- depart the contour with the **DEP** function
- Select a new program with **PGM MGT**

For radius compensation, the TNC takes the delta values from both the ${\bf T}$ block and the tool table into account:

Compensation value = $\mathbf{R} + \mathbf{D}\mathbf{R}_{CALLT \ block} + \mathbf{D}\mathbf{R}_{TAB}$ with

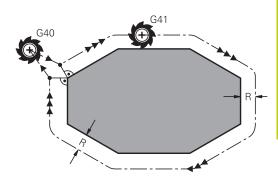
R: Tool radius R from G99 block or tool table

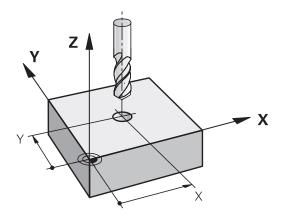
 $\textbf{DR}_{\text{CALLT block}}\text{:}\text{Oversize for radius }\textbf{DR}\text{ in the }\textbf{T}\text{ block}$

DR TAB: Oversize for radius **DR** in the tool table

Contouring without radius compensation: G40

The tool center moves on the machining plane along the programmed path orto the programmed coordinates. Applications: Drilling and boring, pre-positioning





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Contouring with radius compensation: G42 and G41

G42: The tool moves to the right of the programmed contour

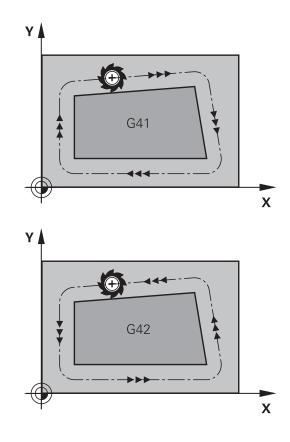
G41: The tool moves to the left of the programmed contour

The tool center moves along the contour at a distance equal to the radius. "Right" or "left" are to be understood as based on the direction of tool movement along the workpiece contour.

Between two program blocks with different radius compensations **G42** and **G41** you must program at least one traversing block in the working plane without radius compensation (that is, with **G40**).

The TNC does not put radius compensation into effect until the end of the block in which it is first programmed.

In the first block in which radius compensation is activated with **G42/G41** or canceled with **G40** the TNC always positions the tool perpendicular to the programmed starting or end position. Position the tool at a sufficient distance from the first or last contour point to prevent the possibility of damaging the contour.



Entering radius compensation

Radius compensation is entered in a **G01** block. Enter the coordinates of the target point and confirm your entry with the **ENT** key.

G 4 1	 Select tool movement to the left of the programmed contour: Press the G41 soft key, or
G 4 2	 Select tool movement to the right of the contour: Press the G42 soft key, or
G 4 Ø	 Select tool movement without radius compensation or cancel radius compensation: Select function G40
END	Terminate the block: Press the END key

Radius compensation: Machining corners

Outside corners:

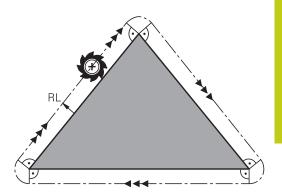
If you program radius compensation, the TNC moves the tool around outside corners on a transitional arc. If necessary, the TNC reduces the feed rate at outside corners to reduce machine stress, for example at very great changes of direction.

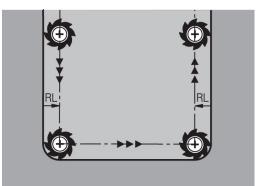
Inside corners:

The TNC calculates the intersection of the tool center paths at inside corners under radius compensation. From this point it then starts the next contour element. This prevents damage to the workpiece at the inside corners. The permissible tool radius is therefore limited by the geometry of the programmed contour

Danger of collision!

To prevent the tool from damaging the contour, be careful not to program the starting or end position for machining inside corners at a corner of the contour.





Tools

5

5.4 Tool management (option number 93)

Basics



Refer to your machine manual. Tool management is a machine-dependent function, which may be partly or completely deactivated. The machine tool builder defines the exact range of functions.

In tool management, your machine manufacturer can provide a wide range of functions for tool handling. Examples:

- Easily readable and, if you desired, adaptable representation of the tool data in fillable forms
- Any description of the individual tool data in the new table view
- Mixed representation of data from the tool table and the pocket table
- Fast sorting of all tool data by mouse
- Use of graphic aids, e.g. color coding of tool or magazine status
- Program-specific list of all available tools
- Program-specific usage sequence of all tools
- Copying and pasting of all tool data pertaining to a tool
- Graphic depiction of tool type in the table view and in the detail view for a better overview of the available tool types



If you edit a tool in tool management, the selected tool is locked. If this tool is required in the NC program being used, the TNC shows the message: **Tool table locked**.

	Pockets Tooling list T u	sage order					
T T	NAME	PT' T	POCI	MAGAZINE	Tool life	REMAIN	M 😡
0 💈	NULLWERKZEUG	0			Not monitored	0 =	
1 🖁	MILL_D2_ROUGH	0	1	Main magazin	Not monitored	0 -	
2	MILL_D4_ROUGH	0	2	Main magazin	Not monitored	0	S 🗆
3	MILL_D6_ROUGH	0	3	Main magazin	Not monitored	0	÷
4	MILL_D8_ROUGH	0	4	Main magazin	Not monitored	0	N N
5 🖁	MILL_D10_ROUGH	0 0	5	Main magazin	Not monitored	0	
6 8	MILL_D12_ROUGH	0	6	Main magazin	Not monitored	0	тД
7	MILL_D14_ROUGH	0	7	Main magazin	Not monitored	0	
8			8	Main magazin	Not monitored	0	· ·
9 🖁	MILL_D18_ROUGH	0 0	9	Main magazin	Not monitored	0	1
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11 🖁	MILL_D22_ROUGH	0	11	Main magazin	Not monitored	0	
12	MILL_D24_ROUGH	0 0		Spindle	Not monitored	0	I
13	MILL_D26_ROUGH	0 0	13	Main magazin	Not monitored	0	\$100%
14 🖁	MILL_D28_ROUGH	0 0	14	Main magazin	Not monitored	0	6.
15 🖁	MILL_D30_ROUGH	0	15	Main magazin	Not monitored	0	OFF
16	MILL_D32_ROUGH	0 0		Main magazin	Not monitored	0	
17	MILL_D34_ROUGH	0 0		Main magazin	Not monitored	0	F100% A
18	MILL_D36_ROUGH	0 (Main magazin	Not monitored	0	(0°
10 1	MTLL D38 ROUGH	0	19	Main magazin	Not monitored	0 ~	OFF

Calling tool management



TOOL

TOOL

MANAGEMENT

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The tool management call can differ as described below. Refer to your machine manual.

Select tool table: Press the TOOL TABLE soft key

- Scroll through the soft-key row
- Select the TOOL MANAGEMENT soft key: The TNC moves to the new table view

Tool management view

In the new view, the TNC presents all tool information in the following four tabs:

- **Tools**: Tool specific information
- **pockets**: Pocket-specific information
- Assembly list: List of all tools in the NC program that is selected in the Program Run mode (only if you have already created a tool usage file)

Further Information: "Tool usage test", page 205

 T usage sequence: List of the sequence of all tools that are inserted in the program selected in the Program Run mode (only if you have already created a tool usage file)
 Further Information: "Tool usage test", page 205

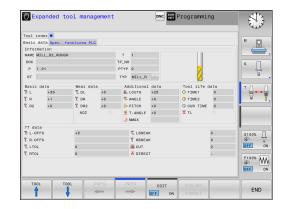
0019	Pockets Tooling list	T usage ord	ler						N m
T	NAME	PT'		POCI	MAGAZINE		11fe	REMAIN	~ -
0 🧋	NULLWERKZEUG	0	-				monitored	0	
1 🐰		0		1	Main magazin		monitored	0	
2 🖁	MILL_D4_ROUGH	0		2	Main magazin	Not	monitored	0	S 🗍
з 🧵		0		3	Main magazin		monitored	0	U
4 🐰	MILL_D8_ROUGH	0		- 4	Main magazin	Not	monitored	0	8
5 🐰	MILL_D10_ROUGH	0		5	Main magazin	Not	monitored	0	
6 🖁	MILL_D12_ROUGH	0		6	Main magazin		monitored	0	T A
7 🖁	MILL_D14_ROUGH	0		7	Main magazin	Not	monitored	0	9.1
8 🦉	MILL_D16_ROUGH	0		8	Main magazin	Not	monitored	0	<u> </u>
9 🐰	MILL_D18_ROUGH	0		9	Main magazin		monitored	0	I
10 🐰	MILL_D20_ROUGH	0		10	Main magazin		monitored	0	
11 🐰	MILL_D22_ROUGH	0		11	Main magazin	Not	monitored	0	
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9 1	MTLL D38 ROUGH	n		19	Main manazin	Not	monitored	n ×	0 0000

5.4 Tool management (option number 93)

Editing tool management

The tool management can be operated by mouse or with the keys and soft keys:

Soft key	Editing functions for tool management								
BEGIN	Select the table start								
	Select the table end								
PAGE	Select the previous page in the table								
	Select the next page in the table								
FORM FOR TOOL	Call the form view of the marked tool.								
	Alternative function: Press the ENT key								
	Changing tab:								
	Tools, Pockets, Assembly list, T usage sequence								
FIND	Search function: Here you can select the column to be searched and then the search term either from a list or by entering it								
TOOL IMPORT	Import tools								
EXPORT TOOL	Export tools								
DELETE MARKED TOOLS	Delete marked tools								
APPEND N LINES	Add several lines at end of table								
UPDATE THE VIEW	Update table view								
PROG. TOOL DISPLAY HIDE	Show the programmed tools column (if the Pockets tab is active)								
COLUMN	Define the settings:								
MOVE	 SORT COLUMN active: Click the column header to sort the content of the column 								
	 SHIFT COLUMN active: The column can be moved by drag and drop 								
RESET	Reset the manually changed settings (move columns) to the original condition								





You can edit the tool data only in the form view, which you can activate by pressing the **FORM FOR TOOL** soft key or the **ENT** key for the currently highlighted tool.

If you use the tool management without a mouse, then you can activate and deactivate functions with the "-/+" key.

In the tool management, use the **GOTO** soft key to search for the tool number or pocket number.

In addition, you can perform the following functions by mouse:

- Sorting function. You can sort the data in ascending or descending order (depending on the active setting) by clicking a column of the table head.
- Arrange columns. You can arrange the columns in any sequence you want by clicking a column of the table head and then moving it with the mouse key pressed down. The TNC does not save the current column sequence when you exit the tool management (depending on the active setting).
- Show miscellaneous information in the form view: The TNC displays tool tips when you leave the mouse pointer on an active entry field for more than a second and when you have set the EDIT ON/OFF soft key to ON

5.4 Tool management (option number 93)

Editing with active form view

If the form view is active, the following functions are available to you:

Soft key	Editing functions, form view
TOOL	Select the tool data of the previous tool
TOOL	Select the tool data of the next tool
	Select previous tool index (only active if indexing is enabled)
	Select the next tool index (only active if indexing is enabled)
DISCARD CHANGES	Discard all changes made since the form was called
INSERT INDEX	Add tool index
DELETE INDEX	Delete tool index
COPY DATA RECORD	Copy the tool data of the selected tool
INSERT DATA REC.	Insert the copied tool data in the selected tool

Deleting marked tool data

Using this function you can simply delete tool data that you no longer need.

Follow the steps outlined below for deleting:

- In the tool management you use the arrow keys or mouse to mark the tool data that you wish to delete
- Select the DELETE MARKED TOOLS soft key and the TNC shows a pop-up window listing the tool data to be deleted
- Press the START soft key to start the delete process: The TNC shows the status of the delete process in a pop-up window
- Terminate the delete process by pressing the END key or soft key



- The TNC deletes all the data of all the tools selected. Make sure that you really no longer need the tool data, because there is no Undo function available.
- You cannot delete the tool data of tools still stored in the pocket table. First remove the tool from the magazine.

Available tool types

The tool management displays the various tool types with an icon. The following tool types are available:

▼Undefined,****99№Milling cutter,MILL0№Drill,DRILL1№Tap,TAP2№Center drill,CENT4№Turning Tool,TURN29№Touch probe,TCHP21№Ream,REAM3↓Countersink,CSINK5	
Drill,DRILL1Tap,TAP2Center drill,CENT4Turning Tool,TURN29Touch probe,TCHP21Ream,REAM3	
Tap,TAP2Center drill,CENT4Turning Tool,TURN29Touch probe,TCHP21Ream,REAM3	
Image: Constraint of the second se	
Image: Turning Tool, TURN 29 Image: Touch probe, TCHP 21 Image: Ream, REAM 3	
Touch probe,TCHP 21 Ream,REAM 3	
Ream,REAM 3	
Lountersink,CSINK 5	
Piloted counterbore(TSINK),TSINK 6	
Boring tool, BOR 7	
Back boring tool,BCKBOR 8	
Thread mill,GF15	
Thread mill w/ countersink,GSF16	
Thread mill w/ single thread, EP 17	
Thread mill w/ indxbl insert,WSP18	
Thread milling drill,BGF 19	
Circular thread mill,ZBGF 20	

5 Tools

5.4 Tool management (option number 93)

lcon	Tool type	Tool type number
3	Roughing cutter (MILL_R),MILL_R	9
8	Finishing cutter (MILL_F),MILL_F	10
5	Rough/finish cutter,MILL_RF	11
8	Floor finisher(MILL_FD),MILL_FD	12
8	Side finisher (MILL_FS),MILL_FS	13
	Face milling cutter,MILL_FACE	14

Import and export tool data

Importing tool data

Using this function you can simply import tool data that you have measured externally on a presetting device, for example. The file to be imported must have the CSV format (comma separated value). The CSV file format describes the structure of a text file for exchanging simply structured data. Accordingly, the import file must have the following structure:

- **Row 1**: In the first line you define the column names in which the data defined in the subsequent lines is to be placed. The column names are separated with a comma.
- **Other lines**: All the other lines contain the data that you wish to import into the tool table. The order of the data must match the order of the column names in Line 1. The data is separated by commas, decimal numbers are to be defined with a decimal point.

Follow the steps outlined below for importing:

- Copy the tool table to be imported to the hard disk of the TNC in the TNC:\systems\tooltab directory
- Start expanded tool management
- Select the TOOL IMPORT soft key in the tool management: The TNC shows a pop-up window with the CSV files stored in the TNC:\system\tooltab directory
- Use the arrow keys or mouse to select the file to be imported and confirm with the ENT key: The TNC shows the content of the CSV file in a pop-up window
- Start import procedure with START soft key

Tools 5.4 Tool management (option number 93)

 The CSV file to be imported must be stored in the TNC:\system\tooltab directory. If you import the tool data of tools whose numbers are in the pocket table, the TNC issues an error message. You can then decide whether you want to skip this data record or insert a new tool. The TNC inserts a new tool into the first empty line of the tool table. If the imported CSV file includes additional table columns unknown to the control, a message is displayed during import specifying these unknown columns and indicating that these values will not be adopted. Make sure that the column designations have been specified correctly. Further Information: "Enter tool data into the table", page 188 You can import any tool data, the associated data record does not have to contain all the columns (or data) of the tool table. The column names can be in any order, the data must be defined in the corresponding order. 	
 numbers are in the pocket table, the TNC issues an error message. You can then decide whether you want to skip this data record or insert a new tool. The TNC inserts a new tool into the first empty line of the tool table. If the imported CSV file includes additional table columns unknown to the control, a message is displayed during import specifying these unknown columns and indicating that these values will not be adopted. Make sure that the column designations have been specified correctly. Further Information: "Enter tool data into the table", page 188 You can import any tool data, the associated data record does not have to contain all the columns (or data) of the tool table. The column names can be in any order, the data 	
 columns unknown to the control, a message is displayed during import specifying these unknown columns and indicating that these values will not be adopted. Make sure that the column designations have been specified correctly. Further Information: "Enter tool data into the table", page 188 You can import any tool data, the associated data record does not have to contain all the columns (or data) of the tool table. The column names can be in any order, the data 	numbers are in the pocket table, the TNC issues an error message. You can then decide whether you want to skip this data record or insert a new tool. The TNC inserts a new tool into the first
 been specified correctly. Further Information: "Enter tool data into the table", page 188 You can import any tool data, the associated data record does not have to contain all the columns (or data) of the tool table. The column names can be in any order, the data 	columns unknown to the control, a message is displayed during import specifying these unknown columns and indicating that these values will not
record does not have to contain all the columns (or data) of the tool table.The column names can be in any order, the data	been specified correctly. Further Information: "Enter tool data into the
	record does not have to contain all the columns

Sample import file:

T,L,R,DL,DR	Line 1 with column names
4,125.995,7.995,0,0	Line 2 with tool data
9,25.06,12.01,0,0	Line 3 with tool data
28,196.981,35,0,0	Line 4 with tool data

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Exporting tool data

Using this function you can simply export tool data to read it into the tool database of your CAM system, for example. The TNC stores the exported file in the CSV format (comma separated value). The CSV file format describes the structure of a text file for exchanging simply structured data. The export file has the following structure:

- Line 1: In the first line the TNC stores the column names of all the relevant tool data to be defined. The column names are separated from each other by commas.
- Further lines: All the other lines contain the data of the tools that you have exported. The order of the data matches the order of the column names in Line 1. The data is separated by commas, the TNC outputs decimal numbers with a decimal point.

Follow the steps outlined below for exporting:

- In the tool management you use the arrow keys or mouse to mark the tool data that you wish to export
- Press the EXPORT TOOL soft key, the TNC shows a pop-up window: specify the name for the CSV file, confirm with the ENT key
- Press the START soft key to start the export process: The TNC shows the status of the delete export process in a pop-up window
- Terminate the export process by pressing the END key or soft key



The TNC always stores the exported CSV file in the **TNC:\system\tooltab** directory.



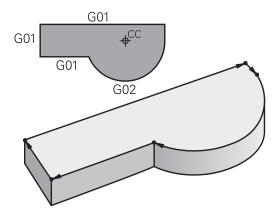
6.1 Tool movements

6.1 Tool movements

Path functions

6

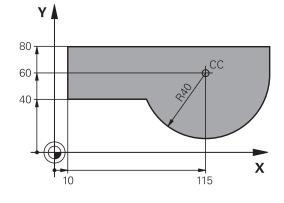
A workpiece contour is usually composed of several contour elements such as straight lines and circular arcs. With the path functions, you can program the tool movements for **straight lines** and **circular arcs**.



FK free contour programming

If a production drawing is not dimensioned for NC and the dimensions given are not sufficient for creating a part program, you can program the workpiece contour with the FK free contour programming. The TNC calculates the missing data.

With FK programming, you also program tool movements for **straight lines** and **circular arcs**.



Miscellaneous functions M

With the TNC's miscellaneous functions you can affect

- the program run, e.g., a program interruption
- the machine functions, such as switching spindle rotation and coolant supply on and off
- the path behavior of the tool

Subprograms and program section repeats

If a machining sequence occurs several times in a program, you can save time and reduce the chance of programming errors by entering the sequence once and then defining it as a subprogram or program section repeat. If you wish to execute a specific program section only under certain conditions, you also define this machining sequence as a subprogram. In addition, you can have a part program call a separate program for execution.

Further Information: "Subprograms and program section repeats", page 293

Programming with Q parameters

Instead of programming numerical values in a machining program, you enter markers called Q parameters. You assign the values to the Q parameters separately with the Q parameter functions. You can use the Q parameters for programming mathematical functions that control program execution or describe a contour.

In addition, programming with Q parameters enables you to measure with the 3-D touch probe during the program run.

Further Information: "Programming Q parameters", page 311

6

6.2 Fundamentals of path functions

6.2 Fundamentals of path functions

Programming tool movements for workpiece machining

You create a machining program by programming the path functions for the individual contour elements in sequence. You do this by entering the coordinates of the end points of the contour elements given in the production drawing. The TNC calculates the actual path of the tool from these coordinates, and from the tool data and radius compensation.

The TNC moves all machine axes programmed in the NC block of a path function simultaneously.

Movement parallel to the machine axes

The NC block contains only one coordinate. The TNC thus moves the tool parallel to the programmed machine axis.

Depending on the individual machine tool, the part program is executed by movement of either the tool or the machine table on which the workpiece is clamped. Path contours are programmed as if the tool were moving.

Example:

N50 G00 X+100*

- N50 Block number
- **G00** Path function "straight line at rapid traverse"
- **X+100** Coordinate of the end point

The tool retains the Y and Z coordinates and moves to the position X=100.

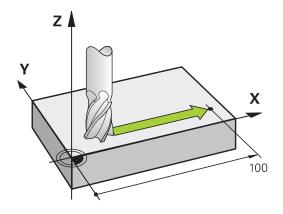
Movement in the main planes

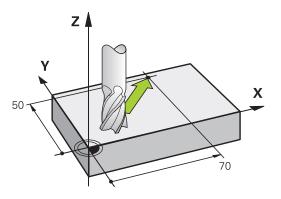
The NC block contains two coordinates. The TNC thus moves the tool on the programmed plane.

Example

N50 G00 X+70 Y+50*

The tool retains the Z coordinate and moves on the XY plane to the position X=70, Y=50.



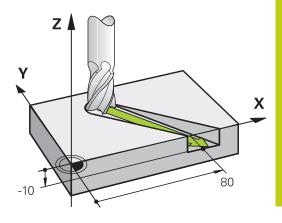


Three-dimensional movement

The NC block contains three coordinates. The TNC thus moves the tool spatially to the programmed position.

Example

N50 G01 X+80 Y+0 Z-10*

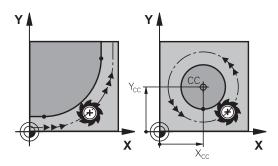


Circles and circular arcs

The TNC moves two axes simultaneously on a circular path relative to the workpiece. You can define a circular movement by entering the circle center with I and J.

When you program a circle, the control assigns it to one of the main planes. This main plane for a \mathbf{T} must be defined when the spindle axis is set:

Spindle axis	Main plane
(G17)	XY , also UV, XV, UY
(G18)	ZX , also WU, ZU, WX
(G19)	YZ , also VW, YW, VZ



You can program circles that do not lie parallel to a main plane by using the function for **Tilt working plane** or with Q parameters.

Further Information: "The PLANE function: Tilting the working plane (software option 8)", page 421 **Further Information:** "Principle and overview of

functions", page 312

Direction of rotation DR for circular movements

When a circular path has no tangential transition to another contour element, enter the direction of rotation as follows: Clockwise direction of rotation: **G02/G12**

Counterclockwise direction of rotation: G03/G13

6.2 Fundamentals of path functions

Radius compensation

The radius compensation must be in the block in which you move to the first contour element. You cannot activate radius compensation in a circle block. It must be activated beforehand in a straight-line block.

Further Information: "Path contours Cartesian coordinates", page 240

Pre-position

6

Danger of collision!

Before running a machining program, always pre-position the tool to prevent the possibility of damaging it or the workpiece.

6.3 Approaching and departing a contour

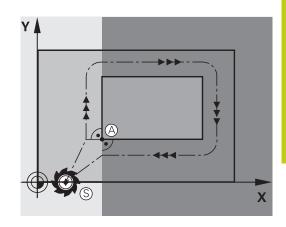
"From" and "To" points

The tool approaches the first contour point from the starting point. The starting point must be:

- Programmed without radius compensation
- Approachable without danger of collision
- Close to the first contour point

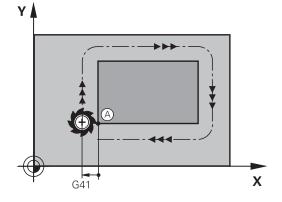
Example in the figure on the right:

If you set the starting point in the dark gray area, the contour will be damaged when the first contour element is approached.



First contour point

You need to program a radius compensation for the tool movement to the first contour point.



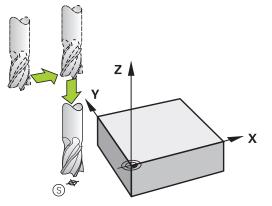
Approaching the starting point in the spindle axis

When the starting point is approached, the tool must be moved to the working depth in the spindle axis. If danger of collision exists, approach the starting point in the spindle axis separately.

NC blocks

N40	G00	Z-10*
	000	2.10

N30 G01 X+20 Y+30 G41 F350*



6.3 Approaching and departing a contour

End point

The end point should be selected so that it is:

- Approachable without danger of collision
- Near to the last contour point
- In order to make sure the contour will not be damaged, the optimal ending point should lie on the extended tool path for machining the last contour element

Example in the figure on the right:

If you set the end point in the dark gray area, the contour will be damaged when the end point is approached.

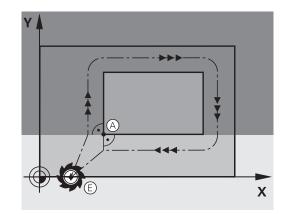
Departing the end point in the spindle axis:

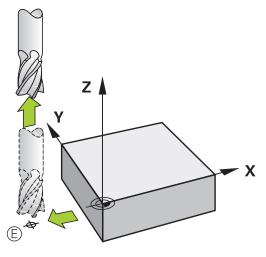
Program the departure from the end point in the spindle axis separately.

NC blocks

N50 G01 G40 X+60 Y+70 F700*

N60 G00 Z+250*





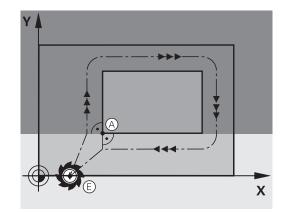
Common starting and end points

Do not program any radius compensation if the starting point and end point are the same.

In order to make sure the contour will not be damaged, the optimal starting point should lie between the extended tool paths for machining the first and last contour elements.

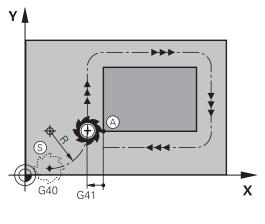
Example in the figure on the right:

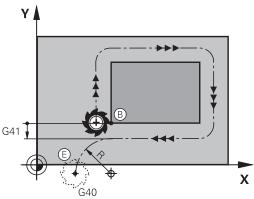
If you set the end point in the dark gray area, the contour will be damaged when the contour is approached/departed.



Tangential approach and departure

With **G26** (figure at center right), you can program a tangential approach to the workpiece, and with **G27** (figure at lower right) a tangential departure. In this way you can avoid dwell marks.





Starting point and end point

The starting point and the end point lie outside the workpiece, close to the first and last contour points. They are to be programmed without radius compensation.

Approach

 G26 is entered after the block in which the first contour element is programmed: This will be the first block with radius compensation G41/G42

Departure

 G27 after the block in which the last contour element is programmed: This will be the last block with radius compensation G41/G42

The radius for **G26** and **G27** must be selected so that the TNC can execute the circular path between the starting point and the first contour point, as well as the last contour point and the end point.

6.3 Approaching and departing a contour

Example NC blocks

6

N50 G00 G40 G90 X-30 Y+50*	Starting point
N60 G01 G41 X+0 Y+50 F350*	First contour point
N70 G26 R5*	Tangential approach with radius $R = 5 \text{ mm}$
PROGRAM CONTOUR BLOCKS	
	Last contour point
N210 G27 R5*	Tangential departure with radius R = 5 mm
N220 G00 G40 X-30 Y+50*	End point

Overview: Types of paths for contour approach and departure

The functions for contour approach **APPR** and departure **DEP** are activated with the **APPR/DEP** key. You can then select the following path forms with the corresponding soft keys:

Approach	Departure	Function
APPR LT		Straight line with tangential connection
APPR LN	DEP LN	Straight line perpendicular to a contour point
	DEP CT	Circular arc with tangential connection
APPR LCT	DEP LCT	Circular arc with tangential connection to the contour. Approach and departure to an auxiliary point outside the contour on a tangentially connecting line

Approaching and departing a helix

The tool approaches and departs a helix on its extension by moving in a circular arc that connects tangentially to the contour. You program helical approach and departure with the **APPR CT** and **DEP CT** functions.

Important positions for approach and departure

Starting point P_S

You program this position in the block before the APPR block. P_S lies outside the contour and is approached without radius compensation (G40).

Auxiliary point P_H

Some of the paths for approach and departure go through an auxiliary point P_H that the TNC calculates from your input in the APPR or DEP block. The TNC moves from the current position to the auxiliary point P_H at the feed rate last programmed. If you have programmed **G00** (positioning at rapid traverse) in the last positioning block before the approach function, the TNC also approaches the auxiliary point P_H at rapid traverse.

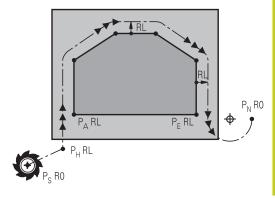
- First contour point P_Aand last contour point P_E
 You program the first contour point P_A in the APPR block. The last contour point P_Ecan be programmed with any path function. If the APPR block also includes the Z coordinate, then the TNC moves the tool simultaneously to the first contour point P_A.
- End point P_N

The position P_N lies outside of the contour and results from your input in the DEP block. If the DEP block also includes the Z coordinate, then the TNC moves the tool simultaneously to the end point $P_N.$

Abbreviation	Meaning
APPR	Approach
DEP	Departure
L	Line
С	Circle
т	Tangential (smooth connection)
N	Normal (perpendicular)

When moving from the actual position to the auxiliary point P_H the TNC does not check whether the programmed contour will be damaged. Use the test graphics to check.

With the **APPR LT**, **APPR LN** and **APPR CT** functions, the TNC moves the tool from the actual position to the auxiliary point P_H at the feed rate/rapid traverse that was last programmed. With the **APPR LCT** function, the TNC moves to the auxiliary point P_H at the feed rate programmed with the APPR block. If no feed rate is programmed before the approach block, the TNC generates an error message.



R0=G40; RL=G41; RR=G42

6.3 Approaching and departing a contour

Polar coordinates

6

You can also program the contour points for the following approach/ departure functions over polar coordinates:

- APPR LT becomes APPR PLT
- APPR LN becomes APPR PLN
- APPR CT becomes APPR PCT
- APPR LCT becomes APPR PLCT
- DEP LCT becomes DEP PLCT

Select an approach or departure function with the soft key, then press the orange ${\bf P}$ key.

Radius compensation

The tool radius compensation is programmed together with the first contour point P_A in the APPR block. The DEP blocks automatically discard the tool radius compensation.



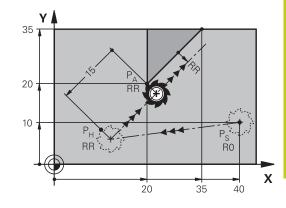
If you program **APPR LN** or **APPR CT** with **G40**, the control stops the machining/simulation with an error message.

This method of function differs from the iTNC 530 control!

Approaching on a straight line with tangential connection: APPR LT

The tool moves on a straight line from the starting point P_S to an auxiliary point P_H . It then moves to the first contour point P_A on a straight line that connects tangentially to the contour. The auxiliary point P_H is separated from the first contour point P_A by the distance **LEN**.

- $\blacktriangleright\,$ Use any path function to approach the starting point ${\rm P}_{\rm S}$
- ► Initiate the dialog with the **APPR DEP** key and **APPR LT** soft key
 - \blacktriangleright Coordinates of the first contour point P_A
 - LEN: Distance from the auxiliary point P_H to the first contour point P_A
 - Radius compensation G41/G42 for machining



R0=G40; RL=G41; RR=G42

Example NC blocks

APPR LT

N70 G00 X+40 Y+10 G40 M3*	Approach P_S without radius compensation
N80 APPR LT X+20 Y+20 Z-10 LEN15 G42 F100*	P_A with radius comp. G42, distance P_H to P_A : LEN=15
N90 G01 X+35 Y+35*	End point of the first contour element
N100 G01*	Next contour element

Approaching on a straight line perpendicular to the first contour point: APPR LN

- ▶ Use any path function to approach the starting point P_S.
 - Initiate the dialog with the **APPR DEP** key and **APPR LN** soft key:

►

- Coordinates of the first contour point P_A
- Length: Distance to the auxiliary point P_H. Always enter LEN as a positive value
- Radius compensation G41/G42 for machining

Example NC blocks

N70 G00 X+40 Y+10 G40 M3*	Approach PS without radius compensation
N80 APPR LN X+10 Y+20 Z-10 LEN15 G24 F100*	PA with radius comp. G42
N90 G01 X+20 Y+35*	End point of the first contour element
N100 G01*	Next contour element

6

6.3 Approaching and departing a contour

Approaching on a circular path with tangential connection: APPR CT

The tool moves on a straight line from the starting point P_S to an auxiliary point P_H . It then moves from PH to the first contour point PA following a circular arc that is tangential to the first contour element.

The arc from P_H to P_A is determined through the radius R and the center angle **CCA**. The direction of rotation of the circular arc is automatically derived from the tool path for the first contour element.

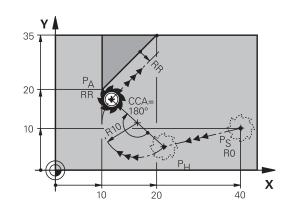
- Use any path function to approach the starting point P_S.
- Initiate the dialog with the APPR DEP key and APPR CT soft key

Coordinates of the first contour point P_A

APPR CT

Example NC blocks

- ► Radius R of the circular arc
 - If the tool should approach the workpiece in the direction defined by the radius compensation: Enter R as a positive value
 - If the tool should approach the workpiece opposite to the radius compensation: Enter R as a negative value.
- Center angle **CCA** of the arc
 - CCA can be entered only as a positive value.
 - Maximum input value 360°
- Radius compensation G41/G42 for machining



R0=G40; RL=G41; RR=G42

N70 G00 X+40 Y+10 G40 M3*	Approach PS without radius compensation
N80 APPR CT X+10 Y+20 Z-10 CCA180 R+10 G42 F100*	PA with radius comp. G42, radius R=10
N90 G01 X+20 Y+35*	End point of the first contour element
N100 G01*	Next contour element

Approaching on a circular path with tangential connection from a straight line to the contour: APPR LCT

The tool moves on a straight line from the starting point P_S to an auxiliary point P_H . It then moves to the first contour point P_A on a circular arc. The feed rate programmed in the APPR block is effective for the entire path that the TNC traversed in the approach block (path P_S to P_A).

If you have programmed the coordinates of all three principal axes X, Y and Z in the approach block, the TNC moves the tool from the position defined before the APPR block to the auxiliary point P_H on all three axes simultaneously. Then the TNC goes from P_H to P_A only on the working plane.

The arc is connected tangentially both to the line P_S - P_H as well as to the first contour element. Once these lines are known, the radius then suffices to completely define the tool path.

Please note that earlier programs may need to be

 P_A P_A

R0=G40; RL=G41; RR=G42

The arc is connected tangentially both to the line P_S-P_H as well as to the first contour element. Once these lines are known, the radius then suffices to completely define the tool path.

- Use any path function to approach the starting point P_S.
- Initiate the dialog with the APPR DEP key and APPR LCT soft key:



- Coordinates of the first contour point P_A
- Radius R of the circular arc. Enter R as a positive value
- Radius compensation G41/G42 for machining

Example NC blocks

adapted.

N70 G00 X+40 Y+10 G40 M3*	Approach PS without radius compensation
N80 APPR LCT X+10 Y+20 Z-10 R10 G42 F100*	PA with radius comp. G42, radius R=10
N90 G01 X+20 Y+35*	End point of the first contour element
N100 G01*	Next contour element

Departing in a straight line with tangential connection: DEP LT

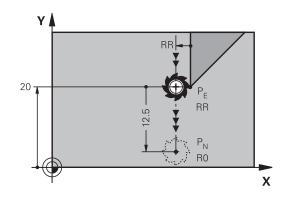
The tool moves on a straight line from the last contour point P_E to the end point P_N . The line lies on the extension of the last contour element. P_N is separated from P_E by the distance **LEN**.

- Program the last contour element with the end point P_E and radius compensation
- Initiate the dialog with the APPR DEP key and DEP LT soft key



6

 LEN: Enter the distance from the last contour element P_E to the end point P_N.



R0=G40; RL=G41; RR=G42

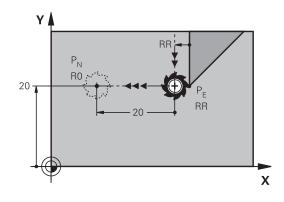
Example NC blocks

N20 G01 Y+20 G42 F100*	Last contour element: PE with radius compensation
N30 DEP LT LEN12.5 F100*	Depart contour by LEN=12.5 mm
N40 G00 Z+100 M2*	Retract in Z, return to block 1, end program

Departing in a straight line perpendicular to the last contour point: DEP LN

The tool moves on a straight line from the last contour point P_E to the end point P_N. The line departs on a perpendicular path from the last contour point P_E. P_N is separated from P_E by the distance **LEN** plus the tool radius.

- Program the last contour element with the end point P_E and radius compensation
- Initiate the dialog with the APPR DEP key and DEP LN soft key
 - LEN: Enter the distance from the last contour element to P_N. Important: Enter a positive value in LEN



R0=G40; RL=G41; RR=G42

Example NC blocks

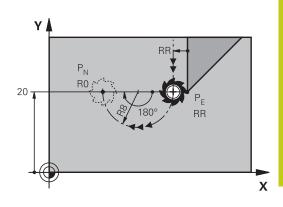
DEP LN

N20 G01 Y+20 G42 F100*	Last contour element: PE with radius compensation
N30 DEP LN LEN+20 F100*	Depart perpendicular to contour by LEN=20 mm
N40 G00 Z+100 M2*	Retract in Z, return to block 1, end program

Departing on a circular path with tangential connection: DEP CT

The tool moves on a circular arc from the last contour point P_E to the end point $\mathsf{P}_\mathsf{N}.$ The circular arc connects tangentially to the last contour element.

- Program the last contour element with the end point P_E and radius compensation
- Initiate the dialog with the APPR DEP key and DEP CT soft key
 - Center angle **CCA** of the arc
 - Radius R of the circular arc
 - If the tool should depart the workpiece in the direction opposite to the radius compensation: Enter R as a positive value.
 - If the tool should depart the workpiece in the direction **opposite** to the radius compensation: Enter R as a negative value.



R0=G40; RL=G41; RR=G42

Example NC blocks

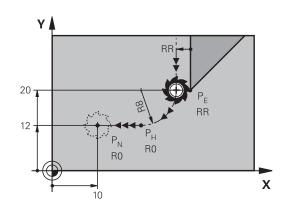
DEP CT

N20 G01 Y+20 G42 F100*	Last contour element: PE with radius compensation	
N30 DEP CT CCA 180 R+8 F100*	Center angle=180°, arc radius=8 mm	
N40 G00 Z+100 M2*	Retract in Z, return to block 1, end program	

Departing on a circular arc tangentially connecting the contour and a straight line: DEP LCT

The tool moves on a circular arc from the last contour point P_{E} to an auxiliary point $\mathsf{P}_{\mathsf{H}}.$ It then moves on a straight line to the end point $\mathsf{P}_{\mathsf{N}}.$ The arc is tangentially connected both to the last contour element and to the line from P_{H} to $\mathsf{P}_{\mathsf{N}}.$ Once these lines are known, the radius R suffices to unambiguously define the tool path.

- Program the last contour element with the end point P_E and radius compensation
- ▶ Initiate the dialog with the **APPR/DEP** key and **DEP LCT** soft key
 - Enter the coordinates of the end point P_N
 - Radius R of the circular arc. Enter R as a positive value



R0=G40; RL=G41; RR=G42

Example NC blocks

DEP LCT

N20 G01 Y+20 G42 F100*	Last contour element: PE with radius compensation	
N30 DEP LCT X+10 Y+12 R+8 F100*	Coordinates PN, arc radius=8 mm	
N40 G00 Z+100 M2*	Retract in Z, return to block 1, end program	

6.4 Path contours — Cartesian coordinates

6.4 Path contours — Cartesian coordinates

Overview of path functions

Path function key	Function	Tool movement	Required input	Page
L of the second	Straight line L	Straight line	Coordinates of the end point of the straight line	241
	G00 and G01			
CHF o o	Chamfer: CHF G24	Chamfer between two straight lines	Chamfer side length	242
	Circle center CC	None	Coordinates of the circle center or pole	244
	l and J			
C م	Circular arc C G02 and G03	Circular arc around a circle center CC to an arc end point	Coordinates of the arc end point, direction of rotation	245
مرج ^{CR}	Circular arc CR G05	Circular arc with a certain radius	Coordinates of the arc end point, arc radius, direction of rotation	246
CT 	Circular arc CT G06	Circular arc with tangential connection to the preceding and subsequent contour elements	Coordinates of the arc end point	248
	Corner rounding RND G25	Circular arc with tangential connection to the preceding and subsequent contour elements	Rounding radius R	243
FK	FK free contour programming	Straight line or circular path with any connection to the preceding contour element	"Path contours – FK free contour programming ", page 259	262

Programming path functions

You can program path functions conveniently by using the gray path function keys. In further dialogs, you are prompted by the TNC to make the required entries.



If you enter DIN/ISO functions via a connected USB keyboard, make sure that capitalization is active. At the start of the block the control automatically

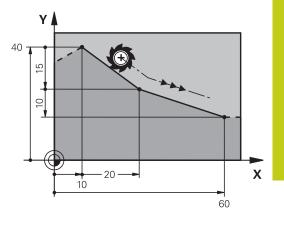
writes in capitals.

Straight line in rapid traverse G00 or straight line with feed rate F G01

The TNC moves the tool in a straight line from its current position to the straight-line end point. The starting point is the end point of the preceding block.



- Press the L key to open a program block for a linear movement with feed rate
- Coordinates of the end point of the straight line, if necessary
- Radius compensation G40/G41/G42
- Feed rate F
- Miscellaneous function M



Movement at rapid traverse

A straight line block for a rapid traverse motion (G00 block) can also be initiated with the ${\bf L}$ key:

- Press the L key to open a program block for a linear movement
- Press the left arrow key to switch to the input range for G codes
- Press the G00 soft key if you want to enter a rapid traverse motion

Example NC blocks

N80 G91 X+20 Y-15*

N70 G01 G41 X+10 Y+40 F200 M3*

N90 G90 X+60 G91 Y-10*

Capture actual position

You can also generate a straight line block (**G01** block) by using the **ACTUAL-POSITION-CAPTURE** key:

- In the Manual Operation mode, move the tool to the position you want to capture
- Switch the screen display to programming.
- Select the NC block after which you want to insert the straight line block

-+--

Press the ACTUAL-POSITION-CAPTURE key: The TNC generates a straight line block with the actual position coordinates.

6.4 Path contours — Cartesian coordinates

Inserting a chamfer between two straight lines

The chamfer enables you to cut off corners at the intersection of two straight lines.

- The line blocks before and after the G24 block must be in the same working plane as the chamfer.
- The radius compensation before and after the G24 block must be the same
- The chamfer must be machinable with the current tool
- CHF o
- Chamfer side length: Length of the chamfer, and if necessary:
- Feed rate F (effective only in G24 block)

Example NC blocks

N70 G01 G41 X+0 Y+30 F300 M3*

N80 X+40 G91 Y+5*

N90 G24 R12 F250*

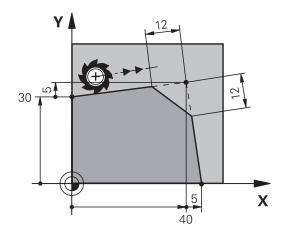
N100 G91 X+5 G90 Y+0*



You cannot start a contour with a **G24** block.

A chamfer is possible only in the working plane. The corner point is cut off by the chamfer and is not part of the contour.

A feed rate programmed in the **G24** block is effective only in that CHF block. After the **G24** block, the previous feed rate becomes effective again.



Rounded corners G25

The G25 function rounds off contour corners.

The tool moves on an arc that is tangentially connected to both the preceding and subsequent contour elements.

The rounding arc must be machinable with the called tool.

- RND o
- Rounding radius: Enter the radius, and if necessary:
- Feed F (effective only in the G25 block)

Example NC blocks

N50 G01 X+10 Y+40 G41 F300 M3*

N60 G01 X+40 Y+25*

N70 G25 R5 F100*

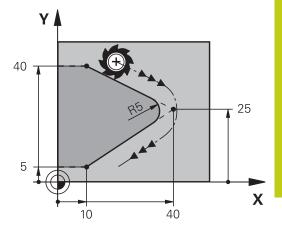
N80 G01 X+10 Y+5*

In the preceding and subsequent contour elements, both coordinates must lie in the plane of the rounding arc. If you machine the contour without tool-radius compensation, you must program both coordinates in the plane.

The corner point is cut off by the rounding arc and is not part of the contour.

A feed rate programmed in the **G25** block is effective only in that **G25** block. After the **G25** block, the previous feed rate becomes effective again.

You can also use an **G25** block for a tangential contour approach.



6.4 Path contours — Cartesian coordinates

Circle center I, J

You can define a circle center for circles that you have programmed with the **G02**, **G03** or **G05** function. This is done in the following ways:

- Entering the Cartesian coordinates of the circle center in the working plane, or
- Using the circle center defined in an earlier block, or
- Capturing the coordinates with the ACTUAL-POSITION CAPTURE key
- SPEC FCT

To program the circle center, press the SPEC FCT key

- Press the PROGRAM FUNCTIONS soft key
- Press the DIN/ISO soft key
- Press the I or J soft key
- Enter coordinates for the circle center or, if you want to use the last programmed position, G29 coordinates

Example NC blocks

N50 I+25 J+25*

or

N10 G00 G40 X+25 Y+25*

N20 G29*

The program lines 10 and 20 do not refer to the illustration.

Validity

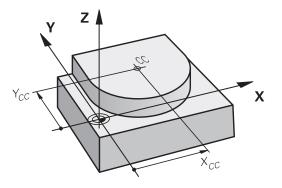
The circle center definition remains in effect until a new circle center is programmed.

Entering the circle center incrementally

If you enter the circle center with incremental coordinates, you have programmed it relative to the last programmed position of the tool.



The only effect of **I** and **J** is to define a position as circle center: The tool does not move to this position. The circle center is also the pole for polar coordinates.

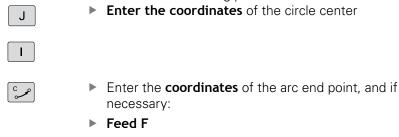


Circular path around circle center

Before programming a circular arc, you must first enter the circle center ${\bf I},\,{\bf J}.$ The last programmed tool position will be the starting point of the arc.

Direction of rotation

- In clockwise direction: G02
- In counterclockwise direction: G03
- Without programmed direction: **G05**. The TNC traverses the circular arc with the last programmed direction of rotation
- Move the tool to the circle starting point



Miscellaneous function M

The TNC normally makes circular movements in the active working plane. If you program circular arcs that do not lie in the active working plane, e.g. **G2 Z... X...** with a tool axis Z, and at the same time rotate this movement, then the TNC moves the tool in a spatial arc, which means a circular arc in 3 axes.

Example NC blocks

N50 I+25	J+25*
----------	-------

N60 G01 G42 X+45 Y+25 F200 M3*

N70 G03 X+45 Y+25*

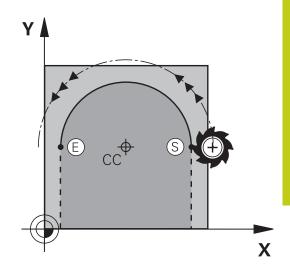
Full circle

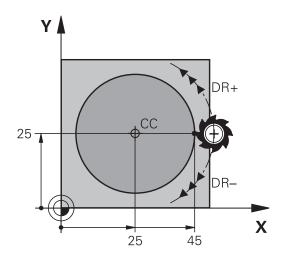
For the end point, enter the same point that you used for the starting point.

The starting and end points of the arc must lie on the circle.

The maximum value for input tolerance is 0.016 mm. Set the input tolerance in the machine parameter **circleDeviation** (no. 200901).

Smallest possible circle that the TNC can traverse: 0.0016 $\mu m.$





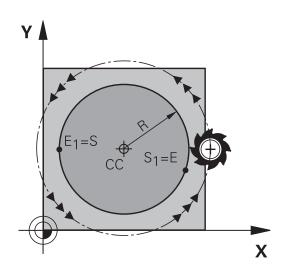
6.4 Path contours — Cartesian coordinates

CircleG02/G03/G05 with defined radius

The tool moves on a circular path with the radius R.

Direction of rotation

- In clockwise direction: G02
- In counterclockwise direction: G03
- Without programmed direction: G05. The TNC traverses the circular arc with the last programmed direction of rotation
- CR
- Coordinates of the arc end point
- Radius R (the algebraic sign determines the size of the arc)
- Miscellaneous function M
- Feed F



Full circle

For a full circle, program two blocks in succession:

The end point of the first semicircle is the starting point of the second. The end point of the second semicircle is the starting point of the first.

Central angle CCA and arc radius R

The starting and end points on the contour can be connected with four arcs of the same radius:

Smaller arc: CCA<180°

Enter the radius with a positive sign R>0

Larger arc: CCA>180°

Enter the radius with a negative sign R<0 $\,$

The direction of rotation determines whether the arc is curving outward (convex) or curving inward (concave):

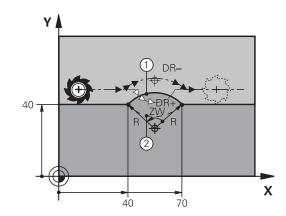
Convex: Direction of rotation ${\bf G02}$ (with radius compensation ${\bf G41})$ Concave: Direction of rotation ${\bf G03}$ (with radius compensation ${\bf G41})$

The distance from the starting and end points of the arc diameter cannot be greater than the diameter of the arc.

The maximum radius is 99.9999 m.

You can also enter rotary axes A, B and C.

The TNC normally makes circular movements in the active working plane. If you program circular arcs that do not lie in the active working plane, and at the same time rotate this movement, then the TNC moves the tool in a spatial arc, which means a circular arc in 3 axes.



Example NC blocks

N100 G01 G41 X+40 Y+40 F200 M3*

N110 G02 X+70 Y+40 R+20* (ARC 1)

or

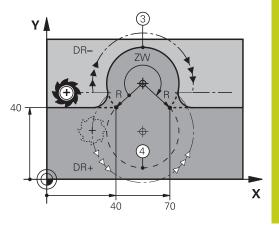
N110 G03 X+70 Y+40 R+20* (ARC 2)

or

N110 G02 X+70 Y+40 R-20* (ARC 3)

or

N110 G03 X+70 Y+40 R-20* (ARC 4)



6.4 Path contours — Cartesian coordinates

Circle G06 with tangential connection

The tool moves on an arc that starts tangentially to the previously programmed contour element.

A transition between two contour elements is called tangential when there is no kink or corner at the intersection between the two contours—the transition is smooth.

The contour element to which the tangential arc connects must be programmed immediately before the **G06** block. This requires at least two positioning blocks.



Coordinates of the arc end point, and if necessary:

- Feed F
- Miscellaneous function M



N70 G01 G41 X+0 Y+25 F300 M3*

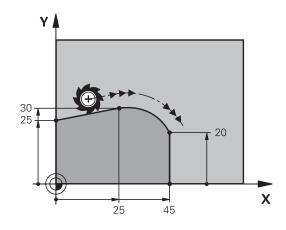
N80 X+25 Y+30*

N90 G06 X+45 Y+20*

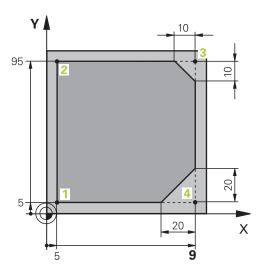
N100 G01 Y+0*



A tangential arc is a two-dimensional operation: the coordinates in the **G06** block and in the contour element preceding it must be in the same plane of the arc!



Example: Linear movements and chamfers with Cartesian coordinates

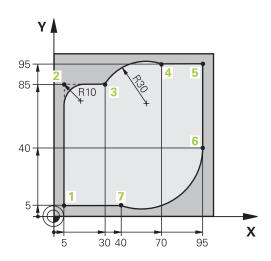


%LINEAR G71 *	
N10 G30 G17 X+0 Y+0 Z-20*	Define the workpiece blank for graphic workpiece simulation
N20 G31 G90 X+100 Y+100 Z+0*	
N30 T1 G17 S4000*	Call the tool in the spindle axis and with the spindle speed S
N40 G00 G40 G90 Z+250*	Retract the tool in the spindle axis at rapid traverse
N50 X-10 Y-10*	Pre-position the tool
N60 G01 Z-5 F1000 M3*	Move to working depth at feed rate F = 1000 mm/min
N70 G01 G41 X+5 Y+5 F300*	Approach the contour at point 1, activate radius compensation G41
N80 G26 R5 F150*	Tangential approach
N90 Y+95*	Move to point 2
N100 X+95*	Point 3: first straight line for corner 3
N110 G24 R10*	Program a chamfer with length 10 mm
N120 Y+5*	Point 4: 2nd straight line for corner 3, 1st straight line for corner 4
N130 G24 R20*	Program a chamfer with length 20 mm
N140 X+5*	Move to last contour point 1, second straight line for corner 4
N150 G27 R5 F500*	Tangential exit
N160 G40 X-20 Y-20 F1000*	Retract the tool in the working plane, cancel radius compensation
N170 G00 Z+250 M2*	Retract the tool, end program
N99999999 %LINEAR G71 *	

⁶ Programming contours

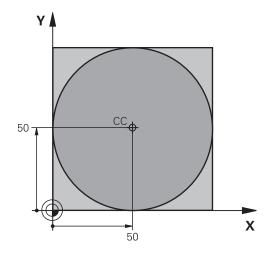
6.4 Path contours — Cartesian coordinates

Example: Circular movements with Cartesian coordinates



%CIRCULAR G71 *	
N10 G30 G17 X+0 Y+0 Z-20*	Define the workpiece blank for graphic workpiece simulation
N20 G31 G90 X+100 Y+100 Z+0*	
N30 T1 G17 S4000*	Call the tool in the spindle axis and with the spindle speed S
N40 G00 G40 G90 Z+250*	Retract the tool in the spindle axis at rapid traverse
N50 X-10 Y-10*	Pre-position the tool
N60 G01 Z-5 F1000 M3*	Move to working depth at feed rate F = 1000 mm/min
N70 G01 G41 X+5 Y+5 F300*	Approach the contour at point 1, activate radius compensation G41
N80 G26 R5 F150*	Tangential approach
N90 Y+85*	Point 2: First straight line for corner 2
N100 G25 R10*	Insert radius with R = 10 mm, feed rate: 150 mm/min
N110 X+30*	Move to point 3: Starting point of the arc
N120 G02 X+70 Y+95 R+30*	Move to point 4: End point of the arc with G02, radius 30 mm
N130 G01 X+95*	Move to point 5
N140 Y+40*	Move to point 6
N150 G06 X+40 Y+5*	Move to point 7: End point of the arc, circular arc with tangential connection to point 6, TNC automatically calculates the radius
N160 G01 X+5*	Move to last contour point 1
N170 G27 R5 F500*	Depart the contour on a circular arc with tangential connection
N180 G40 X-20 Y-20 F1000*	Retract the tool in the working plane, cancel radius compensation
N190 G00 Z+250 M2*	Retract the tool in the tool axis, end of program
N99999999 %CIRCULAR G71 *	

Example: Full circle with Cartesian coordinates



%C-CC G71 *	
N10 G30 G17 X+0 Y+0 Z-20*	Definition of workpiece blank
N20 G31 G90 X+100 Y+100 Z+0*	
N30 T1 G17 S3150*	Tool call
N40 G00 G40 G90 Z+250*	Retract the tool
N50 I+50 J+50*	Define the circle center
N60 X-40 Y+50*	Pre-position the tool
N70 G01 Z-5 F1000 M3*	Move to working depth
N80 G41 X+0 Y+50 F300*	Approach starting point, radius compensation G41
N90 G26 R5 F150*	Tangential approach
N100 G02 X+0*	Move to the circle end point (= circle starting point)
N110 G27 R5 F500*	Tangential exit
N120 G01 G40 X-40 Y-50 F1000*	Retract the tool in the working plane, cancel radius compensation
N130 G00 Z+250 M2*	Retract the tool in the tool axis, end of program
N99999999 %C-CC G71 *	

6.5 Path contours – Polar coordinates

6.5 Path contours – Polar coordinates

Overview

6

With polar coordinates you can define a position in terms of its angle **H** and its distance **R** relative to a previously defined pole **I**, **J**. Polar coordinates are useful with:

- Positions on circular arcs
- Workpiece drawing dimensions in degrees, e.g. bolt hole circles

Overview of path functions with polar coordinates

Path function key	Tool movement	Required input	Page
L + P	Straight line	Polar radius, polar angle of the straight-line end point	253
с_ + Р	Circular path around circle center/pole to arc end point	Polar angle of the arc end point,	254
	Circular path corresponding to active direction of rotation	Polar angle of the circle end point	254
Ст. + Р	Circular arc with tangential connection to the preceding contour element	Polar radius, polar angle of the arc end point	254
с + Р	Combination of a circular and a linear movement	Polar radius, polar angle of the arc end point, coordinate of the end point in the tool axis	255

Zero point for polar coordinates: pole I, J

You can set the pole (I, J) at any point in the machining program, before indicating points in polar coordinates. Set the pole in the same way as you would program the circle center.

- ► To program a pole, press the **SPEC FCT** key.
- ▶ Press the **PROGRAM FUNCTIONS** soft key
- Press the **DIN/ISO** soft key
- Press the I or J soft key
- Coordinates: Enter Cartesian coordinates for the pole or, if you want to use the last programmed position, enter G29. Before programming polar coordinates, define the pole. You can only define the pole in Cartesian coordinates. The pole remains in effect until you define a new pole.

Example NC blocks

N120 I+45 J+45*

Straight line in rapid traverse G10 or straight line with feed rate F G11

The tool moves in a straight line from its current position to the straight-line end point. The starting point is the end point of the preceding block.

L

SPEC FCT

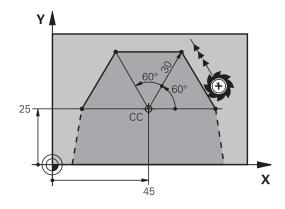
- Polar coordinate radius R: Enter the distance from the pole CC to the straight-line end point.
- Polar coordinate angle H: Angular position of the straight-line end point between -360° and +360°

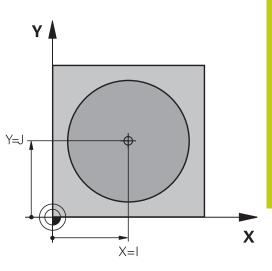
The sign of **H** depends on the angle reference axis:

- If the angle from the angle reference axis to **R** is counterclockwise: **H**>0
- If the angle from the angle reference axis to **R** is clockwise: **H**<0

Example NC blocks

N120 I+45 J+45*	
N130 G11 G42 R+30 H+0 F300 M3*	
N140 H+60*	
N150 G91 H+60*	
N160 G90 H+180*	





6.5 Path contours – Polar coordinates

Circular path G12/G13/G15 around pole I, J

The polar coordinate radius ${\bf R}$ is also the radius of the arc. ${\bf R}$ is defined by the distance from the starting point to the pole I, J. The last programmed tool position will be the starting point of the arc.

Direction of rotation

- In clockwise direction: G12
- In counterclockwise direction: G13
- Without programmed direction: G15. The TNC traverses the circular arc with the last programmed direction of rotation



Polar coordinate angle H: Angular position of the arc end point between -99999.9999° and +99999.9999°

Direction of rotation DR

Example NC blocks

N180 I+25 J+25*

N190 G11 G42 R+20 H+0 F250 M3*

N200 G13 H+180*



With incremental inputs you must enter DR and PA with the same sign.

Consider this behavior when importing programs from earlier controls. Adapt the program if required.

Circle G16 with tangential connection

The tool moves on a circular path, starting tangentially from a preceding contour element.

CT →→

Ρ

- Polar coordinate radius R: Distance between the arc end point and the pole I, J
- Polar coordinate angle H: Angular position of the arc end point.



The pole is **not** the center of the contour arc!

Example NC blocks

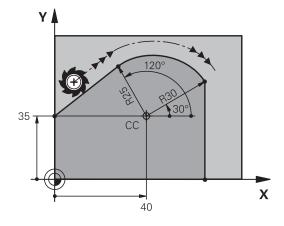
N120 I+40 J+35*

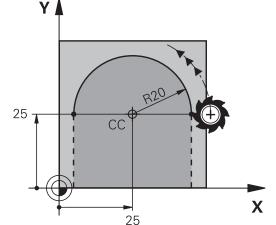
N130 G01 G42 X+0 Y+35 F250 M3*	
--------------------------------	--

N140 G11 R+25 H+120*

N150 G16 R+30 H+30*

N160 G01 Y+0*

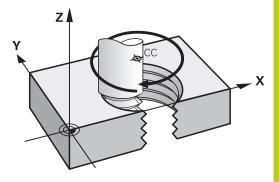




Helix

A helix is a combination of a circular movement in a main plane and a linear movement perpendicular to this plane. You program the circular path in a main plane.

A helix is programmed only in polar coordinates.



Application

- Large-diameter internal and external threads
- Lubrication grooves

Calculating the helix

To program a helix, you must enter the total angle through which the tool is to move on the helix in incremental dimensions, and the total height of the helix.

Thread revolutions n:	Thread revolutions + overrun at start and end of thread
Total height h:	Thread pitch P times thread revolutions n
Incremental total angle G91 H :	Thread revolutions x 360° + angle for beginning of thread + angle for thread overrun
Starting coordinate Z:	Pitch P times (thread revolutions + thread overrun at start of thread)

Shape of the helix

The table below illustrates in which way the shape of the helix is determined by the work direction, direction of rotation and radius compensation.

Internal thread	Work direction	Direction of rotation	Radius compensation
Right-hand	Z+	G13	G41
Left-hand	Z+	G12	G42
Right-hand	Z–	G12	G42
Left-hand	Z–	G13	G41
External thread			
Right-hand	Z+	G13	G42
Left-hand	Z+	G12	G41
Right-hand	Z–	G12	G41
Left-hand	Z–	G13	G42

6.5 Path contours – Polar coordinates

Programming a helix

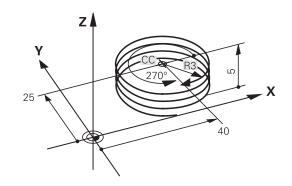
	Always enter the same algebraic sign for the direction of rotation and the incremental total angle G91 H . The tool may otherwise move in a wrong path and damage the contour.
	For the total angle G91 H you can enter a value of -99 999.9999° to +99 999.9999°.
C P	Polar coordinates angle: Enter the total angle of tool traverse along the helix in incremental dimensions. After entering the angle, specify the tool axis with an axis selection key.
	 Coordinate: Enter the coordinate for the height of the helix in incremental dimensions
	Enter the radius compensation according to the

 Enter the radius compensation according to the table

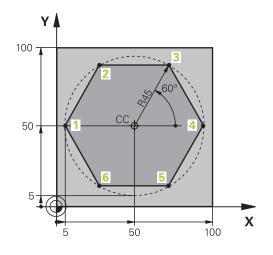
Example NC blocks: Thread M6 x 1 mm with 5 revolutions

N120 I+40 J+25* N130 G01 Z+0 F100 M3* N140 G11 G41 R+3 H+270*

N150 G12 G91 H-1800 Z+5*



Example: Linear movement with polar coordinates



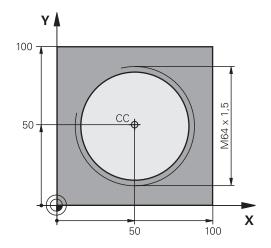
%LINEARPO G71 *	
N10 G30 G17 X+0 Y+0 Z-20*	Definition of workpiece blank
N20 G31 G90 X+100 Y+100 Z+0*	
N30 T1 G17 S4000*	Tool call
N40 G00 G40 G90 Z+250*	Define the datum for polar coordinates
N50 I+50 J+50*	Retract the tool
N60 G10 R+60 H+180*	Pre-position the tool
N70 G01 Z-5 F1000 M3*	Move to working depth
N80 G11 G41 R+45 H+180 F250*	Approach the contour at point 1
N90 G26 R5*	Approach the contour at point 1
N100 H+120*	Move to point 2
N110 H+60*	Move to point 3
N120 H+0*	Move to point 4
N130 H-60*	Move to point 5
N140 H-120*	Move to point 6
N150 H+180*	Move to point 1
N160 G27 R5 F500*	Tangential exit
N170 G40 R+60 H+180 F1000*	Retract the tool in the working plane, cancel radius compensation
N180 G00 Z+250 M2*	Retract in the spindle axis, end of program
N99999999 %LINEARPO G71 *	

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⁶ Programming contours

6.5 Path contours – Polar coordinates

Example: Helix



%HELIX G71 *	
N10 G30 G17 X+0 Y+0 Z-20*	Definition of workpiece blank
N20 G31 G90 X+100 Y+100 Z+0*	
N30 T1 G17 S1400*	Tool call
N40 G00 G40 G90 Z+250*	Retract the tool
N50 X+50 Y+50*	Pre-position the tool
N60 G29*	Transfer the last programmed position as the pole
N70 G01 Z-12,75 F1000 M3*	Move to working depth
N80 G11 G41 R+32 H+180 F250*	Approach first contour point
N90 G26 R2*	Connection
N100 G13 G91 H+3240 Z+13,5 F200*	Helical traverse
N110 G27 R2 F500*	Tangential exit
N120 G01 G40 G90 X+50 Y+50 F1000*	Retract the tool, end program
N130 G00 Z+250 M2*	
N99999999 %HELIX G71 *	

6.6 Path contours – FK free contour programming

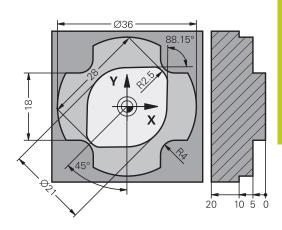
Fundamentals

Workpiece drawings that are not dimensioned for NC often contain unconventional coordinate data that cannot be entered with the gray dialog keys.

You can enter such dimensional data directly by using the free contour programming function FK, e.g.

- If there are known coordinates on or in the proximity of the contour element
- If coordinate data refers to another contour element
- If directional data and data regarding the course of the contour are known

The TNC derives the contour from the known coordinate data and supports the programming dialog with the interactive FK programming graphics. The upper right figure shows a workpiece drawing for which FK programming is the most convenient programming method.





6

The following prerequisites for FK programming must be observed:

The FK free contour programming feature can only be used for programming contour elements that lie in the working plane.

The working plane for FK programming is defined according to the following hierarchy:

- 1. Using the plane defined in an **FPOL** block
- 2. Using the working plane defined in the TOOL CALLT block (e.g. G17 = X/Y plane)
- 3. The standard X/Y plane is active if none of these applies

The display of the FK soft keys depends on the spindle axis in the workpiece blank definition. If for example you enter spindle axis **G17** in the workpiece blank definition, the TNC only shows FK soft keys for the X/Y plane.

You must enter all available data for every contour element. Even the data that does not change must be entered in every block—otherwise it will not be recognized.

Q parameters are permissible in all FK elements, except in elements with relative references (e.g. **RX** or **RAN**), or in elements that are referenced to other NC blocks.

If both FK blocks and conventional blocks are entered in a program, the FK contour must be fully defined before you can return to conventional programming.

The TNC needs a fixed point from which it can calculate the contour elements. Use the gray path function keys to program a position that contains both coordinates of the working plane immediately before programming the FK contour. Do not enter any Q parameters in this block.

If the first block of an FK contour is an **FCT** or **FLT** block, you must program at least two NC blocks with the gray path function keys to fully define the direction of contour approach.

Do not program an FK contour immediately after an L command.

FK programming graphics



If you wish to use graphic support during FK programming, select the **PROGRAM + GRAPHICS** screen layout.

Further Information: "Programming", page 78

Incomplete coordinate data often is not sufficient to fully define a workpiece contour. In this case, the TNC indicates the possible solutions in the FK graphic. You can then select the contour that matches the drawing.

The control uses various colors in the FK graphics:

blue: uniquely specified contour element

The last FK element is only shown in blue after the departure movement.

- violet: not yet uniquely specified contour element
- ocher: tool midpoint path
- red: rapid traverse
- **green:** more than one solution is possible

If the data permit several possible solutions and the contour element is displayed in green, select the correct contour element as follows:



- Press the SHOW SOLUTION soft key repeatedly until the correct contour element is displayed. Use the zoom function if you cannot distinguish possible solutions in the standard setting
- SELECT SOLUTION
- If the displayed contour element matches the drawing, select the contour element with SELECT SOLUTION

If you do not yet wish to select a green contour element, press the **START SINGLE** soft key to continue the FK dialog.



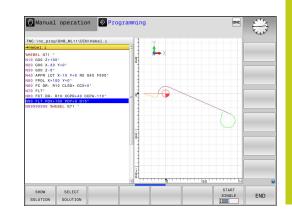
Select the green contour elements as soon as possible with the **SELECT SOLUTION** soft key. This way you can reduce the ambiguity of subsequent elements.

Showing block numbers in the graphic window

To show a block number in the graphic window:



Set the SHOW OMIT BLOCK NR. soft key to SHOW stellen (soft-key row 3)



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6.6 Path contours – FK free contour programming

Initiating the FK dialog

If you press the gray FK button, the TNC displays the soft keys you can use to initiate an FK dialog. Press the **FK** button a second time to deselect the soft keys.

If you initiate the FK dialog with one of these soft keys, the TNC shows additional soft-key rows that you can use for entering known coordinates, directional data and data regarding the course of the contour.

Soft key	FK element
FLT	Straight line with tangential connection
FL	Straight line without tangential connection
FCT	Circular arc with tangential connection
FC	Circular arc without tangential connection
FPOL	Pole for FK programming

Pole for FK programming



- ► To display the soft keys for free contour programming, press the **FK** key
- FPOL
- To initiate the dialog for defining the pole, press the FPOL soft key. The TNC then displays the axis soft keys of the active working plane
- Enter the pole coordinates using these soft keys



The pole for FK programming remains active until you define a new one using FPOL.

Free straight line programming

Straight line without tangential connection

FK

To display the soft keys for free contour programming, press the FK key

- To initiate the dialog for free programming of straight lines, press the FL soft key. The TNC displays additional soft keys
- Enter all known data in the block by using these soft keys. The FK graphic displays the programmed contour element in violet until sufficient data is entered. If the entered data describes several solutions, the graphic will display the contour element in green. Further Information: "FK programming graphics", page 261

Straight line with tangential connection

If the straight line connects tangentially to another contour element, initiate the dialog with the soft key:

- FK
- ► To display the soft keys for free contour programming, press the **FK** key
- FLT
- ► To initiate the dialog, press the **FLT** soft key
- Enter all known data in the block by using the soft keys

Free circular path programming

Circular arc without tangential connection



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- ► To display the soft keys for free contour programming, press the **FK** key
- FC
- To initiate the dialog for free programming of circular arcs, press the FC soft key. The TNC displays soft keys with which you can directly enter data on the circular arc or the circle center
- Enter all known data in the block by using these soft keys. The FK graphic displays the programmed contour element in violet until sufficient data is entered. If the entered data describes several solutions, the graphic will display the contour element in green.
 Further Information: "FK programming graphics", page 261

Circular arc with tangential connection

If the circular arc connects tangentially to another contour element, initiate the dialog with the **FCT** soft key:

FK	

To display the soft keys for free contour programming, press the FK key

- ► To initiate the dialog, press the **FCT** soft key
- Enter all known data in the block by using the soft keys

Υ

30 -

Input possibilities

End point coordinates



Cartesian coordinates X and Y

Known data



Polar coordinates referenced to FPOL

Example NC blocks

N70 FPOL X+20 Y+30*

N80 FL IX+10 Y+20 G42 F100*

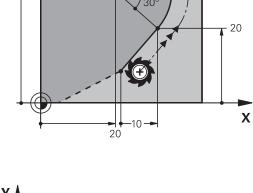
N90 FCT PR+15 IPA+30 DR+ R15*

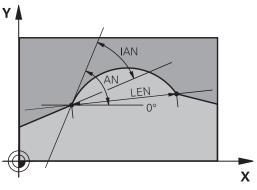
Direction and length of contour elements

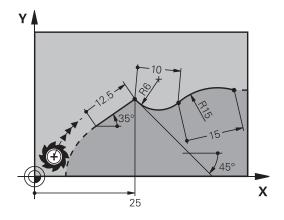
Soft keys	Known data
LEN	Length of a straight line
	Gradient angle of a straight line
LEN	Chord length LEN of an arc
AN	Gradient angle AN of an entry tangent
CCA	Center angle of an arc

Caution: Danger to the workpiece and tool! Gradient angles you defined incrementally (**IAN**) are referenced by the TNC to the direction of the last traversing block. Programs that contain incremental gradient angles and that were created on an iTNC

530 or on earlier TNCs are not compatible.







Example NC blocks

	N20 FLT	X+25 LE	N 12.5	AN+35	G41	F200*
--	---------	---------	--------	-------	-----	-------

N30 FC DR+ R6 LEN 10 AN-45*

N40 FCT DR- R15 LEN 15*

6

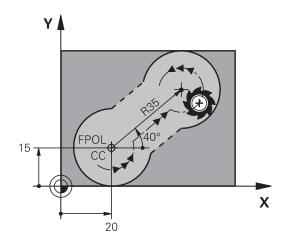
6.6 Path contours – FK free contour programming

Circle center CC, radius and direction of rotation in the FC/FCT block

The TNC calculates a circle center for free-programmed arcs from the data you enter. This makes it possible to program full circles in an FK program block.

If you wish to define the circle center in polar coordinates you must use FPOL, not **CC**, to define the pole. FPOL is entered in Cartesian coordinates and remains in effect until the control encounters a block in which another **FPOL** is defined.

> A circle center that was calculated or programmed conventionally is then no longer valid as a pole or circle center for the new FK contour: If you enter conventional polar coordinates that refer to a pole from a CC block you have defined previously, then you must enter the pole again in a CC block after the FK contour.



Soft keys	Known data
	Circle center in Cartesian coordinates
CC PR + PA + PA + Z	Center point in polar coordinates
	Rotational direction of the arc
R	Radius of an arc

Example NC blocks

N10 FC CCX+20 CCY+15 DR+ R15*	
N20 FPOL X+20 Y+15*	
N30 FL AN+40*	
N40 FC DR+ R15 CCPR+35 CCPA+40*	

Closed contours

You can identify the beginning and end of a closed contour with the **CLSD** soft key. This reduces the number of possible solutions for the last contour element.

Enter **CLSD** as an addition to another contour data entry in the first and last blocks of an FK section.



Beginning of CLSD+ contour: End of contour: CLSD–

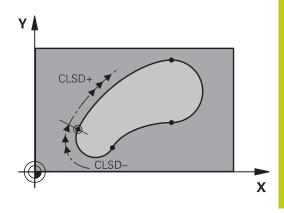
Example NC blocks

N10 G01 X+5 Y+35 G41 F500 M3*

N20 FC DR- R15 CLSD+ CCX+20 CCY+35*

•••

N30 FCT DR- R+15 CLSD-*



6.6 Path contours – FK free contour programming

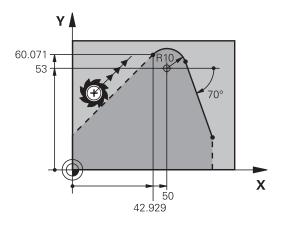
Auxiliary points

For both free-programmed straight lines and free-programmed circular arcs, you can enter the coordinates of auxiliary points that are located on the contour or in its proximity.

Auxiliary points on a contour

The auxiliary points are located on the straight line, the extension of the straight line, or on the circular arc.

Soft keys		Known data	
PIX	PZX	X coordinate of an auxiliary point P1 or P2 of a straight line	
PIY	PZY	Y coordinate of an auxiliary point P1 or P2 of a straight line	
P1X	P2X P3X	X coordinate of an auxiliary point P1, P2 or P3 of a circular path	
PIY	P2Y P3Y	Y coordinate of an auxiliary point P1, P2 or P3 of a circular path	



Auxiliary points near a contour

Soft keys	Known data
	X and Y coordinates of the auxiliary point near a straight line
	Distance of auxiliary point to straight line
	X and Y coordinates of an auxiliary point near a circular arc
	Distance of auxiliary point to circular arc

Example NC blocks

N10 FC DR- R10 P1X+42.929 P1Y+60.071*

N20 FLT AN-70 PDX+50 PDY+53 D10*

Relative data

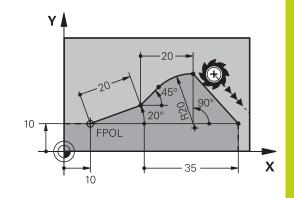
Relative data are values based on another contour element. The soft keys and program words for relative entries begin with the letter \mathbf{R} . The figure on the right shows the dimensional data that should be programmed as relative data.



The coordinates and angles for relative data are always programmed in incremental dimensions. You must also enter the block number of the contour element on which the data are based.

The block number of the contour element on which the relative data are based can only be located up to 64 positioning blocks before the block in which you program the reference.

If you delete a block on which relative data are based, the TNC will display an error message. Change the program first before you delete the block.



Data relative to block N: End point coordinates

Soft keys

2

Known data Cartesian coordinates relative to block N

RX N	RY N	
RPR N	RPA N	Polar coordinates relative to block N

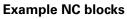
Example NC blocks

N10 FPOL X+10 Y+10*
N20 FL PR+20 PA+20*
N30 FL AN+45*
N40 FCT IX+20 DR- R20 CCA+90 RX 20*
N50 FL IPR+35 PA+0 RPR 20*

6.6 Path contours – FK free contour programming

Data relative to block N: Direction and distance of the contour element

Soft key	Known data	
RAN N	Angle between a straight line and another element or between the entry tangent of the arc and another element	
PAR N	Straight line parallel to another contour element	
DP	Distance from a straight line to a parallel contour element	



• • • • • • • • • • • • • • • • • • • •
N10 FL LEN 20 AN+15*
N20 FL AN+105 LEN 12.5*
N30 FL PAR 10 DP 12.5*
N40 FSELECT 2*
N50 FL LEN 20 IAN+95*
N60 FL IAN+220 RAN 20*

Data relative to block N: Circle center CC

Soft key

RCCX N.

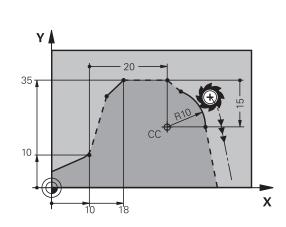
RCCPR N.

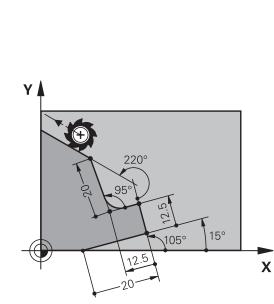
Known data

•••	RCCY N	Cartesian coordinates of the circle center relative to block N
	RCCPA N	Polar coordinates of the circle center relative to block N

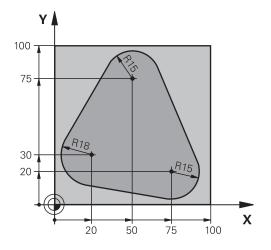
Example NC blocks

N10 FL X+10 Y+10 G41*
N20 FL*
N30 FL X+18 Y+35*
N40 FL*
N50 FL*
N60 FC DR- R10 CCA+0 ICCX+20 ICCY-15 RCCX10 RCCY30*





Example: FK programming 1



%FK1 G71 *	
N10 G30 G17 X+0 Y+0 Z-20*	Definition of workpiece blank
N20 G31 X+100 Y+100 Z+0*	
N30 T 1 G17 S500*	Tool call
N40 G00 G90 Z+250 G40 M3*	Retract the tool
N50 G00 X-20 Y+30 G40*	Pre-positioning the tool
N60 G01 Z-10 G40 F1000*	Move to working depth
N70 APPR CT X+2 Y+30 CCA90 R+5 G41 F250*	Approach the contour on a circular arc with tangential connection
N80 FC DR- R18 CLSD+ CCX+20 CCY+30*	FK contour section:
N90 FLT*	Program all known data for each contour element
N100 FCT DR- R15 CCX+50 CCY+75*	
N110 FLT*	
N120 FCT DR- R15 CCX+75 CCY+20*	
N130 FLT*	
N140 FCT DR- R18 CLSD- CCX+20 CCY+30*	
N150 DEP CT CCA90 R+5 F2000*	Depart the contour on a circular arc with tangential connection
N160 G00 X-30 Y+0*	
N170 G00 Z+250 M2*	Retract the tool, end program
N99999999 %FK1 G71 *	

6

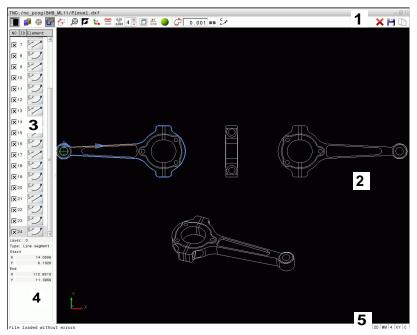
7.1 CAD viewer and DXF converter screen layout

7.1 CAD viewer and DXF converter screen layout

Fundamentals of the CAD viewer and DXF converter

Screen display

If you open the CAD viewer or DXF converter, the following screen layout is displayed:



- 1 Menu bar
- 2 Graphics window
- 3 List View window
- 4 Window element information
- 5 Status bar

File formats

The CAD viewer and DXF converter allow you to open standardized CAD data formats directly on the TNC.

The TNC displays the following file formats:

File	Туре	Format
Step	.STP and .STEP	AP 203
		AP 214
IGES	.IGS and .IGES	Version 5.3
DXF	.DXF	■ R10
		R12
		R13
		2000
		2002

7.2 CAD viewer

Application

The file can simply be selected via the file manager of the TNC, just like NC programs. This allows you to view models quickly and easily.

The datum can be positioned anywhere in the model. Starting from this datum, element information such as centers of circles can be shown.

The following icons are available:

lcon	Setting
	Show or hide the Window List view to expand the Graphics window
1	Display of the various layers
() () ()	Set the datum or delete set datum
X	
\odot	Set the zoom to the largest possible view of the complete graphics
A	Change the background color (black or white)
0,01 0,001	Set resolution: The resolution specifies how many decimal places the TNC will use when generating the contour program.
	Default setting: 4 decimal places with mm and 5 decimal places with inch
	Switch between various views of the model e.g. Top

7.3 DXF converter (option 42)

7.3 DXF converter (option 42)

Application

DXF files can be opened directly by the TNC, in order to extract contours or machining positions, and save them as conversational programs or as point files. Conversational programs acquired in this manner can also be run by older TNC controls, since these contour programs contain only **L** and **CC/C** blocks.

If you process DXF files in **Programming** mode, the TNC generates contour programs with the file extension **.H** and point files with the extension **.PNT** by default. You can choose the desired file type in the save dialog. To add a selected contour or a selected machining position directly in an NC program, use the TNC clipboard.

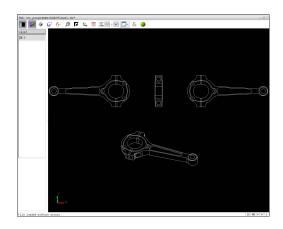


The file to be processed must be stored on the hard disk of your TNC.

Before loading the file to the TNC, ensure that the name of the file does not contain any blank spaces or impermissible special characters.

Further Information: "File names", page 129 The TNC does not support binary DXF format. When generating the DXF file from a CAD or drawing program, make sure that you save the file in ASCII

format. The TNC supports the following types of file formats: **Further Information:** "Fig. X", page



Working with the DXF converter

	\$

You cannot use the DXF converter without a mouse or touch pad. All operating modes and functions as well as contours and machining positions can only be selected with the mouse or touch pad.

The DXF converter runs as a separate application on the third desktop of the TNC. This enables you to use the screen switchover key to switch between the machine operating modes, the programming modes and the DXF converter as desired. This is particularly useful if you want to add contours or machining positions by copying using the clipboard in a conversational program.

Opening a DXF file

- €
- Operating mode: Press the **Programming** key
- PGM MGT
- ► To call the file manager, press the **PGM MGT** key

CAL

- In order to see the soft key menu for selecting the file types to be displayed, press the SELECT TYPE soft key
- In order to show all CAD files, press the SHOW CAD soft key
- Select the directory in which the CAD file is saved



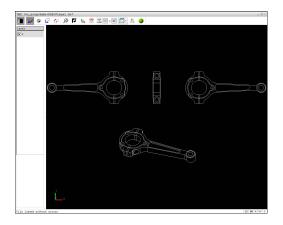
- Select the desired CAD file
- Load it with the ENT key. The TNC starts the DXF converter and shows the contents of the file on the screen. In the List View window, the TNC shows the layers (planes) and it shows the drawing in the Graphics window

7.3 DXF converter (option 42)

Basic settings

The basic settings specified below are selected using the icons in the toolbar.

lcon	Setting
	Show or hide the Window List view to expand the Graphics window
1	Display of the various layers
G	Select the contour
*-	Select hole positions
	Set datum
\odot	Set the zoom to the largest possible view of the complete graphics
	Change the background color (black or white)
₩.	Switch between 2-D and 3-D mode. The active mode is color-highlighted
inch	Set the unit of measure, mm or inch , for the file. The TNC then outputs the contour program and the machining positions in this unit of measure. The active unit of measure is highlighted in red
0,01 0,001	Set resolution: The resolution specifies how many decimal places the TNC will use when generating the contour program. Default setting: 4 decimal places with mm and 5 decimal places with inch
	Switch between various views of the model e.g. Top



The following icons are displayed by the TNC only in certain modes.

lcon	Setting
<u>ل</u>	Contour assumption mode: The tolerance specifies how far apart neighboring contour elements may be from each other. You can use the tolerance to compensate for inaccuracies that occurred when the drawing was made. The default setting is 0.001 mm
W	Point assumption mode: Specify whether the TNC should display the tool path as a dashed straight line during selection of machining positions
<i>∛</i> -•†	Path optimization mode: The TNC optimizes the tool traverse movement to give the shortest traverse movements between the machining positions. Optimization is reset with repeated actuations
C CR	Arc mode: Arc mode determines whether circles should be produced in C format or CR format, e.g. for cylinder coat interpolations in the NC program.
	Please note that you must set the correct unit of measurement, since the DXF file does not contain any such information. If you want to generate programs for older TNC controls, you must limit the resolution to three decimal places. In addition, you must remove the comments that the DXF converter inserts into the contour program. The TNC displays the active basic settings in the footer of the screen.

7.3 DXF converter (option 42)

Setting layers

DXF files usually contain several layers. The designer uses these layers to create groups of various types of elements, e.g. the actual workpiece contour, dimensions, auxiliary and design lines, shadings, and texts.

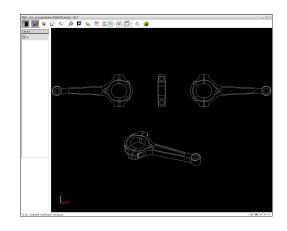
So that little unnecessary information appears on the screen during selection of the contours, you can hide all excessive layers contained in the DXF file.



The DXF file to be processed must contain at least one layer. Elements not assigned to a layer are automatically moved by the TNC to the anonymous layer.

You can even select a contour if the designer has saved it on different layers.

- Select the mode for the layer settings: In the List View window the TNC shows all layers contained in the active DXF file
- Hide a layer: Select the layer with the left mouse button, and click its check box to hide it Alternatively, use the space key
- Show a layer: Select the layer with the left mouse button, and click on its check box to show it. Alternatively, use the space key



Setting a datum

The datum of the drawing for the DXF file is not always located in a manner that lets you use it directly as a datum for the workpiece. Therefore, the TNC has a function with which you can shift the drawing datum to a suitable location by clicking an element.

You can define a datum at the following locations:

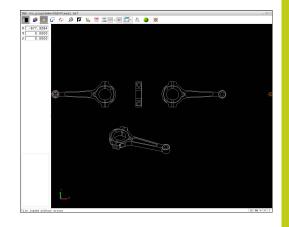
- By directly inputting numerical values into the List View window
- At the beginning, end or center of a straight line
- At the beginning, center or end of a circular arc
- At the transition between quadrants or at the center of a complete circle
- At the intersection between:
 - A straight line and a straight line, even if the intersection is actually on the extension of one of the lines
 - Straight line circular arc
 - Straight line full circle
 - Circle circle (regardless of whether a circular arc or a full circle)

You must use the touchpad or a connected mouse in order to specify a reference point.

You can also change the reference point once you have already selected the contour. The TNC does not calculate the actual contour data until you save the selected contour in a contour program.

Selecting a datum on a single element

- Select the mode for specifying the datum
- Click the desired element with the mouse: The TNC indicates possible locations for datums on the selected element with stars
- Click the star you want to select as reference point. The TNC sets the reference-point symbol to the selected location. If the selected element is too small, then use the zoom function.



7.3 DXF converter (option 42)

Selecting a datum on the intersection of two elements

- Select the mode for specifying the datum
 - Click the first element (straight line, complete circle or circular arc) with the left mouse button. The TNC indicates possible locations for datums on the selected element with stars. The element is color-highlighted
 - Click on the second element (straight line, complete circle or circular arc) with the left mouse button. The TNC sets the datum symbol on the intersection

The TNC calculates the intersection of two elements even if it is on the extension of one of these elements.

If the TNC calculates multiple intersections, it selects the intersection nearest the mouse-click on the second element.

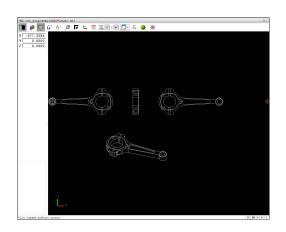
If the TNC cannot calculate an intersection, it rescinds the marking of the element.

If a datum is set, the color of the icon changes Setting a datum.

Delete a datum by clicking on the \cancel{M} icon.

Element Information

In the Element Information window, the TNC shows how far the datum you haven chosen is located from the drawing datum.



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Selecting and saving a contour

You must use the touchpad on the TNC keyboard or a mouse attached via the USB port in order to select a contour.

Specify the direction of rotation during contour selection so that it matches the desired machining direction.

Select the first contour element such that approach without collision is possible.

If the contour elements are very close to one another, use the zoom function.

The following DXF elements are selectable as contours:

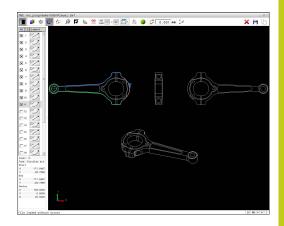
- LINE (straight line)
- CIRCLE (complete circle)
- ARC (circular arc)
- POLYLINE

Ellipses and splines can be used for intersections but cannot be selected. If you select ellipses or splines, these are displayed in red.

Element information

In the Element Information window the TNC displays a range of information about the last contour element that you highlighted in the List View window or in the Graphics window.

- Layer: Indicates the layer you are currently on
- **Type**: Indicates the current element type, e.g. line
- **Coordinates**: Shows the starting point and end point of an element, and circle center and radius where appropriate



7.3 DXF converter (option 42)

- Select the mode for selecting a contour: The Graphics window is active for contour selection
- To select a contour element: Click the desired element with the mouse. The TNC displays the machining sequence as a dashed straight line. Position the mouse on the other side of the center point of an element to modify the machining sequence. Select the element with the left mouse button. The selected contour element turns blue. If further contour elements in the selected machining sequence are selectable, these elements turn green
- If further contour elements in the selected ► machining sequence are selectable, the TNC highlights these elements in green. With divergences, the element with the lowest angle distance is selected. Click on the last green element to assume all elements into the contour program
- ▶ The TNC shows all selected contour elements in the List View window. The TNC displays elements that are still green in the NC column without a check mark. The TNC does not save these elements to the contour program. You can also confirm the highlighted elements in the contour program by clicking in the List View window
- If necessary you can also deselect elements that you already selected by clicking the element in the graphic window again, but this time while pressing the CTRL key. You can deselect all selected elements by clicking the icon
- Save the selected contour elements to the clipboard of the TNC so that you can then insert the contour in a conversational program; or
- To save the selected contour elements in a conversational program, enter any file name, the file type and target directory in the pop-up window displayed by the TNC.
- Confirm the entry: The TNC saves the contour program to the selected directory
- If you want to select more contours, press the Cancel Selected Elements soft key and select the next contour as described above







The TNC also transfers two workpiece-blank definitions (**BLK FORM**) to the contour program. The first definition contains the dimensions of the entire DFX file. The second one, which is the active one, contains only the selected contour elements, so that an optimized size of the workpiece blank results.

The TNC only saves elements that have actually been selected (blue elements), which means that they have been given a check mark in the List View window.

Dividing, extending and shortening contour elements

Proceed as follows to modify contour elements:

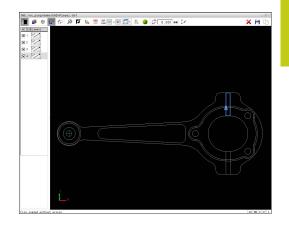


- The Graphics window is active for the contour selection
- To select the starting point: Select an element or the intersection between two elements (using the shift key). A red star is displayed as the starting point.
- To select the next contour element: Click the desired element with the mouse. The TNC displays the machining sequence as a dashed straight line. When the element is selected the TNC displays it in blue. If the elements cannot be connected the TNC displays the selected element in gray.
- If further contour elements in the selected machining sequence are selectable, the TNC highlights these elements in green. With divergences, the element with the lowest angle distance is selected. Click on the last green element to assume all elements into the contour program



You select the machining sequence of the contour with the first contour element.

If the contour element to be extended or shortened is a straight line, then the TNC extends/shortens the contour element along the same line. If the contour element to be extended or shortened is a circular arc, then the TNC extends/shortens the contour element along the same arc.



7.3 DXF converter (option 42)

Selecting and saving machining positions

You must use the touchpad on the TNC keyboard or a mouse attached via the USB port in order to select a machining position.

If the positions to be selected are very close to one another, use the zoom function.

If required, configure the basic settings so that the TNC shows the tool paths.

Further Information: "Basic settings", page 278

Three possibilities are available in the pattern generator for defining machining positions:

Single selection: You select the desired machining position through individual mouse clicks.

Further Information: "Single selection", page 287

Rapid selection of hole positions with the mouse area: By dragging the mouse to define an area, you can select all the hole positions within this area.
Further Information: "Banid selection of hole positions with the select

Further Information: "Rapid selection of hole positions with the mouse area", page 288

 Quick selection of hole positions via an icon: Click on the icon and the TNC then displays all existing hole diameters.
 Further Information: "Rapid selection of hole positions via icon", page 289

Select the file type

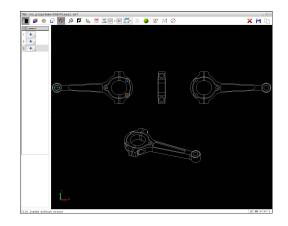
The following file types are available:

- Point table (.PNT)
- Klartext conversational language program (.H)

If you save the machining positions to a plain-language program, the TNC creates a separate linear block with cycle call for every machining position (L X... Y... M99). You can also transfer this program to old TNC controls and run it there.



The point tables (.PNT) of the TNC 640 and iTNC 530 are not compatible. Transferring and processing on the other control type in each case may lead to problems and unforeseen performance.

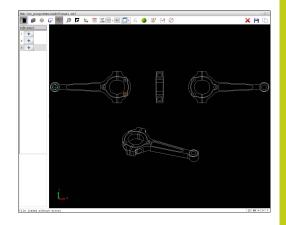


Single selection



 Select the mode for choosing a machining position. The Graphics window becomes active for position selection

- To select a machining position: Click the desired element with the mouse and the TNC displays the element in orange. If the shift key is pressed at the same time, the TNC indicates possible machining positions on the element with stars. If you click a circle, the TNC loads the circle center as machining position. If the shift key is pressed at the same time, the TNC indicates possible machining positions with stars. The TNC loads the selected position into the List View window (displays a point symbol).
- If necessary you can also deselect elements that you already selected by clicking the element in the graphic window again, but this time while pressing the CTRL key. Alternatively, select the element in the List View window and press DEL. You can deselect all selected elements by clicking the icon
- If you want to specify the machining position at the intersection of two elements, click the first element with the left mouse button: the TNC displays stars at the selectable machining positions.
- Click on the second element (straight line, complete circle or circular arc) with the left mouse button. The TNC loads the intersection of the elements into the List View window (displays a point symbol). If there are several intersections, the TNC takes the intersection nearest to the mouse.
- Save the selected machining positions to the clipboard of the TNC so that you can then insert them as a positioning block with cycle call in a Klartext conversational language program, or
- To save the selected machining positions in a point file: The TNC displays a pop-up window for you to enter any file name, the file type and target directory.
- Confirm the entry: The TNC saves the contour program to the selected directory
- If you want to select more machining positions, press the Cancel Selected Elements icon and select as described above



7.3 DXF converter (option 42)

Rapid selection of hole positions with the mouse area

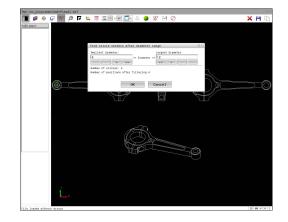


 Select the mode for choosing a machining position: The Graphics window is active for position selection

- To select machining positions, press the shift key and define an area with the left mouse button. The TNC assumes all complete circles that are completely within the area as hole positions: The TNC opens a window in which you can filter the holes by size
- Configure the filter settings and click the OK button to confirm: The TNC loads the selected positions into the List View window (displays a point symbol).

Further Information: "Filter settings", page 290

- If necessary you can also deselect elements that you already selected by clicking the element in the graphic window again, but this time while pressing the CTRL key. Alternatively, select the element in the List View window and press DEL. If necessary you can also deselect elements that you already selected, by dragging an area open again, but this time while pressing the CTRL key
- Save the selected machining positions to the clipboard of the TNC so that you can then insert them as a positioning block with cycle call in a Klartext conversational language program, or
- To save the selected machining positions in a point file: The TNC displays a pop-up window for you to enter any file name, the file type and target directory.
- Confirm the entry: The TNC saves the contour program to the selected directory
- If you want to select more machining positions, press the Cancel Selected Elements icon and select as described above



Rapid selection of hole positions via icon

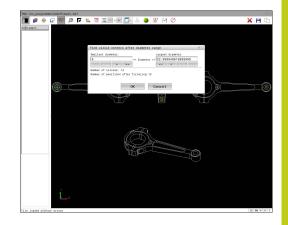
ť-

 Select the mode for choosing a machining position: The Graphics window is active for position selection

- Select the icon: The TNC opens a window in which you can filter the holes by size
- Configure the filter settings if required and click the OK button to confirm: The TNC loads the selected positions into the List View window (displays a point symbol).

Further Information: "Filter settings", page 290

- If necessary you can also deselect elements that you already selected by clicking the element in the graphic window again, but this time while pressing the CTRL key. Alternatively, select the element in the List View window and press DEL. You can deselect all selected elements by clicking the icon
- Save the selected machining positions to the clipboard of the TNC so that you can then insert them as a positioning block with cycle call in a plain-language program, or
- To save the selected machining positions in a point file: The TNC displays a pop-up window for you to enter any file name, the file type and target directory.
- Confirm the entry: The TNC saves the contour program to the selected directory
- If you want to select more machining positions, press the Cancel Selected Elements icon and select as described above



Data transfer from CAD files

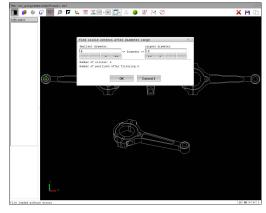
7.3 DXF converter (option 42)

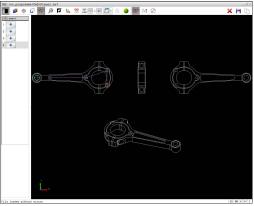
Filter settings

After you have used the quick selection function to mark hole positions, a pop-up window appears in which the smallest diameter found is to the left and the largest diameter to the right. With the buttons just below the diameter display you can adjust the diameter so that you can load the hole diameters that you want.

The following buttons are available:

lcon	Filter setting of smallest diameter
1<<	Display the smallest diameter found (default setting)
<	Display the next smaller diameter found
>	Display the next larger diameter found
>>	Display the largest diameter found. The TNC sets the filter for the smallest diameter to the value set for the largest diameter
1	
lcon	Filter setting of largest diameter
lcon <<	Filter setting of largest diameter Display the smallest diameter found. The TNC sets the filter for the largest diameter to the value set for the smallest diameter
	Display the smallest diameter found. The TNC sets the filter for the largest diameter to the
<<	Display the smallest diameter found. The TNC sets the filter for the largest diameter to the value set for the smallest diameter





You can have the tool paths displayed by clicking the **SHOW TOOL PATH** icon.

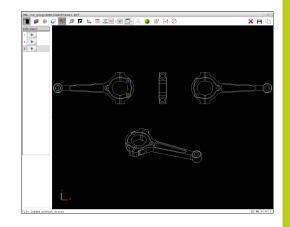
Further Information: "Basic settings", page 278

Element information

In the Element Information window, the TNC displays the coordinates of the machining position that you last selected in the List View window or Graphics window by clicking on the mouse.

You can also use the mouse to change the graphic display. The following functions are available:

- In order to rotate the model shown in three dimensions: Hold down the right mouse button down and move the mouse
- To shift the model shown: Hold the center mouse button or the wheel button down and move the mouse.
- To zoom in on a certain area: Mark a zoom area by holding the left mouse button down. After you release the left mouse button, the TNC zooms in on the defined area
- To rapidly magnify and reduce any area: Rotate the mouse wheel backwards or forwards
- To return to the standard display: Press the shift key and simultaneously double-click with the right mouse key. The rotation angle is maintained if you only double-click with the right mouse key





8.1 Labeling subprograms and program section repeats

8.1 Labeling subprograms and program section repeats

Subprograms and program section repeats enable you to program a machining sequence once and then run it as often as necessary.

Label

The beginnings of subprograms and program section repeats are marked in a part program by labels **(G98 L)**.

A LABEL is identified by a number between 1 and 65535 or by a name you define. Each LABEL number or LABEL name can be set only once in the program with the **LABEL SET** key or by entering **G98**. The number of label names you can enter is only limited by the internal memory.



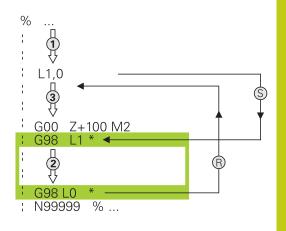
Do not use a label number or label name more than once!

Label 0 (**G98 L0**) is used exclusively to mark the end of a subprogram and can therefore be used as often as desired.

8.2 Subprograms

Operating sequence

- 1 The TNC executes the part program up to calling a subprogram, **Ln.0**.
- 2 The subprogram is then executed from beginning to end, **G98 L0**.
- 3 The TNC then resumes the part program from the block after the subprogram call **Ln.0**



Programming notes

- A main program can contain any number of subprograms
- You can call subprograms in any sequence and as often as desired
- A subprogram cannot call itself
- Write subprograms after the block with M2 or M30
- If subprograms are located before the block with M2 or M30 in the part program, they will be executed at least once even if they are not called

⁸ Subprograms and program section repeats

8.2 Subprograms

Program the subprogram

- ▶ To mark the beginning: Press the LBL SET key
 - Enter the subprogram number. If you want to use a label name, press the LBL NAME soft key to switch to text entry.
 - Enter the text
 - Mark the end: Press the LBL SET key and enter the label number 0

Calling a subprogram

LBL CALL

LBL SET

- Call a subprogram: Press the LBL CALL key
- Enter the subprogram number of the subprogram you wish to call. If you want to use a label name, press the LBL NAME soft key to switch to text entry.

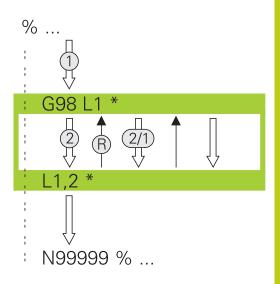


L 0 is not permitted (Label 0 is only used to mark the end of a subprogram).

8.3 **Program-section repeats**

Label G98

The beginning of a program section repeat is marked by the label **G98 L**. The end of a program section repeat is identified by **Ln,m**.



Operating sequence

- 1 The TNC executes the part program up to the end of the program section (**Ln,m**)
- 2 Then the program section between the called LABEL and the label call **Ln,m** is repeated the number of times entered after **m**
- 3 The TNC resumes the part program after the last repetition

Programming notes

- You can repeat a program section up to 65 534 times in succession
- The total number of times the program section is executed is always one more than the programmed number of repeats, because the first repeat starts after the first machining process.

8.3 **Program-section repeats**

Programming a program section repeat

LBL SET

- To mark the beginning, press the LBL SET key and enter a LABEL NUMBER for the program section you wish to repeat. If you want to use a label name, press the LBL NAME soft key to switch to text entry.
- Enter the program section

Calling a program section repeat

- LBL CALL
- Call a program section: Press the LBL CALL key
- Enter the program section number of the program section to be repeated. If you want to use a LABEL name, press the LBL NAME soft key to switch to text entry
- Enter the number of repeats REP and confirm with the ENT key.

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8.4 Any desired program as subprogram

Overview of the soft keys

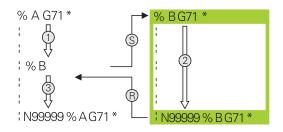
If the $\ensuremath{\text{PGM}}$ CALL key is pressed, the TNC displays the following soft keys:

Soft key	Function
CALL PROGRAM	Call a program with %
SELECT DATUM TABLE	Select a datum table with %:TAB:
SELECT POINT TABLE	Select a point table with %:PAT:
SELECT	Select a contour program with %:CNT:
SELECT PROGRAM	Select a program with %:PGM:
CALL SELECTED PROGRAM	Select last selected file with %<>%

8.4 Any desired program as subprogram

Operating sequence

- 1 The TNC executes the part program up to the block in which another program is called with **%**
- 2 Then the other part program is run from beginning to end
- 3 The TNC then resumes the first part program (i.e. the calling program) with the block after the program call



Programming notes

- The TNC does not need any labels to call any part program
- The called program must not contain the miscellaneous functions M2 or M30. If you have defined subprograms with labels in the called part program, you then need to replace M2 or M30 with the D09 P01 +0 P02 +0 P03 99 jump function to force a jump over this program section
- The called part program must not contain a % call into the calling part program, otherwise an infinite loop will result

Calling any program as a subprogram

Danger of collision!

Coordinate transformations that you define in the called program also remain in effect for the calling program too, unless you reset them.

If the program you want to call is located in the same directory as the program you are calling it from, then you only need to enter the program name.

If the program called is not located in the same directory as the program you are calling it from, you must enter the complete path, for example **TNC**: \ZW35\SCHRUPP\PGM1.H

If you want to call a DIN/ISO program, enter the file type .I after the program name.

You can also call a program with Cycle G39.

As a rule, Q parameters are effective globally with a program call with %. So please note that changes to Q parameters in the called program also influence the calling program.

Call a program with Calling a program

The % function calls any program as a subprogram. The control runs the called program from the position where it was called in the program.

- PGM CALL
- ▶ To select the functions for program call, press the PGM CALL key



Press the CALL PROGRAM soft key: The TNC starts the dialog for defining the program to be called. Enter the path name with the keyboard

or

SELECT FILE

Press the SELECT FILE soft key: The TNC displays a selection window in which you can select the program to be called; confirm with the**ENT** key

8.4 Any desired program as subprogram

Call with SELECT PROGRAM and CALL SELECTED PROGRAM

Use the function %:PGM to select any program as a subprogram and call it at another position in the program. The control runs the called program from the position where it was called in the program with %<>%.

The **%:PGM:** function is also permitted with string parameters, so that you can dynamically control program calls.

To select the program, proceed as follows:



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▶ To select the functions for program call, press the PGM CALL key

SELECT PROGRAM Press the SELECT PROGRAM soft key: The TNC starts the dialog for defining the program to be called



Press the SELECT FILE soft key: The TNC displays a selection window in which you can select the program to be called; confirm with the**ENT** key

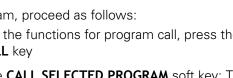
To call the selected program, proceed as follows:

PGM CALL

CALL SELECTED

PROGRAM

- ▶ To select the functions for program call, press the PGM CALL key
- Press the CALL SELECTED PROGRAM soft key: The TNC calls the last program selected with %<>%



8.5 Nesting

Types of nesting

- Subprogram calls in subprograms
- Program-section repeats within a program-section repeat
- Subprogram calls in program section repeats
- Program-section repeats in subprograms

Nesting depth

The nesting depth is the number of successive levels in which program sections or subprograms can call further program sections or subprograms.

- Maximum nesting depth for subprograms: 19
- Maximum nesting depth for main program calls: 19, where a G79 acts like a main program call
- You can nest program section repeats as often as desired

⁸ Subprograms and program section repeats

8.5 Nesting

Subprogram within a subprogram

Example NC blocks

%UPGMS G71 *	
N17 L "UP1",0*	Subprogram at label G98 L1 is called
N35 G00 G40 Z+100 M2*	Last program block of the
	main program with M2
N36 G98 L "UP1"	Beginning of subprogram SP1
N39 L2,0*	Subprogram at label G98 L2 is called
N45 G98 L0*	End of subprogram 1
N46 G98 L2*	Beginning of subprogram 2
N62 G98 L0*	End of subprogram 2
N99999999 %UPGMS G71 *	

Program execution

- 1 Main program UPGMS is executed up to block 17.
- 2 Subprogram SP1 is called, and executed up to block 39.
- 3 Subprogram 2 is called, and executed up to block 62. End of subprogram 2 and return jump to the subprogram from which it was called.
- 4 Subprogram 1 is called, and executed from block 40 up to block 45. End of subprogram 1 and return jump to the main program UPGMS.
- 5 Main program UPGMS is executed from block 18 up to block 35. Return jump to block 1 and end of program.

Repeating program section repeats

Example NC blocks

%REPS G71 *	
N15 G98 L1*	Beginning of program section repeat 1
N20 G98 L2*	Beginning of program section repeat 2
N27 L2,2*	Program section call with two repeats
N35 L1,1*	Program section between this block and G98 L1
	(block N15) is repeated once
N99999999 %REPS G71 *	

Program execution

- 1 Main program REPS is executed up to block 27.
- 2 Program section between block 27 and block 20 is repeated twice.
- 3 Main program REPS is executed from block 28 to block 35.
- 4 Program section between block 35 and block 15 is repeated once (including the program section repeat between 20 and block 27).
- 5 Main program REPS is executed from block 36 to block 50. Return jump to block 1 and end of program.

8.5 Nesting

Repeating a subprogram

Example NC blocks

%UPGREP G71 *	
N10 G98 L1*	Beginning of program section repeat 1
N11 L2,0*	Subprogram call
N12 L1,2*	Program section call with two repeats
N19 G00 G40 Z+100 M2*	Last block of the main program with M2
N20 G98 L2*	Beginning of subprogram
N28 G98 L0*	End of subprogram
N99999999 %UPGREP G71 *	

Program execution

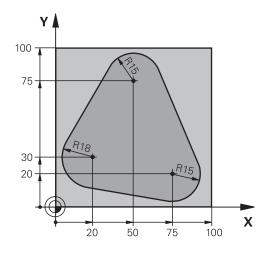
- 1 Main program UPGREP is executed up to block 11.
- 2 Subprogram 2 is called and executed.
- 3 Program section between block 12 and block 10 is repeated twice. This means that subprogram 2 is repeated twice.
- 4 Main program UPGREP is executed from block 13 up to block19. Return jump to block 1 and end of program.

8.6 Programming examples

Example: Milling a contour in several infeeds

Program run:

- Pre-position the tool to the workpiece surface
- Enter the infeed depth in incremental values
- Contour milling
- Repeat infeed and contour-milling



%PGMREP G71 *	
N10 G30 G17 X+0 Y+0 Z-40*	
N20 G31 G90 X+100 Y+100 Z+0*	
N30 T1 G17 S3500*	Tool call
N40 G00 G40 G90 Z+250*	Retract the tool
N50 I+50 J+50*	Set pole
N60 G10 R+60 H+180*	Pre-position in the working plane
N70 G01 Z+0 F1000 M3*	Pre-position to the workpiece surface
N80 G98 L1*	Set label for program section repeat
N90 G91 Z-4*	Infeed depth in incremental values (in space)
N100 G11 G41 G90 R+45 H+180 F250*	First contour point
N110 G26 R5*	Contour approach
N120 H+120*	
N130 H+60*	
N140 H+0*	
N150 H-60*	
N160 H-120*	
N170 H+180*	
N180 G27 R5 F500*	Contour departure
N190 G40 R+60 H+180 F1000*	Retract tool
N200 L1,4*	Return jump to label 1; section is repeated a total of 4 times
N200 G00 Z+250 M2*	Retract the tool, end program
N99999999 %PGMWDH G71 *	

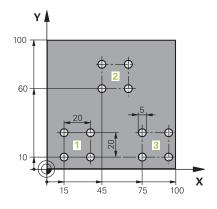
⁸ Subprograms and program section repeats

8.6 **Programming examples**

Example: Groups of holes

Program run:

- Approach the groups of holes in the main program
- Call the group of holes (subprogram 1) in the main program
- Program the group of holes only once in subprogram 1

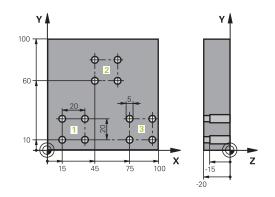


%SP1 G71 *		
N10 G30 G17 X+0 Y+0 Z-40*		
N20 G31 G90 X+100	Y+100 Z+0*	
N30 T1 G17 S3500*		Tool call
N40 G00 G40 G90 Z+250*		Retract the tool
N50 G200 DRILLING		Define the DRILLING cycle
Q200=2	;SET-UP CLEARANCE	
Q201=-30	;DEPTH	
Q206=300	;FEED RATE FOR PLNGNG	
Q202=5	;PLUNGING DEPTH	
Q210=0	;DWELL TIME AT TOP	
Q203=+0	;SURFACE COORDINATE	
Q204=2	;2ND SET-UP CLEARANCE	
Q211=0	;DWELL TIME AT DEPTH	
Q395=0	;DEPTH REFERENCE	
N60 X+15 Y+10 M3*		Move to starting point for group 1
N70 L1,0*		Call the subprogram for the group
N80 X+45 Y+60*		Move to starting point for group 2
N90 L1,0*		Call the subprogram for the group
N100 X+75 Y+10*		Move to starting point for group 3
N110 L1,0*		Call the subprogram for the group
N120 G00 Z+250 M2	*	End of main program
N130 G98 L1*		Beginning of subprogram 1: Group of holes
N140 G79*		Call cycle for 1st hole
N150 G91 X+20 M99*		Move to 2nd hole, call cycle
N160 Y+20 M99*		Move to 3rd hole, call cycle
N170 X-20 G90 M99*		Move to 4th hole, call cycle
N180 G98 L0*		End of subprogram 1
N99999999 %UP1 G7	/1 *	

Example: Group of holes with several tools

Program run:

- Program the fixed cycles in the main program
- Call the complete hole pattern (subprogram 1) in the main program
- Approach the groups of holes (subprogram 2) in subprogram 1
- Program the group of holes only once in subprogram
 2



%SP2 G71 *		
N10 G30 G17 X+0 Y+	0 Z-40*	
N20 G31 G90 X+100 Y+100 Z+0*		
N30 T1 G17 S5000*		Centering drill tool call
N40 G00 G40 G90 Z+250*		Retract the tool
N50 G200 DRILLING		Define the CENTERING cycle
Q200=2	;SET-UP CLEARANCE	
Q201=-3	;DEPTH	
Q206=250	;FEED RATE FOR PLNGNG	
Q202=3	;PLUNGING DEPTH	
Q210=0	;DWELL TIME AT TOP	
Q203=+0	;SURFACE COORDINATE	
Q204=10	;2ND SET-UP CLEARANCE	
Q211=0.2	;DWELL TIME AT DEPTH	
Q395=0	;DEPTH REFERENCE	
N60 L1,0*		Call subprogram 1 for the entire hole pattern
N70 G00 Z+250 M6*		Tool change
N80 T2 G17 S4000*		Drill tool call
N90 D0 Q201 P01 -2	5*	New depth for drilling
N100 D0 Q202 P01 +	5*	New plunging depth for drilling
N110 L1,0*		Call subprogram 1 for the entire hole pattern
N120 G00 Z+250 M6*	•	Tool change
N130 T3 G17 S500*		Reamer tool call
N140 G201 REAMING		Cycle definition: REAMING
Q200=2	;SET-UP CLEARANCE	
Q201=-15	;DEPTH	
Q206=250	;FEED RATE FOR PLNGNG	
Q211=0.5	;DWELL TIME AT DEPTH	
Q208=400	;RETRACTION FEED RATE	
Q203=+0	;SURFACE COORDINATE	
Q204=10	;2ND SET-UP CLEARANCE	
N150 L1,0*		Call subprogram 1 for the entire hole pattern

8.6 **Programming examples**

N160 G00 Z+250 M2*	End of main program
N170 G98 L1*	Beginning of subprogram 1: Entire hole pattern
N180 G00 G40 G90 X+15 Y+10 M3*	Move to starting point for group 1
N190 L2,0*	Call subprogram 2 for the group
N200 X+45 Y+60*	Move to starting point for group 2
N210 L2,0*	Call subprogram 2 for the group
N220 X+75 Y+10*	Move to starting point for group 3
N230 L2,0*	Call subprogram 2 for the group
N240 G98 L0*	End of subprogram 1
N250 G98 L2*	Beginning of subprogram 2: Group of holes
N260 G79*	Call cycle for 1st hole
N270 G91 X+20 M99*	Move to 2nd hole, call cycle
N280 Y+20 M99*	Move to 3rd hole, call cycle
N290 X-20 G90 M99*	Move to 4th hole, call cycle
N300 G98 L0*	End of subprogram 2
N310 %UP2 G71 *	



9.1 Principle and overview of functions

9.1 **Principle and overview of functions**

With Q parameters you can program entire families of parts in a single NC program by programming variable Q parameters instead of fixed numerical values.

Use Q parameters for e.g.:

- Coordinate values
- Feed rates

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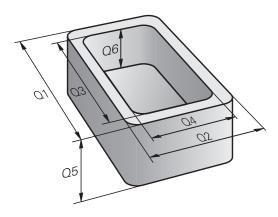
- Spindle speeds
- Cycle data

With Q parameters you can also:

- Program contours that are defined through mathematical functions
- Make execution of machining steps depend on certain logical conditions

Q parameters are always identified with letters and numbers. The letters determine the type of Q parameter and the numbers the Q parameter range.

For more information, see the table below:



Q parameter type	Q parameter range	Meaning
Q parameters:		Parameters effect all NC programs in the TNC memory
	0 – 99	Parameters for the user , if there are no overlaps with the HEIDENHAIN-SL cycles
	100 – 199	Parameters for system information on the TNC that can be read by the NC programs of the user or by cycles
	200 – 1199	Parameters primarily used for HEIDENHAIN cycles
	1200 – 1399	Parameters that are primarily used with manufacturer cycles when values are given back to the user program
	1400 – 1599	Parameters primarily used as input parameters for manufacturer cycles
	1600 – 1999	Parameters for users
OL parameters:		Parameters only effective locally within an NC program
	0 – 499	Parameters for users
QR parameters:		Parameters that are nonvolatile on all NC programs in the TNC memory, i.e. they remain in effect even after a power interruption
	0 – 499	Parameters for users

$\ensuremath{\textbf{QS}}$ parameters (the $\ensuremath{\textbf{S}}$ stands for string) are also available on the TNC and enable you to process texts.

Q parameter type	Q parameter range	Meaning
QS parameters:		Parameters effect all NC programs in the TNC memory
	0 – 99	Parameters for the user , where no overlaps with the HEIDENHAIN SL cycles are present
	100 – 199	Parameters for diverse functions on the TNC that can be read by the NC programs of the user or by cycles
	200 – 1199	Parameters primarily used for HEIDENHAIN cycles
	1200 – 1399	Parameters that are primarily used with manufacturer cycles when values are given back to the user program
	1400 – 1599	Parameters primarily used as input parameters for manufacturer cycles
	1600 – 1999	Parameters for users
using	gain maximum safety for y g only Ω parameter ranges in your NC programs.	
Q pa	se note that the specified arameter ranges is recomn DENHAIN but cannot be er	nended by
still o Plea	hine manufacturer or third- cause overlaps with the us se refer to the machine ma umentation for this.	ser's NC program.

9.1 Principle and overview of functions

Programming notes

You can mix $\ensuremath{\Omega}$ parameters and numerical values within an NC program.

Q parameters can be assigned numerical values between -999,999,999 and +999,999,999. The input range is limited to 16 digits, of which 9 may be before the decimal point. Internally the TNC calculates numbers up to a value of 10¹⁰.

You can assign a maximum of 255 characters to $\ensuremath{\text{QS}}\xspace{\ensuremath{\text{OS}}}$ parameters.



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The TNC automatically assigns some Q and QS parameters the same data, e.g. the Q parameter **Q108** is automatically assigned the current tool radius.

Further Information: " Preassigned Q parameters", page 361

The TNC saves numerical values internally in a binary number format (standard IEEE 754). Due to this standardized format some decimal numbers do not have an exact binary representation (round-off error). Keep this in mind especially when you use calculated Q-parameter contents for jump commands or positioning movements.

Calling Q parameter functions

When you are writing a part program, press the **Q** key (in the numeric keypad for numerical input and axis selection, below the +/- key). The TNC then displays the following soft keys:

Soft key	Function group	Page	
BASIC ARITHM.	Basic arithmetic (assign, add, subtract, multiply, divide, square root)	317	
TRIGO- NOMETRY	Trigonometric functions	319	
JUMP	lf/then conditions, jumps	321	
DIVERSE	Other functions	325	
FORMULA	Entering formulas directly	345	
CONTOUR FORMULA	Function for machining complex contours	See Cycle Programming User's Manual	
⇒	The TNC shows the soft keys Q, QL and QR when you are defining or assigning a Q parameter. First press one of these soft keys to select the desired type of parameter, and then enter the parameter number. If you have a USB keyboard connected, you can press the Q key to open the dialog for entering a formula.		

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9.2 Part families—Q parameters in place of numerical values

9.2 Part families—Q parameters in place of numerical values

Application

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The Q parameter function **D0: ASSIGN** assigns numerical values to Q parameters. This enables you to use variables in the program instead of fixed numerical values.

Example NC blocks

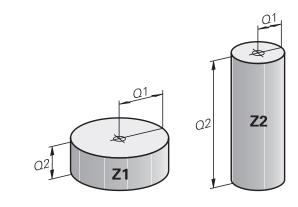
N150 D00 Q10 P01 +25*	Assign		
	Q10 is assigned the value 25		
N250 G00 X +Q10*	Corresponds to G00 X +25		

You need write only one program for a whole family of parts, entering the characteristic dimensions as Q parameters.

To program a particular part, you then assign the appropriate values to the individual $\ensuremath{\mathsf{Q}}$ parameters.

Example: Cylinder with Q parameters

Cylinder radius:	R = Q1
Cylinder height:	H = Q2
Cylinder Z1:	Q1 = +30 Q2 = +10
Cylinder Z2:	Q1 = +10 Q2 = +50



9.3 Describing contours with mathematical functions

Application

The Ω parameters listed below enable you to program basic mathematical functions in a machining program:

- Select a Q parameter function: Press the Q key (in the numerical keypad on the right). The Q parameter functions are displayed in a soft key row
- ► To select the mathematical functions, press the **BASIC ARITHM.** soft key. The TNC then displays the following soft keys:

Overview

Soft key	Function
D0 X = Y	D00 : ASSIGN e. g. D00 Q5 P01 +60 * Directly assign value
D1 X + Y	D01 : ADDITION e.g. D01 Q1 P01 -Q2 P02 -5 * Form and assign sum from two values
D2 X - Y	D02 : SUBTRACTION e. g. D02 Q1 P01 +10 P02 +5 * Form and assign difference between two values
D3 X * Y	D03 : MULTIPLICATION e. g. D03 Q2 P01 +3 P02 +3 * Form and assign the product of two values
D4 X × Y	D04 : DIVISION e.g. D04 Q4 P01 +8 P02 +Q2 * Form and assign the quotient of two values Not permitted: Division by 0
D5 SORT	D05 : SQUARE ROOT e.g. D05 Q50 P01 4 * Form and assign the square root of a value Not permitted: Square root from negative value

To the right of the "=" character you can enter the following:

- Two numbers
- Two Q parameters
- A number and a Q parameter

The $\ensuremath{\Omega}$ parameters and numerical values in the equations can be entered with positive or negative signs.

9.3 Describing contours with mathematical functions

Programming fundamental operations

Example 1

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- Select the Q parameter function: Press the Q key
- To select the mathematical functions, press the BASIC ARITHM. soft key.
- Select the ASSIGN Q parameter function: Press the D0 X=Y soft key

PARAMETER NUMBER FOR RESULT?

- ENT
- Enter 12 (the number of the Q parameter) and confirm with the ENT key

FIRST VALUE / PARAMETER?



Enter 10: Assign the numerical value 10 to Q5 and confirm with the ENT soft key

Example 2

- Select the Q parameter function: Press the **Q** key



Q

 To select the mathematical functions, press the BASIC ARITHM. soft key.



To select the MULTIPLICATION Q parameter function, press the D3 X * Y soft key

PARAMETER NUMBER FOR RESULT?



Enter 12 (the number of the Q parameter) and confirm with the ENT key

FIRST VALUE / PARAMETER?



Enter Q5 as the first value and confirm with the ENT key.

SECOND VALUE / PARAMETER?



Enter 7 as the second value and confirm with the ENT key.

NC sets in the TNC

N16 D00 Q5 P01 +10*

N17 D03 Q12 P01 +Q5 P02 +7*

9.4 Angle functions

Definitions

Sine: $\sin \alpha = a / c$

Cosine: $\cos \alpha = b / c$

Tangent: $\tan \alpha = a / b = \sin \alpha / \cos \alpha$

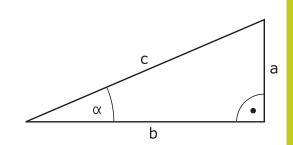
where

- c is the side opposite the right angle
- \blacksquare a is the side opposite the angle α

b is the third side.

The TNC can find the angle from the tangent:

 $\alpha = \arctan (a \ / \ b) = \arctan (\sin \alpha \ / \ \cos \alpha)$



Example:

 $\begin{array}{l} a=25 \text{ mm} \\ b=50 \text{ mm} \\ \alpha=\arctan\left(a\ /\ b\right)=\arctan 0.5=26.57^\circ \\ \text{Furthermore:} \\ a^2+b^2=c^2 \ (\text{where } a^2=a\ x\ a) \\ c=\sqrt{\left(a^2+b^2\right)} \end{array}$

Programming trigonometric functions

Press the **TRIGONOMETRY** soft key to call the trigonometric functions. The TNC then displays the soft keys that are listed in the table below.

Soft key	Function
D6 SIN(X)	D06 : SINUS e. g. D06 Q20 P01 -Q5 * Define and assign the sine of an angle in degrees (°)
FN7 COS(X)	D07 : COSINUS e. g. D07 Q21 P01 -Q5 * Define and assign the cosine of an angle in degrees (°)
D8 X LEN Y	D08 : ROOT SUM OF SQUARES e. g. D08 Q10 P01 +5 P02 +4 * Form and assign length from two values
D13 X ANG Y	D13 : ANGLE e. g. D13 Q20 P01 +10 P02 -Q1 * Calculate the angle from the arc tangent of the opposite and adjacent sides or from the sine and cosine of the angle (0 < angle < 360°) and assign it to a parameter

9.5 Calculation of circles

9.5 Calculation of circles

Application

9

The TNC can use the functions for calculating circles to calculate the circle center and the circle radius from three or four given points on the circle. The calculation is more accurate if four points are used.

Application: These functions can be used if you wish to determine the location and size of a hole or a pitch circle using the programmable probing function.

Soft key Function



FN 23: Determining the CIRCLE DATA from three points e. g.**D23 Q20 P01 Q30**

The coordinate pairs of three points on a circle must be saved in Q30 and the following five parameters—in this case, up to Q35.

The TNC then saves the circle center in the reference axis (X if spindle axis is Z) in parameter Q20, the circle center in the minor axis (Y if spindle axis is Z) in parameter Q21, and the circle radius in parameter Q22.

Function

Soft key



FN 24: Determining the CIRCLE DATA from four points e. g.**D24 Q20 P01 Q30**

The coordinate pairs of four points on a circle must be saved in Q30 and the following seven parameters—in this case, up to Q37.

The TNC then saves the circle center in the reference axis (X if spindle axis is Z) in parameter Q20, the circle center in the minor axis (Y if spindle axis is Z) in parameter Q21, and the circle radius in parameter Q22.



Note that **D23** and **D24** automatically overwrite the resulting parameter and the two following parameters.

9.6 If-then decisions with Q parameters

Application

The TNC can make logical if-then decisions by comparing a Q parameter with another Q parameter or with a numerical value. If the condition is fulfilled, the TNC continues the program at the label that is programmed after the condition.

Further Information: "Labeling subprograms and program section repeats", page 294

If it is not fulfilled, the TNC continues with the next block.

To call another program as a subprogram, enter a **%** program call after the block with the label.

Unconditional jumps

An unconditional jump is programmed by entering a conditional jump whose condition is always true. Example:

D09 P01 +10 P02 +10 P03 1 *

Programming if-then decisions

Possibilities for jump inputs

The following inputs are possible for the condition IF:

- Numbers
- Texts

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- Q, QL, QR
- QS (string parameter)

You have three possibilities for entering the jump address GOTO:

- LBL NAME
- LBL NUMBER

QS

Press the **JUMP** soft key to call the if-then conditions. The TNC then displays the following soft keys:

Soft key	Function
D9 IF X EQ Y Goto	D09 : IF EQUAL, JUMP e. g. D09 P01 +Q1 P02 +Q3 P03 "UPCAN25" * If both values or parameters are equal, jump to specified label
D10 IF X NE Y GOTO	D10: IF UNEQUAL, JUMP e. g.D10 P01 +10 P02 -Q5 P03 10 * If both values or parameters are unequal, jump to specified label
D11 IF X GT Y GOTO	D11: IF GREATER, JUMP g. g.D11 P01 +Q1 P02 +10 P03 QS5 * If the first value or parameter is greater than the second value or parameter, jump to specified label
D12 IF X LT Y GOTO	D12: IF LESS, JUMP e. g. D12 P01 +Q5 P02 +0 P03 "ANYNAME" * If the first value or parameter is smaller than the second value or parameter, jump to specified label

9.7 Checking and changing Q parameters

Procedure

You can check Q parameters in all operating modes, and also edit them.

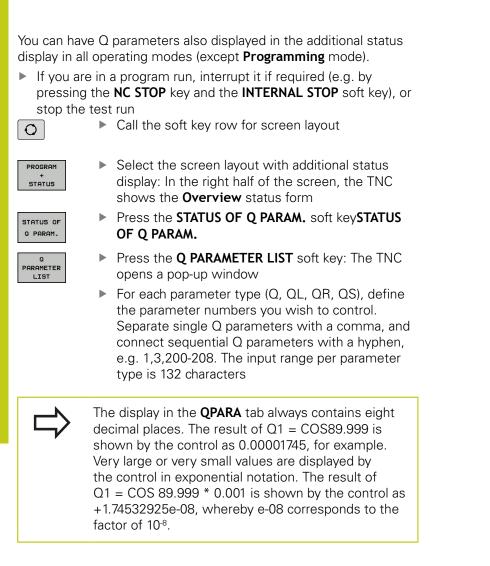
- If you are in a program run, interrupt it if required (e.g. by pressing the NC STOP key and the INTERNAL STOP soft key) or stop the test run
 - Q INFO
- To call the Q parameter functions, press the Q INFO soft key or the Q key
- The TNC lists all parameters and their current values. Use the arrow keys or the GOTO key to select the desired parameter.
- If you would like to change the value, press the EDIT CURRENT FIELD soft key. Enter a new file name and confirm with ENT
- To leave the value unchanged, press the PRESENT VALUE soft key or end the dialog with the END key

The parameters used by the TNC internally or in cycles are provided with comments.

If you want to check or edit local, global or string parameters, press the **SHOW PARAMETERS Q QL QR QS** soft key. The TNC then displays the specific parameter type. The functions previously described also apply.

prople	Inno LOTNI T	* Canaali aaatia			P05 T001 TT -	TRANS OPARA	
	parameter						M C
NK CAS	ao =	0.0000			4		
. \rese	01 -	0.0000	MILLING	DERTH			
G17 >	02 -	0.0000		TH OVERLAP			
X+15C	03 =	0.0000		E FOR STOP		+0.0000	S
uuu_u	Q4 =	0.0000		CE FOR FLOOR		+0.0000.0+	4
	05 -	0.0000		COORDINATE		+0.0000.0+	-
	06 -	0.0000		CLEARANCE		MS	- 0 0
	07 =	0.0000		E HEIGHT			'≙⊷≙
13.	08	0.0000	ROUNDING	RADTUS			
110 G01 G91 120 G02 G90	09 -	0.0000	ROTATIONAL DIRECTION				
	Q10 =	0.0000	PLUNGING				
	011 =	0.0000	FEED BAT	E FOR PLNGNG			
	012 -	0.0000	FEED RAT	E F. ROUGHNG			
	Q13 -	0.0000	ROUGH - OL	T TOOL		00:00:00	
	Q14 =	0.0000	ALLOWANG	E FOR SIDE			\$100%
	Q15 =	0.0000	CLIMB OF	UP-CUT			
	Q16 -	0.0000	RADIUS				OFF ON
	017 -	0.0000	TYPE OF	DIMENSION			
	Q18 =	0.0000	COARSE F	ROUGHING TOOL			F100% W
			END				OFF 0
	•	,					
<u>EN</u>		PAGE	PAGE	EDIT CURRENT FIELD	PRESENT	SHOW PARAMETERS	END

9.7 Checking and changing Q parameters



9

9.8 Additional functions

Overview

Press the **DIVERSE FUNCTION** soft key to call the additional functions. The TNC then displays the following soft keys:

Soft key	Function	Page
D14 ERROR=	D14 Display error messages	326
D16 F-PRINT	D16 Formatted output of texts or Q parameter values	330
D18 SYS-DATUM READ	D18 Read system data	335
D19 PLC=	D19 Transfer values to the PLC	343
D20 WAIT FOR	D20 NC and PLC synchronization	343
D26 OPEN THE TABLE	D26 Open a freely definable table	411
D27 WRITE TO TABLE	D27 Write to a freely definable table	412
D28 READ TABLE	D28 Read from a freely definable table	413
D29 PLC LIST=	D29 Transfer up to eight values to the PLC	344
D37 EXPORT	D37 Export local Q parameters or QS parameters into a calling program	344
D38 TRANSMIT	D38 Send information from the NC program	344

9

9.8 Additional functions

D14: Displaying error messages

With the **D14** function you can call messages under program control. The messages are predefined by the machine manufacturer or by HEIDENHAIN. Whenever the TNC comes to a block with **D14** in the Program Run or Test Run mode, it interrupts the program run and displays a message. The program must then be restarted.

Error numbers area	Standard dialog		
0 999	Machine-dependent dialog		
1000 1199	Internal error messages		

Example NC block

The TNC is to display the message stored under error number 1000.

N180 D14 P01 1000*

Error message predefined by HEIDENHAIN

Error number	Text		
1000	Spindle?		
1001	Tool axis is missing		
1002	Tool radius too small		
1003	Tool radius too large		
1004	Range exceeded		
1005	Start position incorrect		
1006	ROTATION not permitted		
1007	SCALING FACTOR not permitted		
1008	MIRROR IMAGE not permitted		
1009	Datum shift not permitted		
1010	Feed rate is missing		
1011	Input value incorrect		
1012	Incorrect sign		
1013	Entered angle not permitted		
1014	Touch point inaccessible		
1015	Too many points		
1016	Contradictory input		
1017	CYCL incomplete		
1018	Plane wrongly defined		
1019	Wrong axis programmed		
1020	Wrong rpm		
1021	Radius comp. undefined		

Error number	Text			
1022	Rounding-off undefined			
1023	Rounding radius too large			
1024	Program start undefined			
1025	Excessive nesting			
1026	Angle reference missing			
1027	No fixed cycle defined			
1028	Slot width too small			
1029	Pocket too small			
1030	Q202 not defined			
1031	Q205 not defined			
1032	Q218 must be greater than Q219			
1033	CYCL 210 not permitted			
1034	CYCL 211 not permitted			
1035	Q220 too large			
1036	Q222 must be greater than Q223			
1037	Q244 must be greater than 0			
1038	Q245 must not equal Q246			
1039	Angle range must be under 360°			
1040	Q223 must be greater than Q222			
1041	Q214: 0 not permitted			
1042	Traverse direction not defined			
1043	No datum table active			
1044	Position error: center in axis 1			
1045	Position error: center in axis 2			
1046	Hole diameter too small			
1047	Hole diameter too large			
1048	Stud diameter too small			
1049	Stud diameter too large			
1050	Pocket too small: rework axis 1			
1051	Pocket too small: rework axis 2			
1052	Pocket too large: scrap axis 1			
1053	Pocket too large: scrap axis 2			
1054	Stud too small: scrap axis 1			
1055	Stud too small: scrap axis 2			
1056	Stud too large: rework axis 1			
1057	Stud too large: rework axis 2			

9.8 Additional functions

1058TCHPROBE 425: length exceeds max1059TCHPROBE 425: length below min1060TCHPROBE 426: length exceeds max1061TCHPROBE 430: diameter too large1062TCHPROBE 430: diameter too small1064No measuring axis defined1065Tool breakage tolerance exceeded1066Enter 0247 unequal to 01067Enter 0247 greater than 51068Datum table?1069Enter 0251 unequal to 01070Thread depth too large1071Missing calibration data1072Tolerance exceeded1073Block scan active1074ORIENTATION not permitted10753-D ROT not permitted1076Activate 3-D ROT1077Enter depth as negative1078Q303 in meas. cycle undefined!1079Tool axis not allowed1081Contradictory meas. points1082Incorrect clearance height1083Contradictory plunge type1084This fixed cycle not allowed1085Line is write-protected1086Oversize greater than depth1087No point angle defined1088Contradictory data1089Slot position 0 not allowed1080Enter an infeed not equal to 01081Switchover of Q399 not allowed1082Tool not defined1083Tool not defined1084This fixed cycle not allowed1085Line is write-protected1086Oversize greater than	Error number	Text		
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1090Enter an infeed not equal to 01091Switchover of Q399 not allowed1092Tool not defined	1088	Contradictory data		
1091Switchover of Q399 not allowed1092Tool not defined	1089	Slot position 0 not allowed		
1092 Tool not defined	1090	Enter an infeed not equal to 0		
	1091	Switchover of Q399 not allowed		
1093 Tool number not permitted	1092	Tool not defined		
	1093	Tool number not permitted		

1094	Tool name not permitted		
1095	Software option not active		
1096	Kinematics cannot be restored		
1097	Function not permitted		
1098	Contradictory workpc. blank dim.		
1099	Measuring position not allowed		
1100	Kinematic access not possible		
1101	Meas. pos. not in traverse range		
1102	Preset compensation not possible		
1103	Tool radius too large		
1104	Plunging type is not possible		
1105	Plunge angle incorrectly defined		
1106	Angular length is undefined		
1107	Slot width is too large		
1108	Scaling factors not equal		
1109	Tool data inconsistent		

Error number

Text

9.8 Additional functions

D16 – Formatted output of text and Q parameter values



With **D16**, you can also output to the screen any messages from the NC program. Such messages are displayed by the TNC in a pop-up window.

The function **D16** transfers Q parameter values and texts in a selectable format. If you send the values, the TNC saves the data in the file that you defined in the **D16** block. The maximum size of the output file is 20 kilobytes.

To be able to use the function **D16**, first program a text file that defines the output format.

Available functions

When you create a text file, use the following formatting functions:

Special characters	Function			
""	Define output format for texts and variables between the quotation marks			
%9.3F	Format for Q parameter:			
	 Define %: format 9.3: 9 total characters (incl. decimal point), of which 3 are places after the decimal point F: Floating (decimal number), format for Q, QL, QR 			
%+7.3F	Format for Q parameter:			
	Define %: format			
	+: number right-aligned			
	 7.3: 7 total characters (incl. decimal point), of which 3 are places after the decimal point F: Floating (decimal number), format for 			
	Q, QL, QR			
%S	Format for text variable QS			
%D or %I	Format for integer			
1	Separation character between output format and parameter			
;	End of block character			
\n	Line break			
+	Q parameter value, right-aligned			
-	Q parameter value, left-aligned			

The following functions allow you to include the following additional information in the protocol log file:

Keyword	Function	
CALL_PATH	Indicates the path for the NC program where you will find the FN16 function. Example: "Measuring program: %S",CALL_PATH;	
M_CLOSE	Closes the file to which you are writing with FN16. Example: M_CLOSE;	
M_APPEND	Upon renewed output, appends the log to the existing log. Example: M_APPEND;	
M_APPEND_MAX	Upon renewed output, appends the log to the existing log until the maximum specified file size in kilobytes is exceeded. Example: M_APPEND_MAX20;	
M_TRUNCATE	Overwrites the log upon renewed output. Example: M_TRUNCATE;	
L_ENGLISH	Outputs text only for English conversational language	
L_GERMAN	Outputs text only for German conversational language	
L_CZECH	Outputs text only for Czech conversational language	
L_FRENCH	Outputs text only for French conversational language	
L_ITALIAN	Outputs text only for Italian conversational language	
L_SPANISH	Outputs text only for Spanish conversational language	
L_PORTUGUE	Outputs text only for Portuguese conversational language	
L_SWEDISH	Outputs text only for Swedish conversational language	
L_DANISH	Outputs text only for Danish conversational language	
L_FINNISH	Outputs text only for Finnish conversational language	
L_DUTCH	Outputs text only for Dutch conversational language	
L_POLISH	Outputs text only for Polish conversational language	
L_HUNGARIA	Outputs text only for Hungarian conversational language	
L_CHINESE	Outputs text only for Chinese conversational language	
L_CHINESE_TRAD	Outputs text only for Chinese (traditional) conversational language	

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9.8 Additional functions

Keyword	Function
L_SLOVENIAN	Outputs text only for Slovenian conversational language
L_NORWEGIAN	Outputs text only for Norwegian conversational language
L_ROMANIAN	Outputs text only for Rumanian conversational language
L_SLOVAK	Outputs text only for Slovak conversational language
L_TURKISH	Outputs text only for Turkish conversational language
L_ALL	Display text independently of the conversational language
HOUR	Number of hours from the real-time clock
MIN	Number of minutes from the real-time clock
SEC	Number of seconds from the real-time clock
DAY	Day from the real-time clock
MONTH	Month as a number from the real-time clock
STR_MONTH	Month as a string abbreviation from the real-time clock
YEAR2	Two-digit year from the real-time clock
YEAR4	Four-digit year from the real-time clock

Creating a text file

To output the formatted texts and Q-parameter values, create a text file with the TNC's text editor. In this file you then define the output format and Q parameters you want to output. Create this file with the extension .A.

Example of a text file to define the output format:

"MEASURING LOG OF IMPELLER CENTER OF GRAVITY";

"DATUM: %02d.%02d.%04d",DAY,MONTH,YEAR4;

```
"TIME: %02d:%02d:%02d",HOUR,MIN,SEC;
```

"NO. OF MEASURED VALUES: = 1";

"X1 = %9.3F", Q31; "Y1 = %9.3F", Q32;

"Z1 = %9.3F", Q33;

In the part program, program D16 to activate the output:

N90 D16 P01 TNC:\MASK\MASK1.A/ TNC:\PROT1.TXT

The TNC then creates the file PROT1.TXT: **MEASURING LOG OF IMPELLER CENTER OF GRAVITY DATE:** July 15, 2015 TIME: 8:56:34 AM NO. OF MEASURED VALUES : = 1 X1 = 149.360 Y1 = 25.509 Z1 = 37.000

If you output the same file more than once in the program, the TNC appends all texts to the end of the texts already output within the target file.
If you use D16 more than once in the program, the TNC saves all texts in the file that you defined in the D16 function. The file is not output until the TNC reads the block, or you press the NC STOP key, or you close the file with .
In the D16 block, program the format file and the log file with their respective file type extensions
If you enter only the file name for the path of the log file, the TNC saves the log file in the directory

in which the NC program with the **D16** function is located.

In machine parameters (no. 102202) and (no. 102203) you can define a default path for outputting log files. If you use **D16** the file must not be UTF8-encoded.

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9.8 Additional functions

Displaying messages on the TNC screen

You can also use the function **D16** to display any messages from the NC program in a pop-up window on the TNC screen. This makes it easy to display explanatory texts, including long texts, at any point in the program in a way that the operator has to react to them. You can also display Q-parameter contents if the protocol description file contains such instructions.

For the message to appear on the TNC screen, you need only enter **SCREEN:** as the name of the protocol file.

N90 D16 P01 TNC:\MASK\MASK1.A/SCREEN:

If the message has more lines than fit in the pop-up window, you can use the arrow keys to page in the window.

To close the pop-up window, press the **CE** key. To have the program close the window, program the following NC block:

N90 D16 P01 TNC:\MASK\MASK1.A/SCLR:



If you output the same file more than once in the program, the TNC appends all texts to the end of the texts already output within the target file.

Exporting messages

The **D16** function also enables you to save the log files externally.

Enter the complete target path in the **D16** function:

N90 D16 P01 TNC:\MSK\MSK1.A / PC325:\LOG\PR01.TXT



If you output the same file more than once in the program, the TNC appends all texts to the end of the texts already output within the target file.

D18 – Reading system data

With the **D18** function you can read system data and store them in Q parameters. You select the system data through a group name (ID number), and additionally through a number and an index.



Values read from the function **D18** are always output in metric units.

Group name, ID no.	Number	Index	Meaning
Program information, 10	3	-	Number of the active fixed cycle
	103	Q parameter- number	Relevant within NC cycles; for inquiry as to whether the Q parameter given under IDX was explicitly stated in the associated CYCLE DEF.
System jump addresses, 13	1	-	Label jumped to during M2/M30 instead of ending the current program
	2	_	Value = 0: M2/M30 functions normally Label jumped to in the event of FN14:
	_		ERROR with the NC CANCEL reaction instead of aborting the program with an error message. The error number programmed in the FN14 command can be read under ID992 NR14.
			Value = 0: FN14 has the normal effect.
	3	-	Label jumped to in the event of an internal server error (SQL, PLC, CFG) instead of aborting the program with an error message.
Marking status 00	1		Value = 0: Server error has the normal effect
Machine status, 20	1	-	Active tool number (without index)
		-	Prepared tool number (without index)
	3	-	Active tool axis 0=X, 1=Y, 2=Z, 6=U, 7=V, 8=W
	4	-	Programmed spindle speed
	5	-	Active spindle condition: -1=not defined, 0=M3 active, 1=M4 active, 2=M5 after M3, 3=M5 after M4
	7	-	Gear range
	8	-	Coolant status: 0=off, 1=on
	9	-	Active feed rate
	10	-	Index of prepared tool
	11	-	Index of active tool
Channel data, 25	1	-	Channel number
Cycle parameter, 30	1	-	Set-up clearance of active fixed cycle
	2	-	Drilling depth or milling depth in active fixed cycle

9.8 Additional functions

Group name, ID no.	Number	Index	Meaning
	4	-	Feed rate for pecking in active fixed cycle
	5	-	1st side length for rectangular pocket cycle
	6	-	2nd side length for rectangular pocket cycle
	7	-	1st side length for slot cycle
	8	-	2nd side length for slot cycle
	9	-	Radius for circular pocket cycle
	10	-	Feed rate for milling in active fixed cycle
	11	-	Direction of rotation for active fixed cycle
	12	-	Dwell time for active fixed cycle
	13	-	Thread pitch for Cycles 17, 18
	14	-	Finishing allowance for active fixed cycle
	15	-	Direction angle for rough out in active fixed cycle
	21	-	Probing angle
	22	-	Probing path
	23	-	Probing feed rate
Modal condition, 35	1	-	Dimensions: 0 = absolute (G90) 1 = incremental (G91)
Data for SQL tables, 40	1	-	Result code for the last SQL command
Data from the tool table, 50	1	Tool no.	Tool length
	2	Tool no.	Tool radius
	3	Tool no.	Tool radius R2
	4	Tool no.	Oversize for tool length DL
	5	Tool no.	Tool radius oversize DR
	6	Tool no.	Tool radius oversize DR2
	7	Tool no.	Tool locked (0 or 1)
	8	Tool no.	Number of the replacement tool
	9	Tool no.	Maximum tool age TIME1
	10	Tool no.	Maximum tool age TIME2
	11	Tool no.	Current tool age CUR. TIME
	12	Tool no.	PLC status
	13	Tool no.	Maximum tooth length LCUTS
	14	Tool no.	Maximum plunge angle ANGLE
	15	Tool no.	TT: Number of tool teeth CUT
	16	Tool no.	TT: Wear tolerance for length, LTOL
	17	Tool no.	TT: Wear tolerance for radius, RTOL
	18	Tool no.	TT: Rotational direction DIRECT (0=positive/- 1=negative)
	19	Tool no.	TT: Offset in plane R-OFFS
	20	Tool no.	TT: Offset in length L-OFFS

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Group name, ID no.	Number	Index	Meaning
	21	Tool no.	TT: Breakage tolerance for length, LBREAK
	22	Tool no.	TT: Breakage tolerance for radius, RBREAK
	23	Tool no.	PLC value
	25	Tool no.	Probe center offset in minor axis CAL_OF2
	26	Tool no.	Spindle angle during calibration CALANG
	27	Tool no.	Tool type for pocket table
	28	Tool no.	Maximum rpm NMAX
	32	Tool no.	Point angle TANGLE
	34	Tool no.	LIFTOFF allowed (0= No, 1= Yes)
	35	Tool no.	Wear tolerance for radius R2TOL
	37	Tool no.	Corresponding line in the touch-probe table
	38	Tool no.	Timestamp of last use
Pocket table data, 51	1	Pocket number	Tool number
	2	Pocket number	Special tool: 0=No, 1=Yes
	3	Pocket number	Fixed pocket: 0=No, 1=Yes
	4	Pocket number	Locked pocket: 0=No, 1=Yes
	5	Pocket number	PLC status
Tool location, 52	1	Tool no.	Pocket number P
	2	Tool no.	Magazine number
File information, 56	1	-	Number of lines of the selected tool table
	2	-	Number of lines of the selected datum table
	4	-	Number of lines in the open, freely definable table
			Value -1: No table open
Values programmed immediately after tool call, 60	1	-	Tool number T
	2	-	Active tool axis 0 = X 6 = U 1 = Y 7 = V 2 = Z 8 = W
	3	-	Spindle speed S
	4	-	Oversize for tool length DL
	5	-	Tool radius oversize DR
	6	-	Automatic 0 = Yes, 1 = No
	7	-	Tool radius oversize DR2
	8	-	Tool index
	9	-	Active feed rate
Values programmed immediately after tool definition , 61	1	-	Tool number T
	2	-	Length

9.8 Additional functions

Group name, ID no.	Number	Index	Meaning
	3	-	Radius
	4	-	Index
	5	-	Tool data programmed in TOOL DEF 1 = Yes, 0 = No
Active tool compensation, 200	1	1 = without oversize 2 = with oversize 3 = with oversize and Oversize from	Active radius
	2	1 = without oversize 2 = with oversize 3 = with oversize and Oversize from	Active length
	3	1 = without oversize 2 = with oversize 3 = with oversize and Oversize from	Rounding radius R2
Active transformations, 210	1	-	Basic rotation manual operating mode
	2	-	Programmed rotation with Cycle 10
	3	-	Active mirrored axis
			0: Mirroring not active
			+1: X axis mirrored
			+2: Y axis mirrored
			+4: Z axis mirrored
			+64: U axis mirrored
			+128: V axis mirrored
			+256: W axis mirrored
			Combinations = Sum of individual axes
	4	1	Active scaling factor in X axis
	4	2	Active scaling factor in Y axis
	4	3	Active scaling factor in Z axis
	4	7	Active scaling factor in U axis
	4	8	Active scaling factor in V axis
	4	9	Active scaling factor in W axis
	5	1	3-D ROT A axis
	5	2	3-D ROT B axis
	5	3	3-D ROT C axis

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Group name, ID no.	Number	Index	Meaning
	6	-	Tilted working plane active / inactive (–1/0) in a Program Run operating mode
	7	-	Tilted working plane active / inactive (–1/0) in a Manual operating mode
Active datum shift, 220	2	1	X axis
		2	Y axis
		3	Z axis
		4	A axis
		5	B axis
		6	C axis
		7	U axis
		8	V axis
		9	W axis
	3	1 to 9	Difference between reference point and datum in axes 1 to 9
Traverse range, 230	2	1 to 9	Negative software limit switch or traverse range limit in axes 1 to 9
	3	1 to 9	Positive software limit switch or traverse range limit in axes 1 to 9
	5	-	Software limit switch on or off: 0 = on, 1 = off
Nominal position in the machine coordinate system, 240	1	1	X axis
		2	Y axis
		3	Z axis
		4	A axis
		5	B axis
		6	C axis
		7	U axis
		8	V axis
		9	W axis
Current position in the active coordinate system, 270	1	1	X axis
		2	Y axis
		3	Z axis
		4	A axis
		5	B axis
		6	C axis
		7	U axis
		8	V axis

9.8 Additional functions

Group name, ID no.	Number	Index	Meaning
Machining time, 320	3	-	Momentary machining time of the active NC program in minutes
TS triggering touch probe, 350	50	1	Type of touch probe
		2	Line in the touch-probe table
	51	-	Effective length
	52	1	Effective ball radius
		2	Rounding radius
	53	1	Center offset (reference axis)
		2	Center offset (minor axis)
	54	-	Spindle-orientation angle in degrees (center offset)
	55	1	Rapid traverse
		2	Measuring feed rate
	56	1	Maximum measuring range
		2	Safety clearance
	57	1	Spindle orientation possible: 0=No, 1=Yes
		2	Spindle-orientation angle
TT tool touch probe	70	1	Type of touch probe
		2	Line in the touch-probe table
	71	1	Center point in reference axis (REF system)
		2	Center point in minor axis (REF system)
		3	Center point in tool axis (REF system)
	72	-	Plate radius
	75	1	Rapid traverse
		2	Measuring feed rate for stationary spindle
		3	Measuring feed rate for rotating spindle
	76	1	Maximum measuring range
		2	Safety clearance for linear measurement
		3	Safety clearance for radial measurement
	77	-	Spindle speed
	78	-	Probing direction
Reference point from touch probe cycle, 360	1	1 to 9 (X, Y, Z, A, B, C, U, V, W)	Last reference point of a manual touch probe cycle, or last touch point from Cycle 0 without probe length compensation but with probe radius compensation (workpiece coordinate system)
	2	1 to 9 (X, Y, Z, A, B, C, U, V, W)	Last reference point of a manual touch probe cycle, or last touch point from Cycle 0 without probe length or probe radius compensation (machine coordinate system)

Group name, ID no.	Number	Index	Meaning
	3	1 to 9 (X, Y, Z, A, B, C, U, V, W)	Result of measurement of the touch probe cycles 0 and 1 without probe radius or probe length compensation
	4	1 to 9 (X, Y, Z, A, B, C, U, V, W)	Last reference point of a manual touch probe cycle, or last touch point from Cycle 0 without probe length or probe radius compensation (workpiece coordinate system)
	10	-	Oriented spindle stop
	11	-	Error status for suppressed error message 0 = Probe process successful -1 = Touch point not reached
Value from the active datum table in the active coordinate system, 500	Line	Column	Read values
Basic transformation, 507	Line	1 to 6 (X, Y, Z, SPA, SPB, SPC)	Read the basic transformation of a preset
Axis offset, 508	Line	1 to 9 (X_OFFS, Y_OFFS, Z_OFFS, A_OFFS, B_OFFS, C_OFFS, U_OFFS, V_OFFS, W_OFFS)	Read the axis offset of a preset
Active preset, 530	1	-	Read the number of the active preset
SIK, 630	2	-	Read SIK ID
Read data of the current tool, 950	1	-	Tool length L
	2	-	Tool radius R
	3	-	Tool radius R2
	4	-	Oversize for tool length DL
	5	-	Tool radius oversize DR
	6	-	Tool radius oversize DR2
	7	-	Tool locked TL 0 = not locked, 1 = locked
	8	-	Number of the replacement tool RT
	9	_	Maximum tool age TIME1
	10	-	Maximum tool age TIME2
	11	-	Current tool age CUR. TIME
	12	-	PLC status
	13	-	Maximum tooth length LCUTS
			6
	14		Maximum plunge angle ANGLE

9.8 Additional functions

Group name, ID no.	Number	Index	Meaning
	16	-	TT: Wear tolerance for length, LTOL
	17	-	TT: Wear tolerance for radius, RTOL
	18	-	TT: Direction of rotation DIRECT 0 = Positive, -1 = Negative
	19	-	TT: Offset in plane R-OFFS
	20	-	TT: Offset in length L-OFFS
	21	-	TT: Breakage tolerance for length, LBREAK
	22	-	TT: Breakage tolerance for radius, RBREAK
	23	-	PLC value
	24	-	Tool type TYP 0 = Milling cutter, 21 = Touch probe
	27	-	Corresponding line in the touch-probe table
	32	-	Tip angle
	34	-	Lift off
Tool usage test, 975	1	-	Tool usage test of the current NC program -2= no test possible, deactivated by the machine manufacturer -1 = no test possible, no tool usage file 0 = test OK, all tools available 1 = test not OK, no tool or tool is locked
Touch probe cycles, 990	1	-	Approach behaviour: 0 = Standard behavior 1 = Effective radius, Safety clearance zero
	2	-	0 = Pushbutton monitoring off 1 = Pushbutton monitoring on
	4	-	0 = Stylus not deflected 1 = Stylus deflected
	8	-	Current spindle angle
Tool number, 990	10	Q parameter- number	Tool number associated with the tool name of the Q parameter IDX -1 = name is not available or tool is locked
Execution status, 992	10	-	Mid-program startup active 1 = Yes, 0 = No
	11	-	Search phase
	14	-	Number of the last FN14 error
	16	-	Real execution active $1 = execution$, $0 = simulation$
	31	-	Radius compensation in MDI mode with paraxial positioning blocks permitted 0 = Not permitted, 1 = Permitted

Example: Assign the value of the active scaling factor for the Z axis to Q25.

N55 D18 Q25 ID210 NR4 IDX3*

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D19 – Transfer values to the PLC

This function may only be used with the permission of your machine tool builder.

The D19 function transfers up to two numerical values or Q parameters to the PLC.

D20 – NC and PLC synchronization

This function may only be used with the permission of your machine tool builder.

With the **D20** function you can synchronize the NC and PLC during a program run. The NC stops machining until the condition that you have programmed in the **D20** block is fulfilled.

SYNC is used whenever you read, for example, system data via **D18** that require synchronization with real time. The TNC stops the look-ahead calculation and executes the subsequent NC block only when the NC program has actually reached that block.

Example: Pause internal look-ahead calculation, read current position in the X axis

N32 D20 SYNC N33 D18 Q1 ID270 NR1 IDX1*

9.8 Additional functions

D29 – Transfer values to the PLC



This function may only be used with the permission of your machine tool builder.

The $\textbf{D29}\xspace$ function transfers up to eight numerical values or Q parameters to the PLC.

D37 - EXPORT



This function may only be used with the permission of your machine tool builder.

You need the **D37** function if you want to create your own cycles and integrate them in the TNC.

D38 – Send information from NC program

The function **D38** enables you to write texts and Q parameter values to the log from the NC program and send to a DNC application.

Data transmission is through a standard TCP/IP computer network.



For more detailed information, consult the Remo Tools SDK manual.

Example

Document values from Q1 and Q23 in the log.

D38* /"Q PARAMETER Q1: %F Q23: %F" P02 +Q1 P02 +Q23*

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9.9 Entering formulas directly

Entering formulas

You can enter mathematical formulas that include several operations directly into the part program by soft key.

Press the **FORMULA** soft key to call the mathematical functions. The TNC displays the following soft keys in several soft-key rows:

Soft key	Linking function
+	Addition e. g.Q10 = Q1 + Q5
-	Subtraction e. g. Q25 = Q7 - Q108
*	Multiplication e. g.Q12 = 5 * Q5
/	Division e. g.Q25 = Q1 / Q2
C	Opening parenthesis e. g.Q12 = Q1 * (Q2 + Q3)
>	Closing parenthesis e. g.Q12 = Q1 * (Q2 + Q3)
sa	Square the value e.g.Q15 = SQ 5
SORT	Square root e.g.Q22 = SQRT 25
SIN	Sine of an angle e. g.Q44 = SIN 45
COS	Cosine of an angle e. g.Q45 = COS 45
TAN	Tangent of an angle e. g.Q46 = TAN 45
ASIN	Arc sine Inverse function of the sine; determine the angle from the ratio of the opposite side to the hypotenuse e.g.Q10 = ASIN 0.75
ACOS	Arc cosine Inverse function of the cosine; determine the angle from the ratio of the adjacent side to the hypotenuse e. g.Q11 = ACOS Q40

9.9 Entering formulas directly

Soft key	Linking function
RTAN	Arc tangent Inverse function of the tangent; determine the angle from the ratio of the opposite side to the adjacent side e.g.Q12 = ATAN Q50
~	Powers of values e g.Q15 = 3^3
PI	Constant PI (3.14159) e.g. Q15 = PI
LN	Logarithmus Naturalis (LN) of a row Base 2.7183 e.g.Q15 = LN Q11
LOG	Logarithm of a number, Base 10 e. g.Q33 = LOG Q22
EXP	Exponential function, 2.7183 to the power of n e. g.Q1 = EXP Q12
NEG	Negate values (multiply by -1) e.g.Q2 = NEG Q1
INT	Truncate digits after the decimal point Form an integer e.g.Q3 = INT Q42
ABS	Absolute value of a number e. g.Q4 = ABS Q22
FRAC	Truncate digits before the decimal point Form a fraction e.g. Q5 = FRAC Q23
SGN	Check algebraic sign of a number e gQ12 = SGN Q50 When return value Q12 = 1, then Q50 >= 0 When return value Q12 = -1, then Q50 < 0
×	Calculate modulo value (division remainder) e. g.Q12 = 400 % 360 Result: Q12 = 40

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Rules for formulas

Mathematical formulas are programmed according to the following rules:

Higher-level operations are performed first

12 Q1 = 5 * 3 + 2 * 10 = 35

- 1 Calculation 5 * 3 = 15
- 2 Calculation 2 * 10 = 20
- 3 Calculation 15 + 20 = 35

or

13 Q2 = SQ 10 - 3^3 = 73

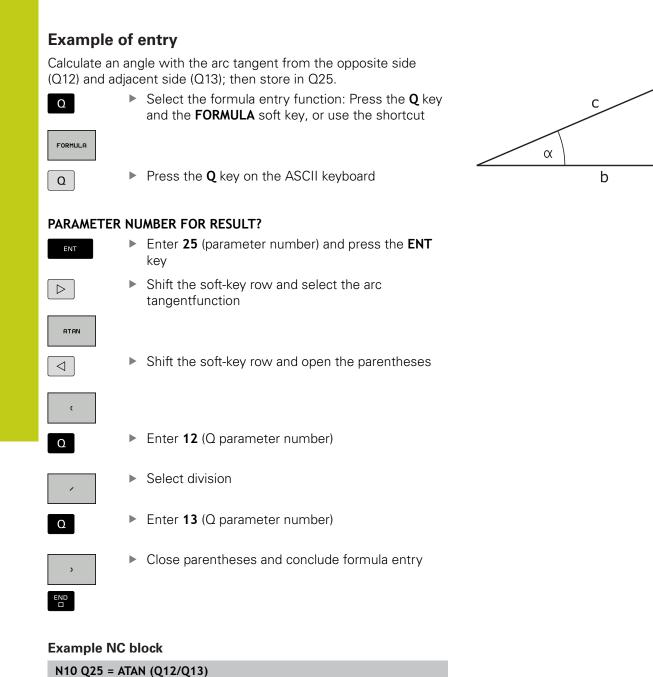
- 1 Calculation step 10 squared = 100
- 2 Calculation step 3 to the third power = 27
- 3 Calculation 100 27 = 73

Distributive law

Law of distribution with parentheses calculation a * (b + c) = a * b + a * c

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9.9 Entering formulas directly



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9.10 String parameters

String processing functions

You can use the **QS** parameters to create variable character strings. You can output such character strings for example through the **D16** function to create variable logs.

You can assign a linear sequence of characters (letters, numbers, special characters and spaces) up to a length of 255 characters to a string parameter. You can also check and process the assigned or imported values using the functions described below. As in Q parameter programming, you can use a total of 2000 QS parameters.

Further Information: "Principle and overview of functions", page 312

The **STRING FORMULA** and **FORMULA** Q parameter functions contain various functions for processing the string parameters.

Soft key	Functions of the STRING FORMULA	Page
STRING	Assigning string parameters	350
CFGREAD	Read out machine parameter	358
	Chain-linking string parameters	350
TOCHAR	Converting a numerical value to a string parameter	351
SUBSTR	Copy a substring from a string parameter	352
SYSSTR	Read out system parameter	353
Soft key	FORMULA string functions	Page
TONUMB	Converting a string parameter to a numerical value	354
INSTR	Checking a string parameter	355
STRLEN	Finding the length of a string parameter	356
STRCOMP	Compare alphabetic priority	357
⇒	When you use the STRING FORMULA fur result of the arithmetic operation is alwa When you use the FORMULA function, t the arithmetic operation is always a num	ays a string. he result of

9.10 String parameters

Assign string parameters

You have to assign a string variable before you use it. Use the **DECLARE STRING** command to do so.

Show the soft-key row with special functions



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Open the function menu

STRING FUNCTIONS Press the String functions soft key

DECLARE STRING Press the DECLARE STRING soft key

Example NC block

N30 DECLARE STRING QS10 = "WORKPIECE"

Chain-linking string parameters

With the concatenation operator (string parameter || string parameter) you can make a chain of two or more string parameters.



Show the soft-key row with special functions



Open the function menu



Press the String functions soft key

STRING FORMULA

- Press the STRING FORMULA soft key
- Enter the number of the string parameter in which the TNC is to save the concatenated string. Confirm with the ENT key
- Enter the number of the string parameter in which the first substring is saved. Confirm with the ENT key: The TNC displays the concatenation symbol ||
- Press the ENT key
- Enter the number of the string parameter in which the second substring is saved. Confirm with the ENT key
- Repeat the process until you have selected all the required substrings. Conclude with the END key

Example: QS10 is to include the complete text of QS12, QS13 and QS14 $\,$

N37 QS10 = QS12 || QS13 || QS14

Parameter contents:

- QS12: Workpiece
- QS13: Status:
- QS14: Scrap
- QS10: Workpiece Status: Scrap

Converting a numerical value to a string parameter

With the **TOCHAR** function, the TNC converts a numerical value to a string parameter. This enables you to chain numerical values with string variables.

SPEC FCT	
PROGRAM FUNCTIONS	
STRING FUNCTIONS	
STRING FORMULA	
TOCHAR	

- Show the soft-key row with special functions
- Open the function menu
- Press the String functions soft key
 - Press the STRING FORMULA soft key
 - Select the function for converting a numerical value to a string parameter
 - Enter the number or the desired Q parameter to be converted, and confirm with the ENT key
 - If desired, enter the number of decimal places that the TNC should convert, and confirm with the ENT key
 - Close the parenthetical expression with the ENT key and confirm your entry with the END key

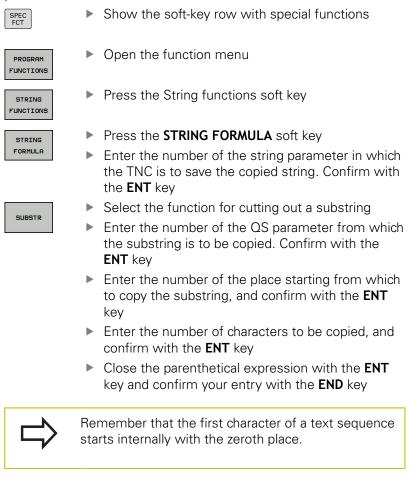
Example: Convert parameter Q50 to string parameter QS11, use 3 decimal places

N37 QS11 = TOCHAR (DAT+Q50 DECIMALS3)

9.10 String parameters

Copying a substring from a string parameter

The **SUBSTR** function copies a definable range from a string parameter.



Example: A four-character substring (LEN4) is read from the string parameter QS10 beginning with the third character (BEG2)

N37 QS13 = SUBSTR (SRC_QS10 BEG2 LEN4)

Reading system data

With the function **SYSSTR** you can read system data and store them in string parameters. You select the system data through a group number (ID) and a number.

Entering IDX and DAT is not required.

Group name, ID no.	Number	Meaning
Program information, 10010	1	Path of the current main program
	3	Path of the cycle selected with CYCL DEF G39 PGM CALL
	10	Path of the program selected with %:PGM
Channel data, 10025	1	Channel name
Values programmed in the tool call, 10060	1	Tool name
Touch-probe data, 10350	50	Probe type of the active touch probe TS
	70	Probe type of the active touch probe TT
	73	Key name of the active touch probe TT from MP activeTT
	2	Path of the selected pallet table
NC software version, 10630	10	Version identifier of the NC software version
Tool data, 10950	1	Tool name
	2	DOC entry of the tool
	3	AFC control setting
	4	Tool-carrier kinematics

9.10 **String parameters**

Converting a string parameter to a numerical value

The **TONUMB** function converts a string parameter to a numerical value. The value to be converted should be only numerical.

	The QS parameter must contain only one numerical value. Otherwise the TNC will output an error message.
Q	 Select Q-parameter functions
FORMULA	Press the FORMULA soft key
	Enter the number of the parameter in which the TNC is to save the numerical value. Confirm with the ENT key
\Box	 Shift the soft-key row
TONUMB	 Select the function for converting a string parameter to a numerical value
	 Enter the number of the QS parameter to be converted, and confirm with the ENT key
	 Close the parenthetical expression with the ENT key and confirm your entry with the END key
Example: 0	Convert string parameter QS11 to a numerical

parameter Q82

N37 Q82 = TONUMB (SRC_QS11)

Testing a string parameter

The **INSTR** function checks whether a string parameter is contained in another string parameter.



Press the FORMULA soft kev

Shift the soft-key row

Select Q-parameter functions

Enter the number of the Q parameter for the result and confirm with the ENT key. The TNC saves in the parameter the position at which the sought-after text begins.

 \triangleleft

INSTR

- Select the function for checking a string parameter
- Enter the number of the QS parameter in which the text to be searched for is saved. Confirm with the ENT key
- Enter the number of the QS parameter to be searched, and confirm with the ENT key
- Enter the number of the place starting from which the TNC is to search the substring, and confirm with the ENT key
- Close the parenthetical expression with the ENT key and confirm your entry with the END key

Remember that the first character of a text sequence starts internally with the zeroth place.

If the TNC cannot find the required substring, it will save the total length of the string to be searched (counting starts at 1) in the result parameter.

If the substring is found in more than one place, the TNC returns the first place at which it finds the substring.

Example: Search through QS10 for the text saved in parameter QS13. Begin the search at the third place.

N37 Q50 = INSTR (SRC_QS10 SEA_QS13 BEG2)

9.10 String parameters

Finding the length of a string parameter

The **STRLEN** function returns the length of the text saved in a selectable string parameter.



- Select Q parameter function
- Press the FORMULA soft key
- Enter the number of the Q parameter in which the TNC is to save the ascertained string length. Confirm with the ENT key
- Shift the soft-key row
- Select the function for finding the text length of a string parameter
- Enter the number of the QS parameter whose length the TNC is to ascertain, and confirm with the ENT key
- Close the parenthetical expression with the ENT key and confirm your entry with the END key

Example: Find the length of QS15

N37 Q52 = STRLEN (SRC_QS15)



If the selected string parameter is not defined the control returns the result **-1**.

Compare alphabetic priority

The $\ensuremath{\textbf{STRCOMP}}$ function compares string parameters for alphabetic priority.

Q	 Select Q parameter function
	 Press the FORMULA soft key Enter the number of the Q parameter in which the TNC is to save the result of comparison. Confirm with the ENT key Shift the soft-key row
STRCOMP	 Select the function for comparing string parameters Enter the number of the first QS parameter to be compared, and confirm with the ENT key Enter the number of the second QS parameter to be compared, and confirm with the ENT key Close the parenthetical expression with the ENT key and confirm your entry with the END key
	 The TNC returns the following results: 0: The compared QS parameters are identical -1: The first QS parameter precedes the second QS parameter alphabetically +1: The first QS parameter follows the second QS parameter alphabetically

Example: QS12 and QS14 are compared for alphabetic priority

N37 Q52 = STRCOMP (SRC_QS12 SEA_QS14)

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9.10 String parameters

Reading out machine parameters

Use the **CFGREAD** function to read out TNC machine parameters as numerical values or as strings. The read values are always output in metric units.

In order to read out a machine parameter, you must use the TNC's configuration editor to determine the parameter name, parameter object, and, if they have been assigned, the group name and index:

lcon	Туре	Meaning	Example
₽ <mark>₿</mark>	Кеу	Group name of the machine parameter (if available)	CH_NC
€	Entity	Parameter object (name begins with " Cfg ")	CfgGeoCycle
	Attribute	Name of the machine parameter	displaySpindleErr
⊕ <mark>€</mark>]	Index	List index of a machine parameter (if available)	[0]

If you are in the configuration editor for the user parameters, you can change the display of the existing parameters. In the default setting, the parameters are displayed with short, explanatory texts. To display the actual system names of the parameters, press the key for the screen layout key and then the **SHOW SYSTEM NAME** soft key. Follow the same procedure to return to the standard display.

Each time you want to interrogate a machine parameter with the **CFGREAD** function, you must first define a QS parameter with attribute, entity and key.

The following parameters are read in the CFGREAD function's dialog:

- **KEY_QS**: Group name (key) of the machine parameter
- **TAG_QS**: Object name (entity) of the machine parameter
- ATR_QS: Name (attribute) of the machine parameter
- **IDX**: Index of the machine parameter

Reading a string of a machine parameter

In order to store the content of a machine parameter as a string in a QS parameter:



Press the Q key.



Press the STRING FORMULA soft key

- Enter the number of the string parameter in which the TNC is to save the machine parameter. Confirm with the ENT key
- Select the CFGREAD function
- Enter the numbers of the string parameters for the key, entity and attribute, then confirm with the ENT key
- Enter the number for the index, or skip the dialog with NNO ENT, whichever applies
- Close the parenthetical expression with the ENT key and confirm your entry with the END key

Example: Read as a string the axis designation of the fourth axis

Parameter settings in the configuration editor

DisplaySettings CfgDisplayData axisDisplayOrder [0] to [5]

14 QS11 = ""	Assign string parameter for key
15 QS12 = "CFGDISPLAYDATA"	Assign string parameter for entity
16 QS13 = "AXISDISPLAY"	Assign string parameter for parameter name
17 QS1 = CEGREAD(KEY OS11 TAG OS12 ATR OS13 IDX3)	Read out machine parameter

9.10 String parameters

Reading a numerical value of a machine parameter

Store the value of a machine parameter as a numerical value in a Q parameter:

1
FORMULA

Q

9

Select Q parameter function

- Press the FORMULA soft key
 Enter the number of the O per
- Enter the number of the Q parameter in which the TNC is to save the machine parameter. Confirm with the ENT key
- Select the CFGREAD function
- Enter the numbers of the string parameters for the key, entity and attribute, then confirm with the ENT key
- Enter the number for the index, or skip the dialog with NNO ENT, whichever applies
- Close the parenthetical expression with the ENT key and confirm your entry with the END key

Example: Read overlap factor as Q parameter

Parameter settings in the configuration editor

ChannelSettings

CH_NC

CfgGeoCycle

pocketOverlap

N10 QS11 = "CH_NC"	Assign string parameter for key
N20 QS12 = "CFGGEOCYCLE"	Assign string parameter for entity
N30 QS13 = "POCKETOVERLAP"	Assign string parameter for parameter name
N40 Q50 = CFGREAD(KEY_QS11 TAG_QS12 ATR_QS13)	Read out machine parameter

9.11 Preassigned Q parameters

The Q parameters Q100 to Q199 are assigned values by the TNC. The following types of information are assigned to Q parameters:

- Values from the PLC
- Tool and spindle data
- Data on operating status
- Results of measurements from touch probe cycles etc.

The TNC saves the values for the preassigned Q parameters Q108, Q114 and Q115 to Q117 in the unit of measure used by the active program.



Preassigned Q parameters (QS parameters) between **Q100** and **Q199** (**QS100** and **QS199**) must not be used in NC programs as calculation parameters. Otherwise you might receive undesired results.

Values from the PLC: Q100 to Q107

The TNC uses the parameters Q100 to Q107 to transfer values from the PLC to an NC program.

Active tool radius: Q108

The active value of the tool radius is assigned to Q108. Q108 is calculated from:

- Tool radius R (tool table or G99 block)
- Delta value DR from the tool table
- Delta value DR from the **T** block



The TNC remembers the current tool radius even if the power is interrupted.

Tool axis: Q109

The value of Q109 depends on the current tool axis:

Tool axis	Parameter value
No tool axis defined	Q109 = -1
X axis	Q109 = 0
Y axis	Q109 = 1
Zaxis	Q109 = 2
U axis	Q109 = 6
Vaxis	Q109 = 7
Waxis	Q109 = 8

Programming Q parameters

9.11 Preassigned Q parameters

Spindle status: Q110

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The value of the parameter Q110 depends on the M function last programmed for the spindle.

M function	Parameter value
No spindle status defined	Q110 = -1
M3: Spindle ON, clockwise	Q110 = 0
M4: Spindle ON, counterclockwise	Q110 = 1
M5 after M3	Q110 = 2
M5 after M4	Q110 = 3

Coolant on/off: Q111

M function	Parameter value
M8: Coolant ON	Q111 = 1
M9: Coolant OFF	Q111 = 0

Overlap factor: Q112

The overlap factor for pocket milling is assigned to Q112.

Unit of measurement for dimensions in the program: Q113

During nesting the %, the value of the parameter Q113 depends on the dimensional data of the program from which the other programs are called.

Dimensional data of the main program	Parameter value
Metric system (mm)	Q113 = 0
Imperial system (inch)	Q113 = 1

Tool length: Q114

The current value for the tool length is assigned to Q114.



The TNC remembers the current tool length even if the power is interrupted.

9

Coordinates after probing during program run

The parameters Q115 to Q119 contain the coordinates of the spindle position at the moment of contact during programmed measurement with the 3-D touch probe. The coordinates refer to the datum point that is active in the **Manual operation** mode.

The length of the stylus and the radius of the ball tip are not compensated in these coordinates.

Coordinate axis	Parameter value
X axis	Q115
Y axis	Q116
Z axis	Q117
4th axis Machine-dependent	Q118
5th axis Machine-dependent	Q119

Deviation between actual value and nominal value during automatic tool measurement with the TT 130

Deviation of actual from nominal value	Parameter value
Tool length	Q115
Tool radius	Q116

Tilting the working plane with mathematical angles: rotary axis coordinates calculated by the TNC

Coordinates	Parameter value
A axis	Q120
B axis	Q121
Caxis	Q122

Programming Q parameters

9.11 Preassigned Q parameters

Measurement results from touch probe cycles

Further information: Cycle Programing User's Manual

Measured actual values	Parameter value
Angle of a straight line	Q150
Center in reference axis	Q151
Center in minor axis	Q152
Diameter	Q153
Pocket length	Q154
Pocket width	Q155
Length of the axis selected in the cycle	Q156
Position of the centerline	Q157
Angle in the A axis	Q158
Angle in the B axis	Q159
Coordinate of the axis selected in the cycle	Q160
Measured deviation	Parameter value
Center in reference axis	Q161
Center in minor axis	Q162
Diameter	Q163
Pocket length	Q164
Pocket width	Q165
Measured length	Q166
Position of the centerline	Q167
Determined space angle	Parameter value
Rotation about the A axis	Q170
Rotation about the B axis	Q171
Rotation about the C axis	Q172
Workpiece status	Parameter value
Good	Q180
Rework	Q181
Scrap	Q182

Tool measurement with the BLUM laser	Parameter value
Reserved	Q190
Reserved	Q191
Reserved	Q192
Reserved	Q193
Reserved for internal use	Parameter value
Marker for cycles	Q195
Marker for cycles	Q196
Marker for cycles (machining patterns)	Q197
Number of the last active measuring cycle	Q198
Status of tool measurement with TT	Parameter value
Tool within tolerance	Q199 = 0.0
Tool is worn (LTOL/RTOL is exceeded)	Q199 = 1.0
Tool is broken (LBREAK/RBREAK is exceeded)	Q199 = 2.0

9 Programming Q parameters

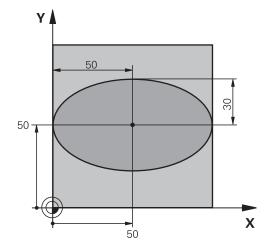
9.12 Programming examples

9.12 Programming examples

Example: Ellipse

Program run

- The contour of the ellipse is approximated by many short lines (defined in Q7). The more calculation steps you define for the lines, the smoother the curve becomes.
- The milling direction is determined with the starting angle and end angle in the plane: Machining direction is clockwise: Starting angle > end angle Machining direction is counterclockwise: Starting angle < end angle
- The tool radius is not taken into account



%ELLIPSE G71 *	
N10 D00 Q1 P01 +50*	Center in X axis
N20 D00 Q2 P01 +50*	Center in Y axis
N30 D00 Q3 P01 +50*	Semiaxis in X
N40 D00 Q4 P01 +30*	Semiaxis in Y
N50 D00 Q5 P01 +0*	Starting angle in the plane
N60 D00 Q6 P01 +360*	End angle in the plane
N70 D00 Q7 P01 +40*	Number of calculation steps
N80 D00 Q8 P01 +30*	Rotational position of the ellipse
N90 D00 Q9 P01 +5*	Milling depth
N100 D00 Q10 P01 +100*	Feed rate for plunging
N110 D00 Q11 P01 +350*	Feed rate for milling
N120 D00 Q12 P01 +2*	Set-up clearance for pre-positioning
N130 G30 G17 X+0 Y+0 Z-20*	Workpiece blank definition
N140 G31 G90 X+100 Y+100 Z+0*	
N150 T1 G17 S4000*	Tool call
N160 G00 G40 G90 Z+250*	Retract the tool
N170 L10.0*	Call machining operation
N180 G00 Z+250 M2*	Retract the tool, end program
N190 G98 L10*	Subprogram 10: Machining operation
N200 G54 X+Q1 Y+Q2*	Shift datum to center of ellipse
N210 G73 G90 H+Q8*	Account for rotational position in the plane
N220 Q35 = (Q6 - Q5) / Q7	Calculate angle increment
N230 D00 Q36 P01 +Q5*	Copy starting angle
N240 D00 Q37 P01 +0*	Set counter
N250 Q21 = Q3 * COS Q36	Calculate X coordinate for starting point
N260 Q22 = Q4 * SIN Q36	Calculate Y coordinate for starting point

Programming examples 9.12

N270 Q00 G40 X+Q21 Y+Q22 M3*	Move to starting point in the plane
N280 Z+Q12*	Pre-position in spindle axis to set-up clearance
N290 G01 Z-Q9 FQ10*	Move to working depth
N300 G98 L1*	
N310 Q36 = Q36 + Q35	Update the angle
N320 Q37 = Q37 + 1	Update the counter
N330 Q21 = Q3 * COS Q36	Calculate the current X coordinate
N340 Q22 = Q4 * SIN Q36	Calculate the current Y coordinate
N350 G01 X+Q21 Y+Q22 FQ11*	Move to next point
N360 D12 P01 +Q37 P02 +Q7 P03 1*	Unfinished? If not finished, return to LBL 1
N370 G73 G90 H+0*	Reset the rotation
N380 G54 X+0 Y+0*	Reset the datum shift
N390 G00 G40 Z+Q12*	Move to set-up clearance
N400 G98 L0*	End of subprogram
N99999999 %ELLIPSE G71 *	

Programming Q parameters

9.12 Programming examples

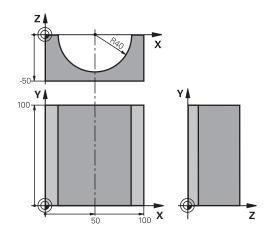
Example: Concave cylinder machined with spherical cutter

Program run

%CVLIN G71 *

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- This program functions only with a spherical cutter. The tool length refers to the sphere center.
- The contour of the cylinder is approximated by many short line segments (defined in Q13). The more line segments you define, the smoother the curve becomes.
- The cylinder is milled in longitudinal cuts (here: parallel to the Y axis).
- The milling direction is determined with the starting angle and end angle in space: Machining direction clockwise: Starting angle > end angle Machining direction counterclockwise: Starting angle < end angle
- The tool radius is compensated automatically



%CYLIN G71 *	
N10 D00 Q1 P01 +50*	Center in X axis
N20 D00 Q2 P01 +0*	Center in Y axis
N30 D00 Q3 P01 +0*	Center in Z axis
N40 D00 Q4 P01 +90*	Starting angle in space (Z/X plane)
N50 D00 Q5 P01 +270*	End angle in space (Z/X plane)
N60 D00 Q6 P01 +40*	Cylinder radius
N70 D00 Q7 P01 +100*	Length of the cylinder
N80 D00 Q8 P01 +0*	Rotational position in the X/Y plane
N90 D00 Q10 P01 +5*	Allowance for cylinder radius
N100 D00 Q11 P01 +250*	Feed rate for plunging
N110 D00 Q12 P01 +400*	Feed rate for milling
N120 D00 Q13 P01 +90*	Number of cuts
N130 G30 G17 X+0 Y+0 Z-50*	Workpiece blank definition
N140 G31 G90 X+100 Y+100 Z+0*	
N150 T1 G17 S4000*	Tool call
N160 G00 G40 G90 Z+250*	Retract the tool
N170 L10.0*	Call machining operation
N180 D00 Q10 P01 +0*	Reset allowance
N190 L10.0*	Call machining operation
N200 G00 G40 Z+250 M2*	Retract the tool, end program
N210 G98 L10*	Subprogram 10: Machining operation
N220 Q16 = Q6 - Q10 - Q108	Account for allowance and tool, based on the cylinder radius
N230 D00 Q20 P01 +1*	Set counter
N240 D00 Q24 P01 +Q4*	Copy starting angle in space (Z/X plane)
N250 Q25 = (Q5 - Q4) / Q13	Calculate angle increment
N260 G54 X+Q1 Y+Q2 Z+Q3*	Shift datum to center of cylinder (X axis)

N270 G73 G90 H+Q8*	Account for rotational position in the plane
N280 G00 G40 X+0 Y+0*	Pre-position in the plane to the cylinder center
N290 G01 Z+5 F1000 M3*	Pre-position in the spindle axis
N300 G98 L1*	
N310 I+0 K+0*	Set pole in the Z/X plane
N320 G11 R+Q16 H+Q24 FQ11*	Move to starting position on cylinder, plunge-cutting obliquely into the material
N330 G01 G40 Y+Q7 FQ12*	Longitudinal cut in Y+ direction
N340 D01 Q20 P01 +Q20 P02 +1*	Update the counter
N350 D01 Q24 P01 +Q24 P02 +Q25*	Update solid angle
N360 D11 P01 +Q20 P02 +Q13 P03 99*	Finished? If finished, jump to end
N370 G11 R+Q16 H+Q24 FQ11*	Move in an approximated "arc" for the next longitudinal cut
N380 G01 G40 Y+0 FQ12*	Longitudinal cut in Y- direction
N390 D01 Q20 P01 +Q20 P02 +1*	Update the counter
N400 D01 Q24 P01 +Q24 P02 +Q25*	Update solid angle
N410 D12 P01 +Q20 P02 +Q13 P03 1*	Unfinished? If not finished, return to LBL 1
N420 G98 L99*	
N430 G73 G90 H+0*	Reset the rotation
N440 G54 X+0 Y+0 Z+0*	Reset the datum shift
N450 G98 L0*	End of subprogram
N99999999 %CYLIN G71 *	

Programming Q parameters

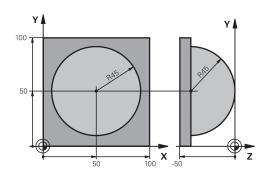
9.12 Programming examples

Example: Convex sphere machined with end mill

Program run

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- This program requires an end mill.
- The contour of the sphere is approximated by many short lines (in the Z/X plane, defined in Q14). The smaller you define the angle increment, the smoother the curve becomes.
- You can determine the number of contour cuts through the angle increment in the plane (defined in Q18).
- The tool moves upward in three-dimensional cuts.
- The tool radius is compensated automatically



%SPHERE G71 *	
N10 D00 Q1 P01 +50*	Center in X axis
N20 D00 Q2 P01 +50*	Center in Y axis
N30 D00 Q4 P01 +90*	Starting angle in space (Z/X plane)
N40 D00 Q5 P01 +0*	End angle in space (Z/X plane)
N50 D00 Q14 P01 +5*	Angle increment in space
N60 D00 Q6 P01 +45*	Sphere radius
N70 D00 Q8 P01 +0*	Starting angle of rotational position in the X/Y plane
N80 D00 Q9 P01 +360*	End angle of rotational position in the X/Y plane
N90 D00 Q18 P01 +10*	Angle increment in the X/Y plane for roughing
N100 D00 Q10 P01 +5*	Allowance in sphere radius for roughing
N110 D00 Q11 P01 +2*	Set-up clearance for pre-positioning in the spindle axis
N120 D00 Q12 P01 +350*	Feed rate for milling
N130 G30 G17 X+0 Y+0 Z-50*	Workpiece blank definition
N140 G31 G90 X+100 Y+100 Z+0*	
N150 T1 G17 S4000*	Tool call
N160 G00 G40 G90 Z+250*	Retract the tool
N170 L10.0*	Call machining operation
N180 D00 Q10 P01 +0*	Reset allowance
N190 D00 Q18 P01 +5*	Angle increment in the X/Y plane for finishing
N200 L10.0*	Call machining operation
N210 G00 G40 Z+250 M2*	Retract the tool, end program
N220 G98 L10*	Subprogram 10: Machining operation
N230 D01 Q23 P01 +Q11 P02 +Q6*	Calculate Z coordinate for pre-positioning
N240 D00 Q24 P01 +Q4*	Copy starting angle in space (Z/X plane)
N250 D01 Q26 P01 +Q6 P02 +Q108*	Compensate sphere radius for pre-positioning
N260 D00 Q28 P01 +Q8*	Copy rotational position in the plane
N270 D01 Q16 P01 +Q6 P02 -Q10*	Account for allowance in the sphere radius
N280 G54 X+Q1 Y+Q2 Z-Q16*	Shift datum to center of sphere
N290 G73 G90 H+Q8*	Account for starting angle of rotational position in the plane
N300 G98 L1*	Pre-position in the spindle axis
N310 I+0 J+0*	Set pole in the X/Y plane for pre-positioning

N320 G11 G40 R+Q26 H+Q8 FQ12*	Pre-position in the plane
N330 I+Q108 K+0*	Set pole in the Z/X plane, offset by the tool radius
N340 G01 Y+0 Z+0 FQ12*	Move to working depth
N350 G98 L2*	
N360 G11 G40 R+Q6 H+Q24 FQ12*	Move upward in an approximated "arc"
N370 D02 Q24 P01 +Q24 P02 +Q14*	Update solid angle
N380 D11 P01 +Q24 P02 +Q5 P03 2*	Inquire whether an arc is finished. If not finished, return to LBL 2
N390 G11 R+Q6 H+Q5 FQ12*	Move to the end angle in space
N400 G01 G40 Z+Q23 F1000*	Retract in the spindle axis
N410 G00 G40 X+Q26*	Pre-position for next arc
N420 D01 Q28 P01 +Q28 P02 +Q18*	Update rotational position in the plane
N430 D00 Q24 P01 +Q4*	Reset solid angle
N440 G73 G90 H+Q28*	Activate new rotational position
N450 D12 P01 +Q28 P02 +Q9 P03 1*	Unfinished? If not finished, return to LBL 1
N460 D09 P01 +Q28 P02 +Q9 P03 1*	
N470 G73 G90 H+0*	Reset the rotation
N480 G54 X+0 Y+0 Z+0*	Reset the datum shift
N490 G98 L0*	End of subprogram
N99999999 %SPHERE G71 *	



10.1 Enter miscellaneous functions M and STOP

10.1 Enter miscellaneous functions M and STOP

Fundamentals

With the TNC's miscellaneous functions—also called M functions —you can affect

- the program run, e.g. a program interruption
- the machine functions, such as switching spindle rotation and coolant supply on and off
- the path behavior of the tool

You can enter up to four M (miscellaneous) functions at the end of a positioning block or in a separate block. The TNC displays the following dialog question: **Miscellaneous function M**?

You usually enter only the number of the miscellaneous function in the programming dialog. Some miscellaneous functions can be programmed with additional parameters. In this case, the dialog is continued for the parameter input.

In the **Manual operation** and **Electronic handwheel** operating modes, the M functions are entered with the ${\bf M}$ soft key.

Effectiveness of miscellaneous functions

Please note that some M functions become effective at the start of a positioning block, and others at the end, regardless of their position in the NC block.

M functions come into effect in the block in which they are called.

Some M functions are effective only in the block in which they are programmed. Unless the miscellaneous function is only effective blockwise, either you must cancel it in a subsequent block with a separate M function, or it is automatically canceled by the TNC at the end of the program.



If several M functions are programmed in one NC block, then the execution sequence is as follows:

- M functions taking effect at the start of the block are executed before those taking effect at the end of the block
- If all M functions take effect at the start or end of block, execution take place in the sequence programmed

Entering a miscellaneous function in a STOP block

If you program a **STOP** block, the program run or test run is interrupted at the block, e.g. for a tool inspection. You can also enter an M (miscellaneous) function in a **STOP** block:



- To program an interruption of program run, press the STOP key
- Enter a miscellaneous function M

Example NC blocks

N87 G38 M6*

10.2 Miscellaneous functions for program run inspection, spindle and coolant

10.2 Miscellaneous functions for program run inspection, spindle and coolant

Overview



The machine tool builder can influence the behavior of the miscellaneous functions described below. Refer to your machine manual.

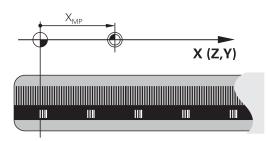
М	Effect	Effective at block	Start	End
M0	Program STOF Spindle STOP)		
M1				
M2	STOP program Spindle STOP Coolant off Return jump to Clear status di Functional sco parameter clearMode (no	o block 1 splay pe depends on machine		•
M3	Spindle ON clo	ockwise		
M4	Spindle ON co	ounterclockwise		
M5	Spindle STOP			
M6	Tool change Spindle STOP Program STOF	0		•
M8	Coolant ON		-	
M9	Coolant OFF			
M13	Spindle ON clo Coolant ON	ockwise	•	
M14	Spindle ON co Coolant ON	unterclockwise	•	
M30	Same as M2			

10.3 Miscellaneous functions for coordinate entries

Programming machine-referenced coordinates: M91/ M92

Scale datum

On the scale, a reference mark indicates the position of the scale datum.



Machine datum

The machine datum is required for the following tasks:

- Define the axis traverse limits (software limit switches)
- Approach machine-referenced positions (e.g. tool change positions)
- Set a workpiece datum

The distance in each axis from the scale datum to the machine datum is defined by the machine manufacturer in a machine parameter.

Standard behavior

The TNC references coordinates to the workpiece datum.

Further Information: "Datum setting without a 3-D touch probe", page 475

Behavior with M91 – Machine datum

If you want the coordinates in a positioning block to be referenced to the machine datum, end the block with M91.



If you program incremental coordinates in an M91 block, enter them with respect to the last programmed M91 position. If no M91 position is programmed in the active NC block, then enter the coordinates with respect to the current tool position.

The coordinate values on the TNC screen are referenced to the machine datum. Switch the display of coordinates in the status display to REF.

Further Information: "Status displays", page 80

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10.3 Miscellaneous functions for coordinate entries

Behavior with M92 – Additional machine datum



In addition to the machine datum, the machine tool builder can also define an additional machine-based position as a reference point.

For each axis, the machine tool builder defines the distance between the machine datum and this additional machine datum. Refer to your machine manual.

If you want the coordinates in positioning blocks to be based on the additional machine datum, end these block with M92.



Radius compensation remains the same in blocks that are programmed with M91 or M92. The tool length is **not** included.

Effect

M91 and M92 are effective only in the blocks in which M91 and M92 have been programmed.

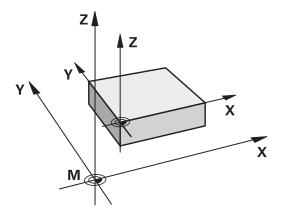
M91 and M92 take effect at the start of block.

Workpiece datum

If you want the coordinates to always be referenced to the machine datum, you can block datum setting for one or more axes.

If datum setting is inhibited for all axes, the TNC no longer displays the **DATUM SET** in the **Manual operation** mode.

The figure shows coordinate systems with the machine and workpiece datum.



M91/M92 in the Test Run mode

In order to be able to graphically simulate M91/M92 movements, you need to activate working space monitoring and display the workpiece blank referenced to the set datum.

Further Information: "Show the workpiece blank in the working space ", page 530

Moving to positions in a non-tilted coordinate system with a tilted working plane: M130

Standard behavior with a tilted working plane

The TNC references coordinates in the positioning blocks to the tilted working plane coordinate system.

Behavior with M130

The TNC references coordinates in straight line blocks with an active tilted working plane to the untilted workpiece coordinate system.

The TNC then positions the tilted tool to the programmed coordinates of the untilted workpiece coordinate system.



Danger of collision!

Subsequent positioning blocks or fixed cycles are carried out in a tilted coordinate system. This can lead to problems in fixed cycles with absolute prepositioning.

The function M130 is allowed only if the tilted working plane function is active.

Effect

M130 functions blockwise in straight-line blocks without tool radius compensation.

10

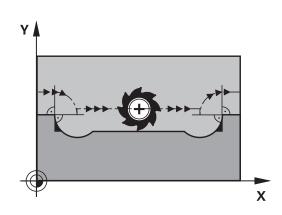
10.4 Miscellaneous functions for path behavior

10.4 Miscellaneous functions for path behavior

Machining small contour steps: M97

Standard behavior

The TNC inserts a transition arc at outside corners. If the contour steps are very small, however, the tool would damage the contour In such cases the TNC interrupts program run and generates the error message "Tool radius too large."



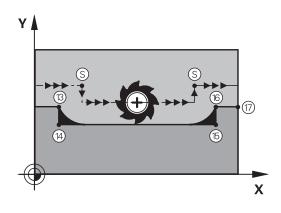
Behavior with M97

The TNC calculates the intersection of the contour elements—as at inside corners—and moves the tool over this point.

Program M97 in the same block as the outside corner.

 \Rightarrow

Instead of **M97** you should use the much more powerful function **M120 LA**. **Further Information:** "Calculating the radius-compensated path in advance (LOOK AHEAD): M120 ", page 385



Effect

M97 is effective only in the blocks in which it is programmed.



A corner machined with M97 will not be completely finished. You may wish to rework the contour with a smaller tool.

Example NC blocks

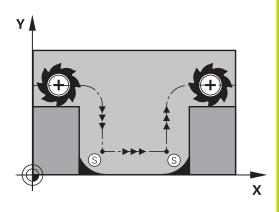
N50 G99 G01 R+20*	Large tool radius
N130 X Y F M97*	Move to contour point 13
N140 G91 Y-0.5 F*	Machine small contour step 13 to 14
N150 X+100*	Move to contour point 15
N160 Y+0.5 F M97*	Machine small contour step 15 to 16
N170 G90 X Y *	Move to contour point 17

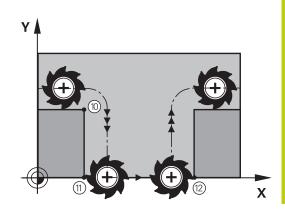
Miscellaneous functions for path behavior 10.4

Machining open contour corners: M98

Standard behavior

The TNC calculates the intersections of the cutter paths at inside corners and moves the tool in the new direction at those points. If the contour is open at the corners, however, this will result in incomplete machining.





Behavior with M98

With the miscellaneous function M98, the TNC temporarily suspends radius compensation to ensure that both corners are completely machined:

Effect

M98 is effective only in the blocks in which it is programmed. M98 takes effect at the end of block.

Example NC blocks

Move to the contour points 10, 11 and 12 in succession:

N100 G01 G41 X ... Y ... F ...*

N110 X ... G91 Y ... M98*

N120 X+ ...*

10.4 Miscellaneous functions for path behavior

Feed rate factor for plunging movements: M103

Standard behavior

The TNC moves the tool at the last programmed feed rate, regardless of the direction of traverse.

Behavior with M103

The TNC reduces the feed rate when the tool moves in the negative direction of the tool axis. The feed rate for plunging FZMAX is calculated from the last programmed feed rate FPROG and a factor F%:

FZMAX = FPROG x F%

Programming M103

If you enter M103 in a positioning block, the TNC continues the dialog by asking you the factor $\ensuremath{\mathsf{F}}$

Effect

M103 becomes effective at the start of block. To cancel M103, program M103 once again without a factor.



M103 is also effective with an active tilted working plane. The feed rate reduction is then effective during traverse in the negative direction of the **tilted** tool axis.

Example NC blocks

The feed rate for plunging is to be 20% of the feed rate in the plane.

	Actual contouring feed rate (mm/min):
N170 G01 G41 X+20 Y+20 F500 M103 F20*	500
N180 Y+50*	500
N190 G91 Z-2.5*	100
N200 Y+5 Z-5*	141
N210 X+50*	500
N220 G90 Z+5*	500

10

Feed rate in millimeters per spindle revolution: M136

Standard behavior

The TNC moves the tool at the programmed feed rate F in mm/min

Behavior with M136



In inch-programs, M136 is not permitted in combination with the new alternate feed rate FU. The spindle is not permitted to be controlled when M136 is active.

With M136, the TNC does not move the tool in mm/min, but rather at the programmed feed rate F in millimeters per spindle revolution. If you change the spindle speed by using the spindle override, the TNC changes the feed rate accordingly.

Effect

M136 becomes effective at the start of block.

You can cancel M136 by programming M137.

10.4 Miscellaneous functions for path behavior

Feed rate for circular arcs: M109/M110/M111

Standard behavior

The TNC applies the programmed feed rate to the path of the tool center.

Behavior at circular arcs with M109

The TNC adjusts the feed rate for circular arcs at inside and outside contours so that the feed rate at the tool cutting edge remains constant.



Caution: Danger to the workpiece and tool!

On very small outside corners the TNC may increase the feed rate so much that the tool or workpiece may be damaged. Avoid **M109** with small outside corners.

Behavior at circular arcs with M110

The TNC keeps the feed rate constant for circular arcs at inside contours only. Adjustment of the feed rate does not have any effect when machining the outside contours of circular arcs.



If you define M109 or M110 before calling a machining cycle with a number greater than 200, the adjusted feed rate is also effective for circular arcs within these machining cycles. The initial state is restored after finishing or canceling a machining cycle.

Effect

M109 and M110 become effective at the start of block. To cancel M109 or M110, enter M111.

Miscellaneous functions for path behavior 10.4

Calculating the radius-compensated path in advance (LOOK AHEAD): M120

Standard behavior

If the tool radius is larger than the contour step that is to be machined with radius compensation, the TNC interrupts program run and generates an error message. M97" suppresses the error message, but it results in dwell marks and will also move the corner.

Further Information: "Machining small contour steps: M97", page 380

If the programmed contour contains undercut features, the tool may damage the contour.

Behavior with M120

The TNC checks radius-compensated contours for undercuts and tool path intersections, and calculates the tool path in advance from the current block. Areas of the contour that might be damaged by the tool are not machined (dark areas in figure). You can also use M120 to calculate the tool radius compensation for digitized data or data created on an external programming system. This means that deviations from the theoretical tool radius can be compensated.

Use LA (Look Ahead) behind M120 to define the number of blocks (maximum: 99) that you want the TNC to calculate in advance. Note that the larger the number of blocks you choose, the higher the block processing time will be.

Input

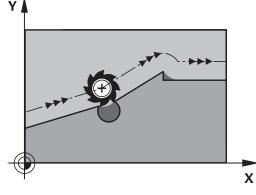
If you enter M120 in a positioning block, the TNC continues the dialog for this block by asking you the number of blocks LA that are to be calculated in advance.

Effect

M120 must be located in an NC block that also contains radius compensation $\bf G41$ or $\bf G42.$ M120 is then effective from this block until

- radius compensation is canceled with G40
- M120 LA0 is programmed, or
- M120 is programmed without LA, or
- another program is called with %
- the working plane is tilted with Cycle G80 or the PLANE function

M120 becomes effective at the start of the block.



10.4 Miscellaneous functions for path behavior

Restrictions

- After an external or internal stop, you can only re-enter the contour with the function **RESTORE POS. AT N**. Before you start the block scan, you must cancel M120, otherwise the TNC will output an error message.
- If you want to approach the contour on a tangential path, you must use the function APPR LCT. The block with APPR LCT must contain only the coordinates of the working plane.
- If you want to depart the contour on a tangential path, you must use the function **DEP LCT**. The block with **DEP LCT** must contain only the coordinates of the working plane.
- Before using the functions listed below, you have to cancel M120 and the radius compensation:
 - Cycle **G60** Tolerance
 - Cycle G80 Working plane
 - PLANE function
 - M114
 - M128

Superimpose handwheel positioning during program run: M118

Standard behavior

In the program run modes, the TNC moves the tool as defined in the part program.

Behavior with M118

M118 permits manual corrections by handwheel during program run. Just program M118 and enter an axis-specific value (linear or rotary axis) in millimeters.



Danger of collision!

If you modify the position of a rotary axis with the handwheel superimposition **M118** function and then run **M140**, the TNC ignores the superimposed values with the retraction movement.

This may cause undesired motion or collisions on machines with rotary axes in the head.

Input

If you enter M118 in a positioning block, the TNC continues the dialog for this block by asking you the axis-specific values. The coordinates are entered with the orange axis direction buttons or the ASCII keyboard.

Effect

Cancel handwheel positioning by programming M118 once again without coordinate input.

M118 becomes effective at the start of the block.

¹⁰ Miscellaneous functions

10.4 Miscellaneous functions for path behavior

Example NC blocks

You want to be able to use the handwheel during program run to move the tool in the working plane X/Y by ± 1 mm and in the rotary axis B by $\pm 5^{\circ}$ from the programmed value:

N250 G01 G41 X+0 Y+38.5 F125 M118 X1 Y1 B5*

M118 is effective in a tilted coordinate system if you activate the tilted working plane function for the Manual Operation mode. If the tilted working plane function is not active for the Manual Operation mode, the untilted workpiece coordinate system is effective.

M118 is also effective in **Positioning with manl.data input** operating mode!

Virtual tool axis VT



Your machine tool builder must have prepared the TNC for this function. Refer to your machine manual.

With the virtual tool axis you can also traverse in the direction of a sloping tool with the handwheel on a machine with swivel heads. To traverse in a virtual tool axis direction, select the VT axis on the display of your handwheel.

Further Information: "Traverse with electronic handwheels", page 455

With an HR 5xx handwheel you can select the virtual axis directly with the orange VI axis key if required (refer to your machine manual).

You can also carry out handwheel superimposing in the currently active tool axis direction with the M118 function. For this purpose, you must at least define the spindle axis with the permitted traverse range (e.g. M118 Z5) in the M118 function and select the VT axis on the handwheel.

10

Retraction from the contour in the tool-axis direction: M140

Standard behavior

In the **Program run single block** and **Program run full sequence** modes, the TNC moves the tool as defined in the machining program.

Behavior with M140

With M140 MB (move back) you can enter a path in the direction of the tool axis for departure from the contour.

Input

If you enter M140 in a positioning block, the TNC continues the dialog and asks for the desired path of tool departure from the contour. Enter the requested path that the tool should follow when departing the contour, or press the MB MAX soft key to move to the limit of the traverse range.

In addition, you can program the feed rate at which the tool traverses the entered path. If you do not enter a feed rate, the TNC moves the tool along the entered path at rapid traverse.

Effect

M140 is effective only in the NC block in which M140 is programmed.

M140 becomes effective at the start of the block.

10.4 Miscellaneous functions for path behavior

Example NC blocks

Block 250: Retract the tool 50 mm from the contour. Block 251: Move the tool to the limit of the traverse range.

N250 G01 X+0 Y+38.5 F125 M140 MB50*

N251 G01 X+0 Y+38.5 F125 M140 MB MAX*

M140 is also effective if the tilted-working-plane function is active. For machines with swivel heads the TNC then moves the tool in the tilted system.

With **M140 MB MAX** you can only retract in the positive direction.

Always define a tool call with tool axis before **M140**, otherwise the traverse direction is not defined.



Danger of collision!

If you modify the position of a rotary axis with the handwheel superimposition **M118** function and then run **M140**, the TNC ignores the superimposed values with the retraction movement.

This may cause undesired motion or collisions on machines with rotary axes in the head.

10

Suppressing touch probe monitoring: M141

Standard behavior

When the stylus is deflected, the TNC outputs an error message as soon as you attempt to move a machine axis.

Behavior with M141

The TNC moves the machine axes even if the touch probe is deflected. This function is required if you wish to write your own measuring cycle in connection with measuring cycle 3 in order to retract the stylus by means of a positioning block after it has been deflected.



Danger of collision!

If you use M141, make sure that you retract the touch probe in the correct direction. M141 functions only for movements with straightline blocks.

Effect

M141 is effective only in the block in which it is programmed. M141 becomes effective at the start of block.

10.4 Miscellaneous functions for path behavior

Deleting basic rotation: M143

Standard behavior

The basic rotation remains in effect until it is reset or is overwritten with a new value.

Behavior with M143

The TNC erases a programmed basic rotation from the NC program.



The function **M143** is not permitted with midprogram startup.

Effect

M143 is effective only from the NC block in which M143 is programmed.

M143 becomes effective at the start of the block.



M143 deletes the entries in columns SPA, SPB and SPC in the preset table; re-activating the corresponding preset lines does not activate the deleted basic rotation.

Automatically retract tool from the contour at an NC stop: M148

Standard behavior

At an NC stop the TNC stops all traverse movements. The tool stops moving at the point of interruption.

Behavior with M148



The M148 function must be enabled by the machine tool builder. The machine tool builder defines in a machine parameter the path that the TNC is to traverse for a **LIFTOFF** command.

Set the parameter **Y** in the **LIFTOFF** column of the tool table for the active tool. The TNC then retracts the tool from the contour by up to 2 mm in the direction of the tool axis.

Further Information: "Enter tool data into the table", page 188

LIFTOFF takes effect in the following situations:

- An NC stop triggered by you
- An NC stop triggered by the software, e.g. if an error occurred in the drive system
- When a power interruption occurs



Danger of collision!

Remember that, especially on curved surfaces, the surface can be damaged during return to the contour. Retract the tool before returning to the contour!

In the **CfgLiftOff** (no. 201400) machine parameter, define the value by which the tool is to be retracted. In the **CfgLiftOff** (no. 201400) machine parameter you can also switch the function off.

Effect

M148 remains in effect until deactivated with M149.

M148 becomes effective at the start of the block, M149 at the end of the block.

10.4 Miscellaneous functions for path behavior

Rounding corners: M197

Standard behavior

The TNC inserts a transition arc at outside corners with active radius compensation. This my lead to grinding of the edge.

Behavior with M197

With Function M197 the contour at the corner is tangentially extended and a smaller transition arc is then inserted. When you program Function M197 and then press the ENT key, the TNC opens the **DL** input field. In **DL** you define the length with which the TNC extends the contour elements. With M197 the corner radius is reduced, the corner grinds less and the traverse movement is still tangential.

Effect

The Function M197 is effective blockwise and is only effective on outside corners.

Example NC blocks

G01 X... Y... RL M197 DL0.876*

Special functions

11 Special functions

11.1 Overview of special functions

11.1 Overview of special functions

The TNC provides the following powerful special functions for a large number of applications:

Function	Description
Working with text files	page 404
Working with freely definable tables	page 408

Press the **SPEC FCT** and the corresponding soft keys to access further special functions of the TNC. The following tables give you an overview of which functions are available.

Main menu for SPEC FCT special functions

SPEC FCT	 Press the SPEC FCT key to s functions 	Press the SPEC FCT key to select the special functions	
Soft key	Function	Description	
PROGRAM DEFAULTS	Define program defaults	page 397	
CONTOUR + POINT MACHINING	Functions for contour and point machining	page 397	
TILT MACHINING PLANE	Define the PLANE function	page 423	
PROGRAM FUNCTIONS	Define different DIN/ISO functions	page 398	
PROGRAM- MING AIDS	Programming aids	page 157	

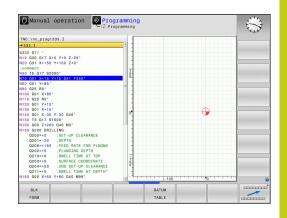
After pressing the **SPEC FCT** key, you can open the **smartSelect** selection window with the **GOTO** key. The TNC displays a structure overview with all available functions. You can rapidly navigate with the cursor or mouse and select functions in the tree diagram. The TNC displays online help for the specific functions in the window on the right.

Program defaults menu

PROGRAM DEFAULTS
DEFAULTS

Press the Program Defaults soft key

Soft key	Function	Description
BLK FORM	Define workpiece blank	page 117
DATUM TABLE	Select datum table	See Cycle- Programming User's Manual
GLOBAL DEF	Define global cycle parameters	See Cycle- Programming User's Manual

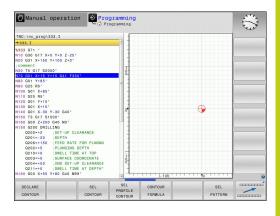


Functions for contour and point machining menu

CONTOUR + POINT MACHINING

Press the soft key for functions for co	ontour and
point machining	

Soft key	Function	Description
DECLARE	Assign contour description	See Cycle- Programming User's Manual
SEL CONTOUR	Select a contour definition	See Cycle- Programming User's Manual
CONTOUR FORMULA	Define a complex contour formula	See Cycle- Programming User's Manual
SEL PATTERN	Select the point file with machining positions	See Cycle- Programming User's Manual



11 Special functions

11.1 Overview of special functions

Menu of various DIN/ISO functions

PROGRAM
FUNCTIONS

 Press the soft key for defining various DIN/ISO functions

Soft key	Function	Description
STRING FUNCTIONS	Define string functions	page 349
FUNCTION	Define pulsing spindle speed	page 414
FUNCTION FEED	Define dwell time	page 416
DIN/ISO	Define DIN/ISO functions	page 403
INSERT COMMENT	Add comments	page 159

11.2 Tool carrier management

Fundamentals

You can create and manage tool carriers using the tool carrier management. The control factors the tool carriers into the calculations.

On machines with 3 axes, tool carriers for right-angled angled heads help processing on tool axes **X** and **Y**, as the control takes the dimensions of the angle heads into consideration.

Along with software option number 8, **Advanced Function Set** 1, you can tilt the working plane to the angle of the removable angled heads and thus keep working with the **Z** tool axis.

You must carry out the following steps so that the control can factors the tool carriers into the calculations:

- Save tool carrier templates
- Assign input parameters to tool carriers
- Allocate parameterized tool carriers

Save tool carrier templates

Many tool carriers only differ from others in terms of their dimensions, but their geometric shape is identical. So that you don't have to design all your tool carriers yourself, HEIDENHAIN supplies a range of ready-made tool carrier templates. Tool carrier templates are 3-D models with fixed geometries but changeable dimensions.

The tool carrier templates must be saved in **TNC:\system \Toolkinematics** and have the extension **.cft**.



If the tool carrier templates are not available in your control, please download the data you require from: http://www.klartext-portal.com/nc-solutions/en

 \Rightarrow

If you need further tool carrier templates, please contact your machine manufacturer or third-party vendor.



The tool carrier templates may consist of several subfiles. If the sub-files are incomplete, the control will display an error message.

Do not use incomplete tool carrier templates!

11 **Special functions**

11.2 Tool carrier management

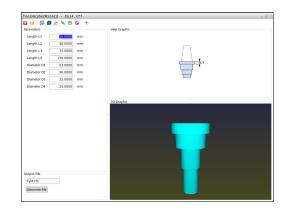
Assign input parameters to tool carriers

Before the control can factor the tool carrier into the calculations, you must give the tool carrier template the actual dimensions. These parameters are entered in the additional ToolHolderWizard tool.

Save the parameterized tool carriers with the extension .cfx under TNC:\system\Toolkinematics.

The additional ToolHolderWizard tool is mainly operated with a mouse. Using the mouse, you can also set the desired screen layout by drawing a line between the areas Parameter, Help graphics and 3-D graphics by holding down the left mouse button.

The following icons are available in the additional ToolHolderWizard tool:



lcon	Function
X	Close tool
<u>-</u>	Open file
Ø	Switch between wire frame model and solid object view
Ø	Switch between shaded and transparent view
teter	Display or hide transformation vectors
^А вс	Show or hide names of collision objects
₽	Display or hide test points
0	Show or hide measurement points
++++	Return to starting view of the 3-D model

If the tool carrier template does not contain any transformation vectors, names, test points and measurement points, the additional ToolHolderWizard tool does not execute any function when the corresponding icons are activated.

11

Proceed as follows to parameterize tool carrier templates and save these parameters:



 Operating mode: Press the MANUAL OPERATION key



- Press the TOOL TABLE soft key
- EDIT OFF ON

♦

- Press the EDIT soft key
- ► Move the cursor to the **KINEMATIC** column



- Press the SELECT soft key
- Press the TOOL HOLDER WIZARD soft key
- The control opens the additional
 ToolHolderWizard tool in a pop-up window
- Press the OPEN FILE icon
 - > The control opens a pop-up window
 - Select the desired tool carrier template using the preview screen
 - Press the OK button
 - The control opens the selected tool carrier template
 - > The cursor goes to the first parameterizable value
 - Adjust values
 - Enter the name for the parameterized tool holder in the **Output file** area
 - Press the GENERATE FILE button
 - If required, reply to the message on the control
 - ► Press the **CLOSE** icon
 - > The control closes the additional tool

11 Special functions

11.2 Tool carrier management

Allocate parameterized tool carriers

To allow the control to factor a parameterized tool carrier into calculations, you must allocate the tool carrier to a tool and **call the tool again**.



Parameterized tool carriers can consist of several sub-files. If the sub-files are incomplete, the control will display an error message.

Only use fully parameterized tool carriers!

Proceed as follows to allocate a parameterized tool carrier to a tool:

Press the TOOL TABLE soft key

 Operating mode: Press the MANUAL OPERATION key



EDIT OFF ON

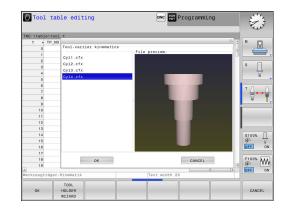
1

- Press the EDIT soft key
- Move the cursor to the KINEMATIC column of the required tool



- Press the SELECT soft key
- The control opens a pop-up window with parameterized tool carriers
- Select the desired tool carrier using the preview screen
- ► Press the **OK** soft key
- The control copies the name of the selected tool carrier to the KINEMATIC column
- Exit the tool table

END



11

11.3 Defining DIN/ISO functions

Overview



If a USB keyboard is connected, you can also enter the DIN/ISO functions by using the USB keyboard.

The TNC provides soft keys with the following functions for creating DIN/ISO programs:

Soft key	Function
DIN/ISO	Select ISO functions
F	Feed rate
G	Tool movements, cycles and program functions
I	X coordinate of the circle center/pole
J	Y coordinate of the circle center/pole
L	Label call for subprogram and program section repeat
М	Miscellaneous function
N	Block number
Т	Tool call
Н	Polar coordinate angle
К	Z coordinate of the circle center/pole
R	Polar coordinate radius
S	Spindle speed

11 Special functions

11.4 Creating text files

11.4 Creating text files

Application

You can use the TNC's text editor to write and edit texts. Typical applications:

- Recording test results
- Documenting working procedures
- Creating formula collections

Text files have the extension .A (for ASCII files). If you want to edit other types of files, you must first convert them into type .A files.

Opening and exiting a text file

- Operating mode: Press the **Programming** key
- ► To call the file manager, press the **PGM MGT** key.
- Display type .A files: Press the SELECT TYPE soft key and SHOW ALL soft key one after the other
- Select a file and open it with the SELECT soft key or ENT key, or create a new file by entering the new file name and confirming your entry with the ENT key

To leave the text editor, call the file manager and select a file of a different file type, for example a part program.

Soft key	Cursor movements
MOVE WORD	Move cursor one word to the right
MOVE WORD	Move cursor one word to the left
	Go to next screen page
	Go to previous screen page
BEGIN	Cursor at beginning of file
	Cursor at end of file

11

Editing texts

Above the first line of the text editor, there is an information field showing the file name, location and line information:

File: Name of the text file

Line: Line in which the cursor is presently located

Column: Column in which the cursor is presently located

The text is inserted or overwritten at the location of the cursor. You can move the cursor to any desired position in the text file by pressing the arrow keys.

You can insert a line break with the **RETURN** or **ENT** key.

Deleting and re-inserting characters, words and lines

With the text editor, you can erase words and even lines, and insert them at any desired location in the text.

- Move the cursor to the word or line that you wish to erase and insert at a different place in the text
- Press the DELETE WORD or DELETE LINE soft key: The text is deleted and stored temporarily.
- Move the cursor to the location where you wish insert the text, and press the INSERT LINE / WORD soft key.

Soft key	Function
DELETE	Delete and temporarily store a line
DELETE WORD	Delete and temporarily store a word
DELETE CHAR	Delete and temporarily store a character
INSERT LINE / WORD	Insert a line or word from temporary storage

11 **Special functions**

11.4 Creating text files

Editing text blocks

You can copy and erase text blocks of any size, and insert them at other locations. Before any of these actions, you must first select the desired text block:

- ► To select a text block: Move the cursor to the first character of the text you wish to select.
 - Press the SELECT BLOCK soft key.
- SELECT BLOCK
- Move the cursor to the last character of the text you wish to select. You can select whole lines by moving the cursor up or down directly with the arrow keys-the selected text is shown in a different color.

After selecting the desired text block, you can edit the text with the following soft keys:

Soft key	Function
CUT OUT BLOCK	Delete the selected block and store temporarily
INSERT BLOCK	Store the selected block temporarily without erasing (copy)

If desired, you can now insert the temporarily stored block at a different location:

- Move the cursor to the location where you want to insert the ► temporarily stored text block
- INSERT BLOCK
- Press the INSERT BLOCK soft key the text block is inserted.

You can insert the temporarily stored text block as often as desired

Transferring the selected block to a different file

- Select the text block as described previously
- APPEND TO FILE
- Press the APPEND TO FILE soft key. The TNC displays the dialog prompt **Destination file =**
- Enter the path and name of the destination file. The TNC appends the selected text to the specified file. If no target file with the specified name is found, the TNC creates a new file with the selected text.

Inserting another file at the cursor position

- Move the cursor to the location in the text where you wish to insert another file
- READ FILE
- Press the READ FILE soft key. The TNC displays the dialog prompt File name =
- Enter the path and name of the file you want to insert

11

Finding text sections

With the text editor, you can search for words or character strings in a text. Two functions are available:

Finding the current text

The search function is used for finding the next occurrence of the word in which the cursor is presently located:

- Move the cursor to the desired word.
- ► To select the search function, press the **FIND** soft key.
- Press the FIND CURRENT WORD soft key.
- ► To find a word: press the **FIND** soft key.
- Exit the search function: Press the END soft key

Finding any text

- To select the search function, press the FIND soft key. The TNC displays the dialog prompt Find text :
- Enter the text that you wish to find
- To find text: press the FIND soft key.
- Exit the search function: Press the END soft key

¹¹ Special functions

11.5 Freely definable tables

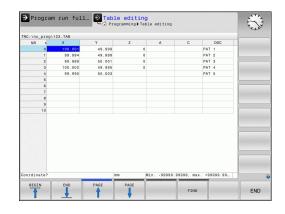
11.5 Freely definable tables

Fundamentals

In freely definable tables you can save and read any information from the NC program. The Q parameter functions **D26** to **D28** are provided for this purpose.

You can change the format of freely definable tables, i.e. the columns and their properties, by using the structure editor. They enable you to make tables that are exactly tailored to your application.

You can also toggle between a table view (standard setting) and form view.



Creating a freely definable table

- ► To call the file manager, press the PGM MGT key
- Enter any file name with the .TAB extension and confirm with the ENT key. The TNC displays a pop-up window with permanently saved table formats
- Use the arrow key to select a table template e.g. EXAMPLE.TAB and confirm with the ENT key: The TNC opens a new table in the predefined format
- To adapt the table to your requirements you have to edit the table format

Further Information: "Editing the table format", page 409



Machine tool builders may define their own table templates and save them in the TNC. When you create a new table, the TNC opens a pop-up window listing all available table templates.

	N.
ſ	$ \rightarrow $

You can also save your own table templates in the TNC. To do this, you create a new table, change the table format and save the table in the **TNC:\system \proto** directory. Then your template will also be available in the list box for table templates when you create a new table.

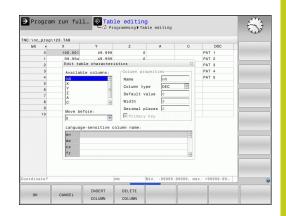
Editing the table format

Press the soft key EDIT FORMAT (switch the soft-key row): The TNC opens the editor form showing the table structure. The meanings of the structure commands (header entries) are shown in the following table.

Structure command	Meaning
Available columns:	List of all columns contained in the table
Move before:	The entry highlighted in Available columns is moved in front of this column
Name	Column name: Is displayed in the header
Column type	TEXT: Text entry SIGN: + or - sign BIN: Binary number DEC: Decimal, positive, whole number (cardinal number) HEX: Hexadecimal number INT: Whole number LENGTH: Length (is converted in inch programs) FEED: Feed rate (mm/min or 0.1 inch/ min) IFEED: Feed rate (mm/min or inch/min) FLOAT: Floating-point number BOOL: Logical value INDEX: Index TSTAMP: Fixed format for date and time UPTEXT: Text entry in upper case PATHNAME: Path name
Default value	Default value for the fields in this column
Width	Width of the column (number of characters)
Primary key	First table column
Language-sensitive column name	Language-sensitive dialogs

You can use a connected mouse or the TNC keyboard to navigate in the form. Navigation using the TNC keyboard:

- Et |
- Press the navigation keys to go to the entry fields. Use the arrow keys to navigate within an entry field. To open pop-down menus, press the GOTO key.



¹¹ Special functions

11.5 Freely definable tables



In a table that already contains lines you can not change the table properties **Name** and **Column type**. Once you have deleted all lines, you can change these properties. If required, create a backup copy of the table beforehand.

In a field of the **TSTAMP** column type you can reset an invalid value if you press the **CE** key and then the **ENT** key.

Exiting the structure editor

Press the OK soft key The TNC closes the editor form and applies the changes. All changes are discarded by pressing the CANCEL soft key.

Switching between table and form view

All tables with the **.TAB** extension can be opened in either list view or form view.

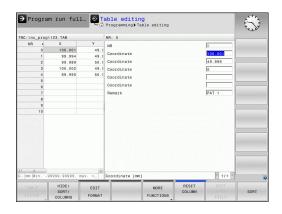


 Press the key for setting the screen layout. Select the respective soft key for list view or form view (form view: with or without dialog texts)

In the form view the TNC lists the line numbers with the contents of the first column in the left half of the screen.

In the right half you can change the data.

- Press the ENT key or the arrow key to move to the next entry field
- To select another line press the navigation key (folder symbol). This moves the cursor to the left window, and you can select the desired line with the arrow keys. Press the green navigation key to switch back to the input window.



D26 – Open a freely definable table

With the function **D26: TABOPEN** you open a freely definable table to be written to with **D27** or to be read from with **D28**.



Only one table can be opened in an NC program at any one time. A new block with **D26** automatically closes the last opened table.

The table to be opened must have the extension **.TAB**.

Example: Open the table TAB1.TAB, which is saved in the directory TNC: \DIR1.

N56 D26 TNC:\DIR1\TAB1.TAB

¹¹ Special functions

11.5 Freely definable tables

D27 – Write to a freely definable table

With the **D27** function you write to the table that you previously opened with **D26**.

You can write several column names in a **D27** block. The column names must be written between quotation marks and separated by a comma. You define the values that the TNC is to write to the respective column with Q parameters.



Note that by default the **D27** function also writes values to the currently open table in **Test run** mode. The **D18 ID992 NR16** function enables you to query in which operating mode the program is to be run. If the **D27** function is to be run only in the **Program run, single block** and **Program run, full sequence** operating modes, you can skip the respective program section by using a jump command.

Further Information: "If-then decisions with Q parameters", page 321

You can write only to numerical table fields.

If you wish to write to more than one column in a block, you must save the values under successive Q parameter numbers.

Example

You wish to write to the columns "Radius," "Depth" and "D" in line 5 of the presently opened table. The value to be written in the table must be saved in the Q parameters Q5, Q6 and Q7.

N53 Q5 = 3.75

N54 Q6 = -5

N55 Q7 = 7.5

N56 D27 P01 5/"RADIUS, DEPTH, D" = Q5

D28 – Read from a freely definable table

With the D28 function you read from the table previously opened with D26.

You can define, i.e. read, several column names in a **D28** block. The column names must be written between quotation marks and separated by a comma. In the **D28** block you can define the Ω parameter number in which the TNC is to write the value that is first read.



You can read only numerical table fields.

If you wish to read from more than one column in a block, the TNC will save the values under successive Q parameter numbers.

Example

You wish to read the values of the columns "Radius," "Depth" and "D" from line 6 of the presently opened table. Save the first value in Q parameter Q10 (second value in Q11, third value in Q12).

N56 D28 Q10 = 6/"RADIUS, DEPTH, D"

Customize table view



This function may only be used with the permission of your machine manufacturer.

Soft key	Function	
ADAPT THE TABLE FORMAT	Adapt format of tables present after changing the control software version	

¹¹ Special functions

11.6 Pulsing spindle speed FUNCTION S-PULSE

11.6 Pulsing spindle speed FUNCTION S-PULSE

Program pulsing spindle speed

Application



Refer to your machine manual.

The behavior of this function varies depending on the respective machine.

Using the **S-PULSE FUNCTION** you can program a pulsing spindle speed, when operating at a constant spindle speed.

You can define the duration of a vibration (period length) using the P-TIME input value or a speed change in percent using the the SCALE input value. The spindle speed changes in a sinusoidal form around the target value.

Procedure

Proceed as follows for the definition:

- Show the soft-key row with special functions
- PROGRAM

SPEC FCT

> Select the menu for defining various conversational functions



PULSE

Press the SPINDLE-PULSE soft key

Press the FUNCTION SPINDLE soft key

- Define period length P-TIME
- Define speed change SCALE



The control never exceeds a programmed speed limit. The spindle speed is maintained until the sinusoidal curve of the **S-PULSE FUNCTION** falls below the maximum speed once more.

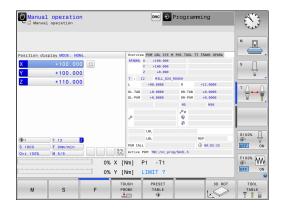
Symbols

In the status bar the symbol indicates the condition of the pulsing shaft speed:

lcon	Function
S %	Pulsing spindle speed active

NC block

N30 FUNCTION S-PULSE P-TIME10 SCALE5*



Pulsing spindle speed FUNCTION S-PULSE 11.6

Reset pulsing spindle speed

Use the **S-PULSE RESET** function to reset the pulsing spindle speed. Proceed as follows for the definition:

SPEC FCT

- Show the soft-key row with special functions
- PROGRAM FUNCTIONS
- Select the menu for defining various plain-language functions
- FUNCTION

RESET SPINDLE-PULSE

- Press the FUNCTION SPINDLE soft key
- Press the RESET SPINDLE-PULSE soft key.

NC block

N40 FUNCTION S-PULSE RESET*

11

¹¹ Special functions

11.7 Dwell time FUNCTION FEED

11.7 Dwell time FUNCTION FEED

Programming dwell time

Application



Refer to your machine manual.

The behavior of this function varies depending on the respective machine.

The **FUNCTION FEED DWELL** function is used to program a recurring dwell time in seconds, e.g. to force chip breaking . Program **FUNCTION FEED DWELL** immediately prior to the machining you wish to run with chip breaking.

The **FUNCTION FEED DWELL** function is not effective with rapid traverse movements and probing motion.



Damage to the workplace!

Do not use **FUNCTION FEED DWELL** for machining threads.

Procedure

Proceed as follows for the definition:

Show the soft-key row with special functions

Press the FUNCTION FEED soft key



 Select the menu for defining various plain-language functions

FUNCTION FEED

FEED

Press the FEED DWELL soft key

- Define the interval duration for dwelling D-TIME
- Define the interval duration for cutting F-TIME

NC block

N30 FUNCTION FEED DWELL D-TIME0.5 F-TIME5*

Resetting dwell time



Reset to the dwell time immediately following the machining with chip breaking.

Use **FUNCTION FEED DWELL RESET** to reset the recurring dwell time.

Proceed as follows for the definition:



Show the soft-key row with special functions

 Select the menu for defining various plain-language functions



PROGRAM FUNCTIONS

Press the FUNCTION FEED soft key



Press the **RESET FEED DWELL** soft key



You can also reset the dwell time by entering D-TIME 0.

The TNC automatically resets the **FUNCTION FEED DWELL** function at the end of a program.

NC block

N40 FUNCTION FEED DWELL RESET*

Special functions

11.8 Dwell time FUNCTION DWELL

11.8 Dwell time FUNCTION DWELL

Programming dwell time

Application

The **FUNCTION DWELL** function enables you to program a dwell time in seconds or define the number of spindle revolutions for dwelling.

Procedure

Proceed as follows for the definition:

Show the soft-key row with special functions



SPEC FCT

> Select the menu for defining various plain-language functions

FUNCTION DWELL FUNCTION DWELL soft key



DWELL REVOLUTIONS

- Press the DWELL TIME soft key
- Define the duration in seconds
- Alternatively, press the DWELL REVOLUTIONS soft key
- Define the number of spindle revolutions

NC block N30 FUNCTION DWELL TIME10*

NC block N40 FUNCTION DWELL REV5.8

11



Multiple axismachining

12 Multiple axismachining

12.1 Functions for multiple axis machining

12.1 Functions for multiple axis machining

The TNC functions for multiple-axis machining are described in this chapter.

TNC function	Description	Page
PLANE	Define machining in the tilted working plane	421
M116	Feed rate of rotary axes	445
M126	Shortest-path traverse of rotary axes	446
M94	Reduce display value of rotary axes	447
M138	Selection of tilted axes	448

12.2 The PLANE function: Tilting the working plane (software option 8)

Introduction



The machine manufacturer must enable the functions for tilting the working plane!

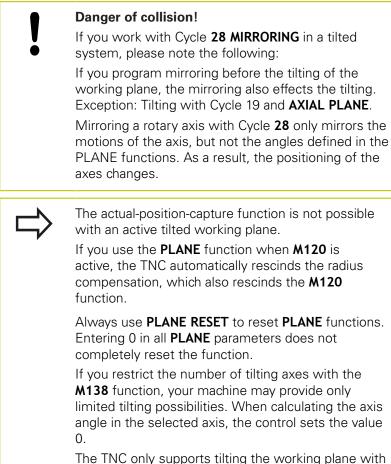
You can only use the **PLANE** function completely on machines which have at least two rotary axes (head and/or table). Exception: **PLANE AXIAL** can also be used if only a single rotary axis is present or active on your machine.

The **PLANE** function is a powerful function for defining tilted working planes in various manners.

The parameter definition of the **PLANE** function is separated into two parts:

- The geometric definition of the plane, which is different for each of the available PLANE functions.
- The positioning behavior of the PLANE function, which is independent of the plane definition and is identical for all PLANE functions

Further Information: "Specifying the positioning behavior of the PLANE function", page 437



The TNC only supports tilting the working plane with spindle axis Z.

12

12 Multiple axismachining

12.2 The PLANE function: Tilting the working plane (software option 8)

Overview

All **PLANE** functions available on the TNC describe the desired working plane independently of the rotary axes actually present on your machine. The following possibilities are available:

Soft key	Function	Required parameters	Page
SPATIAL	SPATIAL	Three spatial angles: SPA, SPB, and SPC	425
PROJECTED	PROJECTED	Two projection angles: PROPR and PROMIN and a rotation angle ROT	426
EULER	EULER	Three Euler angles: precession (EULPR), nutation (EULNU) and rotation (EULROT),	428
VECTOR	VECTOR	Normal vector for defining the plane and base vector for defining the direction of the tilted X axis	430
POINTS	POINTS	Coordinates of any three points in the plane to be tilted	432
REL. SPA.	RELATIVE	Single, incrementally effective spatial angle	434
AXIAL	AXIAL	Up to three absolute or incremental axis angles A,B,C	435
RESET	RESET	Resetting the PLANE function	424

Running an animation

In order to make the differences between each definition possibility more clear even before selecting the function, you can start an animated sequence via soft key. The control turns the soft key blue and shows an animated portrayal of the selected PLANE function.

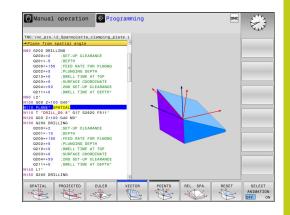
Soft key	Function
SELECT ANIMATION OFF ON	Switch on animation
SPATIAL	Animation mode activated

Defining the PLANE function



Show the soft-key row with special functions

- TILT MACHINING PLANE
- Select the PLANE function: Press the TILT MACHINING PLANE soft key: The TNC displays the available definition possibilities in the soft-key row



Selecting functions

Select the desired function by soft key. The control continues the dialog and requests the required parameters

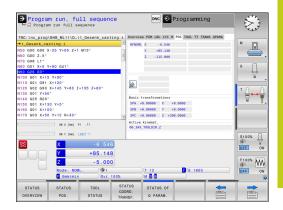
Selecting the function while animation is active

- Select the function using the soft key: Control shows the animation
- To confirm the currently active function: Press the function's soft key again or press the ENT key

Position display

As soon as a **PLANE** function except **PLANE AXIAL** is active, the TNC shows the calculated spatial angle in the additional status display.

In the Distance-To-Go mode (**ACTDST** and **REFDST**) the TNC shows during tilting (**MOVE** or **TURN** mode) in the rotary axis the distance to go (or calculated distance) to the final position of the rotary axis.



12 Multiple axismachining

12.2 The PLANE function: Tilting the working plane (software option 8)

Resetting PLANE function

SPEC FCT	Show the soft-key row with special functions	Ν
TILT MACHINING PLANE	 Select the PLANE function: Press the TILT MACHINING PLANE soft key: The TNC displays the available definition possibilities in the soft-key row 	1
RESET	 Select function to be reset: This resets the PLANE function internally 	
	 Specify whether the TNC automatically moves the rotary axes to the default setting (MOVE or TURN) or not (STAY) Further Information: "Automatic positioning: MOVE/TURN/STAY (entry is mandatory)", page 437 Terminate the entry: Press the END key 	
	The PLANE RESET function resets the active PLANE function—or an active cycle G80 —completely (angles = 0 and function is inactive). It does not need to be defined more than once.	
	Deactivate tilting in the Manual operation operating mode in the 3D ROT menu.	
	Further Information: "Activating manual tilting:", page 509	

NC block

N10 PLANE RESET MOVE DIST50 F1000*

Defining the working plane with the spatial angle: PLANE SPATIAL

Application

Spatial angles define a working plane using up to three rotations of the workpiece coordinate system; two perspectives that have always the same result are available for this purpose.

- Rotations about the untilted coordinate system: The sequence of the rotations is first around the machine axis A, then around the machine axis B, and then around the machine axis C.
- Rotations about the respectively tilted coordinate system: The sequence of rotations is first around the machine axis C, then around the rotated axis B, and then around the rotated axis A. This perspective is usually easier to understand.



Before programming, note the following

You must always define the three spatial angles **SPA**, **SPB**, and **SPC**, even if one of them = 0.

This operation corresponds to **G80** if the entries in Cycle **G80** are defined as spatial angles on the machine side.

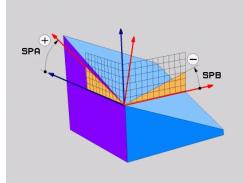
Parameter description for the positioning behavior.

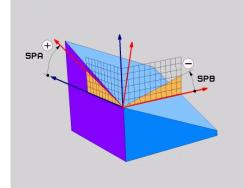
Further Information: "Specifying the positioning behavior of the PLANE function", page 437

Input parameters



- Spatial angle A?: Rotation angle SPA around the machine-referenced axis X. Entry range from -359.9999° to +359.9999°
- Spatial angle B?: Rotation angle SPB around the machine-referenced axis X. Entry range from -359.9999° to +359.9999°
- Spatial angle C?: Rotation angle SPC around the machine-referenced axis X. Entry range from -359.9999° to +359.9999°
- Continue with the positioning properties
 Further Information: "Specifying the positioning behavior of the PLANE function", page 437



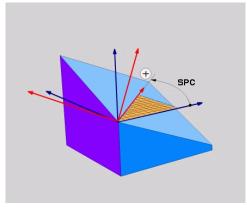


12 Multiple axismachining

12.2 The PLANE function: Tilting the working plane (software option 8)

Abbreviations used

Abbreviation	Meaning
SPATIAL	In space
SPA	Sp atial A : Rotation around the X axis
SPB	Sp atial B : Rotation around the Y axis
SPC	Sp atial C : Rotation around the Z axis



NC block

N50 PLANE SPATIAL SPA+27 SPB+0 SPC +45*

Defining the working plane with the projection angle: PLANE PROJECTED

Application

Projection angles define a working plane by specifying two angles that you can communicate by projection of the 1st coordinate plane (Z/X on tool axis Z) and 2nd coordinate plane (Y/Z on tool axis Z) to the working levels to be be defined.

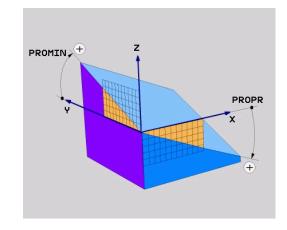


Before programming, note the following

You can only use projection angles if the angle definitions are given with respect to a rectangular cuboid. Otherwise there will be deformations on the workpiece.

Parameter description for the positioning behavior.

Further Information: "Specifying the positioning behavior of the PLANE function", page 437



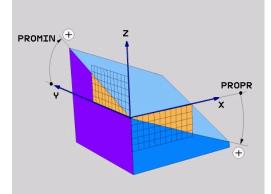
The PLANE function: Tilting the working plane (software option 8) 12.2

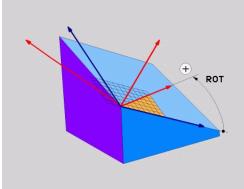
Input parameters



Projection angle on 1st Coordinate plane?:

- Projected angle of the tilted machining plane in the 1st coordinate plane of the untilted coordinate system (Z/X for tool axis Z). Input range: from – 89.9999° to +89.9999°. The 0° axis is the principal axis of the active working plane (X for tool axis Z, positive direction)
- Proj. angle on 2nd Coordinate plane?: Projected angle in the 2nd coordinate plane of the untilted coordinate system (Y/Z for tool axis Z). Input range: from -89.9999° to +89.9999°. The 0° axis is the minor axis of the active machining plane (Y for tool axis Z)
- ROT angle of tilted plane?: Rotation of the tilted coordinate system around the tilted tool axis (corresponds to a rotation with Cycle 10 ROTATION). The rotation angle is used to simply specify the direction of the principal axis of the working plane (X for tool axis Z, Z for tool axis Y). Input range: -360° to +360°
- Continue with the positioning properties
 Further Information: "Specifying the positioning behavior of the PLANE function", page 437





NC block

N50 PLANE PROJECTED PROPR+24 PROMIN+24 ROT+30*

Abbreviations used:

PROJECTED	Projected
PROPR	Principle plane
PROMIN	Minor plane
ROT	Rotation

¹² Multiple axismachining

12.2 The PLANE function: Tilting the working plane (software option 8)

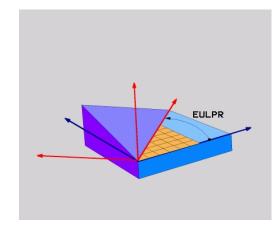
Defining the working plane with the Euler angle: PLANE EULER

Application

Euler angles define a machining plane through up to three **rotations about the respectively tilted coordinate system**. The Swiss mathematician Leonhard Euler defined these angles.

Before programming, note the following

Parameter description for the positioning behavior. **Further Information:** "Specifying the positioning behavior of the PLANE function", page 437



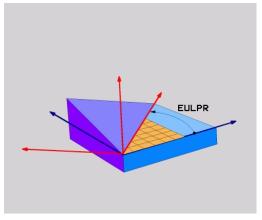
Input parameters

PROJECTED	
	l

- Rot. angle Main coordinate plane?: Rotary angle EULPR around the Z axis. Please note:
 - Input range: -180.0000° to 180.0000°
 - The 0° axis is the X axis
- Tilting angle tool axis?: Tilting angle EULNUT of the coordinate system around the X axis shifted by the precession angle. Please note:
 - Input range: 0° to 180.0000°
 - The 0° axis is the Z axis
- ROT angle of tilted plane?: Rotation EULROT of the tilted coordinate system around the tilted Z axis (corresponds to a rotation with Cycle 10 ROTATION). Use the rotation angle to simply define the direction of the X axis on the tilted working plane. Please note:
 - Input range: 0° to 360.0000°
 - The 0° axis is the X axis
- Continue with the positioning properties
 Further Information: "Specifying the positioning behavior of the PLANE function", page 437

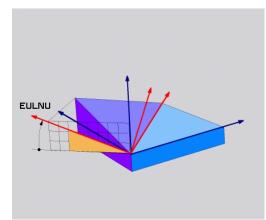
NC block

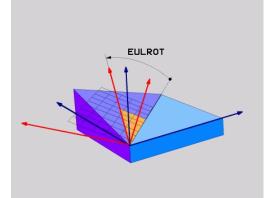
N50 PLANE EULER EULPR45 EULNU20 EULROT22*



Abbreviations used

Abbreviation	Meaning
EULER	Swiss mathematician who defined these angles
EULPR	Pr ecession angle: angle describing the rotation of the coordinate system around the Z axis
EULNU	Nu tation angle: angle describing the rotation of the coordinate system around the X axis shifted by the precession angle
EULROT	Rot ation angle: angle describing the rotation of the tilted machining plane around the tilted Z axis





12 Multiple axismachining

12.2 The PLANE function: Tilting the working plane (software option 8)

Defining the working plane with two vectors: PLANE VECTOR

Application

You can use the definition of a working plane via **two vectors** if your CAD system can calculate the base vector and normal vector of the tilted machining plane. A normalized input is not necessary. The TNC calculates the normal, so you can enter values between -9.999999 and +9.999999.

The base vector required for the definition of the machining plane is defined by the components **BX,BY** and **BZ.** The normal vector is defined by the components **NX**, **NY** and **NZ**.



Before programming, note the following

The TNC calculates standardized vectors from the values you enter.

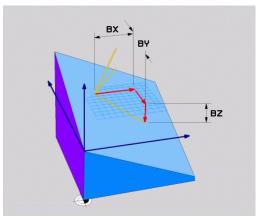
Parameter description for the positioning behavior. **Further Information:** "Specifying the positioning behavior of the PLANE function", page 437



The base vector defines the direction of the principal axis in the tilted machining plane, and the normal vector determines the orientation of the tilted machining plane, and at the same time is perpendicular to it.

Depending on the setting of the machine tool builder, the control either outputs an error message if the vectors are not perpendicular, or it automatically compensates the vectors.

Refer to your machine manual.



Input parameters



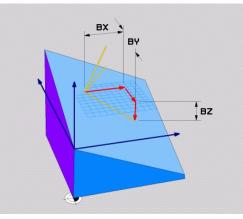
- X component of base vector?: X component BX of the base vector B; input range: from -9.9999999 to +9.99999999
- Y component of base vector?: Y component BY of the base vector B; input range: from -9.9999999 to +9.99999999
- Z component of base vector?: Z component BZ of the base vector B; input range: from -9.9999999 to +9.99999999
- X component of normal vector?: X component NX of the normal vector N; input range: from -9.9999999 to +9.9999999
- Y component of normal vector?: Y component NY of the normal vector N; input range: from -9.9999999 to +9.9999999
- Z component of normal vector?: Z component NZ of the normal vector N; input range: from -9.9999999 to +9.9999999
- Continue with the positioning properties
 Further Information: "Specifying the positioning behavior of the PLANE function", page 437

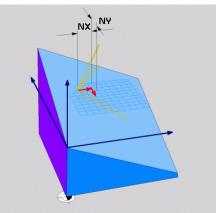
NC block

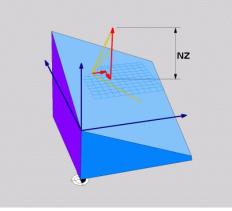
N50 PLANE VECTOR BX0.8 BY-0.4 BZ-0.42 NX0.2 NY0.2 NT0.92 ..*

Abbreviations used

Abbreviation	Meaning
VECTOR	Vector
BX, BY, BZ	Basis vector: X, Y and Z components
NX, NY, NZ	Normal vector: X, Y and Z components







¹² Multiple axismachining

12.2 The PLANE function: Tilting the working plane (software option 8)

Defining the working plane via three points: PLANE POINTS

Application

A working plane can be uniquely defined by entering **any three points P1 to P3 in this plane**. This possibility is realized in the **PLANE POINTS** function.



Before programming, note the following

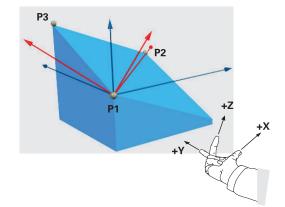
The connection from Point 1 to Point 2 determines the direction of the tilted main axis (X for tool axis Z).

The direction of the tilted tool axis is determined by the position of Point 3 relative to the connecting line between Point 1 and Point 2. Use the right-hand rule (thumb = X axis, index finger = Y axis, middle finger = Z axis) to remember: thumb (X axis) points from Point 1 to Point 2, index finger (Y axis) points parallel to the tilted Y axis in the direction of Point 3. Then the middle finger points in the direction of the tilted tool axis.

The three points define the slope of the plane. The position of the active datum is not changed by the TNC.

Parameter description for the positioning behavior.

Further Information: "Specifying the positioning behavior of the PLANE function", page 437



Input parameters



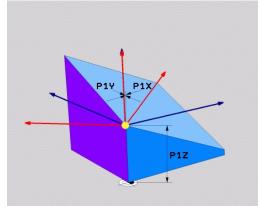
- X coordinate of 1st plane point?: X coordinate P1X of the 1st plane point
- Y coordinate of 1st plane point?: Y coordinate P1Y of the 1st plane point
- Z coordinate of 1st plane point: Z coordinate P1Z of the 1st plane point
- X coordinate of 2nd plane point?: X coordinate P2X of the 2nd. plane point
- Y coordinate of 2nd plane point?: Y coordinate P2Y of the 2nd plane point
- Z coordinate of 2nd plane point?: Z coordinate P2Z of the 2nd plane point
- X coordinate of 3rd plane point?: X coordinate P3X of the 3rd plane point
- Y coordinate of 3rd plane point?: Y coordinate P3Y of the 3rd plane point
- Z coordinate of 3rd plane point?: Z coordinate P3Z of the 3rd plane point
- Continue with the positioning properties
 Further Information: "Specifying the positioning behavior of the PLANE function", page 437

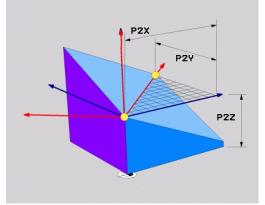
NC block

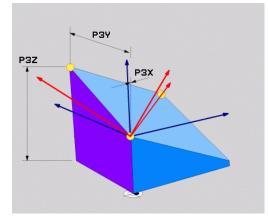
N50 PLANE POINTS P1X+0 P1Y+0 P1Z+20 P2X+30 P2Y+31 P2Z+20 P3X+0 P3Y+41 P3Z+32.5*

Abbreviations used

POINTS Points







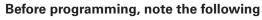
¹² Multiple axismachining

12.2 The PLANE function: Tilting the working plane (software option 8)

Defining the working plane via a single incremental spatial angle: PLANE RELATIV

Application

Use a relative spatial angle when an already active tilted working plane is to be tilted by **another rotation**. Example: machining a 45° chamfer on a tilted plane.



The defined angle is always in effect in respect to the active working plane, regardless of the function you have used to activate it.

You can program any number of **PLANE RELATIV** functions in a row.

If you want to return to the working plane that was active before the **PLANE RELATIV** function, define the same **PLANE RELATIV** function again but with the opposite algebraic sign.

If you use the **PLANE RELATIV** function in a non-tilted working plane, then you simply rotate the non-tilted plane about the spatial angle defined in the **PLANE** function.

Parameter description for the positioning behavior.

Further Information: "Specifying the positioning behavior of the PLANE function", page 437

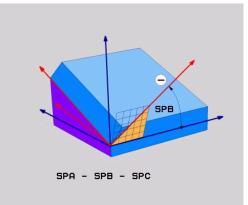
Input parameters

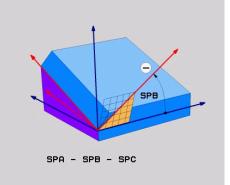


- Incremental angle?: Spatial angle by which the active machining plane is to be rotated. Use a soft key to select the axis to be rotated around. Input range: -359.9999° to +359.9999°
- Continue with the positioning properties
 Further Information: "Specifying the positioning behavior of the PLANE function", page 437

Abbreviations used

Abbreviation	Meaning
RELATIV	Relative to







N50 PLANE RELATIV SPB-45*

Tilting the working plane through axis angle: PLANE AXIAL

Application

The **PLANE AXIAL** function defines both the position of the working plane and the nominal coordinates of the rotary axes. This function is particularly easy to use on machines with Cartesian coordinates and with kinematics structures in which only one rotary axis is active.



PLANE AXIAL can also be used if you have only one rotary axis active on your machine.

You can use the **PLANE RELATIVE** function after **PLANE AXIAL** if your machine allows spatial angle definitions. Refer to your machine manual.



Before programming, note the following

Enter only axis angles that actually exist on your machine. Otherwise the TNC generates an error message.

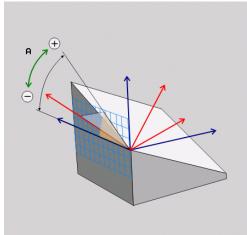
Rotary axis coordinates defined with **PLANE AXIAL** are modally effective. Successive definitions therefore build on each other. Incremental input is allowed.

Use **PLANE RESET** to reset the **PLANE AXIAL** function. Resetting by entering 0 does not deactivate **PLANE AXIAL.**

SEQ, **TABLE ROT** and **COORD ROT** have no function in conjunction with **PLANE AXIAL**.

Parameter description for the positioning behavior.

Further Information: "Specifying the positioning behavior of the PLANE function", page 437

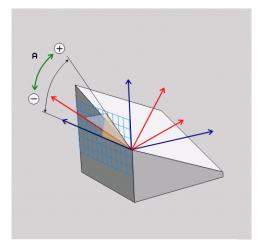


12 Multiple axismachining

12.2 The PLANE function: Tilting the working plane (software option 8)

Input parameters

- AXIAL
- Axis angle A?: Axis angle to which the A axis is to be tilted. If entered incrementally, it is the angle by which the A axis is to be tilted from its current position. Input range: –99999.9999° to +99999.9999°
- Axis angle B?: Axis angle to which the B axis is to be tilted. If entered incrementally, it is the angle by which the B axis is to be tilted from its current position. Input range: –99999.9999° to +99999.9999°
- Axis angle C?: Axis angle to which the C axis is to be tilted. If entered incrementally, it is the angle by which the C axis is to be tilted from its current position. Input range: -99999.9999° to +99999.9999°
- Continue with the positioning properties
 Further Information: "Specifying the positioning behavior of the PLANE function", page 437





Abbreviations used

Abbreviation	Meaning
AXIAL	In the axial direction

Specifying the positioning behavior of the PLANE function

Overview

Independently of which PLANE function you use to define the tilted machining plane, the following functions are always available for the positioning behavior:

- Automatic positioning
- Selection of alternate tilting possibilities (not with PLANE AXIAL)
- Selection of the type of transformation (not with **PLANE AXIAL**)

Danger of collision!

If you work with Cycle 28 MIRRORING in a tilted

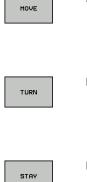
system, please note the following:

If you program mirroring before the tilting of the working plane, the mirroring also effects the tilting. Exception: Tilting with Cycle 19 and **AXIAL PLANE**.

Mirroring a rotary axis with Cycle **28** only mirrors the motions of the axis, but not the angles defined in the PLANE functions. As a result, the positioning of the axes changes.

Automatic positioning: MOVE/TURN/STAY (entry is mandatory)

After you have entered all parameters for the plane definition, you must specify how the rotary axes will be positioned to the calculated axis values:



The PLANE function is to automatically position the rotary axes to the calculated position values. The position of the tool relative to the workpiece is to remain the same. The TNC carries out a compensation movement in the linear axes

The PLANE function is to automatically position the rotary axes to the calculated position values, but only the rotary axes are positioned. The TNC does **not** carry out a compensation movement on the linear axes

 You will position the rotary axes later in a separate positioning block

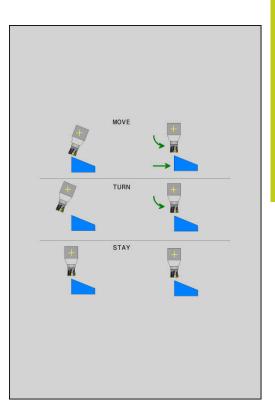
If you have selected the **MOVE** option (**PLANE** function is to position the axes automatically), the following two parameters must still be defined: **Dist. tool tip - center of rot.** and **Feed rate? F =**.

If you have selected the option TURN (PLANE function is to position the axes automatically), the following parameter must still be defined Feed rate? F =.



If you use **PLANE** together with **STAY**, you have to position the rotary axes in a separate block after the **PLANE** function.

Dist. tool tip - center of rot. (incremental): The TNC tilts the tool (or table) relative to the tool tip. The DIST parameter shifts the center of rotation of the positioning movement relative to the current position of the tool tip.



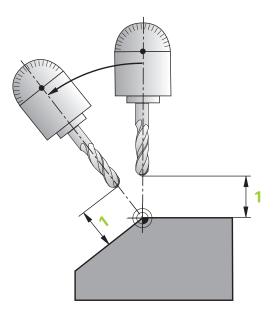
12

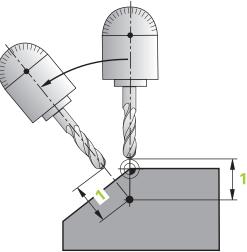
12 Multiple axismachining

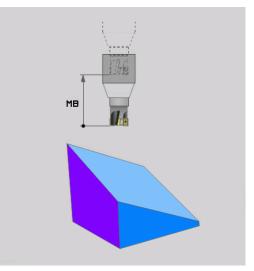
12.2 The PLANE function: Tilting the working plane (software option 8)



- If the tool is already at the given distance to the workpiece before positioning, then relatively speaking the tool is at the same position after positioning (see figure at center right, 1 = DIST)
- If the tool is not at the given distance to the workpiece before positioning, then relatively speaking the tool is offset from the original position after positioning (see figure at bottom right, 1 = DIST)
- Feed rate? F=: Contour speed at which the tool should be positioned
- Retraction length in the tool axis?: Retraction path MB is effective incrementally from the current tool position in the active tool axis direction that the TNC approaches before tilting. MB MAX positions the tool just before the software limit switch.







Positioning the rotary axes in a separate block

Proceed as follows if you want to position the rotary axes in a separate positioning block (option **STAY** selected):

Danger of collision! Pre-position the tool to a position where there is no danger of collision with the workpiece (clamping devices) during positioning.

Do not program mirroring of the rotary axis between the PLANE function and the positioning, otherwise the control positions to the mirrored values but the PLANE function calculates without mirroring.

- Select any PLANE function, and define automatic positioning with the STAY option. During program execution the TNC calculates the position values of the rotary axes present on the machine, and stores them in the system parameters Q120 (A axis), Q121 (B axis) and Q122 (C axis)
- Define the positioning block with the angular values calculated by the TNC

NC example blocks: Position a machine with a rotary table C and a tilting table A to a space angle of B+45°

N10 G00 Z+250 G40*	Position at clearance height
N20 PLANE SPATIAL SPA+0 SPB+45 SPC+0 STAY*	Define and activate the PLANE function
N30 G01 A+Q120 C+Q122 F2000*	Position the rotary axis with the values calculated by the TNC
	Define machining in the tilted working plane

¹² Multiple axismachining

12.2 The PLANE function: Tilting the working plane (software option 8)

Selection of alternate tilting possibilities: SEQ +/- (entry optional)

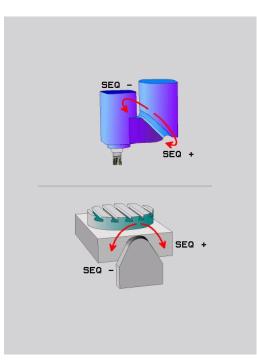
The position you define for the working plane is used by the TNC to calculate the appropriate positioning of the rotary axes present on the machine. In general there are always two solution possibilities.

Use the **SEQ** switch to specify which possibility the TNC should use:

- SEQ+ positions the master axis so that it assumes a positive angle. The master axis is the first rotary axis going out from the tool or the last rotary axis going out from the table (depending on the machine configuration)
- **SEQ-** positions the master axis so that it assumes a negative angle.

If the solution you chose with **SEQ** is not within the machine's range of traverse, the TNC displays the **Entered angle not permitted** error message.

When the **PLANE AXIAL** function is used, the **SEQ** switch is nonfunctional.



If you do not define **SEQ**, the TNC determines the solution as follows:

- 1 The TNC first checks whether both solution possibilities are within the traverse range of the rotary axes.
- 2 If they are, then the TNC selects the shortest possible solution based on the current position of the rotary axes.
- 3 If only one solution is within the traverse range, the TNC selects this solution
- 4 If neither solution is within the traverse range, the TNC displays the **Entered angle not permitted** error message.

Example for a machine with a rotary table C and a tilting table
A. Programmed function: PLANE SPATIAL SPA+0 SPB+45 SPC+0

Limit switch	Starting position	SEQ	Resulting axis position
None	A+0, C+0	not prog.	A+45, C+90
None	A+0, C+0	+	A+45, C+90
None	A+0, C+0	-	A–45, C–90
None	A+0, C–105	not prog.	A–45, C–90
None	A+0, C–105	+	A+45, C+90
None	A+0, C–105	-	A–45, C–90
-90 < A < +10	A+0, C+0	not prog.	A–45, C–90
-90 < A < +10	A+0, C+0	+	Error message
None	A+0, C–135	+	A+45, C+90

Selecting the type of transformation (entry optional)

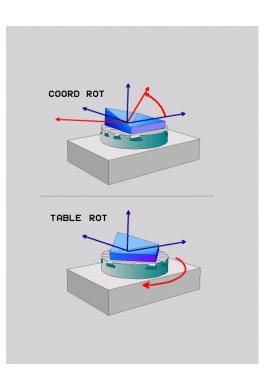
The transformation types COORD ROT and TABLE ROT influence the orientation of the working plane coordinate system through the axis position of a so-called free rotary axis.

Any rotary axis becomes a free rotary axis with the following constellation:

- the rotary axis has no effect on the tool angle of inclination because the rotation axis and tool axis are parallel in the tilting situation
- the rotary axis is the first rotary axis in the kinematic chain starting from the workpiece

The effect of the transformation types **COORD ROT** and **TABLE** ROT therefore depends on the programmed spatial angles and the machine kinematics.

- If no free rotary axis is created in a tilting situation, the COORD ROT and TABLE ROT transformation types have no effect
- With the PLANE AXIAL function the COORD ROT and TABLE ROT transformation types have no effect



12 Multiple axismachining

12.2 The PLANE function: Tilting the working plane (software option 8)

Effect with a free rotary axis

For the positioning behaviour with the COORD ROT and TABLE ROT transformation types, it does not matter if the free rotary axis is in the table or the head
The resulting axis position of the free rotary axis depends on an active basic rotation among other factors
The orientation of the working plane coordinate system also depends on a programmed rotation, for example with Cycle 10 ROTATION
Effect
COORD ROT:
> The control positions the free rotary axis to 0
> The control aligns the working plane coordinate system according to the programmed spatial
angle
TABLE ROT with:
SPA and SPB equal to 0
SPC equal or unequal to 0
The control aligns the free rotary axis according to the programmed spatial angle
The control aligns the working plane coordinate system according to the basic coordinate system
TABLE ROT with:
At least SPA or SPB unequal to 0
SPC equal or unequal to 0
The control does not position the free rotary axis. The position before tilting the working plane is maintained
 Because the workpiece was not positioned, the control aligns the working plane coordinate system according to the programmed spatial angle

uses **COORD ROT** transformation for the PLANE functions

v

Example with a free axis

The example below shows the effect of the **TABLE ROT** transformation type in conjunction with a free rotary axis.

6 L B+45 RO FMAX	Pre-position rotary axis
7 PLANE SPATIAL SPA-90 SPB+20 SPC+0 TURN F5000 TABLE ROT	Tilt working plane

Origin A = 0, B = 45 A = -90, B = 45



- > The control positions the B axis to the axis angle B+45
- > With the programmed tilting situation with SPA-90, the B axis becomes the free rotary axis
- > The control does not position the free rotary axis. The position of the B axis before tilting the working plane is maintained
- Because the workpiece was not positioned, the control aligns the working plane coordinate system according to the programmed spatial angle SPB+20

¹² Multiple axismachining

12.2 The PLANE function: Tilting the working plane (software option 8)

Tilt the working plane without rotary axes



Refer to your machine manual. This feature must be enabled and adapted by the machine tool builder.

The machine tool builder must take into account e.g. the precise angle of a mounted angular head in the kinematics description.

You can also align the programmed working plane perpendicular to the tool without rotary axes, e.g. for adapting the working plane for a mounted angular head.

Use the **PLANE SPATIAL** function and the **STAY** positioning behavior to swivel the working plane to the angle specified by the machine tool builder.

Example of mounted angular head with permanent tool direction Y:

NC syntax

N10 T 5 G17 S4500*

N20 PLANE SPATIAL SPA+0 SPB-90 SPC+0 STAY*



The swivel angle must be precisely adapted to the tool angle, otherwise the TNC outputs an error message.

12.3 Miscellaneous functions for rotary axes

Feed rate in mm/min on rotary axes A, B, C: M116 (option 8)

Standard behavior

The TNC interprets the programmed feed rate of a rotary axis in degrees/min (in mm programs and also in inch programs). The feed rate therefore depends on the distance from the tool center to the center of the rotary axis.

The larger this distance becomes, the greater the contouring feed rate.

Feed rate in mm/min on rotary axes with M116

The machine geometry must be specified by the machine tool builder in the description of kinematics. M116 works only on rotary tables. M116 cannot be used with swivel heads. If your machine is equipped with a table/head combination, the TNC ignores the swivel-head rotary axes.
 M116 is also effective in an active tilted working plane and in combination with M128 if you used the M138 function to select rotary axes.
 Further Information: "Selecting tilting axes: M138", page 448
 Then M116 affects only those rotary axes that were selected with M138.

The TNC interprets the programmed feed rate of a rotary axis in mm/min (or 1/10 inch/min). In this case, the TNC calculates the feed for the block at the start of each block. With a rotary axis, the feed rate is not changed during execution of the block even if the tool moves toward the center of the rotary axis.

Effect

M116 is effective in the working plane. Reset M116 with M117. At the end of the program, M116 is also ineffective.

M116 becomes effective at the start of block.

¹² Multiple axismachining

Shortest-path traverse of rotary axes: M126

Standard behavior



The behavior of the TNC when positioning the rotary axes depends on the machine tool. Refer to your machine manual.

The standard behavior of the TNC while positioning rotary axes whose display has been reduced to values less than 360° is dependent on machine parameter **shortestDistance**(no. 300401). This machine parameter defines whether the TNC should consider the difference between nominal and actual position, or whether it should always (even without M126) choose the shortest path to the programmed position. Examples:

Actual position	Nominal position	Traverse
350°	10°	–340°
10°	340°	+330°

Behavior with M126

With M126, the TNC will move the axis on the shorter path of traverse for rotary axes whose display is reduced to values less than 360°. Examples:

Actual position	Nominal position	Traverse
350°	10°	+20°
10°	340°	–30°

Effect

M126 becomes effective at the start of block.

To cancel M126, enter M127. At the end of program, M126 is automatically canceled.

Reducing display of a rotary axis to a value less than 360°: M94

Standard behavior

The TNC moves the tool from the current angular value to the programmed angular value.

Example:

Current angular value:	538°
Programmed angular value:	180°
Actual distance of traverse:	-358°

Behavior with M94

At the start of block, the TNC first reduces the current angular value to a value less than 360° and then moves the tool to the programmed value. If several rotary axes are active, M94 will reduce the display of all rotary axes. As an alternative you can enter a rotary axis after M94. The TNC then reduces the display only of this axis.

Example NC blocks

To reduce display of all active rotary axes:

N50 M94*

To reduce display of the C axis only:

N50 M94 C*

To reduce display of all active rotary axes and then move the tool in the C axis to the programmed value:

M50 G00 C+180 M94*

Effect

M94 is effective only in the NC block in which it is programmed. M94 becomes effective at the start of block.

12 Multiple axismachining

12.3 Miscellaneous functions for rotary axes

Selecting tilting axes: M138

Standard behavior

The TNC performs M128, and tilts the working plane, only in those axes for which the machine tool builder has set the appropriate machine parameters.

Behavior with M138

The TNC performs the above functions only in those tilting axes that you have defined using M138.



If you restrict the number of tilting axes with the **M138** function, your machine may provide only limited tilting possibilities. When calculating the axis angle in the selected axis, the control sets the value 0.

Effect

M138 becomes effective at the start of the block.

You can reset M138 by reprogramming it without entering any axes.

Example NC blocks

Perform the above-mentioned functions only in the tilting axis C:

N50 G00 Z+100 G40 M138 C*



Manual Operation and Setup

13.1 Switch-on, switch-off

13.1 Switch-on, switch-off

Switch-on



Refer to your machine manual.

Danger exists for the operator when the machine is started up. Read the safety information before switching on the machine.



Switch-on and crossing over the reference points can vary depending on the machine tool.

Refer to your machine manual.

Switch on the power supply for TNC and machine. The TNC then displays the following dialog:

SYSTEM STARTUP

TNC is started

POWER INTERRUPTED



 TNC message that the power was interrupted clear the message

COMPILE A PLC PROGRAM

▶ The PLC program of the TNC is automatically compiled

RELAY EXT. DC VOLTAGE MISSING



Switch on external dc voltage. The TNC checks the functioning of the EMERGENCY STOP circuit

MANUAL OPERATION TRAVERSE REFERENCE POINTS



 Cross the datums manually in the prescribed sequence: For each axis press the NC START key; or



Y+

Cross the datums in any sequence: Press and hold the machine axis direction button for each axis until the datum has been traversed



If your machine is equipped with absolute encoders, you can leave out crossing the reference marks. In such a case, the TNC is ready for operation immediately after the machine control voltage is switched on.

The TNC is now ready for operation in the **Manual operation** mode.

The reference points need only be crossed if the machine axes are to be moved. If you intend only to write, edit or test programs, you can select the **Programming** or **Test run**. mode of operation immediately after switching on the control voltage. You can cross the reference points later. For this purpose, in **Manual operation** mode press the **PASS OVER REFERENCE** soft key.

Crossing the reference point in a tilted working plane

Danger of collision!

Make sure that the angle values entered in the menu for tilting the working plane match the actual angles of the tilted axis.

Deactivate the "Tilt Working Plane" function before you cross the reference points. Take care that there is no collision. Retract the tool from the current position first, if necessary.

If this function was active when the control was turned on, then the TNC automatically activates the tilted working plane. The TNC then moves the axes in the tilted coordinate system when an axisdirection key is pressed. Position the tool in such a way that a collision is excluded during the subsequent crossing of the datums. To cross the datums you have to deactivate the **Tilt the working plane** function.

Further Information: "Activating manual tilting:", page 509



If you use this function, then for non-absolute encoders you must confirm the positions of the rotary axes, which the TNC displays in a pop-up window. The position displayed is the last active position of the rotary axes before switch-off.

If one of the two functions that were active before is active now, the **NC START** key has no function. The TNC outputs a corresponding error message.

13.1 Switch-on, switch-off

Switch-off



Deactivation is a machine-dependent function. Refer to your machine manual.

To prevent data from being lost on switch-off, you need to shut down the operating system of the TNC as follows:



Operating mode: Press the Manual operation key



Select the function for shutting down



Confirm with the SHUT DOWN soft key

When the TNC displays the message Now you can switch off the TNC in a pop-up window, you may switch off the power supply to the TNC

•	

Caution: Data may be lost!

Inappropriate switch-off of the TNC can lead to data loss!

The control restarts after pressing the **RESTART** soft key. Switch-off during a restart can also result in data loss!

13.2 Moving the machine axes

Note



Refer to your machine manual. Moving with the axis direction keys can vary depending on the machine.

Moving the axis with the axis direction keys

M
X+
X+
Ū
ſŌ

- Operating mode: Press the MANUAL OPERATION key
- Press the axis direction key and hold it down as long as you wish the axis to move; or
- To move the axis continuously: Press and hold the axis direction button and press the NC START key
- ► To stop: Press the **NC Stop** key

You can move several axes at a time with these two methods. The control then shows the feed rate. You can change the feed rate at which the axes are moved with the ${\bf F}$ soft key.

Further Information: "Spindle speed S, feed rate F and miscellaneous function M", page 465

If a moving task is active on the machine, the control displays the **control in operation** symbol.

13.2 Moving the machine axes

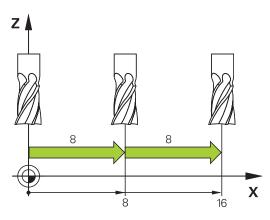
Incremental jog positioning

With incremental jog positioning you can move a machine axis by a preset distance.

$\textcircled{\begin{tabular}{ c c c c } \hline \hline & \\ \hline \\ \hline$	 Operating mode: Press the MANUAL OPERATION or ELECTRONIC HANDWHEEL key
	Shift the soft-key row
INCRE- MENT OFF ON	 Select incremental jog positioning: Switch the INCREMENT soft key to ON
CONFIRM VALUE	Enter the infeed of the linear axes and confirm with the CONFIRM VALUE soft key
ENT	 Alternatively, confirm with the ENT key
t	 Use the arrow keys to position the cursor on the rotary axis
CONFIRM VALUE	Enter the infeed of the rotary axes and confirm with the CONFIRM VALUE soft key
ENT	 Alternatively, confirm with the ENT key
🖌 ок	Confirm with the OK soft key
	> The increment is active.
INCRE- MENT OFF ON	 Deactivate incremental jog positioning: Switch the INCREMENT soft key to OFF
	If you are in the increment menu, you can switch off

If you are in the increment menu, you can switch off incremental jog positioning with the **SWITCH OFF** soft key.

The maximum permissible value for infeed is 10 mm.



Traverse with electronic handwheels

The TNC supports traversing with the following new electronic handwheels:

- HR 520: Handwheel with display, data transfer per cable
- HR 550FS: Handwheel with display, data transfer via radio

In addition to this, the TNC continues to support the cable handwheels HR 410 (without display) and HR 420 (with display).

Caution: Danger to the operator and handwheel!

- All of the handwheel connectors may only be
- removed by authorized service personnel, even if it is possible without any tools!

Ensure that the handwheel is plugged in before you switch on the machine!

If you wish to operate your machine without the handwheel, disconnect the cable from the machine and secure the open socket with a cap!



Refer to your machine manual. Your machine tool builder can make additional functions of the HR 5xx available.

If you want to use the handwheel superimposing function on a virtual axis, then we recommend the handwheel HR 5xx.

Further Information: "Virtual tool axis VT", page 388

The portable HR 5xx handwheels feature a display on which the TNC shows information. In addition, you can use the handwheel soft keys for important setup functions, e.g. datum setting or entering and running M functions.

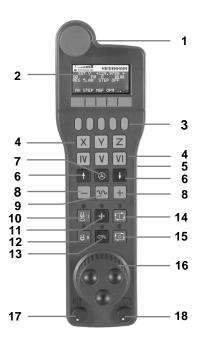
As soon as you have activated the handwheel with the handwheel activation key, the operating panel is locked. This is indicated by a pop-up window on the TNC screen.



13.2 Moving the machine axes

1 EMERGENCY STOP key

- 2 Handwheel display for status and for selecting functions
- **3** Soft keys
- **4** Axis selection keys; can be exchanged by the machine manufacturer depending on the axis configuration
- 5 Permissive key
- 6 Arrow keys for defining handwheel sensitivity
- 7 Handwheel activation key
- **8** Key for TNC traverse direction of the selected axis
- 9 Rapid traverse superimposing for the axis direction key10 Spindle switch-on (machine-dependent function, key can be exchanged by the machine manufacturer)
- **11** "Generate NC block" key (machine-dependent function, key can be exchanged by the machine manufacturer)
- **12** Spindle switch-off (machine-dependent function, key can be exchanged by the machine manufacturer)
- **13 CTRL** key for special functions (machine-specific function, key can be exchanged by the machine manufacturer)
- **14 NC START** key (machine-dependent function, key can be exchanged by the machine manufacturer)
- **15 NC STOP** key (machine-dependent function, key can be exchanged by the machine manufacturer)
- 16 Handwheel
- 17 Spindle speed potentiometer
- **18** Feed rate potentiometer
- **19** Cable connection, not available with the HR 550FS wireless handwheel



Handwheel display

- **1 Only with wireless handwheel HR 550FS**: Shows whether the handwheel is in the docking station or whether wireless operation is active
- **2 Only with wireless handwheel HR 550FS**: Shows the signal strength, 6 bars = maximum signal strength
- **3 Only with wireless handwheel HR 550FS**: Shows the charge status of the rechargeable battery, 6 bars = fully charged A bar moves from the left to the right during recharging
- **4 ACTL**: Type of position display
- 5 Y+129.9788: Position of the selected axis
- 6 *: STIB (control in operation); program run has been started or axis is in motion
- 7 SO: Current spindle speed
- 8 F0: Feed rate at which the selected axis is moving
- 9 E: Error message
- **10 3D**: Tilted-working-plane function is active
- **11 2D**: Basic rotation function is active
- **12 RES 5.0**: Active handwheel resolution. Path traversed by the selected axis with a handwheel revolution
- **13 STEP ON** or **OFF**: Incremental jog active or inactive. If a function is active, the TNC additionally displays the active jog increment.
- **14** Soft-key row: Selection of various functions, described in the following sections



13.2 Moving the machine axes

Special features of the wireless handwheel HR 550FS

Due to various potential sources of interference, a wireless connection is not as reliable as a cable connection. Before you use the wireless handwheel it must therefore be checked whether there are any other radio users in the surroundings of the machine. This inspection for presence of radio frequencies or channels is recommended for all industrial radio systems.

If the HR 550 is not needed, always put it in the handwheel holder. This way you can ensure that the handwheel batteries are always ready for use thanks to the contact strip on the rear side of the wireless handwheel and the recharge control, and that there is a direct contact connection for the emergency stop circuit.

If an error (interruption of the radio connection, poor reception quality, defective handwheel component) occurs, the handwheel always reacts with an emergency stop.

Caution: Danger to the operator and machine!

Due to safety reasons you must switch off the wireless handwheel and the handwheel holder after an operating time of 120 hours at the latest so that the TNC can run a functional test when it is restarted!

If you use several machines with wireless handwheels in your workshop you have to mark the handwheels and holders that belong together so that their respective associations are clearly identifiable (e.g. by color stickers or numbers). The markings on the wireless handwheel and the handwheel holder must be clearly visible to the user!

Before every use, make sure that the correct handwheel for your machine is active.



The HR 550FS wireless handwheel features a rechargeable battery. The battery starts charging when you put the handwheel in the holder.

You can operate the HR 550FS with the battery for up to 8 hours before it must be recharged again. If not in use, it is recommended to put the handwheel in the handwheel holder.

As soon as the handwheel is in its holder, it switches internally to cable operation. This means you can still use it even if the handwheel is fully discharged. The functions are the same as with wireless operation.



When the handwheel is completely discharged, it takes about 3 hours until it is fully recharged in the handwheel holder.

Clean the contacts **1** in the handwheel holder and of the handwheel regularly to ensure their proper functioning.

The transmission range is amply dimensioned. If you should nevertheless happen to come near the edge of the transmission area, which is possible with very large machines, the HR 550FS warns you in time with a plainly noticeable vibration alarm. If this happens you must reduce the distance to the handwheel holder, into which the radio receiver is integrated.



Caution: Danger to the workpiece and tool!

If interruption-free operation is no longer possible within the transmission range the TNC automatically triggers an emergency stop. This can also happen during machining. Keep the distance to the handwheel holder to a minimum. If you do not use the handwheel, put it in the handwheel holder.



13.2 Moving the machine axes

If the TNC has triggered an emergency stop you must reactivate the handwheel. Proceed as follows:

- Select the **Programming** operating mode
- Press the MOD key to select the MOD function
- Scroll through the soft-key row



- Select the configuration menu for the wireless handwheel: Press the SET UP WIRELESS HANDWHEEL soft key
- Click the Start handwheel button to reactivate the wireless handwheel
- To save the configuration and exit the configuration menu, press the END button

The **MOD** operating mode includes a function for commissioning and configuring the handwheel.

Further Information: "Configuring the HR 550FS wireless handwheel", page 580

Selecting the axis to be moved

You can activate directly through the axis address keys the principal axes X, Y, Z and three other axes defined by the machine tool builder. Your machine tool builder can also place the virtual axis VT directly on one of the free axis keys. If the virtual axis VT is not on one of the axis selection keys, proceed as follows:

- Press the F1 (AX) handwheel soft key: The TNC displays all active axes on the handwheel display The currently active axis flashes
- Select the desired axis with the handwheel soft keys F1 (->) or F2 (<-) and confirm with the F3 (OK) handwheel soft key</p>

Setting the handwheel sensitivity

The handwheel sensitivity determines which path an axis takes per revolution of the handwheel. The sensitivity levels are predefined and are selectable with the handwheel arrow keys (only when incremental jog is not active).

Selectable sensitivity levels:

0.001/0.002/0.005/0.01/0.02/0.05/0.1/0.2/0.5/1 [mm/revolution or degrees/revolution]

Selectable sensitivity levels:

0.00005/0.001/0.002/0.004/0.01/0.02/0.03 [in mm/revolution or degrees/revolution]

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Moving the axes

	Activate the handwheel: Press the handwheel key on the HR 5xx: Now you can only operate the TNC via the HR 5xx; the TNC shows a pop-up window containing information on the TNC screen
	 Select the desired operating mode with the OPM soft key if necessary
	 If required, press and hold the permissive button
X	 Use the handwheel to select the axis to be moved. Select the additional axes with the soft keys as required
+	 Move the active axis in the positive direction; or
	Move the active axis in the negative direction
8	Deactivate the handwheel: Press the handwheel key on the HR 5xx: Now you can operate the TNC again via the operating panel

Potentiometer settings

The potentiometers of the machine operating panel continue to be active after you have activated the handwheel. If you want to use the potentiometers on the handwheel, proceed as follows:

- Press the CTRL and Handwheel keys on the HR 5xx. The TNC shows the soft-key menu for selecting the potentiometers on the handwheel display
- Press the HW soft key to activate the handwheel potentiometers

If you have activated the potentiometers on the handwheel, you must reactivate the potentiometers of the machine operating panel before deselecting the handwheel. Proceed as follows:

- Press the CTRL and handwheel keys on the HR 5xx; the TNC shows the soft-key menu for selecting the potentiometers on the handwheel display
- Press the KBD soft key to activate the potentiometers of the machine operating panel

13.2 Moving the machine axes

Incremental jog positioning

With incremental jog positioning the TNC moves the currently active handwheel axis by a preset increment defined by you:

- Press the handwheel soft key F2 (STEP)
- Activate incremental jog positioning: Press handwheel soft key 3 (ON)
- Select the desired jog increment by pressing the F1 or F2 key. If you press and hold the respective key, each time it reaches a decimal value 0 the TNC increases the counting increment by a factor of 10. By also pressing the CTRL key, you can increase the counting increment to 1. The smallest possible increment is 0.0001 mm (0.00001 inches). The largest possible increment is 10 mm (0.3937 inches).
- Confirm the selected jog increment with soft key 4 (OK)
- With the + or handwheel key, move the active handwheel axis in the corresponding direction

Inputting miscellaneous functions M

- Press the F3 (MSF) handwheel soft key
- Press the F1 (M) handwheel soft key
- Select the desired M function number by pressing the F1 or F2 key
- Execute the M miscellaneous function with the NC START key

Entering the spindle speed S

- Press the F3 (MSF) handwheel soft key
- Press the F2 (S) handwheel soft key
- Select the desired speed by pressing the F1 or F2 key. If you press and hold the respective key, each time it reaches a decimal value 0 the TNC increases the counting increment by a factor of 10. By also pressing the CTRL key, you can increase the counting increment to 1000
- Activate the new speed S with the NC START key

Entering the feed rate F

- Press the F3 (MSF) handwheel soft key
- Press the F3 (F) handwheel soft key
- Select the desired feed rate by pressing the F1 or F2 key. If you press and hold the respective key, each time it reaches a decimal value 0 the TNC increases the counting increment by a factor of 10. By also pressing the CRTL key, you can increase the counting increment to 1000
- Confirm the new feed rate F with the F3 (OK) handwheel soft key

Datum setting

- Press the F3 (MSF) handwheel soft key
- Press the F4 (PRS) handwheel soft key
- If required, select the axis in which the datum is to be set.
- Zero the axis with the handwheel soft key F3 (OK) or with F1 and F2 set the desired value and then confirm with F3 (OK). By also pressing the CTRL key, you can increase the counting increment to 10

Changing modes of operation

With the handwheel soft key **F4** (**OPM**) you can use the handwheel to switch the operating mode, provided that the current status of the control allows a mode change.

- Press the F4 (OPM) handwheel soft key
- Select the desired operating mode by handwheel soft key
 - MAN: Manual operation
 MDI: Positioning with manl.data input
 SGL: Program run, single block
 RUN: Program run, full sequence

13.2 Moving the machine axes

Generating a complete traversing block



Your machine tool builder can assign any function to the "Generate NC block" handwheel key. Refer to your machine manual.

- Switch to the Positioning with manl.data input mode of operation
- If required, use the arrow keys on the TNC keyboard to select the NC block after which the new traversing block is to be inserted.
- Activate the handwheel
- Press the "Generate NC block" handwheel key: The TNC inserts a complete traversing block containing all axis positions selected through the MOD function.

Features in the program run modes of operation

You can use the following functions in the Program Run modes of operation:

- The NC START key (NC START handwheel key)
- The NC STOP key (NC STOP handwheel key)
- After the NC STOP key has been pressed: Internal stop (handwheel soft keys MOP and then Stop)
- After the NC STOP key has been pressed: Traverse manual axes (handwheel soft keys MOP and then MAN)
- Returning to the contour after the axes were moved manually during a program interruption (MOP and then REPO handwheel soft keys). The handwheel soft keys, which function similarly to the screen soft keys, are used for operating.
 Further Information: "Returning to the contour", page 549
- On/off switch for the Tilt working plane function (handwheel soft keys MOP and then 3D)

13.3 Spindle speed S, feed rate F and miscellaneous function M

Application

In the **Manual operation** and **Electronic handwheel** operating modes, you can enter the spindle speed S, feed rate F and the miscellaneous functions M with soft keys.

Further Information: "Enter miscellaneous functions M and STOP", page 374



The machine tool builder determines which miscellaneous functions M are available on your control and what effects they have.

Entering values

Spindle speed S, miscellaneous function M



Select input for spindle speed: press the S soft key

SPINDLE SPEED S=



Enter 1000 (spindle speed) and load with the NC START key

The spindle speed with the entered speed ${\bf S}$ is started with a miscellaneous function ${\bf M}.$ Input a miscellaneous function ${\bf M}$ in the same way.

Feed rate F

After entering a feed rate **F**, confirm your entry with the **ENT** key. The following is valid for feed rate F:

- If you enter F=0, then the lowest feed rate from the machine parameter manualFeed (no. 400304) takes effect
- If the feed rate entered exceeds the value defined in the machine parameter **maxFeed** (no. 400302) then the parameter value in the machine parameter takes effect
- F is not lost during a power interruption
- The control displays the feed rate.
 - When **3D ROT** is active the machining feed rate is shown if several axes are moved
 - If 3D ROT is not active, the feed drive display remains empty if several axes are moved

13.3 Spindle speed S, feed rate F and miscellaneous function M

Adjusting spindle speed and feed rate

With the override knobs you can vary the spindle speed S and feed rate F from 0% to 150% of the set value.

The feed rate potentiometer only lowers the programmed feed rate, not the feed rate calculated by the control.



The override knob for spindle speed is only functional on machines with infinitely variable spindle drive.



Feed rate limit F MAX



Refer to your machine manual.

The feed-rate limit depends on the machine.

The **F MAX** soft key enables you to reduce the feed rate speed for all operating modes. The reduction applies to all rapid traverse and feed rate movements. The value you enter remains active after switch-off or switch-on.

The **F MAX** soft key is available in the following operating modes:

- Program run, single block
- Program run, full sequence
- Positioning with manl.data input

Procedure

To activate the feed rate limit F MAX, proceed as follows:

- Operating mode: Press the POSITIONING WITH MANL.DATA INPUT key
- F MAX

ок

3

- Press the F MAX soft key
- Enter the desired maximum feed rate
- Press the OK soft key

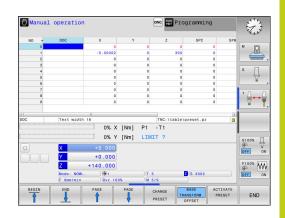
13.4 Datum management with the preset table

Note

⇒	 You should definitely use the preset table if: Your machine is equipped with rotary axes (tilting table or swivel head) and you work with the function for tilting the working plane
	 Your machine is equipped with a spindle-head changing system
	Up to now you have been working with older TNC controls with REF-based datum tables
	 You wish to machine identical workpieces that are differently aligned

The preset table can contain any number of lines (datums). To optimize the file size and the processing speed, only use as many rows as you need to manage your datums.

For safety reasons, new lines can be inserted only at the end of the preset table.



13.4 Datum management with the preset table

Saving the datums in the preset table

The preset table has the name **PRESET.PR**, and is saved in the directory **TNC:\table**. **PRESET.PR** is editable in the **MANUAL OPERATION** and **ELECTRONIC HANDWHEEL** modes only if the **CHANGE PRESET** soft key was pressed. You can open the **PRESET.PR** preset table in the **PROGRAMMING** operating mode but not edit it.

It is permitted to copy the preset table into another directory (for data backup). Write-protected rows are also write-protected in the copied tables.

Never change the number of rows in the copied tables! If you want to reactivate the table, this may lead to problems.

To activate the preset table copied to another directory you have to copy it back to the directory **TNC:**\table\.

There are several methods for saving datums and basic rotations in the preset table:

- Manual input
- Using the probing cycles in the MANUAL OPERATION and ELECTRONIC HANDWHEEL modesELECTRONIC HANDWHEEL
- Using probing cycles 400 to 402 and 410 to 419 in automatic mode

Further information: Cycle Programming User's Manual

Basic rotations from the preset table rotate the coordinate system about the preset, which is shown in the same line as the basic rotation.

Remember to ensure that the position of the tilting axes matches the corresponding values of the 3-D ROT menu when setting the datum. Therefore:

- If the "Tilt working plane" function is not active, the position display for the rotary axes must be = 0° (zero the rotary axes if necessary).
- If the "Tilt working plane" function is active, the position displays for the rotary axes must match the angles entered in the 3-D ROT menu.

PLANE RESET does not reset the active 3-D rotation.

The line 0 in the preset table is write protected. In line 0, the TNC always saves the datum that you most recently set manually via the axis keys or via soft key. If the datum set manually is active, the TNC displays the text **PR MAN(0)** in the status display

Manually saving the datums in the preset table

In order to save datums in the preset table, proceed as follows:

(m)	 Operating mode: Press the Manual operation key
X+ Y+ Z-	Move the tool slowly until it touches (scratches) the workpiece surface, or position the measuring dial correspondingly
PRESET TABLE	 Press the PRESET TABLE soft key The TNC opens the preset table and sets the cursor to the row of the active datum.
CHANGE PRESET	 Select the functions for preset entry The TNC displays all available input options in the soft-key row.
Ŧ	 Select the row in the preset table that you want to change (the row number is the preset number)
-	 If needed, select the column (axis) in the preset table that you want to change
CORRECT THE PRESET	 Use the soft keys to select one of the available entry possibilities

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13 Manual Operation and Setup

13.4 Datum management with the preset table

Input options

Soft key	Function
+	Directly transfer the actual position of the tool (the measuring dial) as the new datum: This function only saves the preset in the axis in which the cursor is currently hovering.
ENTER NEU PRESET	Assign any value to the actual position of the tool (the measuring dial): This function only saves the preset in the axis in which the cursor is currently hovering. Enter the desired value in the pop-up window
CORRECT THE PRESET	Incrementally shift a datum already stored in the table: This function only saves the preset in the axis in which the cursor is currently hovering. Enter the desired corrective value with the correct sign in the pop-up window. If inch display is active: Enter the value in inches, and the TNC will internally convert the entered values to mm
EDIT CURRENT FIELD	Directly enter the new datum without calculation of the kinematics (axis-specific). Only use this function if your machine has a rotary table, and you want to set the datum to the center of the rotary table by entering 0. This function only saves the preset in the axis in which the cursor is currently hovering. Enter the desired value in the pop-up window. If inch display is active: Enter the value in inches, and the TNC will internally convert the entered values to mm
BASE TRANSFORM. OFFSET	Select the BASE TRANSFORM./OFFSET view. The standard BASE TRANSFORM. view shows the X, Y and Z columns. Depending on the machine, the SPA, SPB and SPC columns are displayed additionally. The TNC saves the basic rotation here (with the Z tool axis the TNC uses the SPC column). The OFFSET view shows the offset values for the preset.
SAVE PRESET	Write the currently active datum to a selectable line in the table: This function saves the datum in all axes, and then activates the appropriate row in the table automatically. If inch display is active: Enter the value in inches, and the TNC will internally convert the entered values to mm

Editing the preset table

Soft key	Editing function in table mode
	Select the table start
	Select the table end
PAGE	Select the previous page in the table
PAGE	Select the next page in the table
CHANGE PRESET	Select the functions for entering presets
BASE TRANSFORM. OFFSET	Display the "Basic Transformation/Axis Offset" selection
ACTIVATE PRESET	Activate the datum of the selected line of the preset table
APPEND N LINES	Add the entered number of lines to the end of the table (2nd soft-key row)
COPY FIELD	Copy the highlighted field (2nd soft-key row)
PASTE FIELD	Insert the copied field (2nd soft-key row)
RESET LINE	Reset the selected line: The TNC enters - in all columns (2nd soft-key row)
INSERT LINE	Insert a single line at the end of the table (2nd soft-key row)
DELETE LINE	Delete a single line at the end of the table (2nd soft-key row)

13.4 Datum management with the preset table

Overwrite protection for datum

Row 0 in the preset table is write-protected. The TNC saves the last manually set datum in row 0.

You can protect further rows in the preset table from being overwritten with the **LOCKED** column. The write-protected rows are color-highlighted in the preset table.

If you want to overwrite a write-protected row with a manualprobing cycle, confirm with **OK** and enter the password (wherepassword-protected).



Caution: Data may be lost!

If you forget the password, then you can no longer reset the write protection in a protected row.

If you protect a row with a password, please make a note of this password.

Ideally, use simple protection with the LOCK / UNLOCK soft key.

Proceed as follows to protect a datum from overwriting:



Press the CHANGE PRESET soft key



► Select the LOCKED column



LOCK /

Press the EDIT CURRENT FIELD soft key

Protection for datum without using password:

- Press the LOCK / UNLOCK soft key
- > The TNC writes an L in the LOCKED column.

Protect a datum with a password:



Press the LOCK / UNLOCK PASSWORD soft key



οк

- Enter the password into the pop-up window
- Confirm with the **OK** soft key or with the **ENT** key:
- > The TNC writes ### to the LOCKED column.

Datum management with the preset table 13.4

Rescind write-protection

To edit a line you have previously write-protected, proceed as follows:

Select the LOCKED column



Press the CHANGE PRESET soft key



Press the EDIT CURRENT FIELD soft key

Datum protected without password:



Press the LOCK / UNLOCK soft key

> The TNC rescinds the write protection.

Datum protected with a password:



ок

Press the LOCK / UNLOCK PASSWORD soft key

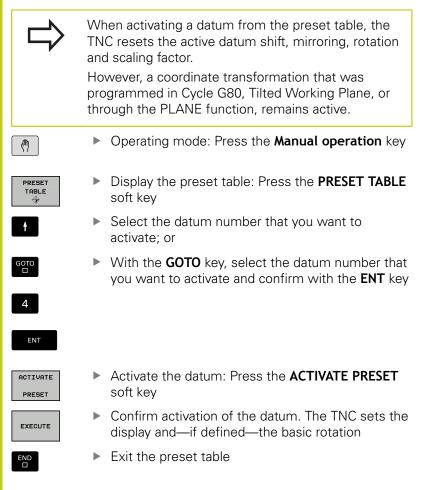
Enter the password into the pop-up window

- Confirm with the **OK** soft key or with the **ENT** key
- > The TNC rescinds the write protection.

13.4 Datum management with the preset table

Activating the datum

Activating a datum from the preset table in the Manual operation mode



Activating a datum from the preset table in an NC program

Use Cycle G247 in order to activate datums from the preset table during a program run. In Cycle G247 you simply define the number of the datum to be activated.

Further information: Cycle Programing User's Manual

13.5 Datum setting without a 3-D touch probe

Note

When you set a datum, you set the TNC display to the coordinates of a known workpiece position.



All manual probe functions are available with a 3-D touch probe.

Further Information: "Datum setting with a 3-D touch probe ", page 497

Preparation

- Clamp and align the workpiece
- Insert the zero tool with known radius into the spindle
- Ensure that the TNC is showing the actual positions

Datum setting with an end mill

!	Protective measure If the workpiece surface must not be scratched, you can lay a metal shim of known thickness d on it. You then enter a value that is greater than the desired preset by the value d.
(m)	 Operating mode: Press the Manual operation key
X+ Y+	 Move the tool slowly until it touches (scratches) the workpiece surface
Z-	 Select the axis

DATUM SETTING Z=



Zero tool in spindle axis: Set the display to a known workpiece position (here, 0) or enter the thickness d of the shim. In the tool axis, offset the tool radius

Repeat the process for the remaining axes.

If the values for the tool in the tool axis have already been set, set the display of the tool axis to the length L of the tool or enter the sum Z=L+d



The TNC automatically saves the datum set with the axis keys in line 0 of the preset table.

13 Manual Operation and Setup

13.5 Datum setting without a 3-D touch probe

Using touch probe functions with mechanical probes or measuring dials

If you do not have an electronic 3-D touch probe on your machine, you can also use all the previously described manual touch probe functions (exception: calibration function) with mechanical probes or by simply touching the workpiece with the tool.

Further Information: "Using a 3-D touch probe ", page 477

In place of the electronic signal generated automatically by a 3-D touch probe during probing, you can manually initiate the trigger signal for capturing the **probing position** by pressing a key.

Proceed as follows:

PR	DBING
	POS

- Select any touch probe function by soft key
- Move the mechanical probe to the first position to be captured by the TNC
- Confirm the position: Press the ACTUAL-POSITION CAPTURE soft key for the TNC to save the current position
- Move the mechanical probe to the next position to be captured by the TNC
- Confirm the position: Press the ACTUAL-POSITION CAPTURE soft key for the TNC to save the current position
- If required, move to additional positions and capture as described previously
- Datum: In the menu window, enter the coordinates of the new datum, confirm with the SET DATUM soft key, or write the values to a table Further Information: "Writing measured values from the touch probe cycles to a datum table", page 483

Further Information: "Writing measured values from the touch probe cycles to the preset table", page 484

Terminate the probing function: Press the END key

13

13.6 Using a 3-D touch probe

Overview

The following touch probe cycles are available in the **Manual operation** mode:



HEIDENHAIN only gives warranty for the function of the probing cycles if HEIDENHAIN touch probes are used.

Make sure during probing that the axis angles match the set tilt angles. The control checks this automatically if the **chkTiltingAxes** machine parameter (no. 204601) is activated.



The TNC must be specially prepared by the machine tool builder for the use of a 3-D touch probe. Refer to your machine manual.

Soft key	Function	Page
CALIBRATE TS	Calibrating the 3-D Touch Probe	485
PROBING	Measuring a 3-D basic rotation by probing a plane	495
PROBING	Measuring a basic rotation using a line	493
PROBING POS	Setting the datum on any axis	497
PROBING	Set a corner as preset	498
PROBING CC	Set a circle center as preset	499
PROBING CL	Setting the centerline as datum	502
TCH PROBE TABLE	Touch probe system data management	See Cycle Programming User's Manual
	For more information about the	touch probe table



For more information about the touch probe table, refer to the User's Manual for Cycle Programming

13.6 Using a 3-D touch probe

Traverse movements with a handwheel with display

With a handwheel with display, it is possible to transfer control to the handwheel during a manual touch probe cycle.

Proceed as follows:

- Start the manual touch probe cycle
- Position the touch probe at a position near the first touch point
- Probe the first touch point
- Activate the handwheel on the handwheel
- > The control shows the pop-up window Handwheel active.
- Position the touch probe at a position near the second touch point
- Deactivate the handwheel on the handwheel
- > The control closes the pop-up window.
- Probe the second touch point
- If necessary, set the datum
- End the probing function



If the handwheel is active you cannot start the probing cycles.

Functions in touch probe cycles

Soft keys that are used to select the probing direction or a probing routine are displayed in the manual touch probe cycles. The soft keys displayed vary depending on the respective cycle:

Soft key	Function
X +	Select the probing direction
	Capture the actual position
	Probe hole (inside circle) automatically
	Probe stud (outside circle) automatically
PROBING CC	Probe a model circle (center point of several elements)
÷	Select a paraxial probing direction for probing of holes, studs and model circles

Automatic probing routine for holes, studs and model circles

!	If you use a function for probing a circle automatically, the TNC automatically positions the touch probe to the respective touch points. Ensure that the positions can be approached without collision.

If you use a probing routine for automatically probing a hole or a stud, or a model circle, the control opens a form with the required entry fields.

Input fields in the Measure stud and Measure hole forms

Input field	Function
Stud diameter? or Hole diameter	Diameter of probe contact (optional for holes)
Safety clearance?	Distance to the probe contact in the plane
Incr. clearance height?	Positioning of touch probe in spindle axis direction (starting from the current position)
Starting angle?	Angle for the first probing operation $(0^{\circ} = \text{positive direction of principal}$ axis, i.e. in X+ for spindle axis Z). All other probe angles result from the number of touch points.
Number of touch points?	Number of probing operations (3 to 8)
Angular length?	Probing a full circle (360°) or a circle segment (angular length<360°)

13.6 Using a 3-D touch probe

Automatic probing routine:

Pre-position touch probe



- Select the probing function: Press the PROBING CC soft key
- •
- Hole should be probed automatically: Press the HOLE soft key
- Select paraxial probing direction
 - Start probing function: Press the NC START key The TNC carries out all pre-positioning and probing processes automatically

The TNC approaches the position at the feed rate **FMAX** defined in the touch probe table. The defined probing feed rate **F** is used for the actual probing operation.



Before starting the automatic probing routine, you need to preposition the touch probe near the first touch point. Offset the touch probe by approximately the safety clearance (value from the touch probe table + value from the input form) opposite to the probing direction.

For inside circles with large diameters, the TNC can also pre-position the touch probe on a circular arc with the positioning feed rate FMAX. This requires that you enter a safety clearance for prepositioning and the hole diameter in the input form. Position the touch probe inside the hole at a position that is offset by approximately the safety clearance from the wall. During pre-positioning, note the starting angle for the first probe process (at 0° the TNC probes in the positive direction of the principal axis).

Selecting the probing cycle

 Operating mode: Select Manual operation or Electronic handwheel



- Select the probing functions: Press the TOUCH PROBE soft key
- PROBING POS
- Select the touch probe cycle by pressing the appropriate soft key, for example **PROBING POS**, for the TNC to display the associated menu



When you select a manual probing function, the TNC opens a form displaying all data required. The content of the forms varies depending on the respective function.

You can also enter values in some of the fields. Use the arrow keys to move to the desired input field. You can position the cursor only in fields that can be edited. Fields that cannot be edited are shown gray.

13.6 Using a 3-D touch probe

Recording measured values from the touch probe cycles



The TNC must be specially prepared by the machine tool builder for use of this function. Refer to your machine manual.

After executing the respective selected touch probe cycle, the TNC displays the **WRITE LOG TO FILE** soft key. If you press this soft key, the TNC will record the current values determined in the active touch probe cycle.

If you store the measuring results, the TNC creates the text file TCHPRMAN.TXT. If you have not defined a path in the machine parameter **fn16DefaultPath**(no. 102202), the TNC will store the TCHPRMAN.TXT and TCHPRMAN.html files in the main directory **TNC:**\.



If you press the **WRITE LOG TO FILE** soft key, the TCHPRMAN.TXT file cannot be selected in the **Programming** operating mode. The TNC will otherwise display an error message.

The TNC writes the measured values to the TCHPRMAN.TXT or TCHPRMAN.html file. If you execute several touch probe cycles in succession and want to store the resulting measured data, you must make a backup of the contents stored in TCHPRMAN.TXT between the individual cycles by copying or renaming the file.

Format and content of the TCHPRMAN.TXT file are preset by the machine tool builder.

Writing measured values from the touch probe cycles to a datum table

Use this function to save measured values in the workpiece coordinate system. If you want to save measured values in the workpiece coordinate system (REF coordinates), press the ENTRY IN PRESET TABLE soft key.

Further Information: "Writing measured values from the touch probe cycles to the preset table", page 484

With the **ENTER IN DATUM TABLE** soft key, the TNC can write the values measured during any touch probe cycle as applicable to a datum table:

- Select any probe function
- Enter the desired coordinates for the datum in the designated input boxes (depends on the touch probe cycle being run)
- Enter the datum number in the Number in table= input box
- Press the ENTER IN DATUM TABLE soft key; the TNC saves the datum in the specified datum table under the entered number

13.6 Using a 3-D touch probe

Writing measured values from the touch probe cycles to the preset table

Use this function if you want to save measured values in the machine coordinate system (REF coordinates). If you want to save measured values in the workpiece coordinate system, press the **ENTER IN DATUM TABLE** soft key.

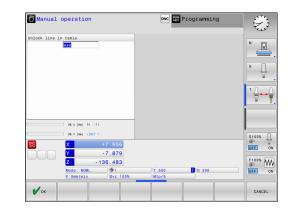
Further Information: "Writing measured values from the touch probe cycles to a datum table", page 483

With the **ENTRY IN PRESET TABLE** soft key, the TNC can write the values measured during any probe cycle in the preset table. The measured values are then stored referenced to the machine coordinate system (REF coordinates). The preset table has the name PRESET.PR, and is saved in the directory TNC:\table\.

- Select any probe function
- Enter the desired coordinates for the datum in the designated input boxes (depends on the touch probe cycle being run)
- Enter the preset number in the **Number in table:** input box
- Press the ENTRY IN PRESET TABLE soft key. The TNC saves the datum in the preset table under the entered number
 - Preset number is not available: The TNC saves the row only after pressing the **OK** soft key (Create row in table?)
 - Preset number is protected: Press the OK soft key and the active preset will be overwritten
 - Preset number is password-protected: Press the **OK** soft key, enter the password and the active preset will be overwritten



If writing to the table row is not possible due to a lock, the control displays a message. The probing is not aborted, however.

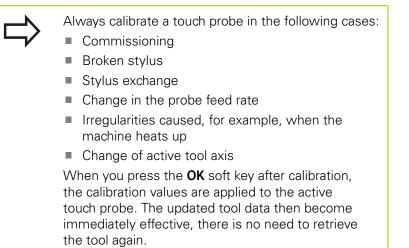


13

13.7 Calibrating 3-D touch probes

Introduction

In order to precisely specify the actual trigger point of a 3-D touch probe, you must calibrate the touch probe, otherwise the TNC cannot provide precise measuring results.



During calibration, the TNC finds the effective length of the stylus and the effective radius of the ball tip. To calibrate the 3-D touch probe, clamp a ring gauge or a stud of known height and known radius to the machine table.

The TNC provides calibration cycles for calibrating the length and the radius:



- Press the TOUCH PROBE soft key
- Display the calibration cycles: Press CALIBRATE TS
- Select the calibration cycle

Calibration cycles of the TNC

Soft key	Function	Page
€ <u></u>	Calibrating the length	486
	Measure the radius and the center offset using a calibration ring	487
	Measure the radius and the center offset using a stud or a calibration pin	487
	Measure the radius and the center offset using a calibration sphere	487

13.7 Calibrating 3-D touch probes

Calibrating the effective length



HEIDENHAIN only gives warranty for the function of the probing cycles if HEIDENHAIN touch probes are used.

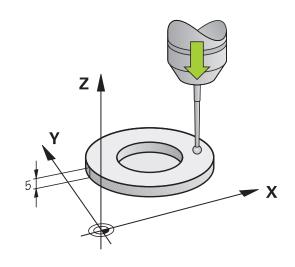


The effective length of the touch probe is always referenced to the tool datum. The machine tool builder usually defines the spindle tip as the tool datum.

Set the datum in the spindle axis such that for the machine tool table Z=0.



- Select the calibration function for the touch probe length: Press the CAL. Press L
- > The TNC displays the current calibration data.
- Datum for length: Enter the height of the ring gauge in the menu window
- Move the touch probe to a position just above the ring gauge
- To change the traverse direction (if necessary), press a soft key or an arrow key
- Probe surface: Press NC START key
- Check results
- Press the OK soft key for the values to take effect
- Press the CANCEL soft key to terminate the calibrating function.
- > The TNC logs the calibration process in TCHPRMAN.html.



Calibrating the effective radius and compensating center misalignment



HEIDENHAIN only gives warranty for the function of the probing cycles if HEIDENHAIN touch probes are used.

The center offset can be determined only with a suitable touch probe.

If you want to calibrate using the outside of an object, you need to preposition the touch probe above the center of the calibration sphere or calibration pin. Ensure that the touch points can be approached without collision.

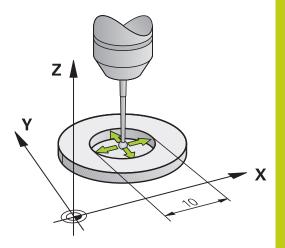
When calibrating the ball tip radius, the TNC executes an automatic probing routine. During the first cycle, the TNC determines the center of the calibration ring or stud (rough measurement) and positions the touch probe in the center. Then the ball tip radius is determined during the actual calibration process (fine measurement). If the touch probe allows probing from opposite orientations, the center offset is determined during another cycle.

The characteristic of whether and how your touch probe can be oriented is predefined in HEIDENHAIN touch probes. Other touch probes are configured by the machine manufacturer.

After the touch probe is inserted, it normally needs to be aligned exactly with the spindle axis. The calibration function can determine the offset between touch probe axis and spindle axis by probing from opposite orientations (rotation by 180°) and can calculate and implement the necessary compensation.

The calibration routine varies depending on how your touch probe can be oriented:

- No orientation possible or orientation possible in only one direction: The TNC executes one rough and one fine measurement and determines the effective ball tip radius (column R in tool.t)
- Orientation possible in two directions (e.g.HEIDENHAIN wired touch probes): The TNC executes one rough and one fine measurement, rotates the touch probe by 180° and then completes one more probing routine. The center offset (CAL_OF in tchprobe.tp) is determined in addition to the radius by probing from opposite orientations
- Orientation possible in any direction (e.g. HEIDENHAIN infrared systems): The TNC executes one rough and one fine measurement, rotates the touch probe by 180° and then completes one more probing routine. The center offset (CAL_OF in tchprobe.tp) is determined in addition to the radius by probing from opposite orientations



13.7 Calibrating 3-D touch probes

Calibration using a calibration ring

Proceed as follows for manual calibration using a calibration ring:

In the Manual operation mode, position the ball tip inside the bore of the ring gauge

Select the calibration function: Press the CAL. R

- soft keyThe TNC displays the current calibration data.
- Enter the diameter of the ring gauge
- Enter the start angle
- Enter the number of touch points
- Probe: Press the NC START key
- > The 3-D touch probe probes all required touch points in an automatic probing routine and calculates the effective ball-tip radius. If probing from opposite orientations is possible, the TNC calculates the center offset.
- Check results
- ▶ Press the **OK** soft key for the values to take effect
- Press the END soft key to terminate the calibrating function.
- The TNC logs the calibration process in TCHPRMAN.html.



In order to be able to determine the ball-tip center misalignment, the TNC needs to be specially prepared by the machine manufacturer. Refer to your machine manual.

Calibration with a stud or calibration pin

soft key

Proceed as follows for manual calibration with a stud or calibration pin:

- In the Manual operation mode, position the ball tip above the center of the calibration pin
 Select the calibration function: Press the CAL. R
- Enter the outside diameter of the stud
- Enter the safety clearance
- Enter the start angle
- Enter the number of touch points
- Probe: Press the NC START key
- The 3-D touch probe probes all required touch points in an automatic probing routine and calculates the effective ball-tip radius. If probing from opposite orientations is possible, the TNC calculates the center offset.
- Check results
- Press the OK soft key for the values to take effect
- Press the END soft key to terminate the calibrating function.
- The TNC logs the calibration process in TCHPRMAN.html.



In order to be able to determine the ball-tip center misalignment, the TNC needs to be specially prepared by the machine manufacturer.

Refer to your machine manual.

13.7 Calibrating 3-D touch probes

Calibration using a calibration sphere

Proceed as follows for manual calibration using a calibration sphere:



tip above the center of the calibration sphere
Select the calibration function: Press the CAL. R soft key

▶ In the Manual operation mode, position the ball

- Enter the outside diameter of the ball
- ► Enter the safety clearance
- Enter the start angle
- Enter the number of touch points
- Select Length measurement, if applicable
- ▶ If necessary, input the reference for the length
- Probe: Press the NC START key
- The 3-D touch probe probes all required touch points in an automatic probing routine and calculates the effective ball-tip radius. If probing from opposite orientations is possible, the TNC calculates the center offset.
- Check results
- ▶ Press the **OK** soft key for the values to take effect
- Press the END soft key to terminate the calibrating function
- > The TNC logs the calibration process in TCHPRMAN.html.



In order to be able to determine the ball-tip center misalignment, the TNC needs to be specially prepared by the machine manufacturer.

Refer to your machine manual.

Displaying calibration values

The TNC saves the effective length and effective radius of the touch probe in the tool table. The TNC saves the touch probe center offset to the touch probe table in the columns **CAL_OF1** (principal axis) and **CAL_OF2** (minor axis). You can display the values on the screen by pressing the **TCH PROBE TABLE** soft key.

During calibration, the TNC automatically creates the TCHPRMAN.html log file to which the calibration values are saved.



Please make sure the correct tool number is active when you use the touch probe system. Regardless of whether you want to use a touch probe cycle in automatic mode or **Manual operation** mode.

For more information about the touch probe table, refer to the User's Manual for Cycle Programming



13.8 Compensating workpiece misalignment with 3-D touch probe

13.8 Compensating workpiece misalignment with 3-D touch probe

Introduction



HEIDENHAIN only gives warranty for the function of the probing cycles if HEIDENHAIN touch probes are used.

Make sure during probing that the axis angles match the set tilt angles. The control checks this automatically if the **chkTiltingAxes** machine parameter (no. 204601) is activated.

The TNC electronically compensates workpiece misalignment by computing a "basic rotation."

For this purpose, the TNC sets the rotation angle to the desired angle with respect to the reference axis in the working plane.

The TNC interprets the measured angle as rotation around the tool direction, and saves the values in the columns SPA, SPB or SPC of the preset table.

To identify the basic rotation, probe two points on the side of the workpiece. The sequence in which you probe the points influences the calculated angle. The measured angle goes from the first to the second probing point. You can also identify the basic rotation by holes or studs.

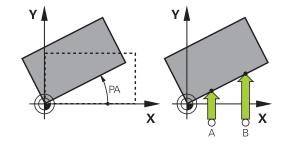


Select the probe direction perpendicular to the angle reference axis when measuring workpiece misalignment.

To ensure that the basic rotation is calculated correctly during program run, program both coordinates of the working plane in the first positioning block.

You can also use a basic rotation in conjunction with the PLANE function. In this case, first activate the basic rotation and then the PLANE function.

You can also activate a basic rotation without probing a workpiece. For this purpose enter a value in the basic rotation menu and press the **SET BASIC ROTATION** soft key.



Identifying basic rotation



- Select the probing function by pressing the PROBE ROTATION soft key
- Position the touch probe at a position near the first touch point
- Select the probe direction or probing routine by soft key
- Probe: Press the NC START key
- Position the touch probe at a position near the second touch point
- Probe: Press the NC START key. The TNC determines the basic rotation and displays the angle after the dialog Rotation angle
- Activate basic rotation: Press the SET BASIC ROTATION soft key
- To terminate the probe function, press the END soft key

The TNC logs the probing process in TCHPRMAN.html.

Saving a basic rotation in the preset table

- After the probing process, enter the preset number in which the TNC is to save the active basic rotation in the Number in table: input box
- Press the BASIC ROT. Press the BASIC ROT. IN PRESET TABLE soft key to save the basic rotation in the preset table

13.8 Compensating workpiece misalignment with 3-D touch probe

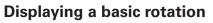
Compensation of workpiece misalignment by rotating the table

To compensate the identified misalignment by a rotary table position, press the ALIGN ROT. soft key after the probing processALIGN ROT. TABLE



Position all axes to avoid a collision before table rotation. The TNC outputs an additional warning before table rotation.

- If you want to set the datum in the rotary table axis, press the SET TABLE ROTATION soft key.
- ➤ You can also save the misalignment of the rotary table in any line of the Preset table. Enter the line number and press the **TABLE ROT. IN PRESET TABLE** soft key. The TNC stores the angle in the offset column of the rotary table, e.g. with a C axis in the C_OFFS column. You may have to change the view in the preset table with the **BASIS-TRANSFORM./OFFSET** soft key for this column to be displayed.

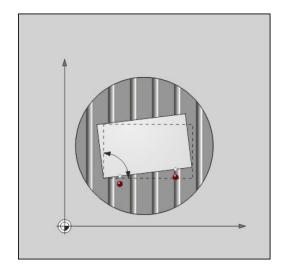


When you select the **PROBING ROT** function, the TNC displays the active angle of basic rotation in the **Rotation angle** dialog. In addition, the rotary angle is shown in the split screen **PROGRAM + STATUS** screen layout in the **STATUS POS.** tab.

When the TNC moves along the machine axis in accordance with the basic rotation, a symbol for the basic rotation is shown in the status display.

Canceling a basic rotation

- Select the probe function by pressing the PROBING ROT soft key
- Enter a rotation angle of "0" and confirm with the SET BASIC ROTATION soft key
- ► To terminate the probe function, press the END soft key



Measuring 3-D basic rotation

The misalignment of any tilted plane can be measured by probing 3 positions. The **Probe in plane** function enables you to measure this misalignment and save it as a 3-D basic rotation in the preset table.



Please take the following into account when selecting probe points:

The sequence and position of the touch points determines how the TNC calculates the direction of the plane.

With the first two points you specify the direction of the reference axis. Define the second point in the positive direction of the desired reference axis. The position of the third point determines the direction of the minor axis and tool axis. Define the third point in the positive Y axis of the desired workplace coordinate system.

- 1ST point: On the reference axis
- 2ND point: On the reference axis, in a positive direction from the first point
- 3RD point: On the minor axis, in a positive direction of the desired workpiece coordinate system

Optionally inputting a datum angle enables you to define the nominal direction of the probed plane.



- Select the probing function: Press the PROBING
 PL soft key. The TNC then displays the current 3-D basic rotation
- Position the touch probe at a position near the first touch point
- Select the probe direction or probing routine by soft key
- Probe: Press the NC START key
- Position the touch probe at a position near the second touch point
- Probe: Press the NC START key
- Position the touch probe near the third touch point
- Probe: Press the NC START key. The TNC measures the 3-D basic rotation and displays the values for SPA, SPB and SPC in relation to the active coordinate system
- If required, enter the datum angle

Activate 3-D basic rotation:



Press the SET BASIC ROTATION soft key

Saving a 3-D basic rotation in the preset table:

Press the BASIC ROT. IN PRESET TABLE soft key



END

To terminate the probe function, press the END soft key

13.8 Compensating workpiece misalignment with 3-D touch probe

The TNC saves the 3-D basic rotation in the columns SPA, SPB or SPC of the preset table.

Aligning 3-D basic rotation

If the machine has two rotary axes and the probed 3-D basic rotation is activated, you can align the rotary axes with reference to the 3-D basic rotation using the **ALIGN ROT.** soft key.Align **ALIGN ROT. AXES**. In such cases, Tilted Working Plane becomes active for all machine operating modes.

After aligning the plane, you can align the reference axis with the **Probing rot** function.

Displaying 3-D basic rotation

When a 3-D basic rotation is saved in the active datum, the TNC

shows the 🖾 symbol for the 3-D basic rotation in the status display. The TNC traverses the machine axes according to the 3-D basic rotation.

Canceling a 3-D basic rotation



- Select the probe function by pressing the PROBING PL soft key
- ► Enter 0 for all angles
- Press the SET BASIC ROTATION soft key
- To terminate the probe function, press the END soft key

13

13.9 Datum setting with a 3-D touch probe

Overview

The following soft-key functions are available for setting a datum on an aligned workpiece:

Soft key	Function	Page
PROBING POS	Datum setting on any axis with	497
PROBING	Setting a corner as datum	498
PROBING CC	Setting a circle center as datum	499
PROBING	Center line as datum	502
CL	Setting the center line as datum	
I	Please ensure that the TNC refers to value on the active datum or the last of	defined datum

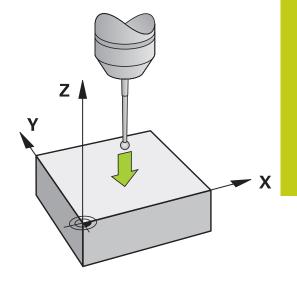
in **MANUAL OPERATION** mode with active datum shift. The datum shift is included in the position display.

Datum setting on any axis

- PROBING POS
- Select the probing function by pressing the **POSITION PROBING** soft key
- Move the touch probe to a position near the touch point
- Select the axis and probing direction, e.g. Probe in direction Z-
- Probe: Press the NC START key
- Datum: Enter the nominal coordinates, confirm with the SET DATUM soft key
 Further Information: "Writing measured values from the touch probe cycles to a datum table", page 483
- To terminate the probe function, press the END soft key



HEIDENHAIN only gives warranty for the function of the probing cycles if HEIDENHAIN touch probes are used.



13.9 Datum setting with a 3-D touch probe

Corner as datum



- Select the probing function: Press the PROBING P soft key
- Position the touch probe near the first touch point on the first workpiece edge
- Select the probe direction by soft key
- Probe: Press the NC START key
- Position the touch probe near the second touch point on the same workpiece edge
- ▶ Probe: Press the NC START key
- Position the touch probe near the first touch point on the second workpiece edge
- Select the probe direction by soft key
- Probe: Press the NC START key
- Position the touch probe near the second touch point on the same workpiece edge
- Probe: Press the NC START key
- Datum: Enter both datum coordinates into the menu window and confirm your entry with the SET DATUM soft key

Further Information: "Writing measured values from the touch probe cycles to the preset table", page 484

To terminate the probe function, press the END soft key



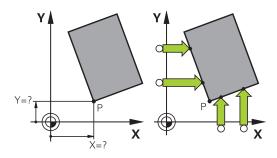
HEIDENHAIN only gives warranty for the function of the probing cycles if HEIDENHAIN touch probes are used.



You can identify the intersection of two straight lines by holes or studs and set this as the datum.

The "Corner as datum" probing cycle identifies the angle and intersection of two straight lines. In addition to datum setting, the cycle can also activate a basic rotation. The TNC has two soft keys for you to determine the straight line that you wish to use for this. The **ROT 1** soft key activates the angle of the first straight line as basic rotation and the **ROT 2** soft key the angle of the second straight line.

If you wish to activate the basic rotation in the cycle, you must always do this before datum setting. After you set a datum and write it into a datum table or preset table, the soft keys **ROT 1** and **ROT 2** will no longer be displayed.



Circle center as datum

With this function, you can set the datum at the center of bore holes, circular pockets, cylinders, studs, circular islands, etc.

Inside circle:

The TNC probes the inside wall of a circle in all four coordinate axis directions.

For incomplete circles (circular arcs) you can choose the appropriate probing direction.

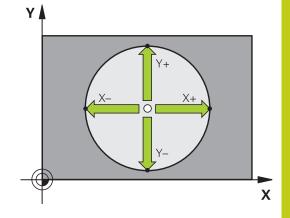
- Position the touch probe approximately in the center of the circle
- Select the touch probe function: Press the PROBING CC soft key
- Select the soft key for the desired probing direction
- Probe: Press the NC START key. The touch probe probes the inside wall of the circle in the selected direction. Repeat this process. After the third probing operation, you can have the TNC calculate the center (four touch points are recommended)
- Terminate the probing procedure and switch to the evaluation menu: Press the EVALUATE soft key
- Datum: In the menu window, enter both coordinates of the circle center, confirm with the SET DATUM soft key, or write the values to a table Further Information: "Writing measured values from the touch probe cycles to a datum table", page 483

Further Information: "Writing measured values from the touch probe cycles to the preset table", page 484

To terminate the probe function, press the END soft key

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The TNC needs only three touch points to calculate outside or inside circles, e.g. with circle segments. More precise results are obtained if you measure circles using four touch points, however. You should always preposition the touch probe in the center, or as close to the center as possible.



13.9 Datum setting with a 3-D touch probe

Outside circle:

Position the touch probe at a position near the first touch point outside of the circle



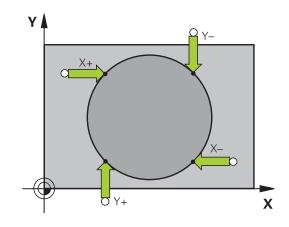
- Select the touch probe function: Press the PROBING CC soft key
- Select the soft key for the desired probing direction
- Probe: Press the NC START key. The touch probe probes the inside wall of the circle in the selected direction. Repeat this process. After the third probing operation, you can have the TNC calculate the center (four touch points are recommended)
- Terminate the probing procedure and switch to the evaluation menu: Press the EVALUATE soft key
- Datum: Enter the coordinates of the datum, confirm with the SET DATUM soft key, or write the values to a table

Further Information: "Writing measured values from the touch probe cycles to a datum table", page 483

Further Information: "Writing measured values from the touch probe cycles to the preset table", page 484)

To terminate the probe function, press the END soft key

Once the probing routine is completed, the TNC displays the current coordinates of the circle center and the circle radius.



Setting the datum using multiple holes/cylindrical studs

The manual probing function Model Circle is part of the Cir probing function. Individual circles can be determined with paraxial probing operations.

A second soft-key row provides the soft key **PROBING CC (model circle)** for using multiple holes or circular studs to set the datum. You can set the intersection of two or more elements as datum.

Setting the datum in the intersection of multiple holes/circular studs:

Pre-position touch probe

Select Model Circle probing function



Select the touch probe function: Press the PROBING CC soft key



Press the PROBING CC (model circle) soft key

Probe a circular stud

- Circular stud should be probed automatically: Press STUD soft key
- Enter starting angle or select using soft key
 - ► Start probing function: Press the NC START soft key

Probe the hole.

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- ► Hole should be probed automatically: Press the HOLE soft key
- Enter starting angle or select using soft key
- Start probing function: Press the NC START soft key
- Repeat the probing procedure for the remaining elements
- Terminate the probing procedure and switch to the evaluation menu: Press the EVALUATE soft key
- **Datum**: In the menu window, enter both coordinates of the circle center, confirm with the **SET DATUM** soft key, or write the values to a table Further Information: "Writing measured values from the touch probe cycles to a datum table", page 483

Further Information: "Writing measured values from the touch probe cycles to the preset table", page 484

To terminate the probe function, press the END soft key

13.9 Datum setting with a 3-D touch probe

Setting a center line as datum



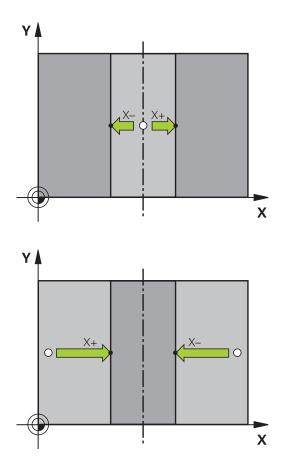
- Select the probing function: Press the PROBING CL soft key
- Position the touch probe at a position near the first touch point
- Select the probing direction by soft key
- ▶ Probe: Press the NC START key
- Position the touch probe at a position near the second touch point
- Probe: Press the NC START key
- Datum: Enter the coordinates of the datum in the menu window, confirm with the SET DATUM soft key, or write the value to a table Further Information: "Writing measured values

from the touch probe cycles to a datum table", page 483

Further Information: "Writing measured values from the touch probe cycles to the preset table", page 484

To terminate the probe function, press the END soft key

After you have measured the second touch point, you can use the evaluation menu to change the direction of the centerline. Using the soft keys, you can choose whether the datum should be set in the principal axis, minor axis or tool axis. This may be required if you want to save the set position on the principal or minor axis.



Measuring workpieces with a 3-D touch probe

You can also use the touch probe in the **Manual operation** and **Electronic handwheel** operating modes to perform simple measurements on the workpiece. Numerous programmable touch probe cycles are available for more complex measuring tasks.

Further information: Cycle Programing User's Manual

With a 3-D touch probe you can determine:

Position coordinates, and from them,

PROBING POS

Dimensions and angles on the workpiece

Finding the coordinates of a position on an aligned workpiece

- Select the probing function: Press the **PROBING POS** soft key
 - Move the touch probe to a position near the touch point
 - Select the probing direction and the axis to which the coordinates relate: Use the corresponding soft keys to select
 - Start the probing process: Press the **NC START** key

The TNC shows the coordinates of the touch point as reference point.

Finding the coordinates of a corner point on the working plane

Find the coordinates of the corner point.

Further Information: "Corner as datum ", page 498

The TNC displays the coordinates of the probed corner as datum.

13.9 Datum setting with a 3-D touch probe

Measuring workpiece dimensions



- Select the probing function: Press the PROBING POS soft key
- Position the touch probe at a position near the first touch point A
- Select the probing direction by soft key
- Probe: Press the NC START key
- If you need the current datum later, write down the value that appears in the Datum display
- ► Datum: Enter "0"
- Cancel the dialog: Press the END key
- Select the probing function again: Press the PROBING POS soft key
- Position the touch probe at a position near the second touch point B
- Select the probe direction with the soft keys: Same axis but from the opposite direction
- Probe: Press the NC START key

The **Measured value** display shows the distance between the two points on the coordinate axis.

To return to the datum that was active before the length measurement:

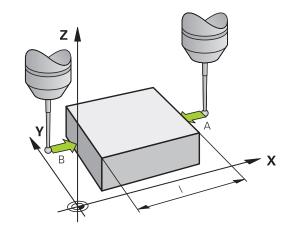
- Select the probing function: Press the **PROBING POS** soft key
- Probe the first touch point again
- Set the datum to the value that you wrote down previously
- Cancel the dialog: Press the END key

Measuring angles

You can use the 3-D touch probe to measure angles in the working plane. You can measure

- The angle between the angle reference axis and a workpiece edge; or
- the angle between two sides

The measured angle is displayed as a value of max. 90°.



Finding the angle between the angle reference axis and a workpiece edge



- Select the probe function by pressing the PROBING ROT soft key
- Rotation angle: If you wish to restore the current basic rotation later, note the value that appears under Rotation Angle
- Perform a basic rotation with the workpiece edge to be compared

Further Information: "Compensating workpiece misalignment with 3-D touch probe ", page 492

- Press the PROBING ROT soft key to display the angle between the angle reference axis and the workpiece edge as the rotation angle
- Cancel the basic rotation, or restore the previous basic rotation
- Set the rotation angle to the value that you previously wrote down

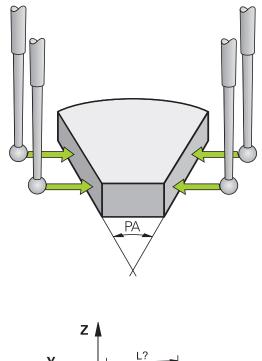
Measuring the angle between two workpiece edges

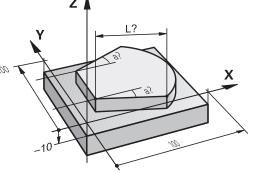


- Select the probe function by pressing the PROBING ROT soft key
- Rotation angle: If you wish to restore the current basic rotation later, note the value that appears under Rotation Angle
- Perform a basic rotation with the workpiece edge to be compared
 Further Information: "Componsating workpiece

Further Information: "Compensating workpiece misalignment with 3-D touch probe ", page 492

- Probe the second edge in the same way as for a basic rotation, but do not set the rotation angle to 0
- Press the ROTATION PROBING soft key to display the angle PA between the workpiece edges as the rotation angle
- Cancel the basic rotation, or restore the previous basic rotation by setting the rotation angle to the value that you wrote down previously





¹³ Manual Operation and Setup

13.10 Tilting the working plane (option 8)

13.10 Tilting the working plane (option 8)

Application, function

The functions for tilting the working plane are interfaced to the control and the machine tool by the machine tool builder. With some swivel heads and tilting tables, the machine tool builder determines whether the entered angles are interpreted as coordinates of the rotary axes or as angular components of a tilted plane. Refer to your machine manual.

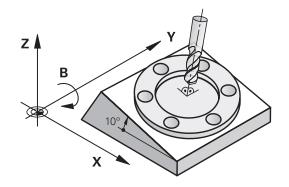
The TNC supports the tilting functions on machine tools with swivel heads and/or tilting tables. Typical applications are, for example, oblique holes or contours in an oblique plane. The working plane is always tilted around the active datum. The program is written as usual in a main plane, such as the X/Y plane, but is executed in a plane that is tilted relative to the main plane.

There are three functions available for tilting the working plane:

- Manual tilting with the 3-D ROT soft key in the Manual operation and Electronic handwheel modes
 Further Information: "Activating manual tilting:", page 509
- Controlled tilting, Cycle G80 in machining program
 Further information: Cycle Programing User's Manual
- Tilting under program control, PLANE function in the machining program

Further Information: "The PLANE function: Tilting the working plane (software option 8)", page 421

The TNC functions for tilting the working plane are coordinate transformations. The working plane is always perpendicular to the direction of the tool axis.



When tilting the working plane, the TNC differentiates between two machine types:

Machine with tilting table

- You must tilt the workpiece into the desired position for machining by positioning the tilting table, for example with an G01 block.
- The position of the transformed tool axis does not change in relation to the machine coordinate system. Thus if you rotate the table—and therefore the workpiece—by 90° for example, the coordinate system does not rotate. If you press the Z+ axis direction button in the Manual operation mode, the tool moves in Z+ direction.
- In calculating the transformed coordinate system, the TNC considers only the mechanically influenced offsets of the particular tilting table (the "translational" components).

Machine with swivel head

- You must tilt the workpiece into the desired position for machining by positioning the swivel head, for example with an G01 block
- The position of the transformed tool axis changes in relation to the machine coordinate system. Thus if you rotate the swivel head of your machine—and therefore the tool—in the B axis by 90° for example, the coordinate system rotates also. If you press the Z+ axis direction button in the **Manual operation** mode, the tool moves in X+ direction of the machine coordinate system.
- In calculating the active coordinate system, the TNC considers both the mechanically influenced offsets of the particular swivel head (the so-called "translational" components) and offsets caused by tilting of the tool (3-D tool length compensation).



The TNC only supports tilting the working plane with spindle axis G17.

13

¹³ Manual Operation and Setup

13.10 Tilting the working plane (option 8)

Traversing datums in tilted axes

The TNC automatically activates the tilted working plane if this function was enabled when the control was switched off. Then the TNC moves the axes in the tilted coordinate system when an axis-direction key is pressed. Position the tool in such a way that a collision is excluded during the subsequent crossing of the datums. To scan the reference points you have to deactivate the "Tilt Working Plane" function,

Further Information: "Activating manual tilting:", page 509

Danger of collision!

Make sure that the Tilt working plane function is active in the **MANUAL OPERATION** mode and that the angle values entered in the menu match the actual angles of the tilted axis.

Deactivate the "Tilt Working Plane" function before you cross the reference points. Take care that there is no collision. Retract the tool from the current position first, if necessary.

Position display in a tilted system

The positions displayed in the status window (ACTL. and NOML.) are referenced to the tilted coordinate system.

Limitations on working with the tilting function

- The Actual-position capture function is not allowed if the Tilt working plane function is active
- PLC positioning (determined by the machine tool builder) is not possible.

Activating manual tilting:

3D ROT

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ACTIVE

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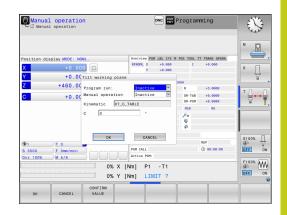
END

►	To select manual tilting, press the 3-D ROT soft
	key.

- Use the arrow keys to move the cursor to the menu pointManual operation
- To activate manual tilting, press the ACTIVE soft key
- Use the arrow keys to position the cursor on the desired rotary axis
- Enter the tilt angle
- ► Terminate the entry: Press the **END** key

If the tilted working plane function is active and the TNC moves the machine axes in accordance with the tilted axes, the status display shows the killed axes are symbol.

If you set the "Tilt working plane" function for the **Program run** operating mode to **Active**, the tilt angle entered in the menu becomes active in the first block of the machining program. If you use Cycle **G80** or the **PLANE** function in the machining program, the angle values defined there are in effect. Angle values entered in the menu will be overwritten.



13 Manual Operation and Setup

13.10 Tilting the working plane (option 8)

	The control uses the following transformation types for tilting:
,	COORD ROT
	 if a PLANE function was previously executed with COORD ROT
	after PLANE RESET
	 with corresponding configuration of the machine parameter CfgRotWorkPlane(no. 201200) by the machine tool builder
	after starting the control
	after switching the kinematics
	after running the cycle G80
	TABLE ROT
	 if a PLANE function was previously executed with TABLE ROT
	 with corresponding configuration of the machine parameter CfgRotWorkPlane(no. 201200) by the machine tool builder
	after starting the control
	after switching the kinematics

- after switching the kinematics
- after running the cycle G80

To deactivate manual tilting

To deactivate, set the appropriate operating modes to **Inactive** in the **Tilt working plane** menu.

Even if the **3D-ROT** dialog in the **Manual operation** mode is set to **Active**, resetting the tilting (**PLANE RESET**) with an active basic transformation still functions correctly.

Setting the tool-axis direction as the active machining direction



This function must be enabled by your machine manufacturer. Refer to your machine manual.

Using this function in the **Manual operation** and **Electronic handwheel** operating modes, you can move the tool in the direction in which the tool axis is currently pointed using the axis direction keys or with the handwheel. Use this function if

- You want to retract the tool in the direction of the tool axis during suspension of a 5-axis machining program
- You want to machine with an inclined tool using the handwheel or the axis direction keys in Manual Operation mode



- To select manual tilting, press the 3-D ROT soft key.
- +

TOOL AXIS

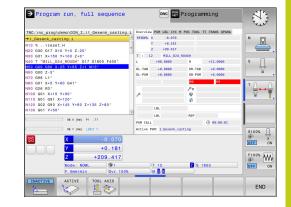
- Use the arrow keys to move the cursor to the
 - menu item Manual operation
- To activate the current tool axis direction as the active machining direction, press the TOOL AXIS soft key
- Terminate the entry: Press the END key

To deactivate the tilting function, set the **Manual operation** menu item in the "Tilt working plane" menu to inactive.

The 上 symbol appears in the status display when the Move in tool axis direction function is active.



This function is even available when you interrupt program run and want to move the axes manually.



¹³ Manual Operation and Setup

13.10 Tilting the working plane (option 8)

Setting a datum in a tilted coordinate system

After you have positioned the rotary axes, set the preset in the same manner as for a non-tilted system. The behavior of the TNC during datum setting depends on the setting in machine parameter **chkTiltingAxes** (no. 204601):

- **chkTiltingAxes: On** With an active tilted working plane, the TNC checks during datum setting in the X, Y and Z axes whether the current coordinates of the rotary axes agree with the tilt angles that you defined (3-D ROT menu). If the Tilt working plane function is not active, the TNC checks whether the rotary axes are at 0° (actual positions). If the positions do not reconcile, then the TNC issues an error message.
- chkTiltingAxes: Off The TNC does not check whether the current coordinates of the rotary axes (actual positions) agree with the tilt angles that you have defined.



Danger of collision!

Always set a reference point in all three reference axes.

Positioning with Manual Data Input

14 Positioning with Manual Data Input

14.1 Programming and executing simple machining operations

14.1 Programming and executing simple machining operations

The **Positioning with manl.data input** mode of operation is particularly convenient for simple machining operations or to pre-position the tool. It enables you to write a short program, depending on the **programInputMode** (no. 101201), in HEIDENHAIN Klartext conversational programming or in ISO format, and execute it immediately. The program is stored in the file \$MDI.

You can use the following functions for example:

- Cycles
- Radius compensation
- Program section repetitions
- Q parameters

In the **Positioning with manl.data input** mode of operation, the additional status display can also be activated.



Danger of collision!

The control loses modally affective program information and therefore contextual references after the following handling:

- Cursor movement to another NC block
- The jump command GOTO to another NC block
- Editing an NC block
- Modifying Q parameter values with the Q INFO soft key
- Switching the operating modes

Loss of this contextual reference may cause undesired tool positions!

Positioning with manual data input (MDI)

|--|--|

- Switch to the Positioning with manl.data input mode of operation
- Program the desired available function
- Press the NC START key
- > The control executes the highlighted NC block. Further Information: "Programming and executing simple machining operations", page 514

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	γ

Limitation

The following functions are not available in the **Positioning with manl.data input** operating mode:

- FK free contour programming
- Program call
 - %
 - %:PGM:
 - %<>%
- Programming graphics
- Program-run graphics

Using the **SELECT BLOCK** and **CUT OUT BLOCK** soft keys etc. you can also conveniently and rapidly reuse program sections from other NC programs.

Further Information: "Marking, copying, cutting and inserting program sections", page 126

You can control and modify Q parameters with the soft keys **Q PARAMETER LIST** and **Q INFO**.

Further Information: "Checking and changing Q parameters", page 323

14

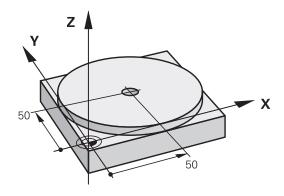
14 Positioning with Manual Data Input

14.1 Programming and executing simple machining operations

Example 1

A hole with a depth of 20 mm is to be drilled into a single workpiece. After clamping and aligning the workpiece and setting the datum, you can program and execute the drilling operation with a few lines of programming.

First you pre-position the tool above the workpiece with straightline blocks and position with a safety clearance of 5 mm above the hole. Then drill the hole with Cycle **G200**.



%\$MDI G71 *		
N10 T1 G17 S2000*		Call the tool: tool axis Z,
		spindle speed 2000 rpm
N20 G00 G40 G90 Z+200* Retract the tool (rapid traverse)		Retract the tool (rapid traverse)
N30 X+50 Y+50 M3*		Move the tool at rapid traverse to a position above the hole. Spindle on.
N40 G01 Z+2 F2000	*	Position the tool to 2 mm above the hole
N50 G200 DRILLING		Define Cycle G200 DRILLING
Q200=2	;SET-UP CLEARANCE	Set-up clearance of the tool above the hole
Q201=-20	;DEPTH	Hole depth (algebraic sign=working direction)
Q206=250	;FEED RATE FOR PLNGNG	Feed rate for drilling
Q202=10	;PLUNGING DEPTH	Depth of each infeed before retraction
Q210=0	;DWELL TIME AT TOP	Dwell time at top for chip release (in seconds)
Q203=+0	;SURFACE COORDINATE	Workpiece surface coordinate
Q204=50	;2ND SET-UP CLEARANCE	Position after the cycle, with respect to Q203
Q211=0.5	;DWELL TIME AT DEPTH	Dwell time in seconds at the hole bottom
Q395=0	;DEPTH REFERENCE	Depth referenced to the tool tip or the cylindrical part of the tool
N60 G79*		Call Cycle G200 PECKING
N70 G00 G40 Z+200 M2*		Retract the tool
N9999999 %\$MDI G7	71 *	End of program

Straight-line function:

Further Information: "Straight line in rapid traverse G00 or straight line with feed rate F G01", page 241

Programming and executing simple machining operations 14.1

Protecting programs in \$MDI

The \$MDI file is intended for short programs that are only needed temporarily. Nevertheless, you can store a program, if necessary, by proceeding as described below:



- Operating mode: Press the Programming key
- PGM MGT
- ► To call the file manager, press the **PGM MGT** key.



Move the highlight to the **\$MDI** file



► To copy the file: Press the **COPY** soft key

DESTINATION FILE =

Enter the name under which you want to save the current contents of the \$MDI file, e.g.HOLE

Press the OK soft key.

END

ок

► To exit the file manager, press the END soft key

Further Information: "Copying a single file", page 136



15.1 Graphics

15.1 Graphics

Application

In operating modes **Program run, single block** and **Program run, full sequence** and the operating mode **Test run** the TNC graphically simulates a machining operation.

The TNC features the following views:

- Plan view
- Projection in three planes
- 3-D view

In the **Test run** operating mode, you can also use the 3-D line graphics.

The TNC graphic depicts the workpiece as if it were being machined with a cylindrical end mill.

If a tool table is active, the TNC also considers the entries in the LCUTS, T-ANGLE and R2 columns.

The TNC will not show a graphic if

- the current program has no valid workpiece blank definition
- no program is selected
- with blank form definition with a subprogram, the BLK FORM block was not yet run



The simulation of programs with 5-axis machining or tilted machining might run at reduced speed. With the MOD menu **Graphic settings** you and decrease the **Model quality** and in that way increase the speed of simulation.

Speed of the setting test runs



The most recently set speed stays active until a power interruption. After the control is switched on the speed is set to FMAX.

After you have started a program, the TNC displays the following soft keys with which you can set the simulation speed:

Soft key	Functions
1:1	Test program with the speed that will be used when actually running the program (programmed feed rates will be taken into account)
	Increase the simulation speed incrementally
	Decrease the simulation speed incrementally



Test run at the maximum possible speed (default setting)

You can also set the simulation speed before you start a program:

- Select the function for setting the simulation speed
- Select the desired function by soft key, e.g. incrementally increasing the simulation speed

15.1 Graphics

Overview: Display modes

In operating modes **Program run, single block** and **Program run, full sequence** and in the operating mode **Test run** the TNC displays the following soft keys:

Soft key	View
	Plan view
	Projection in three planes
	3-D view
	The position of the soft keys depends on the

The Test run mode of operation also offers the following views:

selected operating mode.

Soft key	View
VIEWS	Volume view
VIEWS	Volume view and tool paths
VIEWS	Tool paths

Limitations during program run



The result of the simulation can be faulty if the TNC's computer is overloaded with complicated processing tasks.

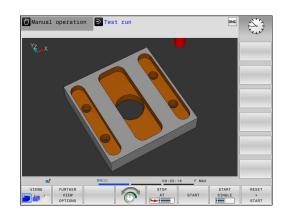
3-D view

Choose 3-D view:

The high-resolution 3-D view enables you to display the surface of the machined workpiece in greater detail. With a simulated light source, the TNC creates realistic light and shadow conditions.



Press the 3-D view soft key



15

Rotating, enlarging and shifting the 3-D view



Select the functions for rotating and enlarging: The TNC displays the following soft keys:

Soft keys	Function
	Rotate in 5° steps about the vertical axis
	Tilt in 5° steps about the horizontal axis
+	Enlarge the graphic stepwise
-	Reduce the graphic stepwise
1:1	Reset the graphic to its original size and angle
Sci	roll through the soft-key row

Soft keys	Function
1 U	Move the graphic upward or downward
\	Move the graphic to the left or right
1:1	Reset the graphic to its original position and angle

You can also use the mouse to change the graphic display. The following functions are available:

- In order to rotate the model shown in three dimensions, hold down the right mouse button and move the mouse. If you simultaneously press the shift key, you can only rotate the model horizontally or vertically
- To shift the model shown: Hold the center mouse button or mouse wheel down and move the mouse. If you simultaneously press the shift key, you can only shift the model horizontally or vertically
- To zoom in on a certain area: Mark a zoom area by holding the left mouse button down. After you release the left mouse button, the TNC zooms in on the defined area
- To rapidly magnify or reduce any area: Rotate the mouse wheel backwards or forwards
- To return to the standard display: Press the shift key and simultaneously double-click with the right mouse key. The rotation angle is maintained if you only double-click with the right mouse key

15.1 Graphics

3-D view in the Test Run operating mode

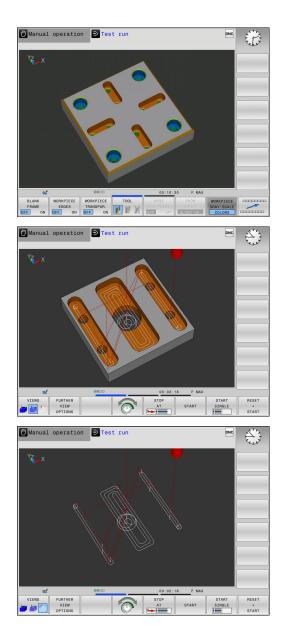
The Test run mode of operation also offers the following views:

Soft keys	Function
VIEWS	Volume view
VIEUS	Volume view and tool paths
VIEWS	Tool paths

The **Test run** mode of operation also offers the following functions:

Soft keys	Function
BLANK FRAME OFF ON	Show workpiece blank frame
WORKPIECE EDGES OFF ON	Highlight workpiece edges on 3-D model
WORKPIECE TRANSPAR. OFF ON	Show a transparent workpiece
MARK END POINT OFF ON	Show the end points of the tool paths
BLOCK NUMBERS OFF ON	Show the block numbers of the tool paths
WORKPIECE GRAY-SCALE COLORS	Show the workpiece in color
RESET THE VOLUME MODEL	Reset the volume model
RESET TOOL PATHS	Reset the tool paths
FMAX PATHS DISPLAY HIDE	Display the rapid traverse movements
MEASURING	Activate measuring
OFF ON	If measuring is activated, the control shows the
	corresponding coordinates in close proximity if you position the mouse cursor on the 3-D graphics of the workpiece.
	Note that the range of functions depends on the model quality selected. You can select the model quality in the MOD function Graphic settings

 $\ensuremath{\mathsf{quality}}$ in the MOD function $\ensuremath{\mathsf{Graphic settings}}.$





By showing the tool paths you can depict the programmed paths of the TNC in three dimensions. A powerful zoom function is available for recognizing the details quickly.

You can use the tool paths display to inspect programs created externally for irregularities before machining. This can help you to avoid undesirable machining marks on the workpiece. If points were output wrongly by the the postprocesssor, machining marks may arise.

The TNC shows traverse movements in rapid traverse in red.

15.1 Graphics

Plan view

Select the plan view in the **Test run** operating mode:



Press the PLAN VIEW soft key

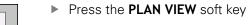
Press the FURTHER VIEW OPTIONS soft key

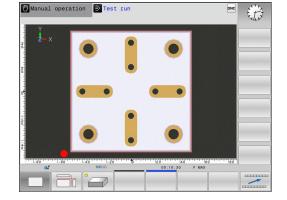
Select plan view in the operating modes **Program run, single block** and **Program run, full sequence**:

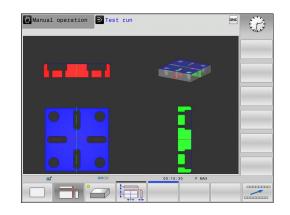


▶ Press the **GRAPHICS** soft key









Projection in three planes

The simulation shows three sectional planes and a 3-D model, similar to a technical drawing.

Select projection in three planes in the $\ensuremath{\text{Test run}}$ operating mode:



Press the FURTHER VIEW OPTIONS soft key



Press the VIEW ON 3 PLANES soft key

Select projection in three planes in the operating modes **Program run, single block** and **Program run, full sequence**:



Press the GRAPHICS soft key



Press the VIEW ON 3 PLANES soft key

Move the sectional planes



Select the functions for shifting the sectional plane. The TNC offers the following soft keys:

Soft keys

Function

+	

Shift the vertical sectional plane to the right or left Shift the vertical sectional plane forward or backward Shift the horizontal sectional plane upwards

or downwards

The position of the sectional planes is visible during shifting.

The default setting of the sectional plane is selected so that it lies in the working plane in the workpiece center and in the tool axis on the top surface.

Return sectional planes to default setting:



 Select the function for resetting the sectional planes.

15.1 Graphics

Repeating graphic simulation

A part program can be graphically simulated as often as desired. To do so you can reset the graphic to the workpiece blank.

Soft key	Function
RESET BLK FORM	Display unmachined blank in the operating modes Program run, single block and Program run, full sequence
RESET THE VOLUME MODEL	Display unmachined blank in the operating mode Test run

Tool display

Regardless of the operating mode, you can also show the tool during the simulation.

Soft key	Function
TOOLS DISPLAY HIDE	Program run, full sequence / Program run, single block
	Test run

15

Measurement of machining time

Machining time in the Test Run mode of operation

The control calculates the duration of the tool movements and displays this as machining time in the test run. The control takes feed movements and dwell times into account.

The time calculated by the control can only conditionally be used for calculating the production time because the control does not account for machine-dependent times, such as tool change.

Machining time in the machine operating modes

Time display from program start to program end. The timer stops whenever machining is interrupted.

Activating the stopwatch function

\triangleright	 Shift the soft-key row until the soft-key for the stopwatch functions appears
	 Select the stopwatch functions
STORE	 Select the desired function via soft key, e.g. saving the displayed time
Soft key	Stopwatch functions
Soft key	Store displayed time
-	·

15.2 Show the workpiece blank in the working space

15.2 Show the workpiece blank in the working space

Application

In the **Test run** operating mode, you can graphically check the position of the workpiece blank or datum in the machine's working space and activate work space monitoring in the **Test run** mode: Press the **BLANK IN WORK SPACE** soft key to activate this function. Use the soft key **SW LIMIT MONITORING** (in the second soft key row) to activate or deactivate the function.

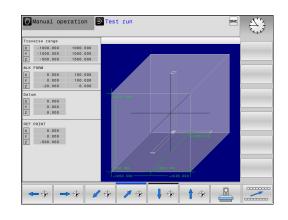
A transparent cuboid represents the workpiece blank. Its dimensions are shown in the **BLK FORM** table. The TNC takes the dimensions from the workpiece blank definition of the selected program.

For a test run it normally does not matter where the workpiece blank is located within the working space. However, if you activate working-space monitoring, you must graphically shift the workpiece blank so that it lies within the working space. Use the soft keys shown in the table.

You can also activate the current datum for the **Test run** operating mode.

Soft keys	Function
← ⊕	Shift workpiece blank in positive/negative X direction
	Shift workpiece blank in positive/negative Y direction
↑ ⊕	Shift workpiece blank in positive/negative Z direction
	Show workpiece blank referenced to the set datum
SW limit monitoring	Switch monitoring function on or off
MACHINE REF POINT OFF ON	Display machine reference point

Note that even with **BLK FORM CYLINDER**, a cuboid is shown in the working space as workpiece blank. When **BLK FORM ROTATION** is used, no workpiece blank is shown in the working space.



15.3 Functions for program display

Overview

In the **Program run single block** and **Program run full sequence** operating mode, the TNC displays the following soft keys for displaying a machining program in pages:

Soft key	Functions
	Go back one screen of the program
	Go forward one screen of the program
BEGIN	Select start of program
	Select end of program

15.4 Test run

15.4 Test run

Application

In the **Test run** operating mode, you can simulate programs and program sections to reduce programming errors when programs are running. The TNC checks the programs for the following:

- Geometrical incompatibilities
- Missing data
- Impossible jumps
- Violation of the machine's working space

The following functions are also available:

- Blockwise test run
- Interruption of test at any block
- Optional block skip
- Functions for graphic simulation
- Measure machining time
- Additional status display

Danger of collision!

The TNC cannot graphically simulate all traverse motions actually performed by the machine. These include

- Traverse motions during tool change, if the machine manufacturer defined them in a toolchange macro or via the PLC
- Positioning movements that the machine manufacturer defined in an M-function macro
- Positioning movements that the machine manufacturer performs via the PLC

HEIDENHAIN therefore recommends proceeding with caution for every new program, even when the program test did not output any error message, and no visible damage to the workpiece occurred.

With cuboid workpiece blanks, the TNC starts a program test run after a tool call at the following position:

- In the working plane in the center of the defined BLK FORM
- In the tool axis, 1 mm above the MAX point defined in the BLK FORM

With rotationally symmetric workpiece blanks, the TNC starts a program test run after a tool call at the following position:

- In the machining plane at the position X=0, Y=0
- In the tool axis 1 mm above the defined workpiece blank

In order to ensure unambiguous behavior during program run, after a tool change you should always move to a position from which the TNC can position the tool for machining without causing a collision.



Your machine tool builder can also define a toolchange macro for the **Test run** operating mode. This macro will simulate the exact behavior of the machine. Refer to your machine manual.

15.4 Test run

Execute test run



If the central tool file is active, a tool table must be active (status S) to conduct a test run. Select a tool table via the file manager in the **Test run** mode of operation.

You can select any preset table (status S) for the test run.

After **RESET + START**, line 0 of the temporarily loaded preset table automatically displays the momentarily active datum from **Preset.pr** (execution). Line 0 is selected when starting the test run until you define another datum in the NC program. All datums from lines > 0 are read by the control from the selected preset table of the test run.

With the **BLANK IN WORK SPACE** function, you activate working space monitoring for the test run.

Further Information: "Show the workpiece blank in the working space ", page 530



PGM MGT • Operating mode: Press the **Test run** key

Call the file manager with the PGM MGT key and select the file you wish to test

The TNC then displays the following soft keys:

Soft key	Functions
RESET + START	Reset the blank form, reset the previous tool data and test the entire program
START	Test the entire program
START SINGLE	Test each NC block individually
STOP AT	Executes the Test run until block N
STOP	Halt test run (soft key only appears once you have started the test run)

You can interrupt the test run and continue it again at any point —even within a fixed cycle. In order to continue the test, the following actions must not be performed:

- Selecting another block with the arrow keys or the **GOTO** key
- Making changes to the program
- Selecting a new program

Test run up to a certain block

With the **STOP AT** function the TNC executes a **Test run** up to the block with block number N.

To stop the **Test run** at any block, proceed as follows:



- Press the STOP AT soft key
- Stop at: N = Enter the block number at which the simulation should stop
- Program = Enter the name of the program containing the block with the selected block number. The control displays the name of the selected program; if the stop should be executed in a program that was called with %, enter this name.
- Repetitions = If N is located in a program section repeat, enter the number of repeats that you want to run.

Default 1: The control stops before ${\bf N}$ is simulated

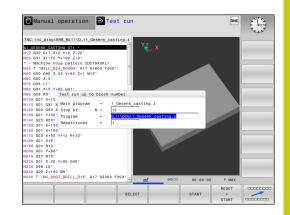
Possibilities in stopped condition

If you interrupt the **Test run** with the **STOP AT** function, you have the following possibilities in this stopped condition:

- Block skip enable or disable
- Optional program stop enable or disable
- Modify graphics resolution and model
- Modify the NC program in the **Programming** operating mode

If you modify the NC program in the **Programming** operating mode the simulation behaves as follows:

- Modification before the interruption point: The simulation restarts at the beginning
- Modification after the interruption point: Positioning at the interruption point is possible with GOTO



¹⁵ Test Run and Program Run

15.5 Program run

15.5 Program run

Application

In the **Program run, full sequence** operating mode, the TNC executes a machining program continuously to its end or up to a program stop.

In the **Program run, single block** operating mode, the TNC executes each block individually after pressing the **NC START** key. With point pattern cycles and **G79 PAT** the controls stops after each point.

You can use the following TNC functions in the operating modes **Program run, single block** and **Program run, full sequence**:

- Interrupt program run
- Start the program run from a certain block
- Optional block skip
- Edit the tool table TOOL.T
- Checking and changing Q parameters
- Superimpose handwheel positioning
- Functions for graphic simulation
- Additional status display

Running a part program

Preparation

- 1 Clamp the workpiece to the machine table.
- 2 Set the datum
- 3 Select the necessary tables and pallet files (status M)
- 4 Select the part program (status M)



You can change the feed rate and spindle speed using the potentiometers.



Refer to your machine manual. The behavior of this function varies depending on the respective machine.

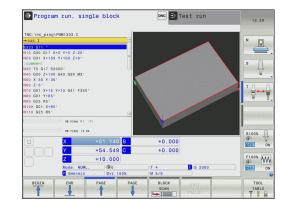
You can reduce the feed rate with the **FMAX** soft key. The reduction applies to all rapid traverse and feed rate movements. The value you enter remains active after switch-off or switch-on.

Program Run, Full Sequence

Start the machining program with the **NC START** key

Program Run, Single Block

 Start each block of the machining program individually with the NC START key



Interrupt, stop or abort machining

There are several ways to stop a program run:

- Interrupt the program run with e.g. the miscellaneous function MO
- Interrupt the program run e.g. with the miscellaneous function MO
- Stop the program run e.g. with the **NC STOP** key in conjunction with the **INTERNAL STOP** soft key**INTERNAL STOP**
- Terminate the program run e.g. with the miscellaneous functions M2 or M30

The control shows the current status of the program run in the status display.

Further Information: "General status display", page 80

The difference between an interrupted (terminated) program run and a stopped run is that an interrupted run allows the user to carry out the following actions:

- Select operating mode
- Check Q parameters and change these if necessary using the Q INFO function
- Change setting for the optional programmed interruption with M1
- Change setting for the programmed skipping of NC blocks with /



If the control registers an important error during a program run, it automatically stops the program run. Example: Cycle call with stationary spindle

¹⁵ Test Run and Program Run

15.5 Program run

Program-controlled interruptions

You can define interruptions directly in the machining program. The control interrupts the program run in the NC Block containing one of the following inputs:

- Programmed stop G38 (with and without miscellaneous function)
- Programmed stop MO
- Conditional stop M1



Danger of collision!

The control loses modally affective program information and therefore contextual references after the following handling:

- Cursor movement to another NC block
- The jump command **GOTO** to another NC block
- Editing an NC block

Loss of this contextual reference may cause undesired tool positions!



The miscellaneous function **M6** may also lead to a suspension of the program run. The machine manufacturer sets the functional scope of the miscellaneous functions.

15

Manual program interruption

While a machining program is being executed in the **Program run, full sequence** operating mode, select the **Program run, single block** operating mode. The control interrupts the machining process at the end of the current machining step.

Abort program run.

- Press NC STOP key
- > The control does not exit the current NC block
 - > The control shows the symbol for stopped status in the status display
 - Actions such as a change of operating mode are not possible
 - The program can be resumed with theNC START key
 - Press the INTERNAL STOP soft key
 - The control briefly shows the symbol for aborting the program in the status display
 - The control shows the symbol for the exited inactive status in the status display
 - Actions such as a change of operating mode are available again

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¹⁵ Test Run and Program Run

15.5 Program run

Moving the machine axes during an interruption

You can move the machine axes during an interruption in the same way as in the **Manual operation** mode.



Danger of collision!

If you interrupt the program run while the working plane is tilted, you can switch the coordinate system between tilted and non-tilted, as well as to the active tool axis direction, by pressing the **3-D ROT** soft key.

The functions of the axis direction keys, the electronic handwheel and the positioning logic for returning to the contour are evaluated by the TNC. When retracting the tool, make sure the correct coordinate system is active and the angular values of the tilt axes are entered in the 3-D ROT menu, if necessary.

Modifying the reference point during an interruption

If you modify the active reference point during an interruption, resuming the program run is only possible with **GOTO** or midprogram startup at the interruption point.

Example:

Retracting the spindle after tool breakage

- Interrupt machining
- Enable the axis direction keys: Press the MANUAL TRAVERSE soft key
- Move the machine axes with the axis direction keys



On some machines you may have to press the **NC START** key after the **MANUAL TRAVERSE** soft key to enable the axis direction keys. Refer to your machine manual.

Resuming program run after an interruption

If you interrupt an NC program using the **INTERNAL STOP** key, you have to start machining at the start of the program or using the **BLOCK SCAN** function. With machining cycles, mid-program startup is

always executed at the start of the cycle. If you interrupt a program run during a machining cycle, the control repeats machining steps already carried out after a block scan.

If you interrupt the program run within a program section repetition, or within a subprogram, you must return to the interruption point using the **BLOCK SCAN** function.

When a program run is interrupted, the TNC stores:

- The data of the last defined tool
- Active coordinate transformations (e.g. datum shift, rotation, mirroring)
- The coordinates of the circle center that was last defined



Note that the stored data remain active until they are reset (e.g. if you select a new program).

The TNC uses the stored data for returning the tool to the contour after manual machine axis positioning during an interruption (**RESTORE POSITION** soft key).

Resuming the program run with the NC Start key

You can resume program run by pressing the machine **START** button if the program was interrupted in one of the following ways:

- Press the NC STOP key
- Programmed interruption

Resuming program run after an error

With an erasable error message:

- Remove the cause of the error
- Clear the error message from the screen: Press the CE key
- Restart the program, or resume program run where it was interrupted

¹⁵ Test Run and Program Run

15.5 Program run

Retraction after a power interruption



The **Retraction** mode is enabled and adapted by the machine manufacturer. Refer to your machine manual.

With the **Retraction** mode of operation you can disengage the tool from the workpiece after an interruption in power.

If you activated a feed rate limit before a power failure, this is still active. You can deactivate the feed rate limit with the **CANCEL THE FEED RATE LIMITATION** soft key.

The **Retraction** mode of operation is selectable in the following conditions:

- Power interrupted
- No control voltage for the relay
- Traverse reference points

The **Retraction** operating mode offers the following modes of traverse:

Mode	Function
Machine axes	Movement of all axes in the machine coordinate system
Tilted system	Movement of all axes in the active coordinate system
	Effective parameters: Position of the tilting axes
Tool axis	Movements of the tool axis in the active coordinate system
Thread	Movements of the tool axis in the active coordinate system with compensating movement of the spindle
	Effective parameters: Thread pitch and direction of rotation



If tilting the working plane (option 8) is activated on your TNC, then the **Tilted system** traverse mode is available for you.(option 8)

The TNC selects the mode of traverse and the associated parameters automatically. If the traverse mode oder the parameters have not been correctly preselected, you are unable to reset them manually.

Danger of collision!

The TNC uses the last stored axis values for undefined axes. These axis values may not exactly correspond with the actual axis positions!

Consequently, the TNC may be unable to move the tool exactly along the actual tool direction when moving forward in the tool direction. If the tool is still in contact with the workpiece, it can cause stress or damage to the tool and workpiece. Stress or damage to the workpiece or tool can also be caused by uncontrolled coasting or braking of axes after a power interruption. If the tool is still in contact with the workpiece, move the axes carefully. Set the feed rate override to the smallest values possible. If you use the handwheel, use a small feed rate factor.

The traverse mode monitoring mode is not available for undefined axes. Watch the axes while you are moving them. Do not move to the traverse mode limits.

¹⁵ Test Run and Program Run

15.5 Program run

Example

The power failed while a thread cutting cycle in the tilted working plane was being performed. You have to retract the tap:

- Switch on the power supply for control and machine. The TNC starts the operating system. This process may take several minutes. Then the TNC will display the message "Power interrupted" in the screen header
- RETRACT
- Activate the Retraction mode: Press the RETRACT soft key. The TNC displays the message Retraction selected
- CE
- Acknowledge the power interruption: Press the CE key. The TNC compiles the PLC program.
- Switch on the control voltage: The TNC checks the functioning of the EMERGENCY STOP circuit. If there is at least one undefined axis you will have to compare the displayed positions with the actual axis values and confirm they are correct, and, if needed, following any instructions given in the dialog
- Check the preselected traverse mode: If required, select THREAD
- Check the preselected thread pitch: if required, enter the thread pitch
- Check the preselected direction of rotation: if needed, select the turning direction of the thread Right-handed thread: the main spindle turns clockwise when moving into the workpiece, counter-clockwise when retracting from it; left-handed thread: main spindle turns counter-clockwise when moving into the workpiece and clockwise when retracting from it
- RETRACT

Activate retraction: Press the **RETRACT** soft key

 Retraction: Retract the tool with the axis direction keys or the electronic handwheel

Axis key Z+: Retraction from the workpiece Axis key Z-: Moving into the workpiece



Exit retraction: Return to the original soft-key level

END RETRACTION

- End the Retraction mode: Press the END RETRACTION soft key. The TNC checks whether the Retract mode can be exited, following any instructions given in the dialog
- Answer confirmation request: If the tool was not correctly retracted, press the NO soft key. If the tool was correctly retracted, press the YES soft key. The TNC hides Retraction selected mode
- Initialize the machine: if required, cross the datums
- Establish the desired machine condition: If required, reset the tilted working plane

Any entry into program: Mid-program startup

Danger of collision!

If you use the **GOTO** key and the number of the NC block for going into a program, neither the TNC nor the PLC will execute any functions that ensure a safe start.

For safe entry, always use the **BLOCK SCAN** function.



The **BLOCK SCAN** function must be enabled and adapted by the machine manufacturer. Refer to your machine manual.

With the **BLOCK SCAN** function you can start an NC program at any desired NC block. The control factors workpiece machining up to this NC block into the calculations.

You can run the mid-program startup in the following ways:

- Mid-program startup in the main program, with repetitions if necessary
- Multi-level mid-program startup in subprograms and touch probe cycles
- Mid-program startup in a point table
- Block scan in pallet programs

At the start of mid-program startup the control resets all data, as with a selection of the NC program. During the mid-program startup you can change between **Program run full sequence** and **Program run single block**.

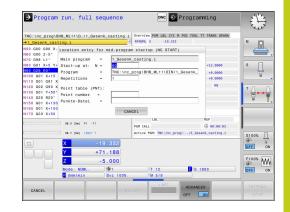


The TNC skips all touch probe cycles in a midprogramstartup. Result parameters from these cycles might therefore remain empty. If you wish to continue working with the results of a touch probe cycle, use the multi-level mid-program startup.

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You must not use mid-program startup if you: use the touch probe cycle G55 in the search

phase of the mid-program startup



¹⁵ Test Run and Program Run

15.5 Program run

Procedure for simple mid-program startup

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The control only displays the dialogs required by the process in the pop-up window.

BLOCK	SCAN
+	

Press the BLOCK SCAN soft key

- The control shows a pop-up window with the active main program.
- Start-up at: N = Enter the number of the NC block where you wish to enter the NC program
- Program = Check the name and path of the NC program containing the NC block, or enter with the SELECT soft key
- Repetitions = Enter the number of repetitions which should be taken into account in the block scan if the NC block is located within a program section repetition.
 Default 1 means first machining
- Press the NC START key

The control starts the block scan, calculates until the entered NC block and shows the next dialog.

If you changed the machine status:

Press the NC START key

The control restores the machine status, e.g. tool call, M functions and shows the next dialog.

If you changed the axis positions:

- Press the NC START key
 The control approaches the specified positions in
 - the specified sequence and shows the next dialog. Approach axes in individually selected sequence: **Further Information:** "Returning to the contour", page 549
 - Press the NC START key
 - > The control resumes execution of the NC program.

Example of simple mid-program startup

After an internal stop you wish to start in block 120 in the third machining of G98 L1.

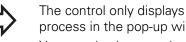
In the pop-up window enter the following data:

- Start-up at: N =120
- Repetitions = 3

15

Procedure for multi-level mid-program startup

If you start in a subprogram that is called several times by the main program, use the multi-level mid-program startup. For this purpose, jump in the main program to the desired subprogram call. Use the function CONTINUE BLOCK SCAN to jump further from this position.



The control only displays the dialogs required by the process in the pop-up window.

You can also jump to the next startup point without restoring the machine status and the axis positions of the first startup point. For this purpose press the soft key CONTINUE BLOCK SCAN before you confirm the restoration with the NC START key.

Mid-program startup to the first start-up point:

	a ock	SCAN
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11	-	
	* ==	
11		
100		

- Press the BLOCK SCAN soft key
 - Enter the first NC block where you wish to start
- Press the NC START key
- > The control starts the block scan and calculates until the entered NC block.

If the control should restore the machine status of the entered NC block:



- Press the NC START key
- > The control restores the machine status, e.g. tool call. M functions.

If the control should restore the axis positions:

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	-		у.	

- Press the NC START key
- > The control moves in the specified sequence to the specified positions.

If the control should run the NC block:

- Ð
- Select the **Program run single block** operating mode if required

Press the NC START key

> The control runs the NC block.

Mid-program startup to the next start-up point:

- CONTINUE BLOCK SCAN
- Press the CONTINUE BLOCK SCAN soft key
- Enter the NC block where you wish to start

If you changed the machine status:

Press the NC START key

If you changed the axis positions:



Press the NC START key

If the control should run the NC block:

- Press the NC START key
- Repeat these steps if required to jump to the next start-up point

15 **Test Run and Program Run**

15.5 Program run

- Press the NC START key
- > The control resumes execution of the NC program.

Example of multi-level mid-program startup

You run a main program with several subprogram calls in the program Sub.i. You work with a touch probe cycle in the main program. You use the result of the touch probe cycle later for positioning.

After an internal stop you wish to start up in block 80 in the second call of the subprogram. This subprogram call is in block 530 of the main program. The touch probe cycle is in block 280 of the main program, i.e. before the desired start-up point.

BLOCK	SCAN

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€∎

- Press the BLOCK SCAN soft key
- In the pop-up window enter the following data:
 - Start-up at: N =280
 - Repetitions = 1
- Select the Program run single block operating mode if required
- Press the NC START key until the control runs the touch probe cycle
- CONTINUE BLOCK SCA
- Press the CONTINUE BLOCK SCAN soft key
- In the pop-up window enter the following data:
 - Start-up at: N =530

> The control saves the result.

- Repetitions = 1
- Press the NC START key until the control runs the NC block
- > The control jumps into the subprogram Sub.i.
- Press the CONTINUE BLOCK SCAN soft key
- In the pop-up window enter the following data:
 - Start-up at: N =80
 - Repetitions = 1
- Press the NC START key until the control runs the NC block
- > The control continues to run the subprogram and then returns to the main program.



Program run 15.5

15

Block scan in a point table

If you start in a point table called by the main program, use the ADVANCED soft key.

BLOCK	SCAN
1 ou	
ADVA	NCED

OFF ON

- Press the BLOCK SCAN soft key
- > The control shows a pop-up window.
- Press the ADVANCED soft key
- > The control expands the pop-up window.
- **Point number =** enter the line number of the point ► table you start with
- Point file = Enter the name and path of the point table
- Press the NC START key

Returning to the contour

With the **RESTORE POSITION** function, the TNC moves the tool to the workpiece contour in the following situations:

- Return to the contour after the machine axes were moved during a program interruption that was not performed with the **INTERNAL STOP** function.
- Return to the contour with a block scan with **RESTORE POS AT** N, for example after an interruption with INTERNAL STOP
- Depending on the machine, if the position of an axis has changed after the control loop has been opened during a program interruption

Procedure

To move to the contour, proceed as follows:



- Press the **RESTORE POSITION** soft key
- POSITION
- Restore the machine status, if required

Approach the axes in the sequence shown by the control:

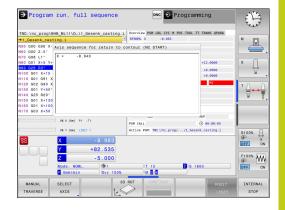


Press the NC START key

Approach the axes according to individually selected sequence:

AXIS
t I

- Press the SELECT AXIS soft key Press the axis soft key of the first axis
- Press the NC START key
- Press the axis soft key of the second axis
- Press the NC START key
- Repeat the process for all axes



15 Test Run and Program Run

15.6 Automatic program start

15.6 Automatic program start

Application



The TNC must be specially prepared by the machine tool builder for use of the automatic program start function. Refer to your machine manual.



Caution: Danger for the operator!

The autostart function must not be used on machines that do not have an enclosed working space.

In a Program Run operating mode, you can use the **AUTOSTART** soft key to define a specific time at which the program that is currently active in this operating mode is to be started:



- Display window for setting the starting time
- Time (hrs:min:sec): Time of day at which the program is to be started
- Date (DD.MM.YYYY): Date on which the program is to be started
- ► To activate the start, press the **OK**

➔ Program run, full sequence DNC	Programming	\odot
TNC:\nc_prog\demo\DIN_ISO\1_Gesenk_casting.i		
→1_Gesenk_casting.i		M D
%1_GESENK_CASTING G71 *		
N10 %\reset.H		
N20 G30 G17 X+0 Y+0 Z-20*		S
N30 G31 X+15 Automatic program start		T
N40 T "MILL_ Current date 16 . 7 . 15		
N50 G00 G90 Current time 9 : 59 : 11		Δ.Δ'
N60 G00 Z-5* start program ISO/I_Gesenk_cast	ing.i	
N70 G98 L1* Date (DD.MM.YY) 16 .7 .15		
N80 G01 X+5 Time (HRS:MIN:SEC) 9 : 59 : 11		
Start enabled Yes Autostart active No	3	
Autostart active ING		
OK	CANCEL	\$100% []
		OFF ON
Y +0.000		OFF ON
Z +200,000		F100% AAA
Mode: NOML. 191	Z S 3333	(A) (VVV
0 0mm/min 0vr 100% M 5/9	6 2333	OFF ON
	COPY	PASTE
OK EXIT CANCEL	FIELD	FIELD

15.7 Optional block skip

Application

Blocks that you mark with a "/" sign may be skipped in **Test run** or **Program Run, Full Sequence/Single Block**:

- To run or test the program without the NC blocks preceded by a slash, set the soft key to ON
- To run or test the program with the NC blocks preceded by a slash, set the soft key to OFF



> This function does not work for **G99** blocks. After a power interruption the TNC returns to the most recently selected setting.

Inserting the "/" character

In the **Programming** mode you select the block in which the character is to be added



Press the INSERT soft key

Erasing the "/" character

In the **Programming** mode you select the block in which the character is to be erased



Press the **REMOVE** soft key

15 Test Run and Program Run

15.8 Optional program-run interruption

15.8 Optional program-run interruption

Application



Refer to your machine manual.

The behavior of this function varies depending on the respective machine.

The TNC optionally interrupts program run at blocks containing M1. If you use M1 in the **Program run** mode, the TNC does not switch off the spindle or coolant.



Do not interrupt Program run or Test run with blocks containing M1: Set the soft key to OFF



Interrupt Program run or Test run with blocks containing M1: Set the soft key to ON

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MOD Functions

16 MOD Functions

16.1 MOD function

16.1 MOD function

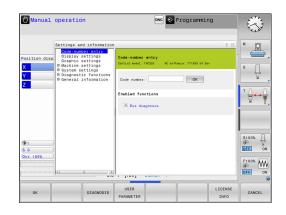
The MOD functions provide additional input possibilities and displays. In addition, you can enter code numbers to enable access to protected areas.

Selecting MOD functions

Open the pop-up window with the MOD functions:



To select the MOD functions, press the MOD key. The TNC opens a pop-up window displaying the available MOD functions.



Changing the settings

As well as with the mouse, navigation with the keyboard is also possible in the MOD functions:

- Switch from the input area in the right window to the MOD function selections in the left window with the tab key
- Select MOD function
- Switch to the input field with the tab key or ENT key
- Enter value according to function and confirm with OK or make selection and confirm with Apply



If more than one possibility is available for a particular setting, you can superimpose a window listing all of the given possibilities by pressing the **GOTO** key. Select the setting with the **ENT** key. If you do not wish to change the setting, close the window with the **END** key.

Exiting MOD functions

▶ Exit the MOD functions: Press the END soft key or the END key

Overview of MOD functions

The following functions are available independent of the selected operating mode:

Code-number entry

Code number

Display settings

- Digital readouts
- Measuring unit (mm/inch) for position display
- Program entry for MDI
- Show time of day
- Show the info line

Graphic settings

- Model type
- Model quality

Machine settings

- Kinematics
- Traverse limits
- Tool-usage file
- External access

System settings

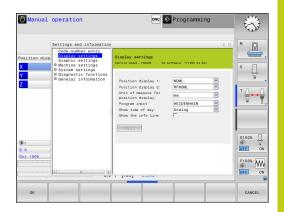
- Set the system time
- Define the network connection
- Network: IP configuration

Diagnostic functions

- Bus diagnosis
- Diagnosis of Drives
- HEROS information

General information

- Software version
- FCL information
- License information
- Machine times



16

16 MOD Functions

16.2 Graphic settings

16.2 Graphic settings

With the MOD function $\ensuremath{\textbf{Graphic settings}}$ you can select the model type and model quality .

To select **Graphic settings** proceed as follows:

- Select the group **Graphic settings** from the MOD menu
- Select the model type
- Select the model quality
- Press the APPLY soft key
- ▶ Press the **OK** soft key.

You have the following simulation parameters for the graphic settings:

Model type

Displayed symbol	Choice	Properties	Application
	3-D	Very true to detail, heavy time and processor consumption	Milling with undercuts, milling-turning operations
Ľ	2.5 D	Fast	Milling without undercuts
*	No model	Very fast	Line graphics

Model quality

Displayed symbol	Choice	Properties
0000	Very high	High data transfer rate, exact depiction of tool geometry,
0000		depiction of block end points and block numbers possible
0000	High	High data transfer rate, exact depiction of tool geometry
0000	Medium	Medium data transfer rate, approximation of tool geometry
0000	Low	Low data transfer rate, coarse approximation of tool geometry

16.3 Machine settings

External access



Refer to your machine manual. The machine tool builder can configure the external access options.

Machine-dependent function: With the **TNCOPT** soft key, you can permit or lock access for an external diagnostics or commissioning program.

With the MOD function **External access** you can grant or restrict access to the TNC. If you have restricted the external access it is no longer possible to connect to the TNC and exchange data via a network or a serial connection, e.g. with the TNCremo data transfer software.

Restricting external access:

- In the MOD menu select the Machine settings groupMachine settings
- Select the External access menu
- Set the EXTERNAL ACCESS ON/OFF soft key to OFF
- Press the OK soft key

	Settings and information	1 P S	
Position disp	Code-number entry Display settings Graphic settings B Machine settings Kinematics	External access Control model: TMCSDD NC software: 771855 04 Dev	s T
Y Z	Traverse limits Tool-usage file External access D System settings	External access permitted	
	B Diagnostic functions B General information	The computer-specific access restriction was deactivated by the machine manufacturer.	
⊕1 S 0			S100%
Ovr 100%			

16 MOD Functions

16.3 Machine settings

Computer-specific access control

If your machine manufacturer has set up computer-specific access control (machine parameter **CfgAccessControl** no. 123400)), you can permit access for up to 32 connections authorized by you. Select **Add** to create a new connection. The TNC opens an input window for you to enter the connection data.

Access settings

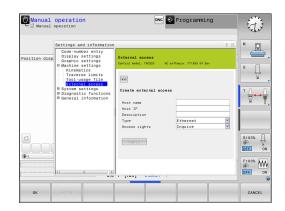
Host name	Host name of the external computer
Host IP	Network address of the external computer
Description	Additional information (text is shown in the overview list)
Туре:	
Ethernet	Network connection
Com 1	Serial interface 1
COM 2	Serial interface 2
Access rights:	
Inquire	The TNC opens a query dialog with external access
Deny	Do not permit network access
Permit	Permit network access without query

If you assign the access right **Inquire** to a connection and access is implemented from this address, the TNC opens a pop-up window. You must permit or deny external access in the pop-up window:

External access	Permission
Yes	Permit once
Always	Permit continuously
Never	Deny continuously
No	Deny once



In the overview list an active connection is shown with a green symbol. Connections without access rights are shown gray in the overview list.



Entering traverse limits



Refer to your machine manual.

The **Traverse limits** function must be enabled and adapted by the machine manufacturer.

The MOD function **Traverse limits** enables you to limit the actually usable tool path within the maximum traverse range. This enables you to define protection zones on each axis to protect a component from collision for example.

To enter traverse limits:

- In the MOD menu select the Machine settings groupMachine settings
- Select the Traverse limits menuTraverse limits
- Enter the values of the desired axes as a reference value or load the momentary position with the ACTUAL POSITION CAPTURE soft key
- Press the APPLY soft key The TNC checks the values entered for validity.
- Press the soft key OK

The protection zone becomes active automatically as soon as you set a valid limit in an axis. Settings are kept even after restarting the control.

You can only deactivate the protection zone by deleting all values or pressing the **EMPTY EVERYTHING** soft key.

Original State Official State Southan weak Model Southan weak Model Southan weak Southan weak	Position disp	Settings and information Code-number entry Display settings	Traverse linits		<u> 9 X</u>	" _ P
(P) (P) (S o) (P) (DVC 1005) (P) (P) (P)	X Y	Graphic settings E Machine settings Kinematics Traverse limits Tool-usage file External access B Diagnostic functions	Axis Status Lower : X J C Y Z	Limit Upper limit		s
	S 0		i fimil remeri i			0FF

¹⁶ MOD Functions

16.3 Machine settings

Tool usage file



The tool usage test function must be enabled by your machine manufacturer. Refer to your machine manual.

With the MOD function **Tool-usage file** you can select whether the TNC never, once, or always creates a tool usage file.

Generate a tool usage file:

- In the MOD menu select the Machine settings groupMachine settings
- Select the Tool-usage file menuTool-usage file
- Select the desired setting for the operating modes Program Run, Full Sequence/Single Block and Test run
- Press the APPLY soft keyAPPLY
- Press the OK soft key

Select kinematics



The **Kinematics selection** function must be enabled and adapted by the machine manufacturer.

Refer to your machine manual.

You can use this function to test programs whose kinematics does not match the active machine kinematics. If your machine manufacturer saved different kinematic configurations in your machine, you can activate one of these kinematics configurations with the MOD function. When you select a kinematics model for the test run this does not affect machine kinematics.



Danger of collision!

When you switch the kinematics model for machine operation, the TNC implements all of subsequent movements with modified kinematics.

Ensure that you have selected the correct kinematics in the test run for checking your workpiece.

16

16.4 System settings

Set the system time

With the **Set the system time** MOD function you can set the time zone, date and time manually or with the aid of an NTP server synchronization.

To set the system time manually:

- In the MOD menu select the System settings groupSystem settings
- Press the SET DATE/ TIME soft keySET DATE/ TIME
- Select your time zone in the **Time zone** area**Time zone**
- Press the LOCAL/NTP soft key in order to select the Set the time manually entry
- If required, change the datum and the time
- Press the OK soft key

To set the system time with the aid of an NTP server:

- In the MOD menu select the System settings groupSystem settings
- Press the SET DATE/ TIME soft keySET DATE/ TIME
- Select your time zone in the Time zone areaTime zone
- Press the LOCAL/NTP soft key in order to synchronize the time entry through the NTP server
- Enter the host name or the URL of an NTP server
- Press the ADD soft key
- Press the OK soft key

16 MOD Functions

16.5 Select the position display

16.5 Select the position display

Application

You can influence the display of the coordinates for the operating mode **Manual operation** and the operating modes **Program run, full sequence** and **Program run, single block**.

The figure on the right shows the different tool positions:

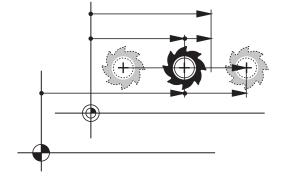
- Initial position
- Target position of the tool
- Workpiece zero point
- Machine datum

The TNC position displays can show the following coordinates:

Function	Display
Nominal position: the value presently commanded by the TNC	NOML.
Actual position; current tool position	ACTL.
Reference position; actual position relative to the machine datum	REF ACTL
Reference position; nominal position relative to the machine datum	REF NOML
Servo lag; difference between nominal and actual positions	LAG
Distance remaining to the programmed position in the input system; difference between actual and target positions	ACTDST
Distance remaining to the programmed position with reference to the machine datum; difference between reference and target positions	REFDST
Traverses that were carried out with handwheel superimpositioning (M118)	M118

With the MOD function **Position display 1**, you can select the position display in the status display.

With the MOD function **Position display 2**, you can select the position display in the additional status display.



16.6 Setting the unit of measure

Application

This MOD function determines whether the coordinates are displayed in millimeters (metric system) or inches.

- Metric system: e.g. X = 15.789 (mm), the value is displayed to 3 decimal places
- Inch system: e.g. X = 0.6216 (inches), value is displayed to 4 decimal places

If you would like to activate the inch display, the TNC shows the feed rate in inch/min. In an inch program you must enter the feed rate larger by a factor of 10.

16.7 Displaying operating times

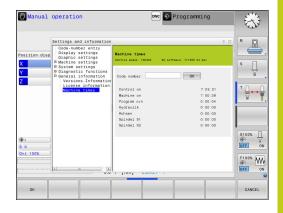
Application

The **MACHINE TIME** MOD function enables you to see various types of operating times:

Operating time	Meaning
Control on	Operating time of the control since being put into service
Machine on	Operating time of the machine tool since being put into service
Program run	Duration of controlled operation since being put into service



Refer to your machine manual. The machine tool builder can provide further operating time displays.



¹⁶ MOD Functions

16.8 Software numbers

16.8 Software numbers

Application

The following software numbers are displayed on the TNC screen after the **Software version** MOD function has been selected:

- Control model: Designation of the control (managed by HEIDENHAIN)
- NC SW: Number of the NC software (managed by HEIDENHAIN)
- NCK: Number of the NC software (managed by HEIDENHAIN)
- PLC: Number or name of the PLC software (managed by your machine manufacturer)

In the **FCL Information** MOD function, the TNC shows the following information:

 Development level (FCL=Feature Content Level): Development level of the software installed on the control Further Information: "Feature Content Level (upgrade functions)", page 9

16.9 Enter the code number

Application

The TNC requires a code number for the following functions:

Function	Code number
Select user parameters	123
Configuring an Ethernet card	NET123
Enabling special functions for Q parameter programming	555343

HEIDENHAIN | TNC 320 | ISO Programming User's Manual | 9/2016

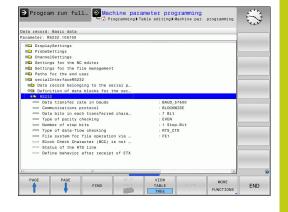
16.10 Setting up data interfaces

Serial interfaces on the TNC 320

The TNC 320 automatically uses the LSV2 transmission protocol for serial data transfer. The LSV2 protocol is prescribed and cannot be modified apart from setting the baud rate (machine parameter **baudRateLsv2,** no. 106606). You can also define another type of data transfer (interface). The settings described below are therefore effective only for the respective newly defined interface.

Application

To set up a data interface, press the **MOD** key. Enter the code number 123. In the **CfgSerialInterface** (no. 106700) machine parameter, you can enter the following settings:



Setting the RS-232 interface

Open the RS232 folder. The TNC then displays the following settings:

Set BAUD RATE (baud rate no. 106701)

You can set the BAUD RATE (data transfer speed) from 110 to 115 200 baud.

¹⁶ MOD Functions

16.10 Setting up data interfaces

Set protocol (protocol no. 106702)

The data transfer protocol controls the data flow of a serial transmission (comparable to MP5030 of the iTNC 530).

The BLOCKWISE setting here designates a method of data transfer in which data is transferred grouped in blocks. This should not be confused with the block-wise data reception and simultaneous blockwise running of older TNC contouring controls. The block-wise reception and simultaneous running of the same NC program is not supported by the control.

Data transmission protocol	Selection
Standard data transmission (transmission line-by-line)	STANDARD
Packet-based data transfer	BLOCKWISE
Transmission without protocol (only character-by-character)	RAW_DATA

Set data bits (dataBits no. 106703)

By setting the data bits you define whether a character is transmitted with 7 or 8 data bits.

Check parity (parity no. 106704)

The parity bit helps the receiver to detect transmission errors. The parity bit can be formed in three different ways:

- No parity (NONE): There is no error detection
- Even parity (EVEN): Here there is an error if the receiver finds that it has received an odd number of set bits
- Odd parity (ODD): Here there is an error if the receiver finds that it has received an even number of set bits

Set stop bits (stopBits no. 106705)

The start bit and one or two stop bits enable the receiver to synchronize each transmitted character during serial data transmission.

Set handshake (flowControl no. 106706)

By handshaking, two devices control data transfer between them. A distinction is made between software handshaking and hardware handshaking.

- No data flow checking (NONE): Handshaking is not active
- Hardware handshaking (RTS_CTS): Transmission stop is active through RTS
- Software handshaking (XON_XOFF): Transmission stop is active through DC3 (XOFF)

File system for file operation (fileSystem no. 106707)

In **fileSystem** you define the file system for the serial interface. This machine parameter is not required if you don't need a special file system.

- EXT: Minimum file system for printers or non-HEIDENHAIN transmission software. Corresponds to the EXT1 and EXT2 modes of earlier TNC controls.
- FE1: Communication with the TNCserver PC software or an external floppy disk unit.

Block check character (bccAvoidCtrlChar no. 106708)

With Block Check Character (optional) no control character, you determine whether the checksum can correspond to a control character.

- TRUE: The checksum does not correspond to a control character
- FALSE: The checksum can correspond to a control character

Condition of RTS line (rtsLow no. 106709)

With Condition of RTS line (optional) you determine whether the "low" level is active in idle state.

- TRUE: Level is "low" in idle state
- FALSE: Level is not "low" in idle state

16 MOD Functions

16.10 Setting up data interfaces

Define behavior after receipt of ETX (noEotAfterEtx no. 106710)

With define behavior after reception of ETX (optional) you determine whether the EOT character is sent after the ETX character was received.

- TRUE: The EOT character is not sent
- FALSE: The EOT character is sent

Settings for the transmission of data using PC software TNCserver

Apply the following settings in machine parameter **RS232** (no. 106700):

Parameters	Selection
Data transfer rate in baud	Has to match the setting in TNCserver
Data transmission protocol	BLOCKWISE
Data bits in each transferred character	7 bits
Type of parity checking	EVEN
Number of stop bits	1 stop bit
Specify type of handshake:	RTS_CTS
File system for file operations	FE1

use

Setting the operating mode of the external device (fileSystem)

	In the FE2 and FEX operating modes you cannot the "load all programs", "load offered program" ar "load directory" functions.		
lcon	External device	Operating mode	
E	PC with HEIDENHAIN TNCremo data transfer software	LSV2	
	HEIDENHAIN floppy disk units	FE1	
₽	Non-HEIDENHAIN devices such as printers, scanners, punchers, PC without TNCremo	FEX	

Software for data transfer

For transmitting files to and from the TNC, we recommend using the HEIDENHAIN TNCremo data transmission software. With TNCremo, data transmission is possible with all HEIDENHAIN controls via the serial interface or the Ethernet interface.



You can download the current version of TNCremofree of charge from the HEIDENHAIN Filebase (www.heidenhain.com, <Software>, <PC software>, <TNCremo>).

System requirements for TNCremo:

- PC with 486 processor or higher
- Windows XP, Windows Vista, Windows 7, Windows 8 operating system
- 16 MB RAM
- 5 MB free memory space on your hard disk
- An available serial interface or connection to the TCP/IP network

Installation under Windows

- Start the SETUP.EXE installation program with the file manager (Explorer)
- Follow the setup program instructions

Starting TNCremo under Windows

 Click on <Start>, <Programs>, <HEIDENHAIN Applications>, <TNCremo>

When you start TNCremo for the first time, TNCremo automatically tries to set up a connection with the TNC.

¹⁶ MOD Functions

16.10 Setting up data interfaces

Data transfer between the TNC and TNCremo



Before you transmit a program from the TNC to the PC, you must make absolutely sure that you have already saved the program currently selected on the TNC. The TNC saves changes automatically when you switch the operating mode on the TNC, or when you select the file manager with the **PGM MGT** key.

Check whether the TNC is connected to the correct serial port on your PC or to the network.

Once you have started TNCremo, you will see a list of all files that are stored in the active directory in the upper section of the main window 1. Using <File>, <Change directory>, you can select any drive or another directory on your PC.

If you want to control data transfer from the PC, establish the connection with your PC in the following manner:

- Select <File>, <Setup connection>. TNCremo now receives the file and directory structure from the TNC and displays this at the bottom left of the main window 2
- To transfer a file from the TNC to the PC, select the file in the TNC window with a mouse click and drag and drop the highlighted file into the PC window 1
- To transfer a file from the PC to the TNC, select the file in the PC window with a mouse click and drag and drop the highlighted file into the TNC window 2

If you want to control data transfer from the TNC, establish the connection with your PC in the following manner:

- Select <Extras>, <TNCserver>. TNCremo is now started in server mode, and can receive data from the TNC and send data to the TNC
- You can now call the file management functions on the TNC by pressing the key PGM MGT in order to transfer the desired files Further Information: "Data transfer to or from an external data carrier", page 152



If you have exported a tool table from the control, the tool types are converted to a tool type number. **Further Information:** "Available tool types", page 217

End TNCremo

Select <File>, <Exit>



Refer also to the TNCremo context-sensitive help texts where all of the functions are explained in more detail. The help texts must be called with the **F1** key.

			-	Steuerung
Name	Größe	Attribute Datum		TNC 400
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		SCRDUMP[*.*]		Verbindung
Name 200.H P 201.H P 201.H P 203.H P 210.H P 211.H P 212.H P 212.H	Große 1596 1004 1892 2340 3974 3604 3352 2352	Attribute Datum 06 04 99 15:39:42 06 04 99 15:39:44 06 04 99 15:39:44 06 04 99 15:39:44 06 04 99 15:39:46 06 04 99 15:39:40 06 04 99 15:39:40 06 04 99 15:39:40 06 04 99 15:39:40		Protokol: [LSV-2 Schnittstelle: [CDM2 Baudrate (Auto Detect [115200

16

16.11 Ethernet interface

Introduction

The TNC is shipped with a standard Ethernet card to connect the control as a client in your network. The TNC transmits data via the Ethernet card with

- the smb protocol (Server Message Block) for Windows operating systems, or
- the TCP/IP protocol family (Transmission Control Protocol/ Internet Protocol) and with the NFS (Network File System)

Connection possibility

You can connect the Ethernet card in your TNC to your network through the RJ45 connection (X26,1000BaseTX, 100BaseTX and 10BaseT), or directly to a PC. The connection is metallically isolated from the control electronics.

For a 1000Base TX, 100BaseTX or 10BaseT connection you need a Twisted Pair cable to connect the TNC to your network.



The maximum cable length between TNC and a node depends on the quality grade of the cable, the sheathing and the type of network (1000BaseTX, 100BaseTX or 10BaseT).

No great effort is required to connect the TNC directly to a PC that has an Ethernet card. Simply connect the TNC (port X26) and the PC with an Ethernet crossover cable (trade names: crossed patch cable or crossed STP cable).

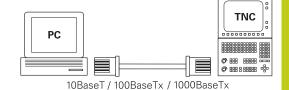
Configuring the TNC



Make sure that the person configuring your TNC is a network specialist.

- Press the MOD key in the Programming mode and enter the code number NET123
- In the file manager, press the soft key NET



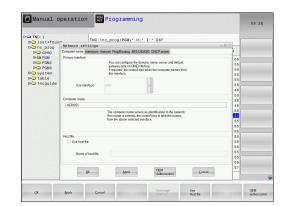


16 MOD Functions 16.11 Ethernet interface

General network settings

Press the CONFIGURE NETWORK soft key to enter the general network settings. The Computer name tab is active:

Setting	Meaning
Primary interface	Name of the Ethernet interface to be integrated in your company network. Only active if a second, optional Ethernet interface is available on the control hardware
Computer name	Name displayed for the TNC in your company network
Host file	Only required for special applications : Name of a file in which the assignments of IP addresses to computer names is defined



- Wanual operation
 Programming
 09:28

 00 TRC: 1
 TRC: Inc. programming
 09:28

 00 TRC: 1
 TRC: Inc. programming
 09:28

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 05 Data four mark between the hydroxy MSU000 DMCPanel
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 06 Data four mark between the hydroxy MSU000 DMCPanel
 10
 10

 07 Data four
- Select the **Interfaces** tab to enter the interface settings:

Setting	Meaning					
Interface list	List of the active Ethernet interfaces. Select one of the listed interfaces (via mouse or arrow keys)					
	 Activate button: Activate the selected interface (X appears in the Active column) 					
	 Deactivate button: Deactivate the selected interface (- appears in the Active column) 					
	 Configuration button: Open the configuration menu 					
Allow IP forwarding	This function must be kept deactivated . Only activate this function if external access via the second, optional Ethernet interface of the TNC is necessary for diagnostic purposes. Only do so after instruction by our Service Department					

16

Press the Configuration button to open the Configuration menu:

Setting	Meaning
Status	Interface active: Connection status of the selected Ethernet interface
	 Name: Name of the interface you are currently configuring
	Plug connection: Number of the plug connection of this interface on the logic unit of the control
Profile	Here you can create or select a profile in which all settings shown in this window are stored. HEIDENHAIN provides two standard profiles:
	 DHCP-LAN: Settings for the standard TNC Ethernet interface, should work in a standard company network
	 MachineNet: Settings for the second, optional Ethernet interface; for configuration of the machine network
	Press the corresponding buttons to save, load and delete profiles
IP address	Option Automatically procure IP address: The TNC is to procure the IP address from the DHCP server
IP address	address: The TNC is to procure the IP
Domain Name Server (DNS)	 address: The TNC is to procure the IP address from the DHCP server Option Manually set IP address: Manually define the IP address and subnet mask. Input: Four numerical values separated by periods, e.g. 160.1.180.20 and
Domain Name	 address: The TNC is to procure the IP address from the DHCP server Option Manually set IP address: Manually define the IP address and subnet mask. Input: Four numerical values separated by periods, e.g. 160.1.180.20 and 255.255.0.0 Option Automatically procure DNS: The TNC is to automatically procure the IP
Domain Name	 address: The TNC is to procure the IP address from the DHCP server Option Manually set IP address: Manually define the IP address and subnet mask. Input: Four numerical values separated by periods, e.g. 160.1.180.20 and 255.255.0.0 Option Automatically procure DNS: The TNC is to automatically procure the IP address of the domain name server Option Manually configure the DNS: Manually enter the IP addresses of the

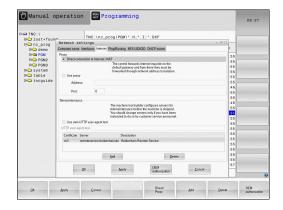
 Apply the changes with the OK button, or discard them with the Cancel button

16 MOD Functions

16.11 Ethernet interface

Select the tab **Internet**.

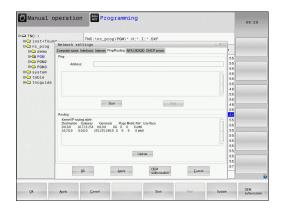
Setting	Meaning
Proxy	Direct connection to Internet / NAT: The control forwards Internet inquiries to the default gateway and from there they must be forwarded through network address translation (e.g. if a direct connection to a modem is available)
	Use proxy: Define the Address and Port of the Internet router in your network, ask your network administrator for the correct address and port
Telemaintena	nce The machine manufacturer configures the server for telemaintenance here. Changes must always be made in agreement with your machine tool builder

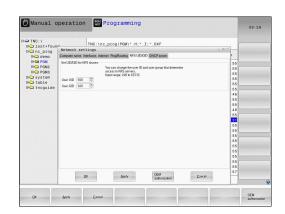


Select the **Ping/Routing** tab to enter the ping and routing settings:

Setting	Meaning
Ping	In the Address: field, enter the IP number for which you want to check the network connection. Input: four numerical values separated by periods, e.g. 160.1.180.20 . As an alternative, you can enter the name of the computer whose connection you want to check
	Press the Start button to begin the test. The TNC shows the status information in the Ping field
	Press the Stop button to conclude the test
Routing	For network specialists: Status information of the operating system for the current routing
	Press the Update button to refresh the routing information
Select the NFS identifications:	UID/GID tab to enter the user and group

luentincations						
Setting	Meaning					
Set UID/GID for NFS shares	User ID: Definition of which user identification the end user uses to access files in the network. Ask your network specialist for the proper value					
	 Group ID: Definition of the group identification with which you access files in the network. Ask your network specialist for the proper value 					





DHCP server: Settings for automatic network configuration		DHCP server:	Settings for	automatic	network	configuration
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Setting	Meaning					
DHCP server		IP addresses from: Define the IP address				
		as of which the TNC is to derive the pool of dynamic IP addresses. The TNC transfers the values that appear dimmed from the static IP address of the defined Ethernet interface; these values cannot be edited.				
		IP addresses to : Define the IP address up to which the TNC is to derive the pool of dynamic IP addresses				
		Lease Time (hours) : Time within which the dynamic IP address is to remain reserved for a client. If a client logs on within this time, the TNC reassigns the same dynamic IP address.				
		Domain name : Here you can define a name for the machine network if required. This is necessary if thesame names are assigned in the machine network and in the external network, for example.				
		Forward DNS to external: If IP Forwarding is active (Interfaces tab) and the option is active, you can specify that the name resolution for devices in the machine network can also be used by the external network.				
		Forward DNS from external: If IP Forwarding is active (Interfaces tab) and the option is active, you can specify that the TNC is to forward DNS inquiries from devices within the machine network to the name server of the external network if the DNS server of the MC cannot answer the inquiry.				
	•	Status button: Call an overview of the devices that are provided with a dynamic IP address in the machine network. You can also select settings for these devices.				
		Advanced options button: Additional settings for the DNS/DHCP server.				
		Set stan- dard values button: Set factory settings.				

TNC:\	TNC: \nc	_prog\PGM*.H;*.I;*.DXF					
Banc prog	Network settings						
ID-Ca demo		net PingRouting NES UID/GID DHCP server	2				
B-C PGM	DHCP settings	Activate DHCP/DNS server services for	5	5			
EHC PGM2		Activate UHCHDNS server services for devices in the machine network	5				
B-C system	Fill DHCP server active on:		- 5				
⊞ Cable	IP addresses as of	192 00 168 00 254 00 10	5				
🕮 🖵 tncguide			5				
	IP addresses up to:	192 2 168 2 254 2 100	4				
	Lease Time (hours):	240	5				
	GI Domain name:	machine net	5				
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	Advanced Setstan						
	and the second sec	options dand values	5				
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	The	SHCP server service cannot be activated on the primary interface.	5				
	ine t	which service cannot be acavated on the privaty interacte.	5				
			5				
	QK	Apply OEM Cancel	E				

your machine tool builder

16 MOD Functions 16.11 Ethernet interface

Network settings specific to the device

Press the DEFINE NETWORK CONNECTN. soft key to enter the network settings for a specific device. You can define any number of network settings, but you can manage only seven at one time

Setting	Meaning					
Network drive	List of all connected network drives. The TNC shows the respective status of the network connections in the columns:					
	 Mount: Network drive connected / not connected 					
	Auto: Network drive is to be connected automatically/manually					
	 Type: Type of network connection. cifs and nfs are possible 					
	 Drive: Designation of the drive on the TNC 					
	 ID: Internal ID that identifies if a mount point has been used for more than one connection 					
	Server: Name of the server					
	Share: Name of the directory on the server that the TNC is to access					
	User: User name with which the user logs on to the network					
	Password: Network password protected or not					
	Query password?: Query / do not query password during connection					
	 Options: Display additional connection options 					
	To manage the network drives, use the screen buttons.					
	To add network drives, use the Add button: The TNC then starts the connection wizard, which guides you by dialog through the required definitions.					
Status log	Display of status information and error messages.					
	Press the Clear button to delete the contents of the Status Log window.					

HO THC: 1										
BC lost			TN	IC:\nc_p1	og\PGM\	•.H;•.I;	•.DXF			
Mount Setup			-	**** ***	-				••••	av E
Network drive										
Nount Auto	Type	Drive S:	10	Server	Share	User	Password	Ask for password?	Options	
Mount		Auto			Add		Веточ		Copy	Edit
Status log										
						Gear	-			
						Apply				Cancel
OK										

🕐 Manua	l operatio	on Programming	09:22
BC Inst+		TNC:\nc_prog\PGM*.H;*.I;*.DXF	
Mount Setup			. n ×
Network drive Nount Auto	Mount assistan	t	8
Mcunt Status log	Network Dri	ve - Define Name For a vibra some for the sound, convertion, Sould for cipil lensy with science "write end Udder this name you can accord the selevel share on your cented. Differ some II Voting ID	Ee
OK		Creat Appy-	Cancel (Service)
Çarcel	Back	Firmet	

16.12 Firewall

Application

You can set up a firewall for the primary network interface of the control. It can be configured so that incoming network traffic is blocked and/or a message is displayed, depending on the sender and the service. The firewall cannot be started for the second network interface of the control if it is active as the DHCP server.

Once the firewall has been activated, a symbol appears at the lower right in the taskbar. The symbol changes depending on the safety level that the firewall was activated with, and informs about the level of the safety settings:

lcon	Meaning
♥♥	Firewall protection does not yet exist although configured according to the configuration. This can happen, for example, if PC names for which there are no equivalent IP addresses as yet were used in the configuration.
0	Firewall active with medium security level
🛡 🧵	Firewall active with high safety level. (All services except for the SSH are blocked)
⇒	Have the standard settings checked by your network specialist and change them if necessary. The settings in the additional tab SSH settings are in preparation for future enhancements and currently

Configuring the firewall

Make your firewall settings as follows:

have no function.

 Use the mouse to open the task bar at the bottom edge of the screen

Further Information: "Window manager", page 88

- Press the green HEIDENHAIN button to open the JH menu
- Select the Settings menu itemSettings
- Select the **Firewall** menu item.

HEIDENHAIN recommends activating the firewall with the prepared default settings:

- Set the Active option to enable the firewall
- Press the Set standard values button to activate the default settings recommended by HEIDENHAIN.
- Exit the dialog with the **OK** button.

16 MOD Functions

16.12 Firewall

Firewall settings

Option	Meaning
Active	Switching the firewall on and off
Interface:	Selection of the eth0 interface usually corresponds to X26 of the MC main computer. eth1 corresponds to X116. You can check this in the network settings in the Interfaces tab. On main computer units with two Ethernet interfaces, the DHCP server is active by default for the second (non-primary) interface for the machine network. With this setting it is not possible to activate the firewall for eth1 because the firewall and the DHCP server exclude themselves mutually
Report other inhibited packets:	Firewall active with high safety level. (All services except for the SSH are blocked)
Inhibit ICMP echo answer:	If this option is set, the control no longer responds to a PING request
Service	This column contains the short names of the services that are configured with this dialog. For the configuration it is not important here whether the services themselves have been started
	 LSV2 contains the functionality for TNCremo and Teleservice, as well as the HEIDENHAIN DNC interface (ports 19000 to 19010) SMB only refers to incoming SMB connections, i.e. if a Windows release is made on the NC. Outgoing SMB connections (i.e. if a Windows release is connected to the NC) cannot be prevented. SSH stands for the Secure Shell protocol (port 22). As of HEROS 504, the LSV2 can be executed securely tunneled via this SSH protocol. VNC protocol means access to the screen contents. If this service is blocked, the screen content can no longer be accessed, not even with the TeleService programs from HEIDENHAIN (e.g. screenshot). If this service is blocked, the VNC configuration dialog shows a warning from HEROS that VNC is disabled in the firewall.

Firewall 16.12

Option	Meaning
Method	Under Method you can configure whether the service should not be available to anyone (Prohibit all), available to everyone (Permit all) or only available to some (Permit some). If you set Permit some you must also specify the computer (under Computer) that you wish to grant access to the respective service. If you do not specify any computer under Computer , the setting Prohibit all will automatically become active when the configuration is saved.
Log	If Log is activated, a "red" message is output if a network package for this service has been blocked. A "blue" message is output if a network packet for this service has been accepted.
Computer	If the setting Permit some is selected under Method , the relevant computers can be specified here. The computers can be entered with their IP addresses or host names separated by commas. If a host name is used, the system checks upon closing or saving of the dialog whether the host name can be translated into an IP address. If this is not the case, an error message is displayed and the dialog does not terminate. If a valid host name is specified, this host name is translated into an IP address each time the control is started. If a computer that was entered with its name changes its IP address, you may have to restart the control or formally change the firewall configuration to ensure that the control uses the new IP address for a host name in the firewall.
Advanced options	These settings are only intended for your network specialists
Set standard values	Resets the settings to the default values recommended by HEIDENHAIN

¹⁶ MOD Functions

16.13 Configuring the HR 550FS wireless handwheel

16.13 Configuring the HR 550FS wireless handwheel

Application

Press the **SET UP WIRELESS HANDWHEEL** soft key to configure the HR 550FS wireless handwheel. The following functions are available:

- Assigning the handwheel to a specific handwheel holder
- Setting the transmission channel
- Analyzing the frequency spectrum for determining the optimum transmission channel
- Select transmitter power
- Statistical information on the transmission quality

Assigning the handwheel to a specific handwheel holder

- Make sure that the handwheel holder is connected to the control hardware.
- Place the wireless handwheel you want to assign to the handwheel holder in the handwheel holder
- Press the MOD key to select the MOD function
- Select the Machine settings menu
- Select the configuration menu for the wireless handwheel: Press the SET UP WIRELESS HANDWHEEL soft key
- Click the Connect HW button: The TNC saves the serial number of the wireless handwheel located in the handwheel holder and shows it in the configuration window to the left of the Connect HW button
- ► To save the configuration and exit the configuration menu, press the **END** button
- Select the Machine settings menu
- Select the configuration menu for the wireless handwheel: Press the SET UP WIRELESS HANDWHEEL soft key
- Click the Connect HR button: The TNC saves the serial number of the wireless handwheel located in the handwheel holder and shows it in the configuration window to the left of the Connect HR button
- To save the configuration and exit the configuration menu, press the END button

Properties Frequency s	pecuum				
Configuration			Statistics		
handwheel serial no.	0037478964	Connect HW	Data packets	12023	
Channel setting	Best channel	Select channel	Lost packets	0	0.00%
Channel in use	24		CRC error	0	0.00%
Transmitter power	Full power	Set power	Max. successive lost	0	
HW in charger	6				
Status					
HANDWHEEL ONL	INE Err	or code			

Configuring the HR 550FS wireless handwheel 16.13

Setting the transmission channel

If the wireless handwheel is started automatically, the TNC tries to select the transmission channel supplying the best transmission signal. If you want to set the transmission channel manually, proceed as follows:

- Press the MOD key to select the MOD function
- Select the Machine settings menu
- Select the configuration menu for the wireless handwheel: Press the SET UP WIRELESS HANDWHEEL soft key
- Click the Frequency spectrum tab
- Click the Stop HW button: The TNC stops the connection to the wireless handwheel and determines the current frequency spectrum for all of the 16 available channels
- Memorize the number of the channel with the least amount of radio traffic (smallest bar)
- ► Click the **Start handwheel** button to reactivate the wireless. handwheel
- Click the Properties tab
- Click the Select channel button: The TNC shows all available channel numbers. Click the channel number for which the TNC determined the least amount of radio traffic
- ▶ To save the configuration and exit the configuration menu, press the END button

Selecting the transmitter power



Please keep in mind that the transmission range of the wireless handwheel decreases when the transmitter power is reduced.

- Press the MOD key to select the MOD function
- Select the Machine settings menu
- Select the configuration menu for the wireless handwheel: Press the SET UP WIRELESS HANDWHEEL soft key
- Click the Set power button: The TNC shows the three available power settings. Click the desired setting
- To save the configuration and exit the configuration menu, press ► the END button

Properties	Frequency	spectrum												
Configura	tion							Sta	tistics					
handwheel serial no. 00374 Channel setting Best c Channel in use 24		00374	0037478964				Connect HW		Data packets		1	12023		
		Best c	Best channel			Select channel		L	Lost packets		0	0		0.00%
		24						с	RC erro	r	0			0.00%
Transm	itter power	Full po	wer			Se	t power	м	ax. suce	essive lo	st 0			
HW in c	harger	đ												
Status														
HAN	OWHEEL OF	ILINE			Error code									
Configu	ration	Stop H		s har		Start hand	lwheel			E	ind			. 0
Properties	Frequency	of wir	eles		dwheel									
-		of wir	eles	s har 15				20	21	22	23	24	25	
Properties	Frequency	of wir	eles		dwheel			20	21			24		
Properties Ch 0 dBm	Frequency	of wir	eles		dwheel			20	21			24		
Properties Ch 0 dBm -50 dBm	Frequency	of wir	eles		dwheel			20	21			24		
Properties Ch 0 dBm -S0 dBm 100 dBm	Frequency 11 12	of wir spectrum 13	eles:	15	idwheel	7 18	19			22	23		25	26
Properties Ch 0 dBm -S0 dBm 100 dBm	Frequency	of wir	eles		dwheel	7 18		20	21	22		24		2
Properties Ch 0 dBm -50 dBm 100 dBm Act Status	Frequency 11 12 89 -89	of wir spectrum 13	eles:	15	16 1	7 18	19			22	23		25	2
Properties Ch 0 dBm -50 dBm 100 dBm Act Status	Frequency 11 12	of wir spectrum 13	eles:	15	idwheel	7 18	19			22	23		25	20

Properties Frequency s			Statistics		
-					
handwheel serial no.	0037478964	Connect HW	Data packets	12023	
Channel setting	Best channel	Select channel	Lost packets	0	0.009
Channel in use	24		CRC error	0	0.009
Transmitter power	Full power	Set power	Max. successive lost	0	
HW in charger					
Status					
HANDWHEEL ONL	INE	Error code			

							Sta	03003					
no. 00374	478964				Conn	ect HW	D	ata pac	kets	120	123		
Best	channel				Select	channel	ь	Lost packets		0		0	.00%
Channel in use 24			in use 24		CRC error 0		0	0.0	.00%				
Full p	ower				Set	ower	м	ax. suc	cessive los	at 0			
ONLINE			Error co	ode									
Stop H	IW			Sta	rt handw	heel			Er	nd			
											_		
of wi	roloc	e han	dubool										
		o nan	0411001								-		1 10 0
		15	16	17	18	19	20	21	22	23	24	25	26
			**										
9 -85	-85	-89	-89	-89	.74	-89	-53	-85	-83	89	-89	-89	-74
9 -85	-85	-89	-89	-89	-74	-89	-53	-85	-83	89	-89	-89	-74
9 -85 OFFLINE	-85	-89	-89 (Error cc		-74	-89	-53	-85	-83 .	89	-89	-89	-74
	24 er Full p Ø ONLINE Stop I	CONLINE Stop HW	24 er Full power concluse Stop HW h of wireless han cy spectrum	24 Prover CNLUNE CNULNE Error co Stop HW CNULNE Crossectum Crossec	24 Tr Full power CNLINE Enor code Stop HW Sta n of wireless handwheel cyspectum	24 Tr Full power Solp HW San handw h of wireless handwheel ky spectum	24 r Full power Set power ONLINE Error code Stop HW Start handwheel roy spectum	24 C C C C C C C C C C C C C C C C C C C	24 CKC err r Full power Set power Max. suc ONLINE Error code Stop HW Stant handwheel to of witcless handwheel cy spectum	24 CRC error rr Full power Ser power Max. successive for CNLINE Enor code Stop HW Start handwheel Enor cy spectrum	24 CR error 0 rr Full power Set power Max. successive lost 0 ONLINE Error code Stop HW Start handwheel End to of wizeless handwheel ky systetum	24 CRC error 0 rr Full power Set power ONLINE Error code Stop HW Start handwheel End	24 CRC error 0 0 rr Full power Set power Max. successive lost 0 ONLINE Error code Start handwheel End Stop HW Start handwheel End of wizeless handwheel of wizeless handwheel of wizeless handwheel

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¹⁶ MOD Functions

16.13 Configuring the HR 550FS wireless handwheel

Statistical data

To display the statistical data, proceed as follows:

- Press the MOD key to select the MOD function
- Select the Machine settings menu
- To select the configuration menu for the wireless handwheel, press the SET UP WIRELESS HANDWHEEL soft key: The TNC displays the configuration menu with the statistical data

Under **Statistics**, the TNC displays information about the transmission quality.

If the reception quality is poor so that a proper and safe stop of the axes cannot be ensured anymore, an emergency-stop reaction of the wireless handwheel is triggered.

The displayed value **Max. successive lost** indicates whether reception quality is poor. If the TNC repeatedly displays values greater than 2 during normal operation of the wireless handwheel within the desired range of use, then there is a risk of an undesired disconnection. This can be corrected by increasing the transmitter power or by changing to another channel with less radio traffic.

If this occurs, try to improve the transmission quality by selecting another channel or by increasing the transmitter power.

Further Information: "Setting the transmission channel", page 581 **Further Information:** "Selecting the transmitter power", page 581

roperties Frequency sp	pectrum				
Configuration			Statistics		
handwheel serial no.	0037478964	Connect HW	Data packets	12023	
Channel setting	Best channel	Select channel	Lost packets	0	0.009
Channel in use	24		CRC error	0	0.005
Transmitter power	Full power	Set power	Max. successive lost	0	
HW in charger	<i></i>				
Status					

16.14 Load machine configuration

Application

Caution: Data loss! The TNC overwrites your machine configuration when you load (restore) a backup. The overwritten machine data will be lost in the process. You can no longer undo this process!

Your machine tool builder can provide you a backup with a machine configuration. After entering the keyword **RESTORE**, you can load the backup on your machine or programming station. Proceed as follows to load the backup:

- ▶ In the MOD dialog, enter the keyword **RESTORE**
- In the TNC's file manager, select the backup file (e.g. BKUP-2013-12-12_.zip). The TNC opens a pop-up window for the backup
- Press emergency stop.
- ▶ Press the **OK** soft key to start the backup process



17.1 Machine-specific user parameters

17.1 Machine-specific user parameters

Application

The parameter values are entered in the **configuration editor**.



To enable you to set machine-specific functions for users, your machine tool builder can define which machine parameters are available as user parameters. Furthermore, your machine tool builder can integrate additional machine parameters, which are not described in the following, into the TNC. Refer to your machine manual.

The machine parameters are grouped as parameter objects in a tree structure in the configuration editor. Each parameter object has a name (e.g. **Settings for screen displays**) that gives information about the parameters it contains. A parameter object, also called "entity," is marked with an "E" in the folder symbol in the tree structure. Some machine parameters have a key name to identify themunambiguously. The key name assigns the parameter to a group (e.g. X for X axis). The respective group folder bears the key name and is marked by a "K" in the folder symbol.

If you are in the configuration editor for the user parameters, you can change the display of the existing parameters. In the default setting, the parameters are displayed with short, explanatory texts. To display the actual system names of the parameters, press the key for the screen layout key and then the **SHOW SYSTEM NAME** soft key. Follow the same procedure to return to the standard display.

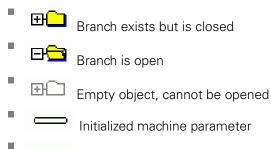
The icons of not yet active parameters and objects appear dimmed. These can be activated with the **MORE FUNCTIONS** and **INSERT** soft key.

The TNC saves a modification list of the last 20 changes to the configuration data. To restore modifications, select the corresponding line and press the **MORE FUNCTIONS** and **CANCEL CHANGE** soft keys.

Calling the configuration editor and changing parameters

- Select the **PROGRAMMING** operating mode
- Press the MOD key
- Enter the code number 123
- Changing parameters
- Press the END soft key to exit the configuration editor
- Confirm changes with the STORE soft key

The icon at the beginning of each line in the parameter tree shows additional information about this line. The icons have the following meanings:



- Uninitialized (optional) machine parameter
- Can be read but not edited
 - 🔀 Can neither be read nor edited

The type of the configuration object is identified by its folder symbol:

- ∎ ⊞⊡ _{List}

Œ۱

Entity (parameter object)

Displaying help texts

The **HELP** key enables you to call a help text for each parameter object or attribute.

If the help text does not fit on one page (1/2 is then displayed at the upper right, for example), press the **HELP PAGE** soft key to scroll to the second page.

To exit the help text, press the **HELP** key again.

As well as the Help text, other information is displayed, e.g. unit of measurement, initial value, selection list. If the selected machine parameter matches a parameter in the previous control model, the corresponding MP number is displayed.

17.1 Machine-specific user parameters

Parameter list

Parameter settings

DisplaySettings

Settings for screen display

Sequence of displayed axes

[0] to [5]

Depends on available axes

Type of position display in position window

NOMINAL ACTUAL REF ACTL REF NOML LAG ACTDST REFDST M 118

Type of position display in status display

NOMINAL ACTUAL REF ACTL REF NOML LAG ACTDST REFDST M 118

.

Definition of decimal separator for position display

Display of feed rate in operating mode Manual operation

at axis key: Only display feed rate if axis direction key is pressed always minimum: Always display feed rate

Display of spindle position in the position display

during closed loop: Only display spindle position if spindle is in position control during closed loop and M5: Display spindle position if spindle is in position control and with M5

Show or hide soft key preset table

True: Soft key preset table is not displayed False: Display soft key preset table

Font size with program display

FONT_APPLICATION_SMALL FONT_APPLICATION_MEDIUM

Parameter settings

DisplaySettings

Display step for individual axes

List of all available axes

Display step for position display in mm or degrees

0.1 0.05 0.01 0.005 0.001 0.0005 0.0001

Display step for position display in inches

0.005 0.001 0.0005 0.0001

DisplaySettings

Definition of unit of measure valid for the display

metric: Use metric system

inch: Use inch system

DisplaySettings

Format of NC programs and display of cycles

Program input in HEIDENHAIN Klartext conversational text or in DIN/ISO

HEIDENHAIN: Program input in operating mode MDI in Klartext conversational text dialog

ISO: Program input in Positioning with MDI mode of operation in DIN/ISO

17.1 Machine-specific user parameters

Parameter settings

DisplaySettings Setting the NC and PLC dialog language NC dialog language ENGLISH **GERMAN CZECH** FRENCH ITALIAN **SPANISH** PORTUGUESE **SWEDISH** DANISH **FINNISH** DUTCH POLISH **HUNGARIAN RUSSIAN** CHINESE CHINESE_TRAD **SLOVENIAN** KOREAN **NORWEGIAN** ROMANIAN **SLOVAK** TURKISH PLC dialog language See NC dialog language

> PLC error message language See NC dialog language

> Help language
> See NC dialog language

Parameter settings

DisplaySettings

Behavior with control start-up

Acknowledge "Power interrupted" message

TRUE: Control start-up is not continued until the message has been acknowledged FALSE: "Power interrupted" message not displayed

DisplaySettings

Display mode for time display

Selection for display mode in the time display

Analog Digital Logo Analog and Logo Digital and Logo Analog on Logo Digital on Logo

DisplaySettings

Link row On/Off

Display setting for link row

OFF: Deactivate the information line in the operating mode line ON: Activate the information line in the operating mode line

DisplaySettings

Settings for 3-D display

Model type of 3-D display

3-D (compute-intensive): Model display for complex machining operations with undercuts
2.5-D: Model display for 3-axis machining operations
No Model: Model display is disabled

Model quality of the 3-D display

very high: High resolution; Block end points can be displayed high: High resolution medium: Medium resolution low: Low resolution

17.1 Machine-specific user parameters

Parameter settings

DisplaySettings Settings for the position display

Position display

with TOOL CALL DL

As Tool Length: The programmed oversize DL is considered as the tool length modification for display of the workpiece-based position

As Workpiece Oversize: The programmed oversize DL is considered as the workpiece oversize for display of the workpiece-based position

Parameter settings

ProbeSettings

Configuration of tool measurement

TT140_1

M function for spindle orientation

-1: Spindle orientation directly by NC0: Function inactive1 to 999: Number of M function for spindle orientation

Probing routine

MultiDirections: Probing from several directions SingleDirection: Probing from one direction

Probing direction for tool radius measurement

X_Positive, Y_Positive, X_Negative, Y_Negative, Z_Positive, Z_Negative (depending on tool axis)

Distance between lower surface of tool and upper surface of stylus 0.001 bis 99.9999 [mm]: Offset between stylus to tool

Rapid traverse in probing cycle

10 to 300 000 [mm/min]: Rapid traverse in probing cycle

Probing feed rate with tool measurement

1 to 3 000 [mm/min]: Probing feed rate with tool measurement

Calculation of probing feed rate

ConstantTolerance: Calculation of probing feed rate with constant tolerance VariableTolerance: Calculation of probing feed rate with variable tolerance ConstantFeed: Constant probing feed rate

Type of speed detection

Automatic: Determine speed automatically MinSpindleSpeed: Use minimum spindle speed

Maximum permissible rotational speed the tool tip

1 to 129 [m/min]: Permissible rotational speed on cutter circumference

Maximum permissible speed with tool measurement

0 to 1 000 [1/min]: Maximum permissible speed

Maximum permissible measuring error with tool measurement

0.001 to 0.999 [mm]: First maximum permissible measuring error

Maximum permissible measuring error with tool measurement

0.001 to 0.999 [mm]: Second maximum permissible measuring error

NC stop during tool check

True: NC program is stopped if breakage tolerance is exceeded False: NC program is not stopped

17.1 Machine-specific user parameters

Parameter settings

NC stop during tool measurement

True: NC program is stopped if breakage tolerance is exceeded False: NC program is not stopped

Modifying of tool table during tool check and measurement

AdaptOnMeasure: Table is modified after tool measurement AdaptOnBoth: Table is modified after tool check and measurement AdaptNever: Table is not modified after tool check and measurement

Configuration of a round stylus

TT140_1

Coordinates of the stylus center

[0]: X coordinate of stylus center referenced to machine datum

[1]: Y coordinate of stylus center referenced to machine datum

[2]: Z coordinate of stylus center referenced to machine datum

Safety clearance over stylus for pre-positioning

0.001 to 99 999.9999 [mm]: Safety clearance in tool axis direction

Safety zone around stylus for pre-positioning

0.001 to 99 999.9999 [mm]: Safety clearance in plane perpendicular to tool axis

Parameter settings

ChannelSettings CH_NC

Active kinematics

Kinematics to be activated

List of machine kinematics

Kinematics to be activated with control start-up List of machine kinematics

Determining the behavior of the NC program

Resetting the machining time with program start

True: Machining time is reset

False: Machining time is not reset

PLC signal for number of pending machining cycle
Dependent on machine manufacturer

Geometry tolerances

Permissible deviation of circle radius

0.0001 to 0.016 [mm]: Permissible deviation of circle radius on the circle end pointcompared to circle start point

Configuration of machining cycles

Overlap factor for pocket milling

0.001 to 1.414: Overlap factor for Cycle 4 POCKET MILLING and Cycle 5 CIRCULARPOCKET

Behavior after machining a contour pocket

PosBeforeMachining: Position as before machining a cycle ToolAxClearanceHeight: Position tool axis to clearance height

Display "Spindle ?" error message if M3/M4 is not active

on: Output error message off: Do not output error message

Display "Enter negative depth" error message

on: Output error message off: Do not output error message

Approach behavior on a slot wall in a cylindrical surface

LineNormal: Approach with straight line

CircleTangential: Approach with an arc movement

M function for spindle orientation in machining cycles

-1: Spindle orientation directly via NC

0: Function inactive

1 to 999: Number of M function for spindle orientation

Do not display "Plunging type not possible" error message

on: Error message is not displayed

17.1 Machine-specific user parameters

Parameter settings

off: Error message is displayed

Behavior of M7 and M8 with cycles 202 and 204

TRUE: At the end of cycle 202 and 204 the condition of M7 and M8 is restored before the cycle call

FALSE: At the end of cycle 202 and 204 the condition of M7 and M8 is not restored independently

Geometry filter for filtering out linear elements

Type of stretch filter

- Off: No filter active
- ShortCut: Leave out single points on polygon
- Average: The geometry filter smooths corners

Maximum distance of filtered to unfiltered contour

0 to 10 [mm]: The filtered out points lie within this tolerance to the resultant distance

Maximum length of distance resulting from filtering

0 to 1000 [mm]: Length over which geometry filtering is effective

Parameter settings

Settings for the NC editor

Creating backup files

TRUE: Create backup file after editing NC programs FALSE: Create no backup file after editing NC programs

Cursor behavior after deleting lines

TRUE: Cursor is on previous line after deletion (iTNC behavior) FALSE: Cursor is on subsequent line after deletion

Cursor behavior with the first and last line

TRUE: All-round cursors permitted at PGM beginning/end FALSE: All-round cursors not permitted at PGM beginning/end

Line break with multi-line blocks

ALL: Always show lines completely ACT: Only show lines of the active block completely NO: Only show lines completely if the block is edited

Activate help graphics with cycle input

TRUE: Fundamentally always show help graphics during input FALSE: Only show help graphics if the CYCLE HELP soft key is set to ON. The CYCLE HELPOFF/ ON soft key is displayed in the Programming mode after pressing the "Screen layout"button

Behavior of soft key row following a cycle input

TRUE: Leave cycle soft key row active after a cycle definition FALSE: Hide cycle soft key row after a cycle definition

Confirmation request before block is deleted

TRUE: Display confirmation request before deleting an NC block FALSE: Do not display confirmation request before deleting an NC block

Line number up to which NC program is tested

100 to 50000: Programmlänge, auf die die Geometrie überprüft werden soll

ISO programming: Block number increment

0 to 250: Increment for generating ISO blocks in the program

Define programmable axes

TRUE: Use defined axis configuration FALSE: Use default axis configuration XYZABCUVW

Behavior with paraxial positioning blocks

TRUE: Paraxial positioning blocks permitted FALSE: Paraxial positioning blocks locked

Line number up to which identical syntax elements are searched for

500 to 50000: Search for selected elements with up/down arrow keys

Behavior of PARAXMODE function with UVW axes

FALSE: PARAXMODE function permitted

17.1 Machine-specific user parameters

Parameter settings

TRUE: PARAXMODE function locked

Settings for the file manager Display of dependent files

> MANUAL: Dependent files are displayed AUTOMATIC: Dependent files are not displayed

Path specifications for end users

List with drives and/or directories

Drives and directories entered here are shown by the TNC in the file manager

FN 16 output path for execution Path for FN 16 output if no path has been defined in the program

FN 16 output path for Programming and Test Run operating modes Path for FN 16 output if no path has been defined in the program

Serial Interface RS232 **Further Information:** "Setting up data interfaces", page 565

17.2 Connector pin layout and connection cables for data interfaces

RS-232-C/V.24 interface for HEIDENHAIN devices

The interface complies with the requirements of EN 50 178 for **low voltage electrical separation**.

TNC		Conn. cable 365725-xx			Adapter 310085-		Conn. cable 274545-xx			
Male	Assignment	Female	Color	Female	Male	Female	Male	Color	Femal	е
1	Do not assign	1		1	1	1	1	White/ Brown	1	
2	RXD	2	Yellow	3	3	3	3	Yellow	2	
3	TXD	3	Green	2	2	2	2	Green	3	
4	DTR	4	Brown	20	20	20	20	Brown	8	7
5	Signal GND	5	Red	7	7	7	7	Red	7	-
6	DSR	6	Blue	6	6	6	6 7		6	-
7	RTS	7	Gray	4	4	4	4	Gray	5	
8	CTR	8	Pink	5	5	5	5	Pink	4	
9	Do not assign	9					8	Violet	20	
Hsg.	External shield	Hsg.	External shield	Hsg.	Hsg.	Hsg.	Hsg.	External shield	Hsg.	

When using the 25-pin adapter block:

17.2 Connector pin layout and connection cables for data interfaces

When using the 9-pin adapter block:

TNC		Conn. cable 355484-xx			-	Adapter block 363987-02		Conn. cable 366964-xx			
Male	Assignment	Female	Color	Male	Female	Male	Female	Color	Female		
1	Do not assign	1	Red	1	1	1	1	Red	1		
2	RXD	2	Yellow	2	2	2	2	Yellow	3		
3	TXD	3	White	3	3	3	3	White	2		
4	DTR	4	Brown	4	4	4	4	Brown	6		
5	Signal GND	5	Black	5	5	5	5	Black	5		
6	DSR	6	Violet	6	6	6	6	Violet	4		
7	RTS	7	Gray	7	7	7	7	Gray	8		
8	CTR	8	White/ Green	8	8	8	8	White/ Green	7		
9	Do not assign	9	Green	9	9	9	9	Green	9		
Hsg.	External shield	Hsg.	External shield	Hsg.	Hsg.	Hsg.	Hsg.	External shield	Hsg.		

Non-HEIDENHAIN devices

The connector layout of a non-HEIDENHAIN device may substantially differ from that of a HEIDENHAIN device. It depends on the unit and the type of data transfer. The table

Adapter block 263097-02 Copp. cable 366964-vv	
below shows the connector pin layout on the adapter block.	

Adapter blo	ock 363987-02	Conn. cable 366964-xx				
Female	Male	Female	Color	Female		
1	1	1	Red	1		
2	2	2	Yellow	3		
3	3	3	White	2		
4	4	4	Brown	6		
5	5	5	Black	5		
6	6	6	Violet	4		
7	7	7	Gray	8		
8	8	8	White/ Green	7		
9	9	9	Green	9		
Hsg.	Hsg.	Hsg.	External shield	Hsg.		

17.2 Connector pin layout and connection cables for data interfaces

Ethernet interface RJ45 socket

- Maximum cable length:
- Unshielded: 100 m
- Shielded: 400 m

Pin	Signal	Description
1	TX+	Transmit Data
2	TX-	Transmit Data
3	REC+	Receive Data
4	Vacant	
5	Vacant	
6	REC-	Receive Data
7	Vacant	
8	Vacant	

17.3 Technical Information

Explanation of symbols

- Default
- Axis option
- 1 Advanced Function Set 1

Specifications

Components		Operating panel
		TFT color flat-panel display with soft keys
Program memory		2 GB
Input resolution and display step		As fine as 0.1 μ m for linear axes
		Up to 0.0001° for rotary axes
Input range		Maximum 999 999 999 mm or 999 999 999°
Interpolation		Linear in 4 axes
		Circular in 2 axes
		Helical: superimposition of circular and straight paths
Block processing time		6 ms
3-D straight line without radius compensation		
Axis feedback control		Position loop resolution: Signal period of the position encoder/1024
		Cycle time of position controller: 3 ms
		Cycle time of speed controller: 200 µs
Range of traverse		Maximum 100 m (3937 inches)
Spindle speed		Maximum 100,000 rpm (analog speed command signal)
Error compensation	-	Linear and nonlinear axis error, backlash, reversal peaks during circular movements, thermal expansion
		Static friction
Data interfaces		One each RS-232-C /V.24 max. 115 kilobaud
	-	Expanded interface with LSV-2 protocol for external operation of the TNC over the interface with HEIDENHAIN software TNCremo
		Ethernet interface 1000 BaseT
		3 x USB (1 x front USB 2.0; 2 x rear USB 3.0)
Ambient temperature		Operation: 5 °C to +40 °C

17.3 Technical Information

Input formats and units of TNC functions	
Positions, coordinates, circle radii, chamfer lengths	-99 999.9999 to +99 999.9999 (5, 4: places before the decimal point, places after the decimal point) [mm]
Tool numbers	0 to 32 767.9 (5, 1)
Tool names	32 characters, enclosed by quotation marks with T . Permitted special characters: # \$ % & . ,
Detail values for tool compensation	-99.9999 to +99.9999 (2, 4) [mm]
Spindle speeds	0 to 99 999.999 (5, 3) [rpm]
Feed rates	0 to 99,999.999 (5, 3) [mm/min] or [mm/tooth] or [mm/1]
Dwell time in Cycle 9	0 to 3600.000 (4, 3) [s]
Thread pitch in various cycles	-9.9999 to +9.9999 (2, 4) [mm]
Angle for spindle orientation	0 to 360.0000 (3, 4) [°]
Angle for polar coordinates, rotation, tilting the working plane	-360.0000 to 360.0000 (3, 4) [°]
Polar coordination for screw line interpolation (CP)	-5 400.0000 to 5 400.0000 (4, 4) [°]
Datum numbers in Cycle 7	0 to 2999 (4, 0)
Scaling factor in Cycles 11 and 26	0.000001 to 99.999999 (2, 6)
Miscellaneous functions M	0 to 999 (4, 0)
Q parameter numbers	0 to 1999 (4, 0)
Q parameter values	-99 999.9999 to +99 999.9999 (9, 6)
Labels (LBL) for program jumps	0 to 999 (5, 0)
Labels (LBL) for program jumps	Any text string in quotation marks ("")
Number of program section repeats REP	1 to 65 534 (5, 0)
Error number in Q parameter function FN14	0 to 1199 (4, 0)

User functions

User functions	
Short description	Basic version: 3 axes plus closed-loop spindle
	Fourth NC axis plus auxiliary axis
	■ Or
	Additional axis for 4 axes plus closed-loop spindle
	Additional axis for 5 axes plus closed-loop spindle
Program entry	In HEIDENHAIN conversational format and DIN/ISO
Position entry	 Nominal positions for lines and arcs in Cartesian coordinates or polar coordinates
	Incremental or absolute dimensions
	Display and entry in mm or inches
Tool compensation	Tool radius in the working plane and tool length
	 Radius compensated contour look ahead for up to 99 blocks (M120)
Tool tables	Multiple tool tables with any number of tools

Constant contour speed	-	With respect to the path of the tool center
		With respect to the cutting edge
Parallel operation	Cre	ating a program with graphical support while another program is being run
Rotary table machining (Advanced Function Set 1)	1	Programming of cylindrical contours as if in two axes
	1	Feed rate in distance per minute
Contour elements		Straight line
		Chamfer
		Circular path
		Circle center
		Circle radius
		Tangentially connected arc
		Rounded corners
Approaching and departing the contour		Via straight line: tangential or perpendicular
		Via circular arc
FK free contour programming	-	FK free contour programming in HEIDENHAIN conversational format with graphic support for workpiece drawings not dimensioned for NC
Program jumps	-	Subprograms
		Program section repeat
		Any desired program as subprogram
Machining cycles		Cycles for drilling, and conventional and rigid tapping
		Roughing of rectangular and circular pockets
		Cycles for pecking, reaming, boring, and counterboring
		Cycles for milling internal and external threads
		Finishing of rectangular and circular pockets
		Cycles for clearing level and inclined surfaces
		Cycles for milling linear and circular slots
		Cartesian and polar point patterns
		Contour-parallel contour pocket
		Contour train
		OEM cycles (special cycles developed by the machine manufacturer) can also be integrated
Coordinate transformation		Datum shift, rotation, mirroring
		Scaling factor (axis-specific)
	1	Tilting the working plane (Advanced Function Set 1)
Q parameters	-	Mathematical functions: =, +, -, *, sin α , cos α , root
Programming with variables		Logical operations (=, \neq , <, >)
		Calculating with parentheses

17.3 Technical Information

User functions

		tan α , arc sin, arc cos, arc tan, a ⁿ , e ⁿ , In, log, absolute value of a number, constant π , negation, truncation of digits before or after the decimal point
		Functions for calculation of circles
		String parameters
Programming aids		Calculator
		Complete list of all current error messages
	-	Context-sensitive help function for error messages
		Graphic support for the programming of cycles
		Comment blocks in NC program
Teach-In		Actual positions can be transferred directly to the NC program
Test graphics Display modes		Graphical simulation before a program run, also while another program is being run
	-	Plan view / projection in 3 planes / 3-D view / 3-D line graphic
		Detail enlargement
Programming graphics	•	In Programming mode, the contour of the NC blocks is drawn on screen while they are being entered (2-D pencil-trace graphics), even if another program is running
Program-run graphics Display modes		Graphic simulation of real-time machining in plan view / projection in 3 planes / 3-D view
Machining time		Calculating the machining time in the Test Run operating mode
		Display of the current machining time in the Program Run operating modes
Contour, returning to		Block scan in any block in the program, returning the tool to the calculated nominal position to continue machining
		Program interruption, contour departure and return
Datum tables		Multiple datum tables for storing workpiece-specific datums
Touch probe cycles		Calibrating the touch probe
		Compensation of workpiece misalignment, manual or automatic
		Datum setting, manual or automatic
		Automatically measuring workpieces
		Cycles for automatic tool measurement

Software options

Advanced Function Set 1 (option	8)
Expanded functions Group 1	Machining with rotary tables
	 Cylindrical contours as if in two axes
	Feed rate in distance per minute
	Coordinate conversions:
	Tilting the working plane
HEIDENHAIN DNC (option 18)	
	Communication with external PC applications over COM component
DXF Converter (option 42)	
DXF converter	Supported DXF format: AC1009 (AutoCAD R12)
	 Adoption of contours and point patterns
	 Simple and convenient specification of reference points
	 Selecting graphical features of contour sections from conversational programs
Extended Tool Management (opt	ion 93)
Extended tool management	Python-based

17.3 Technical Information

Accessories

Accessories		
Electronic handwheels		HR 410: Portable handwheel
		HR 550FS: Portable wireless handwheel with display
		HR 520: Portable handwheel with display
		HR 420: Portable handwheel with display
		HR 130: Panel-mounted handwheel
		HR 150: Up to three panel-mounted handwheels via handwheel adapter HRA 110
Touch probes		TS 260: Triggering 3-D touch probe with cable connection
		TS 440: 3-D touch trigger probe with infrared transmission
	-	TS 444: Battery-free 3-D touch trigger probe with infrared transmission
		TS 640: 3-D touch trigger probe with infrared transmission
	-	TS 740: High-precision 3-D touch trigger probe with infrared transmission
		TT 160: 3-D touch trigger probe for tool measurement
		TT 449: 3-D touch trigger probe for tool measurement with infrared transmission

17.4 Overview tables

Fixed cycles

7 DATUM SHIFT # 8 MIRRORING # 9 DWELL TIME # 10 ROTATION # 11 SCALINO FACTOR # 12 PGM CALL # 13 ORIENTATION # 14 CONTOUR # 19 WORKING PLANE # 20 CONTOUR DATA # 21 PILOT DRILLING # 22 ROUGH-OUT # 23 FLOOR FINISHING # 24 SIDE FINISHING # 25 CONTOUR TRAIN # 26 AXIS-SPECIFIC SCALING # 27 CYLINDER SURFACE # 29 CYL SURFACE CONTOUR # 200 DRILLING # 201 REAMING # 202 BORING # 203 UNIVERSAL PRICHOTOUR # 204 BACK BORING # 205 UNIVERSAL PECKING # 206 TAPPING <	Cycle number	Cycle name	DEF activ	CALL e active
9 DWELL TIME • 10 ROTATION • 11 SCALING FACTOR • 12 PGM CALL • 13 ORIENTATION • 14 CONTOUR • 19 WORKING PLANE • 20 CONTOUR DATA • 21 PILOT DRILLING • 22 ROUGH-OUT • 23 FLOOR FINISHING • 24 SIDE FINISHING • 25 CONTOUR TRAIN • 26 AXIS-SPECIFIC SCALING • 27 CYLINDER SURFACE • 28 CYLINDER SURFACE • 29 CYL SURFACE • 200 DRILLING • 201 REAMING • 202 BORING • 203 UNIVERSAL DRILLING • 204 BACK BORING • 205 UNIVERSAL DRILLING • 206 TAPPING • 207 RIGID TAPPING	7	DATUM SHIFT		
10 ROTATION III 11 SCALING FACTOR III 12 PGM CALL III 13 ORIENTATION IIII 14 CONTOUR IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	8	MIRRORING		
11SCALING FACTORII12PGM CALLII13ORIENTATIONII14CONTOURII19WORKING PLANEII20CONTOUR DATAII21PILOT DRILLINGII22ROUGH-OUTII23FLOOR FINISHINGII24SIDE FINISHINGII25CONTOUR TRAINII26AXIS-SPECIFIC SCALINGII27CYLINDER SURFACEII28CYLINDER SURFACEII29CYL SURFACE RIDGEII200DRILLINGII201REAMINGII202BORINGII203UNIVERSAL DRILLINGII204BACK BORINGII205UNIVERSAL PECKINGII206TAPPINGII207RIGID TAPPINGII208BORE MILLINGII209TAPPINGII201SLOT RECIP, PLNGII211CIRCULAR SLOTII212POCKET FINISHINGII	9	DWELL TIME		
12PGM CALLII13ORIENTATIONII14CONTOURII19WORKING PLANEII20CONTOUR DATAII21PILOT DRILLINGII22ROUGH-OUTII23FLOOR FINISHINGII24SIDE FINISHINGII25CONTOUR TRAINII26AXIS-SPECIFIC SCALINGII27CYLINDER SURFACEII28CYLINDER SURFACEII29CYL SURFACE RIDGEII200DRILLINGII201REAMINGII202BORINGII203UNIVERSAL DRILLINGII204BACK BORINGII205UNIVERSAL PECKINGII206TAPPINGII207RIGID TAPPINGII208BORE MILLINGII209TAPPINGII201SLOT RECIP, PLNGII211CIRCULAR SLOTII212POCKET FINISHINGII	10	ROTATION		
13ORIENTATIONImage: Control of the second sec	11	SCALING FACTOR		
14CONTOURImage: Contour Data19WORKING PLANEImage: Contour Data20CONTOUR DATAImage: Contour Data21PILOT DRILLINGImage: Contour Data22ROUGH-OUTImage: Contour Data23FLOOR FINISHINGImage: Contour Tain24SIDE FINISHINGImage: Contour Tain26AXIS-SPECIFIC SCALINGImage: Contour Tain27CYLINDER SURFACEImage: Contour Tain28CYLINDER SURFACEImage: Contour Data29CYL SURFACE RIDGEImage: Contour Data20DRILLINGImage: Contour Data200DRILLINGImage: Contour Data201REAMINGImage: Contour Data202BORINGImage: Contour Data203UNIVERSAL DRILLINGImage: Contour Data204BACK BORINGImage: Contour Data205UNIVERSAL PECKINGImage: Contour Data206TAPPINGImage: Contour Data207RIGID TAPPINGImage: Contour Data208BORE MILLINGImage: Contour Data209TAPPING W/ CHIP BRKGImage: Contour Data210SLOT RECIP. PLNGImage: Contour Data211CIRCULAR SLOTImage: Contour Data212POCKET FINISHINGImage: Contour Data212POCKET FINISHINGImage: Contour Data212POCKET FINISHINGImage: Contour Data	12	PGM CALL		
19WORKING PLANE20CONTOUR DATA21PILOT DRILLING22ROUGH-OUT23FLOOR FINISHING24SIDE FINISHING25CONTOUR TRAIN26AXIS-SPECIFIC SCALING27CYLINDER SURFACE28CYLINDER SURFACE29CYL SURFACE RIDGE39CYL. SURFACE CONTOUR39CYL. SURFACE CONTOUR200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	13	ORIENTATION		
20CONTOUR DATA21PILOT DRILLING22ROUGH-OUT23FLOOR FINISHING24SIDE FINISHING25CONTOUR TRAIN26AXIS-SPECIFIC SCALING27CYLINDER SURFACE28CYLINDER SURFACE29CYL SURFACE200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	14	CONTOUR		
21PILOT DRILLING22ROUGH-OUT23FLOOR FINISHING24SIDE FINISHING25CONTOUR TRAIN26AXIS-SPECIFIC SCALING27CYLINDER SURFACE28CYLINDER SURFACE29CYL SURFACE RIDGE32TOLERANCE39CYL. SURFACE CONTOUR200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING // CHIP BRKG210SLOT RECIP, PLNG211CIRCULAR SLOT212POCKET FINISHING	19	WORKING PLANE		
22ROUGH-OUTII23FLOOR FINISHINGII24SIDE FINISHINGII25CONTOUR TRAINII26AXIS-SPECIFIC SCALINGII27CYLINDER SURFACEII28CYLINDER SURFACEII29CYL SURFACE RIDGEII32TOLERANCEII39CYL. SURFACE CONTOURII200DRILLINGII201REAMINGII202BORINGII203UNIVERSAL DRILLINGII206TAPPINGII207RIGID TAPPINGII208BORE MILLINGII209TAPPING VICHIP BRKGII210SLOT RECIP. PLNGII211CIRCULAR SLOTII212POCKET FINISHINGII	20	CONTOUR DATA		
23FLOOR FINISHING24SIDE FINISHING25CONTOUR TRAIN26AXIS-SPECIFIC SCALING27CYLINDER SURFACE28CYLINDER SURFACE29CYL SURFACE RIDGE32TOLERANCE39CYL. SURFACE CONTOUR200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING MILLING201SLOT RECIP. PLNG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	21	PILOT DRILLING		
24SIDE FINISHING25CONTOUR TRAIN26AXIS-SPECIFIC SCALING27CYLINDER SURFACE28CYLINDER SURFACE29CYL SURFACE RIDGE32TOLERANCE39CYL. SURFACE CONTOUR200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP, PLNG211CIRCULAR SLOT212POCKET FINISHING	22	ROUGH-OUT		-
25CONTOUR TRAIN26AXIS-SPECIFIC SCALING27CYLINDER SURFACE28CYLINDER SURFACE29CYL SURFACE RIDGE32TOLERANCE39CYL. SURFACE CONTOUR200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP, PLNG211CIRCULAR SLOT212POCKET FINISHING	23	FLOOR FINISHING		
26AXIS-SPECIFIC SCALING27CYLINDER SURFACE28CYLINDER SURFACE29CYL SURFACE RIDGE32TOLERANCE39CYL. SURFACE CONTOUR200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	24	SIDE FINISHING		
27CYLINDER SURFACE28CYLINDER SURFACE29CYL SURFACE RIDGE32TOLERANCE39CYL. SURFACE CONTOUR200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	25	CONTOUR TRAIN		
28CYLINDER SURFACE29CYL SURFACE RIDGE32TOLERANCE39CYL. SURFACE CONTOUR200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING U210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	26	AXIS-SPECIFIC SCALING		
29CYL SURFACE RIDGE32TOLERANCE39CYL. SURFACE CONTOUR39CYL. SURFACE CONTOUR200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING209TAPPING210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	27	CYLINDER SURFACE		
32TOLERANCE39CYL. SURFACE CONTOUR200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	28	CYLINDER SURFACE		
39CYL. SURFACE CONTOUR200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	29	CYL SURFACE RIDGE		
200DRILLING201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	32	TOLERANCE		
201REAMING202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	39	CYL. SURFACE CONTOUR		
202BORING203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	200	DRILLING		
203UNIVERSAL DRILLING204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	201	REAMING		-
204BACK BORING205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	202	BORING		
205UNIVERSAL PECKING206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	203	UNIVERSAL DRILLING		
206TAPPING207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	204	BACK BORING		
207RIGID TAPPING208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	205	UNIVERSAL PECKING		
208BORE MILLING209TAPPING W/ CHIP BRKG210SLOT RECIP. PLNG211CIRCULAR SLOT212POCKET FINISHING	206	TAPPING		-
209 TAPPING W/ CHIP BRKG 210 SLOT RECIP. PLNG 211 CIRCULAR SLOT 212 POCKET FINISHING	207	RIGID TAPPING		-
210 SLOT RECIP. PLNG 211 CIRCULAR SLOT 212 POCKET FINISHING	208	BORE MILLING		-
211 CIRCULAR SLOT 212 POCKET FINISHING	209	TAPPING W/ CHIP BRKG		
212 POCKET FINISHING	210	SLOT RECIP. PLNG		
	211	CIRCULAR SLOT		
213 STUD FINISHING	212	POCKET FINISHING		
	213	STUD FINISHING		-

17.4 Overview tables

Cycle number	Cycle name	CALL active
214	C. POCKET FINISHING	
214	C. STUD FINISHING	
220	POLAR PATTERN	
221	CARTESIAN PATTERN	
225	ENGRAVING	
230	MULTIPASS MILLING	
231	RULED SURFACE	
232	FACE MILLING	
233	FACE MILLING	
240	CENTERING	
241	SINGLE-LIP D.H.DRLNG	
247	DATUM SETTING	
251	RECTANGULAR POCKET	
252	CIRCULAR POCKET	
253	SLOT MILLING	
254	CIRCULAR SLOT	
256	RECTANGULAR STUD	
257	CIRCULAR STUD	
258	POLYGON STUD	
262	THREAD MILLING	
263	THREAD MLLNG/CNTSNKG	
264	THREAD DRILLNG/MLLNG	
265	HEL. THREAD DRLG/MLG	
267	OUTSIDE THREAD MLLNG	
270	CONTOUR TRAIN DATA	
275	TROCHOIDAL SLOT	

Miscellaneous functions

М	Effect	Effective at block	Start	End	Page
M0	Program STOP/Spindle STOP/Coolant OFF				376
M1	Optional program run STOP/Spindle STOP/Coolant Ol	F			552
M2	Stop program/Spindle STOP/Coolant OFF/ CLEAR sta (depending on machine parameter)/Return jump to bl				376
M3 M4	Spindle ON clockwise Spindle ON counterclockwise				376
M5	Spindle STOP				
M6	Tool change/STOP program run (depending on machin Spindle STOP	ne parameter)/			376

М	Effect Effective at block	Start	End	Page
M8	Coolant ON	-		376
M9	Coolant OFF			
M13 M14	Spindle ON clockwise/Coolant ON Spindle ON counterclockwise/Coolant on	1		376
M30	Same function as M2			376
M89	Vacant miscellaneous function or cycle call, modally effective (depending on machine parameter)	•		Cycles Manual
M91	Within the positioning block: Coordinates are referenced to machine datum	•		377
M92	Within the positioning block: Coordinates are referenced to a position defined by machine manufacturer, e.g. tool change position	•		377
M94	Reduce the rotary axis display to a value below 360°			447
M97	Machine small contour steps			380
M98	Machine open contours completely			381
M99	Blockwise cycle call			Cycles Manual
	Automatic tool change with replacement tool if maximum tool life has expired Reset M101			203
	Suppress error message for replacement tools with oversize Reset M107			203
M110	Constant contouring speed at cutting edge (feed rate increase andreduction) Constant contouring speed at cutting edge (only feed rate reduction) Reset M109/M110			384
	Feed rate in mm/min on rotary axes Reset M116	•		445
M118	Superimpose handwheel positioning during program run			387
M120	Pre-calculate the radius-compensated contour (LOOK AHEAD)			385
	Shorter-path traverse of rotary axes Reset M126	•		446
M130	Within the positioning block: Points are referenced to the untilted coordinate system	•		379
	Feed rate F in millimeters per spindle revolution Reset M136	•		383
M138	Selection of tilted axes			448
M140	Retraction from the contour in the tool-axis direction			389
M143	Delete basic rotation			392
M141	Suppress touch probe monitoring			391
	Automatically retract tool from the contour at an NC stop Reset M148	•		393

17.5 Functions of the TNC 320 and the iTNC 530 compared

17.5 Functions of the TNC 320 and the iTNC 530 compared

Comparison: Specifications

Function	TNC 320	iTNC 530
Axes	6 maximum	18 maximum
Input resolution and display step:		
Linear axes	■ 0.1µm	■ 0.1 µm
Rotary axes	■ 0.001°	■ 0.0001°
Display	15.1-inch TFT color flat-panel display	19-inch TFT color flat-panel display or 15.1-inch TFT color flat-panel display
Memory media for NC, PLC programs and system files	CompactFlash memory card	Hard disk or SSDR solid state disk
Program memory for NC programs	2 GB	> 21 GB
Block processing time	6 ms	0.5 ms
HeROS operating system	Yes	Yes
Interpolation:		
Straight line	5 axes	5 axes
Circle	3 axes	3 axes
Helix	yes	Yes
Spline	No	Yes with option 9
Hardware	Compact in operating panel	Modular in electrical cabinet

Comparison: Data interfaces

Function	TNC 320	iTNC 530
Gigabit Ethernet 1000BaseT	Х	Х
RS-232-C/V.24 serial interface	Х	Х
RS-422/V.11 serial interface	-	Х
USB interface	Х	Х

Comparison: Accessories

Function	TNC 320	iTNC 530
Electronic handwheels		
HR 410510	Х	Х
HR 420	Х	Х
HR 520/530/550FS	Х	Х
HR 130	Х	Х
HR 150 via HRA 110	Х	Х
Touch probes		
TS 260/TS 460	Х	Х
TS 440/TS 444	Х	Х
TS 640/TS 642/TS 740	Х	Х
TS 220/TS 230	Х	Х
■ TS 249	Х	Х
■ SE 660	Х	Х
SE 540/SE 640/SE 642	Х	Х
TT 140	Х	Х
TT 160/TT460	Х	Х
TT 449	Х	Х
TL Nano	Х	Х
TL Micro 150/200/300	Х	Х
Industrial PCs		
■ IPC 6641	Х	Х
■ ITC 750/760	Х	Х
■ ITC 755	Х	Х

Comparison: PC software

Function	TNC 320	iTNC 530
Programming station software	Available	Available
TNCremo for data transfer with TNCbackup for data back-up	Available	Available
TNCremoPlus data transfer software with "live" screen	Available	Available
virtualTNC : Control component for virtual machines	Available	Available

17.5 Functions of the TNC 320 and the iTNC 530 compared

Comparison: Machine-specific functions

Function	TNC 320	iTNC 530
Switching the traverse range	Function available	Function available
Central drive (1 motor for multiple machine axes)	Function available	Function available
C axis drive (spindle motor drives rotary axis)	Function available	Function available
Automatic exchange of milling head	Function available	Function available
Support of angle heads	Function available	Function available
Balluf tool identification	Function available (with Python)	Function available
Management of multiple tool magazines	Function available	Function available
Expanded tool management via Python	Function available	Function available

Comparison: User functions

Function	TNC 320	iTNC 530
Program entry		
In Klartext conversational language	X	■ X
DIN/ISO	X	■ X
With smarT.NC		■ X
With ASCII editor	 X, directly editable 	 X, editable after conversion
Position entry		
 Nominal positions for lines and arcs in Cartesian coordinates 	■ X	■ X
 Nominal positions for lines and arcs in polar coordinates 	■ X	■ ×
Incremental or absolute dimensions	■ X	■ X
Display and entry in mm or inches	■ X	■ X
 Set the last tool position as pole (empty CC block) 	 X (error message if pole transfer is ambiguous) 	■ X
Surface-normal vectors (LN)		■ X
Spline sets (SPL)		X, with option 9

Function	TNC 320	iTNC 530
Tool compensation		
In the working plane and tool length	■ X	■ X
 Radius compensated contour look ahead for up to 99 blocks 	■ X	■ X
Three-Dimensional Tool Radius Compensation		X, with option 9
Tool table		
 Central storage of tool data 	■ X	■ X
 Multiple tool tables with any number of tools 	■ X	■ X
 Flexible management of tool types 	■ X	
 Filtered display of selectable tools 	■ X	
 Sorting function 	■ X	
Column names	Sometimes with _	Sometimes with -
 Copy function: Over writing relevant tool data 	■ X	■ X
Form view	 Switchover with Screen Layout key 	 Switchover by soft key
 Exchange of tool table between TNC 320 and iTNC 530 	■ X	 Not possible
Touch probe table for managing different 3-D touch probes	Х	-
Creating tool-usage file, checking the availability	Х	Х
Cutting data calculator : Automatic calculation of spindle speed and feed rate	Simple cutting data calculator	Using stored technology tables
Define any tables	 Freely definable tables (.TAB files) 	 Freely definable tables (.TAB files)
	 Reading and writing with FN functions 	 Reading and writing with FN functions
	 Definable via config. data 	
	 Table names must start with a letter 	
	 Reading and writing with SQL functions 	

Function	TNC 320	iTNC 530
Constant contouring speed relative to the path of the tool center or relative to the tool's cutting edge	Х	Х
Parallel operation : Creating programs while another program is being run	Х	Х
Programming of counter axes	Х	Х
Tilting the working plane (Cycle 19, PLANE function)	X, option 8	X, option 8
Machining with a rotary table:		
Programming of cylindrical contours as if in two axes		
 Cylindrical surface (Cycle 27) 	X, option 8	X, option 8
 Cylinder surface, slot (Cycle 28) 	X, option 8	X, option 8
 Cylinder surface, ridge (Cycle 29) 	X, option 8	X, option 8
 Cylinder surface, external contour (Cycle 39) 	X, option 8	X, option 8
Feed rate in mm/min or rev/min	X, option 8	X, option 8
Traverse in tool-axis direction		
Manual operation (3-D ROT menu)	■ X	 X, FCL2 function
 During program interruption 	■ X	■ X
With handwheel superimpositioning	■ X	X, option #44
Approaching and departing the contour via a straight line or arc	Х	Х
Entry of feed rates:		
F (mm/min), rapid traverse FMAX	■ X	■ X
FU (feed per revolution mm/1)		■ X
FZ (tooth feed rate)		■ X
FT (time in seconds for path)		■ X
 FMAXT (only for active rapid traverse potentiometer: time in seconds for path) 		• X
FK free contour programming		
 Programming for workpiece drawings not dimensioned for NC programming 	■ X	■ X
 Conversion of FK program to Klartext conversational language 		■ X
Program jumps:		
 Maximum number of label numbers 	■ 9999	1000
Subprograms	X	X
Nesting depth for subprograms	20	■ 6
Program section repetitions	• X	X
Any desired program as subroutine	• X	■ X

Function	TNC 320	iTNC 530
Q parameter programming:		
Standard mathematical functions	■ X	■ X
Formula entry	■ X	■ X
String processing	■ X	■ X
Local Q parameters QL	■ X	■ X
Nonvolatile Q parameters QR	■ X	■ X
 Changing parameters during program interruption 	■ X	■ X
■ FN15:PRINT		■ X
■ FN25:PRESET		■ X
■ FN26:TABOPEN	■ X	■ X
■ FN27:TABWRITE	■ X	■ X
■ FN28:TABREAD	■ X	■ X
■ FN29: PLC LIST	■ X	I -
FN31: RANGE SELECT		■ X
FN32: PLC PRESET		■ X
■ FN37:EXPORT	■ X	I -
FN38: SEND	■ X	■ X
Saving file externally with FN16	■ X	■ X
 FN16 formatting: Left-aligned, right-aligned, string lengths 	■ X	■ X
Writing to LOG file with FN16	■ X	I -
 Displaying parameter contents in the additional status display 	■ X	· -
 Displaying parameter contents during programming (Q-INFO) 	■ X	■ X
SQL functions for writing and reading tables	■ X	

Function	TNC 320	iTNC 530	
Graphic support			
2-D programming graphics	■ X	X	
REDRAW function (REDRAW)		■ X	
Show grid lines as the background	X		
 3-D line graphics 	■ X	■ X	
 Test graphics (plan view, projection on 3 planes, 3-D view) 	X	■ X	
 High-resolution view 	■ X	■ X	
Tool display	■ X	= ×	
 Adjusting the simulation speed 	X	■ X	
 Coordinates of line intersection for projection in 3 planes 		■ X	
Expanded zoom functions (mouse operation)	X	■ X	
Displaying frame for workpiece blank	X	■ X	
 Displaying the depth value in plan view during mouse-over 	■ X	■ X	
Deliberately stop test run (STOP AT)	X	■ X	
 Factor in tool change macro 	 X (differing to actual execution 	■ X	
 Program run graphics (plan view, projection in 3 planes, 3-D view) 	• X	X	
 High-resolution view 	■ X	X	

Function	TNC 320	iTNC 530
Datum tables: Storing workpiece-specific datums	Х	Х
Preset table: for saving reference points (presets)	Х	Х
Pallet management		
 Support of pallet files 		X
Tool-oriented machining		X
Pallet preset table: Managing pallet datums	1 -	■ X
Returning to the contour		
With mid-program startup	■ X	X
After program interruption	X	■ X
Auto-start function	Х	Χ
Teach-in: Actual positions can be transferred to an NC program	Х	X
Enhanced file management		
 Creating multiple directories and subdirectories 	■ X	■ X
 Sorting function 	■ X	X
Mouse operation	X	■ X
Selection of target directory by soft key	X	■ X
Programming aids:		
 Help graphics for cycle programming 	■ X	■ X
Animated help graphics when PLANE/PATTERN DEF function is selected	■ X	• X
Help graphics for PLANE/PATTERN DEF	■ X	X
 Context-sensitive help function for error messages 	■ X	X
TNCguide, browser-based help system	■ X	X
Context-sensitive call of help system	■ X	X
Calculator	 X (scientific) 	 X (standard)
 Comment blocks in NC program 	■ X	X
 Structure blocks in NC program 	■ X	X
Structure view in test run		X
Dynamic Collision Monitoring (DCM):		
 Collision monitoring in Automatic operation 		X, option 40
 Collision monitoring in Manual operation 		X, option 40
 Graphic depiction of the defined collision objects 		X, option 40
 Collision checking in test run 		X, option 40
 Fixture monitoring 		X, option 40
 Tool carrier management 	■ X	X, option 40

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Function	TNC 320	iTNC 530
CAM support:		
Loading of contours from DXF data	X, option 42	X, option 42
Loading of machining positions from DXF data	X, option 42	X, option 42
 Offline filter for CAM files 		■ X
Stretch filter	■ X	I -
MOD functions:		
User parameters	 Config data 	 Numerical structure
 OEM help files with service functions 		X
Data medium inspection		■ X
Load service packs		X
Setting the system time	■ X	X
 Specify the axes for actual position capture 		X
 Definition of traverse range limits 	■ X	X
 Restricting external access 	■ X	X
 Switching the kinematics 	■ X	■ X
Calling fixed cycles:		
With M99 or M89	■ X	X
With CYCL CALL	■ X	■ X
With CYCL CALL PAT	■ X	X
With CYC CALL POS	■ X	■ X
Special functions:		
Create reverse program		X
Datum shift with TRANS DATUM	■ X	■ X
Adaptive Feed Control AFC		X, option 45
Global definition of cycle parameters: GLOBAL DEF	■ X	■ X
Pattern definition with PATTERN DEF	■ X	■ X
 Definition and processing of point tables 	■ X	■ X
Simple contour formula CONTOUR DEF	■ X	■ X
Functions for large molds and dies:		
 Global program settings (GS) 		X, option 44
Expanded M128: FUNCTION TCPM		■ X

Function	TNC 320	iTNC 530	
Status displays:			
 Positions, spindle speed, feed rate 	■ X	X	
Larger depiction of position display, Manual operation	■ X	X	
 Additional status display, form view 	■ X	X	
 Display of the handwheel path during machining with handwheel superimposing 	■ X	■ X	
 Display of distance-to-go in a tilted system 	■ X	X	
 Dynamic display of Q-parameter contents, definable number ranges 	■ X	• -	
 Machine manufacturer-specific additional status display via Python 	■ X	■ X	
 Graphic display of residual run time 		X	
Individual color settings of user interface	_	Х	

17.5 Functions of the TNC 320 and the iTNC 530 compared

Comparator: Cycles

Cycle	TNC 320	iTNC 530
1 PECKING	Х	Х
2 TAPPING	Х	Х
3 SLOT MILLING	Х	Х
4 POCKET MILLING	Х	Х
5 CIRCULAR POCKET	Х	Х
6 ROUGH-OUT (SL I, recommended: SL II, Cycle 22)	-	Х
7 DATUM SHIFT	Х	Х
8 MIRRORING	Х	Х
9 DWELL TIME	Х	Х
10 ROTATION	Х	Х
11 SCALING FACTOR	Х	Х
12 PGM CALL	Х	Х
13 ORIENTATION	Х	Х
14 CONTOUR	Х	Х
15 PILOT DRILLING (SL I, recommended: SL II, Cycle 21)	_	Х
16 CONTOUR MILLING (SL I, recommended: SL II, Cycle 24)	_	Х
17 RIGID TAPPING	Х	Х
18 THREAD CUTTING	Х	Х
19 WORKING PLANE	X, option 8	X, option 8
20 CONTOUR DATA	Х	Х
21 PILOT DRILLING	Х	Х
22 ROUGH-OUT	Х	Х
23 FLOOR FINISHING	Х	Х
24 SIDE FINISHING	Х	Х
25 CONTOUR TRAIN	Х	Х
26 AXIS-SPECIFIC SCALING	Х	Х
27 CYLINDER SURFACE	X, option 8	X, option 8
28 CYLINDER SURFACE	X, option 8	X, option 8
29 CYL SURFACE RIDGE	X, option 8	X, option 8
30 RUN CAM DATA	-	Х
32 TOLERANCE	Х	Х
39 CYL. SURFACE CONTOUR	X, option 8	X, option 8
200 DRILLING	Х	Х
201 REAMING	Х	Х
202 BORING	Х	Х
203 UNIVERSAL DRILLING	Х	Х
204 BACK BORING	X	Х

Сусіе	TNC 320	iTNC 530
205 UNIVERSAL PECKING	Х	Х
206 TAPPING	Х	Х
207 RIGID TAPPING	Х	Х
208 BORE MILLING	Х	Х
209 TAPPING W/ CHIP BRKG	Х	Х
210 SLOT RECIP. PLNG	Х	Х
211 CIRCULAR SLOT	Х	Х
212 POCKET FINISHING	Х	Х
213 STUD FINISHING	Х	Х
214 C. POCKET FINISHING	Х	Х
215 C. STUD FINISHING	Х	Х
220 POLAR PATTERN	Х	Х
221 CARTESIAN PATTERN	Х	Х
225 ENGRAVING	Х	Х
230 MULTIPASS MILLING	Х	Х
231 RULED SURFACE	Х	Х
232 FACE MILLING	Х	Х
233 FACE MILLING	Х	_
240 CENTERING	Х	Х
241 SINGLE-LIP D.H.DRLNG	Х	Х
247 DATUM SETTING	Х	Х
251 RECTANGULAR POCKET	Х	Х
252 CIRCULAR POCKET	Х	Х
253 SLOT MILLING	Х	Х
254 CIRCULAR SLOT	Х	Х
256 RECTANGULAR STUD	Х	Х
257 CIRCULAR STUD	Х	Х
258 POLYGON STUD	Х	_
262 THREAD MILLING	Х	Х
263 THREAD MLLNG/CNTSNKG	Х	Х
264 THREAD DRILLNG/MLLNG	Х	Х
265 HEL. THREAD DRLG/MLG	Х	Х
267 OUTSIDE THREAD MLLNG	Х	Х
270 CONTOUR TRAIN DATA for defining the behavior of Cycle 25	Х	Х
275 TROCHOIDAL SLOT	Х	Х
276 THREE-D CONT. TRAIN	_	Х
290 INTERPOLATION TURNING	_	X, option 96

17.5 Functions of the TNC 320 and the iTNC 530 compared

Comparison: Miscellaneous functions

М	Effect	TNC 320	iTNC 530
M00	Program STOP/Spindle STOP/Coolant OFF	Х	Х
M01	Optional program STOP	Х	Х
M02	Stop program/Spindle STOP/Coolant OFF/ Clear status display (depending on machine parameter)/Return jump to block 1	Х	Х
M03 M04 M05	Spindle ON clockwise Spindle ON counterclockwise Spindle STOP	X	Х
M06	Tool change/Program run STOP (machine-specific function)/ Spindle STOP	Х	Х
M08 M09	Coolant ON Coolant OFF	Х	Х
M13 M14	Spindle ON clockwise/Coolant ON Spindle ON counterclockwise/Coolant on	Х	Х
M30	Same function as M02	Х	Х
M89	Free miscellaneous function or cycle call, modally effective (machine-specific function)	Х	Х
M90	Constant contouring speed at corners (not required at TNC 320)	-	Х
M91	Within the positioning block: Coordinates are referenced to machine datum	Х	Х
M92	Within the positioning block: Coordinates are referenced to a position defined by machine manufacturer, e.g. tool change position	X	Х
M94	Reduce the rotary axis display to a value below 360°	Х	Х
M97	Machine small contour steps	Х	Х
M98	Machine open contours completely	Х	Х
M99	Blockwise cycle call	Х	Х
M101 M102	Automatic tool change with replacement tool if maximum tool life has expired Reset M101	Х	Х
M103	Reduce feed rate during plunging to factor F (percentage)	X	X
M104	Reactivate most recently set datum	– (recommended: Cycle 247)	X
M105 M106	Machining with second $k_{\rm v}$ factor Machining with first $k_{\rm v}$ factor	-	Х
M107 M108	Suppress error message for replacement tools with oversize Reset M107	Х	Х
M109 M110 M111	Constant contouring speed at cutting edge (feed rate increase and reduction) Constant contouring speed at cutting edge (only feed rate reduction) Reset M109/M110	X	X

М	Effect	TNC 320	iTNC 530
M112	Enter contour transitions between any two contour transitions	– (recommended: Cycle 32)	Х
M113	Reset M112		
M114	Automatic compensation of machine geometry when working with tilted axes Reset M114	– recommended: M128, TCPM)	X, option 8
M116 M117	Feed rate on rotary tables in mm/min Reset M116	X, option 8	X, option 8
M118	Superimpose handwheel positioning during program run	Х	Х
M120	Pre-calculate the radius-compensated contour (LOOK AHEAD)	Х	Х
M124	Contour filter	– (possible via user parameters)	Х
M126 M127	Shorter-path traverse of rotary axes Reset M126	Х	Х
M128	Maintaining the position of the tool tip when positioning tilted axes (TCPM)	_	X, option 9
M129	Reset M128		
M130	Within the positioning block: Points are referenced to the untilted coordinate system	Х	Х
M134 M135	Precision stop at non-tangential contour transitions when positioning with rotary axes Reset M134	-	Х
M136 M137	Feed rate F in millimeters per spindle revolution Reset M136	Х	Х
M138	Selection of tilted axes	Х	Х
M140	Retraction from the contour in the tool-axis direction	Х	Х
M141	Suppress touch probe monitoring	Х	Х
M142	Delete modal program information	-	Х
M143	Delete basic rotation	Х	Х
M148 M149	Automatically retract tool from the contour at an NC stop Reset M148	Х	Х
M150	Suppress limit switch message	– (possible via FN 17)	Х
M197	Rounding the corners	Х	-
M200 -M204	Laser cutting functions	_	Х

Comparison: Touch probe cycles in the Manual operation and Electronic handwheel modes of operationElectronic handwheel

Cycle	TNC 320	iTNC 530
Touch-probe table for managing 3-D touch probes	Х	_
Calibrating the effective length	Х	Х
Calibrating the effective radius	Х	Х
Measuring a basic rotation using a line	Х	Х
Setting the datum on any axis	Х	Х
Setting a corner as datum	Х	Х
Setting a circle center as datum	Х	Х
Setting a center line as datum	Х	Х
Measuring a basic rotation using two holes/cylindrical studs	Х	Х
Setting the datum using four holes/cylindrical studs	Х	Х
Setting the circle center using three holes/cylindrical studs	Х	Х
Determine and offset misalignment of a plane	Х	_
Support of mechanical touch probes by manually capturing the current position	By soft key or hard key	By hard key
Write measurement values to the preset table	Х	Х
Write measurement values to the datum table	Х	Х

Comparison: Probing system cycles for automatic workpiece control

Cycle	TNC 320	iTNC 530
0 REF. PLANE	Х	Х
1 POLAR DATUM	Х	Х
2 CALIBRATE TS	-	Х
3 MEASURING	Х	Х
4 MEASURING IN 3-D	Х	Х
9 CALIBRATE TS LENGTH	-	Х
30 CALIBRATE TT	Х	Х
31 CAL. TOOL LENGTH	Х	Х
32 CAL. TOOL RADIUS	Х	Х
33 MEASURE TOOL	Х	Х
400 BASIC ROTATION	Х	Х
401 ROT OF 2 HOLES	Х	Х
402 ROT OF 2 STUDS	Х	Х
403 ROT IN ROTARY AXIS	Х	Х
404 SET BASIC ROTATION	Х	Х
405 ROT IN C-AXIS	Х	Х
408 SLOT CENTER REF PT	Х	Х
409 RIDGE CENTER REF PT	Х	Х
410 DATUM INSIDE RECTAN.	Х	Х
411 DATUM OUTS. RECTAN.	Х	Х
412 DATUM INSIDE CIRCLE	Х	Х
413 DATUM OUTSIDE CIRCLE	Х	Х
414 DATUM OUTSIDE CORNER	Х	Х
415 DATUM INSIDE CORNER	Х	Х
416 DATUM CIRCLE CENTER	Х	Х
417 DATUM IN TS AXIS	Х	Х
418 DATUM FROM 4 HOLES	Х	Х
419 DATUM IN ONE AXIS	Х	Х
420 MEASURE ANGLE	Х	Х
421 MEASURE HOLE	Х	Х
422 MEAS. CIRCLE OUTSIDE	Х	Х
423 MEAS. RECTAN. INSIDE	Х	Х
424 MEAS. RECTAN. OUTS.	Х	Х
425 MEASURE INSIDE WIDTH	Х	Х
426 MEASURE RIDGE WIDTH	Х	Х
427 MEASURE COORDINATE	Х	Х

Cycle	TNC 320	iTNC 530
430 MEAS. BOLT HOLE CIRC	Х	Х
431 MEASURE PLANE	Х	Х
440 MEASURE AXIS SHIFT	_	Х
441 FAST PROBING	Sometimes possible via touch probe table	Х
450 SAVE KINEMATICS	_	X, option 48
451 MEASURE KINEMATICS	_	X, option 48
452 PRESET COMPENSATION	-	X, option 48
460 CALIBRATION OF TS ON A SPHERE	Х	Х
461 TS CALIBRATION OF TOOL LENGTH	Х	Х
462 CALIBRATION OF A TS IN A RING	Х	Х
463 TS CALIBRATION ON STUD	Х	Х
480 CALIBRATE TT	Х	Х
481 CAL. TOOL LENGTH	Х	Х
482 CAL. TOOL RADIUS	Х	Х
483 MEASURE TOOL	Х	Х
484 CALIBRATE IR TT	Х	Х
600 GLOBAL WORKING SPACE	Х	_
601 LOCAL WORKING SPACE	Х	-

Comparison: Differences in programming

Function	TNC 320	iTNC 530
Switching the operating mode while a block is being edited	Permitted	Permitted
File handling:		
Save file function	 Available 	Available
Save file as function	 Available 	Available
 Discard changes 	 Available 	Available
File management:		
 Mouse operation 	 Available 	Available
 Sorting function 	 Available 	Available
Entry of name	Opens Select file pop-up windowSelect file	 Synchronizes the cursor
 Support of key combinations 	 Not available 	Available
 Favorites Management 	 Not available 	Available
 Configuration of column structure 	Not available	 Available
 Soft-key arrangement 	 Slightly different 	 Slightly different
Skip block function	Available	Available
Selecting a tool from the table	Selection via split-screen menu	Selection in a pop-up window
Programming special functions with the SPEC FCT key	Pressing the key opens a soft-key row as a submenu. To exit the submenu, press the SPEC FCT key again; then the TNC shows the last active soft-key row	Pressing the key adds the soft- key row as the last row. To exit the menu, press the SPEC FCT key again; then the TNC shows the last active soft-key row
Programming approach and departure motions with the APPR DEP key	Pressing the key opens a soft-key row as a submenu. To exit the submenu, press the APPR DEP key again; then the TNC shows the last active soft-key row	Pressing the key adds the soft- key row as the last row. To exit the menu, press the APPR DEP key again; then the TNC shows the last active soft-key row
Pressing the hard key END with active CYCLE DEF and TOUCH PROBE menus	Terminates the editing process and calls the file manager	Exits the respective menu
Calling the file manager while the CYCLE DEF and TOUCH PROBE menus are active	Terminates the editing process and calls the file manager. The respective soft-key row remains selected when the file manager is exited	Key non-functional error messageKey non-functional
Calling the file manager while CYCL CALL, SPEC FCT, PGM CALL and APPR/DEP menus are active	Terminates the editing process and calls the file manager. The respective soft-key row remains selected when the file manager is exited	Terminates the editing process and calls the file manager. The basic soft-key row is selected when the file manager is exited

Function	TNC 320	iTNC 530
Datum table:		
 Sorting function by values within an axis 	Available	Not available
Resetting the table	Available	 Not available
 Hiding axes that are not present 	Available	 Available
 Switching the list/form view 	Switchover via split-screen key	 Switchover by toggle soft key
 Inserting individual line 	 Allowed everywhere, renumbering possible after request. Empty line is inserted, must be filled with zeros manually 	 Only allowed at the end of the table. Line with value 0 in all columns is inserted
 Transfer of actual position values on individual axis to the datum table using the keys 	Not available	 Available
 Transfer of actual position values on all active axes to the datum table using the keys 	Not available	 Available
 Capturing the last positions measured by TS using the keys 	 Not available 	 Available
FK free contour programming:		
 Programming of parallel axes 	 With X/Y coordinates, independent of machine type; switchover with FUNCTION PARAXMODE 	 Machine-dependent with the existing parallel axes
 Automatic correction of relative references 	 Relative references in contour subprograms are not corrected automatically 	 All relative references are corrected automatically

Function	TNC 320	iTNC 530
Handling of error messages:		
 Help with error messages 	Call via ERR key	Call via HELP key
 Switching the operating mode while help menu is active 	Help menu is closed when the operating mode is switched	 Operating mode switchover is not allowed (key is non- functional)
 Selecting the background operating mode while help menu is active 	 Help menu is closed when F12 is used for switching 	 Help menu remains open when F12 is used for switching
 Identical error messages 	 Are collected in a list 	 Are displayed only once
 Acknowledgment of error messages 	 Every error message (even if it is displayed more than once) must be acknowledged, the Delete All is available 	 Error message to be acknowledged only once
 Access to protocol functions 	 Log and powerful filter functions (errors, keystrokes) are available 	 Complete log without filter functions available
 Saving service files 	 Available. No service file is created when the system crashes 	 Available. A service file is automatically created when the system crashes

Function	TNC 320	iTNC 530
Find function:		
 List of words recently searched for 	 Not available 	 Available
Show elements of active block	Not available	Available
 Show list of all available NC blocks 	Not available	 Available
Starting the search function with the up/down arrow keys when highlighted	Works up to max. 50,000 blocks, can be set via configuration datum	No limitation regarding program length
Programming graphics:		
 True-to-scale display of grid 	Available	 Not available
 Editing contour subprograms in SLII cycles with AUTO DRAW ON 	With error messages, in the main program the cursor is on the CYCL CALL block	If error messages occur, the cursor is on the block in the contour subprogram responsible for the error
 Moving the zoom window 	 Repeat function not available 	 Repeat function available
Programming minor axes:		
Syntax FUNCTION PARAXCOMP: Define the behavior of the display and the paths of traverse	Available	Not available
Syntax FUNCTION PARAXMODE: Define the assignment of the parallel axes to be traversed	Available	Not available
Programming OEM cycles		
 Access to table data 	 Via SQL commands and via FN17/FN18 or TABREAD-TABWRITE functions 	 Via FN17/FN18 or TABREAD-TABWRITE functions
 Access to machine parameters 	With the CFGREAD function	Via FN18 functions
 Creating interactive cycles with CYCLE QUERY, e.g. touch probe cycles in Manual Operation 	Available	Not available

Comparison: Differences in Test Run, functionality

Function	TNC 320	iTNC 530
Entering a program with the GOTO key	Function only possible if the START SINGLE soft key was not pressed	Function also possible after START SINGLE
Calculation of machining time	Each time the simulation is repeated by pressing the START soft key, the machining time is totaled	Each time the simulation is repeated by pressing the START soft key, time calculation starts at 0
Single block	With point pattern cycles and CYCL CALL PAT , the control stops after each point	Point pattern cycles and CYCL CALL PAT are handled by the control as a single block

Comparison: Differences in Test Run, operation

Function	TNC 320	iTNC 530
Arrangement of soft-key rows and soft keys within the rows	Arrangement of soft-key rows and s active screen layout.	oft-keys varies depending on the
Zoom function	Each sectional plane can be selected by individual soft keys	Sectional plane can be selected via three toggle soft keys
Machine-specific miscellaneous functions M	Lead to error messages if they are not integrated in the PLC	Are ignored during Test Run
Displaying/editing the tool table	Function available via soft key	Function not available
3-D view: Transparent display of workpiece	Available	Function not available
3-D view: Transparent display of workpiece	Available	Function not available
3-D view: Display tool path	Available	Function not available
Adjustable model quality	Available	Function not available

Comparison: Differences in Manual Operation, functionality

Function	TNC 320	iTNC 530
Jog increment function	The jog increment can be defined separately for linear and rotary axes	The jog increment applies for both linear and rotary axes
Preset table	Basic transformation (translation and rotation) of machine table system to workpiece system via the X, Y und Z columns, as well as spatial angles SPA, SPB and SPC. In addition, the X_OFFS to W_OFFS columns can be used to define the axis offset of each individual axis. The function of the axis offsets can be configured.	Basic transformation (translation) of machine table system to workpiece system via the columns X, Y and Z, as well as a ROT basic rotation in the working plane (rotation). In addition, columns A to W can be used to define datums on the rotary and parallel axes.
Behavior when setting datums	Presetting in a rotary axis has the same effect as an axis offset. The offset is also effective for kinematics calculations and for tilting the working plane. The machine parameter presetToAlignAxis (no. 300203) is used to define whether the axis offset is to be taken into account internally after datum setting. Independently of this, an axis offset has always the following effects:	Rotary axis offsets defined by machine parameters do not influence the axis positions that were defined in the Tilt working plane function. MP7500 bit 3 defines whether the current rotary axis position referenced to the machine datum is taken into account, or whether a position of 0° is assumed for the first rotary axis (usually the C axis).
	 An axis offset always influences the nominal position display of the affected axis (the axis offset is subtracted from the current axis value). If a rotary axis coordinate is programmed in an straight line block, then the axis offset is added to the programmed coordinate. 	
Handling of preset table:		
Preset tables that depend on the range of traverse	 Not available 	Available
Definition of feed-rate limitation	Feed-rate limitation can be defined separately for linear and rotary axes	Only one feed-rate limitation can be defined for linear and rotary axes

Comparison: Differences in Manual Operation, operation

Function	TNC 320	iTNC 530
Capturing the position values from mechanical probes	Confirm actual position with a soft key or hard key	Actual-position capture by hard key
Exiting the Touch Probe Functions menu	Using the END soft key or the END hard key	Using the END soft key or the END hard key

Comparison: Differences in Program Run, operation

Function	TNC 320	iTNC 530	
Arrangement of soft-key rows and soft keys within the rows	Arrangement of soft-key rows and soft-keys differs according to the active screen layout.		
Operating mode switchover after program run has been suspended by switching to the Program run, single block operating mode and canceled with INTERNAL STOP	When you return to the Program run, full sequence mode: error message Current block not selected . Use mid-program startup to select the point of interruption	Switching the operating mode is allowed, modal information is saved, program run can be continued by pressing NC start	
GOTO is used to go to FK sequences after program run was interrupted there before switching the operating mode	Error message FK programming: Undefined starting position Entering with mid-program startup is permitted	GOTO allowed	
Mid-program startup:			
Switching the screen layout for mid-program startup	Only possible, if startup position has already been approached	Possible in all operating states	
Error messages	Error messages are still active after the error has been corrected and must be acknowledged separately	Error messages are sometimes acknowledged automatically after the error has been corrected	
Point patterns in single block	With point pattern cycles and CYCL CALL PAT , the control stops after each point.	Point pattern cycles and CYCL CALL PAT are handled by the control as a single block	

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Comparison: Differences in Program Run, traverse movements

Caution: Check the traverse movements!

NC programs that were created on earlier TNC controls may lead to different traverse movements or error messages on a TNC 320!

Be sure to take the necessary care and caution when running-in programs!

See below for a list of known differences. The list does not claim to be complete!

Function	TNC 320	iTNC 530	
Handwheel-superimposed traversing with M118	Effective in the active coordinate system (which may also be rotated or tilted), or in the machine coordinate system, depending on the setting in the 3-D ROT menu for manual operation	Effective in the machine coordinate system	
Deleting basic rotation with M143	M143 deletes the entries in columns SPA, SPB and SPC in the preset table, reactivating the corresponding preset table row does not activate the deleted basic rotation	M143 does not delete the entry in the ROT column in the preset table, reactivating the corresponding preset table row activates the deleted basic rotation	
Scaling approach/departure movements (APPRDEP/RND)	Axis-specific scaling factor is allowed, radius is not scaled	Error message	
Approach/departure with APPRDEP	Error message if R0 is programmed for APPR/DEP LN or APPR/DEP CT	Tool radius 0 and compensation direction RR are assumed	
Approach/departure with APPR/DEP if contour elements with length 0 are defined	Contour elements with length 0 are ignored. The approach/ departure movements are calculated for the first and last valid contour element	An error message is issued if a contour element with length 0 is programmed after the APPR block (relative to the first contour point programmed in the APPR block) For a contour element with length 0 before a DEP block, the iTNC does not issue an error message, but uses the last valid contour element to calculate the departure movement	

Function	TNC 320	iTNC 530 Q60 to Q99 (QS60 to QS99) are local or global, depending on MP7251 in converted cycle programs (.cyc). Nested calls may cause problems	
Effect of Q parameters	Q60 to Q99 (QS60 to QS99) arealways local.		
Automatic cancelation of tool	Block with R0	Block with RO	
radius compensation	DEP block	DEP block	
	Program selection	Program selection	
	END PGM	 Programming of G73 ROTATION 	
		PGM CALL	
NC blocks with M91	No consideration of tool radius compensation	Consideration of tool radius compensation	
Behavior with M120 LA1	No effect on processing, as the control interprets the input internally as an LAO	Possible undesired effect on processing, as the control interprets the entry internally as an LA2	
Block scan in a point table	The tool is positioned above the next position to be machined	The tool is positioned above the last position that has been completely machined	
Emtpy CC block (pole adoption from last tool position) in the NC program	Last positioning block in the working plane must contain both coordinates of the working plane	Last positioning block in the working plane does not necessarily need to contain both coordinates of the working plane. Can cause problems with RND or CHF blocks	
Axis-specific scaling of RND block	RND block is scaled, the result is an ellipse	Error message is issued	
Reaction if a contour element with length 0 is defined before or after a RND or CHF block	Error message is issued	Error message is issued if a contour element with length 0 is located before the RND or CHF block	
		Contour element with length 0 is ignored if the contour element with length 0 is located after the RND or CHF block	

Function	TNC 320	iTNC 530	
Circle programming with polar coordinates	The incremental rotation angle IPA and the direction of rotation DR must have the same sign. Otherwise, an error message will be issued	The algebraic sign of the direction of rotation is used if the sign defined for DR differs from the one defined for IPA	
Tool radius compensation on circular arc or helix with angular length = 0	The transition between the adjacent elements of the arc/helix is generated. Also, the tool axis motion is executed right before this transition. If the element is the first or last element to be corrected, the next or previous element is dealt with in the same way as the first or last element to be corrected	The equidistant line of the arc/ helix is used for generating the tool path	
Compensation of tool length in the position display	The values L and DL from the tool table and the value DL from the T block are taken into account in the position display	The values L and DL from the tool table are taken into account in the position display	
SLII Cycles 20 to 24:			
 Number of definable contour elements 	 Max. 16384 blocks in up to 12 subcontours 	 Max. 8192 contour elements in up to 12 subcontours, no restrictions for subcontour 	
 Define the working plane 	 Tool axis in T block defines the working plane 	 The axes of the first positioning block in the first subcontour define the working plane 	
Position at end of SL cycle	 With the posAfterContPocket(no. 201007) parameter, you can define whether the end position is above the last programmed position, or whether the tool moves to clearance height in the tool axis If the tool moves to clearance height in the tool axis, both coordinates must be programmed with the first traverse movement 	 With MP7420, you can define whether the end position is above the last programmed position, or whether the tool moves only to clearance height in the tool axis If the tool moves to clearance height in the tool axis, one coordinate must be programmed with the first traverse movement 	

Function		TNC 320		iΤ	NC 530
S	Il Cycles 20 to 24:				
	Behavior with islands not contained in pockets		e defined with contour formula		Restricted definition in complex contour formula is possible
	Set operations for SL cycles with complex contour formulas	Real set o	operation possible		Only restricted performance of real set operation possible
	Radius compensation is active during CYCL CALL	Error me	ssage is issued	-	Radius compensation is canceled, program is executed
	Paraxial positioning blocks in contour subprogram	Error me	ssage is issued		Program is executed
•	Miscellaneous functions M in contour subprogram	Error me	ssage is issued	-	M functions are ignored
	/linder surface machining in eneral:				
•	Contour definition		coordinates, lent of machine type	-	Machine-dependent, with existing rotary axes
•	Offset definition on cylinder surface		um shift in X/Y, s of machine type	-	Machine-specific datum shift in rotary axes
	Offset definition for basic rotation	Function	available	-	Function not available
	Circle programming with C/CC	Function	available		Function not available
	APPR/DEP blocks in contour definition	Function	not available		Function available
	/linder surface machining with /cle 28:				
	Complete roughing-out of slot	Function	available		Function not available
	Definable tolerance	Function	available		Function available
	/linder surface machining with vcle 29	irect plung	ing to contour of ridge		rcular approach to contour of Ige
	/cles 25x for pockets, studs nd slots:				
•	Plunging movements	onditions o nessages a	es (geometrical f tool/contour) error re triggered if plunging lead to unreasonable/ vior	СС	limit ranges (geometrical onditions of tool/contour), vertical unging is used if required

Function	TNC 320	iTNC 530		
PLANE function:				
TABLE ROT/COORD ROT	 Effect: The transformation types are effective on all free rotary axes The control does not always position the free rotary axis with TABLE ROT, but depending on the current position, the programmed spatial angle and the machine kinematics Default with missing selection: COORD ROT is used 	 Effect The transformation types are only effective with a C rotary axis With TABLE ROT the control always positions the rotary axis Default with missing selection: COORD ROT is used 		
 Machine is configured for axis angle 	 All PLANE functions can be used 	Only PLANE AXIAL is executed		
 Programming an incremental spatial angle according to PLANE AXIAL 	Error message is issued	 Incremental spatial angle is interpreted as an absolute value 		
 Programming an incremental axis angle according to PLANE SPATIAL if the machine is configured for spatial angle 	 Error message is issued 	 Incremental axis angle is interpreted as an absolute value 		
 Programming of PLANE functions with active Cycle 8 MIRRORING 	Mirroring has no influence on tilting using AXIAL PLANE and Cycle 19	 Function is available with all PLANE functions 		
Special functions for cycle programming:				
■ FN17	 Function available Values are always output in metric form Further details are different 	 Function available Values are output in the units of the active NC program Details are different 		
■ FN18	 Function available Values are always output in metric form Details are different 	Function availableValues are output in the units of the active NC programDetails are different		
Compensation of tool length in the position display	The tool length entries L and DL from the tool table are taken into account in the position display, from T block depending on the machine parameter progToolCalIDL (no. 124501)	The tool length entries L and DL from the tool table are taken into account in the position display		

Comparison: Differences in MDI operation

Function	TNC 320	iTNC 530	
Execution of connected sequences	Function available	Function available	
Saving modally effective functions	Function available	Function available	
Miscellaneous functions	 Status display for Q parameters Block functions, e.g. COPY BLOCK 	 Global program settings 	
	 Miscellaneous program functions, e.g. FUNCTION DWELL 		

Comparison: Differences in programming station

Function	TNC 320	iTNC 530	
Demo version	Programs with more than 100 NC blocks cannot be selected, an error message is issued	Programs can be selected, max. 100 NC blocks are displayed, further blocks are truncated in the display	
Demo version	If nesting with % results in more than 100 NC blocks, there is no test graphic display; an error message is not issued	Nested programs can be simulated	
Copying NC programs	Copying to and from the directory TNC:\ is possible with Windows Explorer	TNCremo or file manager of programming station must be used for copying	
Shifting the horizontal soft-key row	Clicking on the soft-key bar shifts one soft-key row to the right or left	Clicking any soft-key bar activates the respective soft-key row	

17.6 DIN/ISO function overview

17.6 DIN/ISO function overview

DIN/ISO Function Overview TNC 320

M functions

M00 M01 M02	Program run STOP/Spindle STOP/Coolant OFF Optional program run STOP Program run STOP/Spindle/STOP/Coolant OFF/if nec. Clear status display (depending on machine parameter)/Return jump to block 1
M03 M04 M05	Spindle ON clockwise Spindle ON counterclockwise Spindle STOP
M06	Tool change/Program run STOP (depending on machine parameter)/Spindle STOP
M08 M09	Coolant ON Coolant OFF
M13 M14	Spindle ON clockwise/Coolant ON Spindle ON counterclockwise/Coolant on
M30	Same function as M02
M89	Free miscellaneous function or cycle call, modally effective (depending on machine parameter)
M99	Blockwise cycle call
M91 M92	Within the positioning block: Coordinates are referenced to machine datum Within the positioning block: Coordinates are referenced to position defined by machine tool builder, such as tool change position
M94	Reduce the rotary axis display to a value below 360°
M97 M98	Machine small contour steps Machine open contours completely
M109 M110 M111	Constant contouring speed at cutting edge (feed rate increase andreduction) Constant contouring speed at cutting edge (only feed rate reduction) Reset M109/M110
M116 M117	Feed rate for rotary axes in mm/min Reset M116
M118	Superimpose handwheel positioning during program run
M120	Pre-calculate radius-compensated contour (LOOK AHEAD)
M126 M127	Shorter-path traverse of rotary axes: Reset M126
M128 M129	Maintain position of the tool tip when positioning with tilted axes (TCPM) Reset M128
M130	Within the positioning block: Points are referenced to the untilted coordinate system
M140	Retraction from the contour in the tool-axis direction
M141	Suppress touch probe monitoring
M143	Delete basic rotation
M148 M149	Retract the tool automatically from the contour at NC stop Reset M148

G codes	
Tool move	ments
G00	Cartesian line in rapid traverse
G01	Cartesian line at feed rate
G02	Cartesian circle clockwise
G03	Cartesian circle CCW
G05	Cartesian circle
G06	Cartesian circle, tang. transit.
G07*	Cartesian line, paraxial
G10	Polar line in rapid traverse
G11	Polar line at feed rate
G12	Polar circle clockwise
G13	Polar circle counterclockwise
G15	Polar circle
G16	Polar circle, tang. transition
Chamfar/E	, C
	Rounding/Approach contour/Depart contour
G24*	Chamfer with length R with chamfer length R
G25*	Corner rounding with radius R with radius R
G26*	Tangential approach to a contour with radius R
G27*	Tangential departure from a contour with radius R
Tool defini	tion
G99*	Tool definition with tool number T, length L and radius R
Tool radius	s compensation
G40	Path of tool center without tool radius compensation
G41	Radius compensation left of path
G42	Radius compens. right of path
G43	Radius compensation: extend path for G07
G44	Radius compens.: shorten path for G07
Blank form	n definition for graphics
G30	Workpiece blank def.: MIN point (G17/G18/G19)
G31	Workpiece blank def.: MAX point (G90/G91)
Cycles for	drilling, tapping and thread milling
G200	DRILLING
G201	REAMING
G202	BORING
G203	UNIVERSAL DRILLING
G204	BACK BORING
G205	UNIVERSAL PECKING
G206	TAPPING with floating tap holder
G207	RIGID TAPPING without floating tap holder
G208	BORE MILLING
G209	TAPPING W/ CHIP BRKG
G240	CENTERING
G241	SINGLE-LIP D.H.DRLNG

17.6 DIN/ISO function overview

G codes

0.00000	
Cycles for	drilling, tapping and thread milling
G262	THREAD MILLING
G263	THREAD MLLNG/CNTSNKG
G264	THREAD DRILLNG/MLLNG
G265	HEL. THREAD DRLG/MLG
G267	OUTSIDE THREAD MLLNG
Cycles for	milling pockets, studs and slots
G233	FACE MILLING
G251	RECTANGULAR POCKET
G252	CIRCULAR POCKET
G253	SLOT MILLING
G254	CIRCULAR SLOT
G256	RECTANGULAR STUD
G257	CIRCULAR STUD
G258	POLYGON STUD
Cycles for	creating point patterns
G220	POLAR PATTERN
G221	CARTESIAN PATTERN
SL Cycles	
G37	CONTOUR
G120	CONTOUR DATA for G121 to G124
G121	PILOT DRILLING
G122	ROUGH-OUT
G123	FLOOR FINISHING
G124	SIDE FINISHING
G125	CONTOUR TRAIN for open contour
G270	CONTOUR TRAIN DATACYLINDER SURFACE
G127	CYLINDER SURFACE
G128	CYL SURFACE RIDGE
G129	CYL. SURFACE CONTOUR
G139	TROCHOIDAL SLOT
G275	
Coordinat	e conversions
G53	DATUM SHIFT from datum tables
G54	DATUM SHIFT in programMIRRORING
G28	ROTATION
G73	SCALING FACTOR
G72	WORKING PLANE
G80	DATUM SETTING
G247	
-	multipass milling
G230	MULTIPASS MILLING
G231	RULED SURFACE
*) blockwis	e effective function

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G codes	
Touch probe o	cycles for measuring workpiece misalignment
G400	BASIC ROTATION
G401	ROT OF 2 HOLES
G402	ROT OF 2 STUDS
G403	ROT IN ROTARY AXIS
G404	SET BASIC ROTATION
G405	ROT IN C-AXIS
Touch probe s	system cycles for setting datum
G408	SLOT CENTER REF PT
G409	RIDGE CENTER REF PT
G410	DATUM INSIDE RECTAN.
G411	DATUM OUTS. RECTAN.
G412	DATUM INSIDE CIRCLE
G413	DATUM OUTSIDE CIRCLE
G414	DATUM OUTSIDE CORNER
G415	DATUM INSIDE CORNER
G416	DATUM CIRCLE CENTER
G417	DATUM IN TS AXISDATUM FROM 4 HOLES
G418	DATUM IN ONE AXIS
G419	
Touch probe of	cycles for workpiece measurement
G55	REF. PLANE
G420	MEASURE ANGLE
G421	MEASURE HOLE
G422	MEAS. CIRCLE OUTSIDE
G423	MEAS. RECTAN. INSIDE
G424	MEAS. RECTAN. OUTS.
G425	MEASURE INSIDE WIDTH
G426	MEASURE RIDGE WIDTH
G427	MEASURE COORDINATE
G430	MEAS. BOLT HOLE CIRC
G431	MEASURE PLANE
Touch probe of	cycles for tool measurement
G480	CALIBRATE TT
G481	CAL. TOOL LENGTHCAL. TOOL RADIUS
G482	MEASURE TOOL
G483	CALIBRATE IR TT
G434	
Special cycles	3
G04*	DWELL TIME
G36	ORIENTATION
G39*	PGM CALL
G62	TOLERANCE
Define the wo	orking plane
G17	Spindle axis Z - plane XY
G18	Spindle axis Y - plane ZX
G19	Spindle axis X - plane YZ

17.6 DIN/ISO function overview

G codes

DimensionsG90
G91Absolute dimension
Incremental dimensionUnit of measureG70
G71Unit of measure inch (at start of program)
Unit of measure mm (at start of program)Other G codesG29
G38Load current position (e.g. circle center as pole)
Stop program run

G38	Stop program run
G51*	Prepare tool changer (with central tool magazine)
G79*	Cycle call
G98*	Set label

*) blockwise effective function

Addresses

/ (441 00000	
%	Start of program
%	Program call
#	Datum number with G53
A B	Rotation around the X axis Rotation around the Y axis
C	Rotation around the Z axis
D	Q parameter definitions
DL DR	Wear compensation length with T Wear compensation radius with T
E	Tolerance with M112 and M124
F F F	Feed rate Dwell time with G04 Scaling factor with G72
F	Factor F reduction with M103
G	G codes
H H H	Polar angle Rotation angle with G73 Limit angle with M112
Ι	X coordinate of the circle center/pole
J	Y coordinate of the circle center/pole
К	Z coordinate of the circle center/pole
L L L	Setting a label number with G98 Jumping to a label number Tool length with G99
Μ	M functions
Ν	Block number
P P	Cycle parameter in machining cycles Value or Q parameter in Q-parameter definition
Q	Q parameter

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{	Polar coordinate radius	
{	Circle radius with G02/G03/G05	
7	Rounding radius with G25/G26/G27	
3	Tool radius with G99	
S	Spindle speed	
S	Spindle orientation with G36	
Г	Tool definition with G99	
Г	Tool call	
Г	Next tool with G51	
U	Axis parallel to X axis	
\checkmark	Axis parallel to Y axis	
N	Axis parallel to Z axis	
Х	X axis	
Y	Yaxis	
Z	Zaxis	
×	End of block	
_ist of contou		G37 P01
Defining con	tour data	G120 Q1
Defining con Drill define/ca	all	
Defining con Drill define/c Contour cycle	tour data	G120 Q1
Defining con Drill define/c Contour cycle Cycle call	tour data all e: Pilot drilling	G120 Q1 G121 Q10
Defining con Drill define/c Contour cycle Cycle call Roughing m	tour data all e: Pilot drilling ill define/call	G120 Q1
Defining con Drill define/ca Contour cycle Cycle call Roughing m Contour cycle	tour data all e: Pilot drilling ill define/call	G120 Q1 G121 Q10
Defining con Drill define/c Contour cycle Cycle call Roughing m Contour cycle Cycle call	tour data all e: Pilot drilling ill define/call e: Rough-out	G120 Q1 G121 Q10 G122 Q10
Defining con Drill define/ca Contour cycle Cycle call Roughing m Contour cycle Cycle call Finishing mi	tour data all e: Pilot drilling ill define/call e: Rough-out Il define/call	G120 Q1 G121 Q10
Defining con Drill define/ca Contour cycle Cycle call Roughing m Contour cycle Cycle call Finishing mi Contour cycle	tour data all e: Pilot drilling ill define/call e: Rough-out	G120 Q1 G121 Q10 G122 Q10
Defining con Drill define/ca Contour cycle Cycle call Roughing m Contour cycle Cycle call Finishing mi Contour cycle Cycle call	tour data all e: Pilot drilling ill define/call e: Rough-out Il define/call e: Floor finishing	G120 Q1 G121 Q10 G122 Q10 G123 Q11
Defining con Drill define/ca Contour cycle Cycle call Roughing m Contour cycle Cycle call Finishing mi Contour cycle Cycle call Finishing mi	tour data all e: Pilot drilling ill define/call e: Rough-out Il define/call e: Floor finishing	G120 Q1 G121 Q10 G122 Q10
Defining con Drill define/ca Contour cycle Cycle call Roughing m Contour cycle Cycle call Finishing mi Contour cycle Cycle call Finishing mi Contour cycle	tour data all e: Pilot drilling ill define/call e: Rough-out il define/call e: Floor finishing il define/call	G120 Q1 G121 Q10 G122 Q10 G123 Q11
Defining con Drill define/ca Contour cycle Cycle call Roughing m Contour cycle Cycle call Finishing mi Contour cycle Cycle call Finishing mi Contour cycle Cycle call	tour data all e: Pilot drilling ill define/call e: Rough-out il define/call e: Floor finishing il define/call	G120 Q1 G121 Q10 G122 Q10 G123 Q11
Defining con Drill define/ca Contour cycle Cycle call Roughing m Contour cycle Cycle call Finishing mi Contour cycle Cycle call Finishing mi Contour cycle Cycle call	tour data all e: Pilot drilling ill define/call e: Rough-out Il define/call e: Floor finishing Il define/call e: Side finishing program, return	G120 Q1 G121 Q10 G122 Q10 G123 Q11 G124 Q11

Contour	Programming sequence of the contour elements	Radius Compensation
Inside (pocket)	clockwise (CW) counterclockwise (CCW)	G42 (RR) G41 (RL)
Outside (island)	clockwise (CW) counterclockwise (CCW)	G41 (RL) G42 (RR)

17.6 DIN/ISO function overview

Coordinate conversions

Coordinate conversion	Activate	Cancel	
Zero point shift	G54 X+20 Y+30 Z+10	G54 X0 Y0 Z0	
Mirroring	G28 X	G28	
Rotation	G73 H+45	G73 H+0	
Scaling factor	G72 F 0.8	G72 F1	
Machining plane	G80 A+10 B+10 C+15	G80	
Machining plane	PLANE	PLANE RESET	

Q parameter definitions

Function
Q parameter: Assign
Q parameter: Addition
Q parameter: Subtraction
Q parameter: Multiplication
Q parameter: Division
Q parameter: Square root
Q parameter: Sine
Q parameter: Cosine
Q parameter: Root sum of squares $c = \sqrt{(a^2+b^2)}$
Q parameter: If equal, go to label number
Q parameter: If unequal, go to label number
Q parameter: If greater, go to label number
Q parameter: If less than, go to label number
Q parameter: Angle with ARCTAN (angle from c sin a and c cos a)
Q parameter: Error message
Q parameter: External output
Q parameter: Write file
Q parameter: Read system data
Q parameter: Send value to PLC

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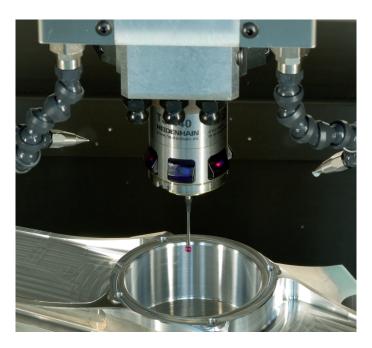
help you reduce non-productive time and improve the dimensional accuracy of the finished workpieces.

Workpiece touch probes

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Signal transmission by cable Infrared transmission Infrared transmission

- Workpiece alignment
- Setting datums
- Workpiece measurement



Tool touch probes

TT 140	Signal transmission by cable
TT 449	Infrared transmission
TL	Contact-free laser systems

- Tool measurement
- Wear monitoring
- Tool breakage detection



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