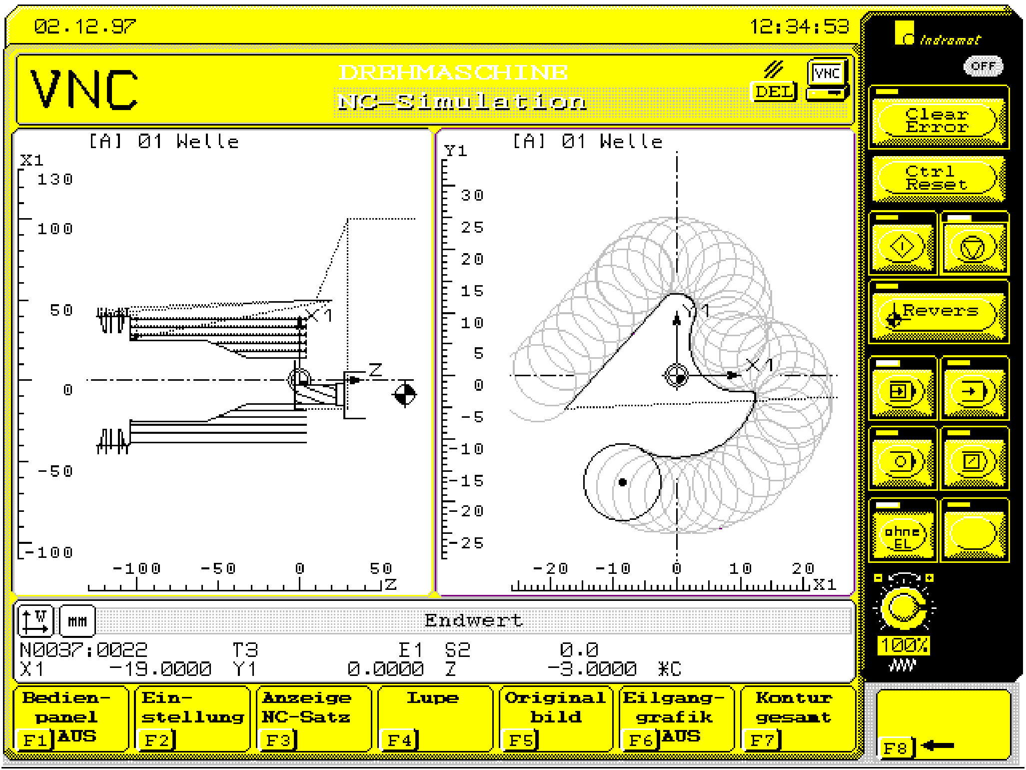
engineering
mannesmann
Rexroth



MT-CNC/MTC200

NC Simulation

17VRS

Applications Manual

DOK-MTC200-NC**SIM*V17-ANW1-EN-P

277436

Indramat

Title NC Simulation

Type of document Application manual

Documentation type DOK-MTC200-NC**SIM*V17-ANW1-EN-P ·

Internal filing

- Drawing number, 109-1041-4104-00_EN/12.97

Purpose of the document

This document is intended to be used by the user of the machine tool. It describes

- operation and installation of the virtual NC,
- the function of the NC simulation,
- and its handling.

Configuration control

Documentation identification of previous releases	Release date	Comment
109-1041-4104-00	12/97	New issue

Published by

INDRAMAT GmbH • Bgm.-Dr.-Nebel-Str. 2 • D-97816 Lohr a. Main

Phone +49 (0)9352/40-0 • Tx 689421 • Fax +49 (0)9352/40-4885

Dept. ENC (JA)

Contents

1 General

1.1 Preface

Application

NC simulation is intended to be an aid for visual control and for testing NC programs within the scope of NC part programming, and a graphically supported position display that is used during automatic and MDI mode.

Classification

NC simulation is an optional component of the graphical user interface (GUI) for MTC200 and MT-CNC. It is available in two configuration levels.

Configuration levels

Configuration level 1 contains the on line version of the NC simulation. It is executable under the MS-DOS and WindowsNT operating systems. Configuration level 2 contains on line simulation and off line simulation. Off line simulation (virtual NC) is a WindowsNT application. Thus, it requires a WindowsNT operating system.

Ordering information

The NC simulation options can be ordered under the following type specifications:

Option	Type specification
NC simulation on line - SIM	SWS-MTC200-SIM-17VRS-MS-MS*DOS
NC simulation on line and off line - SIM	SWS-MTC200-SIM-17VRS-MS-WIN*NT

Fig. 1-1: Type specifications of NC simulation

Note: The operation of the off line simulation (virtual NC) requires communication addresses and device addresses to be configured and machining options to be selected (see 5.1 Configuration File IND_DEV.INI, page 5-1).

This document describes both, on line simulation and off line simulation.

1.2 Base Modes

Base modes

In connection with the utilization of the NC simulation, two base modes of the MTC controller must be distinguished:

- on line mode and
- off line mode.

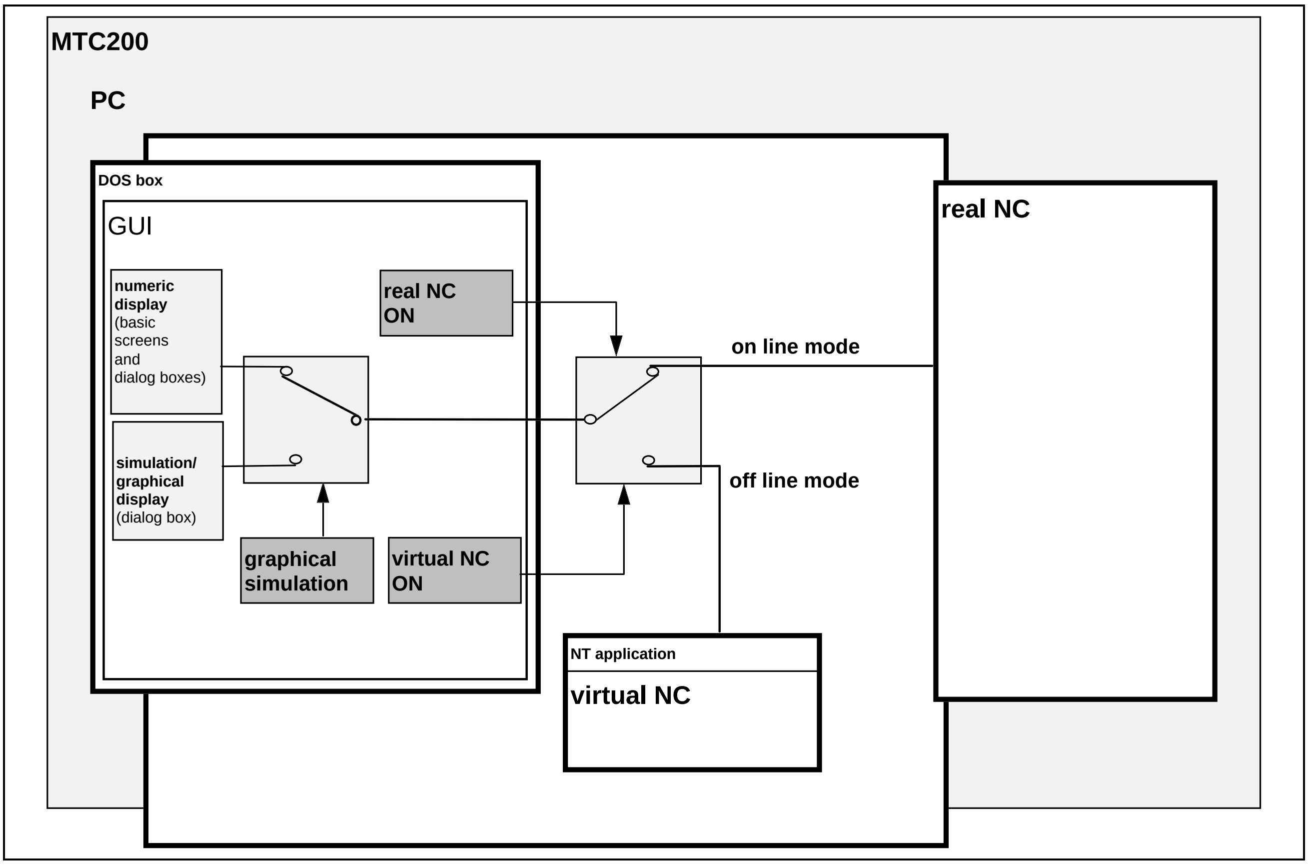


Fig. 1-1: Structure of on line and off line operation

on line operation

On line operation means the utilization of the physically existent MTC (that will be referred to in this document as *real* NC) and the SPS for controlling the machine functions and NC axes of a machine tool.

The data that is immediately required for the machining process (such as parameter record, cycles, NC programs, tools lists, D correction lists, zero offsets, NC events, and NC variables) are stored in the MTC storage device. Providing the MTC with the above-mentioned data is done in the usual way by selecting and downloading the NC data and NC programs that are stored on the hard disk of the operator terminal.

Since the data in the real NC is used for the graphical representation, this method of operation is only possible simultaneously to the machining sequence on the machine.

The machine can be controlled via machine keys and via SPS soft keys.

off line operation

Off line operation permits an NC program to be executed without actually employing a real NC. A software simulation in the NC (the *virtual* NC) substitutes for the controller. The NC functions that are required for the NC program execution are implemented in that simulation.

The virtual NC works completely independently of the operating modes of the real NC. Albeit its data storage is separated from the real NC, it is of the same structure. Independently of the real NC, it must equally be provided with data. The entire data set of a real plant on the hard disk may be used for the real NC and for the virtual NC (see Fig. 1-2). This enables a completely different NC program to be tested and/or simulated at the same time, independently of the actual machining process on the machine tool.

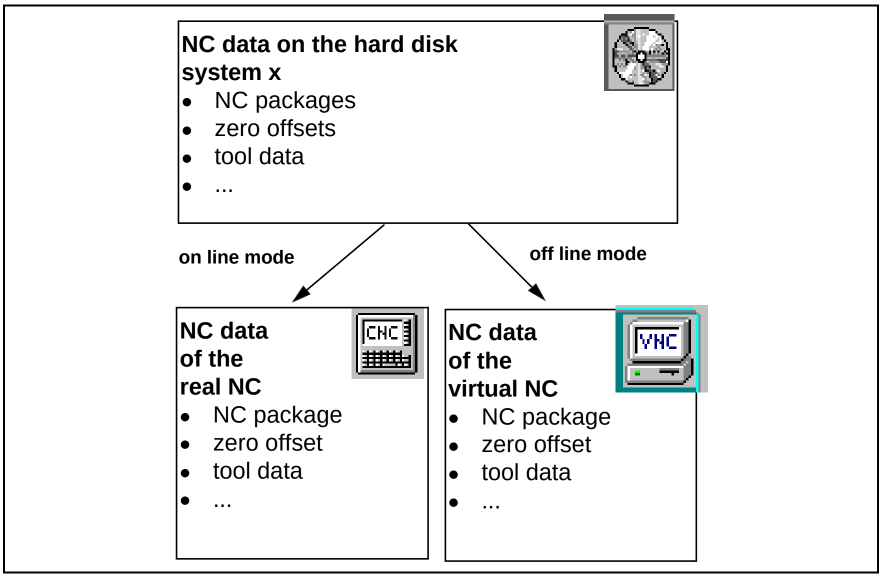


Fig. 1-2: Data flow in on line and off line operation

The virtual NC only works if *automatic mode* has been selected as the main mode. It is controlled via a *control panel* that appears on the screen instead of the SPS soft keys.

Once off line mode has been selected, controlling the real NC, that continues its operation, is very restricted because there are no operating state displays on the screen of the operator terminal (exception: Messages of malfunctions in the system or in a station).

The virtual NC may also be used on its own as a PC variant, e.g. in *production planning*. Here, there are no interdependencies with a real NC, and special control hardware is not required.

Note: **Off line operation is only possible if the GUI executes as a DOS box under the WindowsNT operating system.**

Base mode selection

Off line mode is implemented via a separate device number. This means that changing between on line mode and off line mode is identical to the usual device changeover. Starting from the GUI base menu, the change proper is performed via the function key sequence (default soft key assignments) <F5> Selections, followed by <F5> Virtual NC or <F6> Real NC.

In order to enable the user to be informed of the selected base mode and the database, the banner line of the screen shows the icons of the real NC, of the virtual NC , and of the hard disk as the common database.

Fehler! Kein gültiger Dateiname.

This symbol shows that the displayed data are related to the real NC and that on line mode is active for the graphical display.

Fehler! Kein gültiger Dateiname.

Once the virtual NC has been selected, the real NC is disconnected and the symbol of the virtual NC is displayed (off line mode).

Note: **Changing the base mode is possible at any moment and without losing information. The virtual NC is set to „sleeper“ state when the system is changed over to the real NC.**

1.3 Function of NC Simulation

Scope of functions

NC simulation permits a geometric verification of the NC *control program blocks* to be performed. To do this, each block is represented graphically on the screen simultaneously to its execution. Thus, NC simulation is only possible in the main modes

- automatic mode, and
- manual direct input MDI (on line only).

The graphic that is produced in the simulation result consists of lines that represent the motion paths (wire model) and a tool graphic. Both components are projected on the screen under different viewing angles (parallel projection).

In its current version, the simulation is only designed for a one-station display.

Communications with NC

Simulation works blockwise. At the beginning of a block, all relevant data and end-of-block co-ordinates are transferred to the simulation module. The time required for the simulation depends on the base mode:

- on line simulation: The timing of the block change is not influenced by the graphical representation; it is solely determined by the real NC. The graphic of an NC block cannot be displayed if the execution time of the block is shorter than the time required for data transfer and simulation (*lost blocks*).

  Note: In on line mode, NC simulation is only of limited use for NC programs that contain a large number of blocks which require little time only.

- off line simulation: NC-block execution is not performed in real-time, i.e. NC program execution within the virtual NC is not carried out using the programmed feed. The timing is always determined by the graphical representation. Due to the data exchange, the simulation of blocks that require only little execution time (no movement of the NC axes or short distances), takes significantly longer than their execution in the real NC.

  Note: Compared with on line mode, the program execution time required in off line mode is higher. This is caused particularly by blocks that require little execution time in on line mode.

Restrictions

In first instance, NC simulation is restricted to the following applications:

- Main machining modes: Turning and milling/boring
- Machine configuration:
  at least two linear main axes at the station;
  a maximum of two workpiece spindles (turning), and
  no rotary axes that swivel the tool (e.g. rotary axes of a general-purpose milling head).
- The rotary main axes rotate, according to their meaning, around X, Y and Z. Irrespective of the meaning of the assigned rotary axis, main spindles with rotary axis capability always rotate around Z.
- Special interdependencies of the NC axes (e.g. telescopic axes) are not taken into account.
- Only one rotary axis may interpolate in an NC block.

Requirements

Successful utilization of the simulation requires the following conditions to be satisfied:

- The pre-selected station has at least two linear main axes assigned.
- All relevant NC data items have been loaded into the data storage device, and an NC program has been pre-selected;
  or
  the station is in MDI mode.

Activation

Starting from the GUI base menu, the graphical representation of workpiece machining is activated via the following operator input steps (default function key assignments):

<F1> Production - <F3> NC program - <F7> Special functions -

<F4> Graphic simulation

Activation may differ from the key-in sequence described due to modification of the standard function key assignment carried out by the machine tool builder. Please refer to the machine operators manual.

1.4 Screen Layout

Display information In addition to the graphical information, the simulation screen informs of the active modes (base and main mode) and about a minimum number of machine states at the block end.

Screen layout The screen is subdivided into different areas. Size and arrangement of those areas may differ according to the given conditions at the station concerned and to the currently made simulation selections. The figures below show one view of the simulation screen for on line simulation, and two views of the off line simulation.

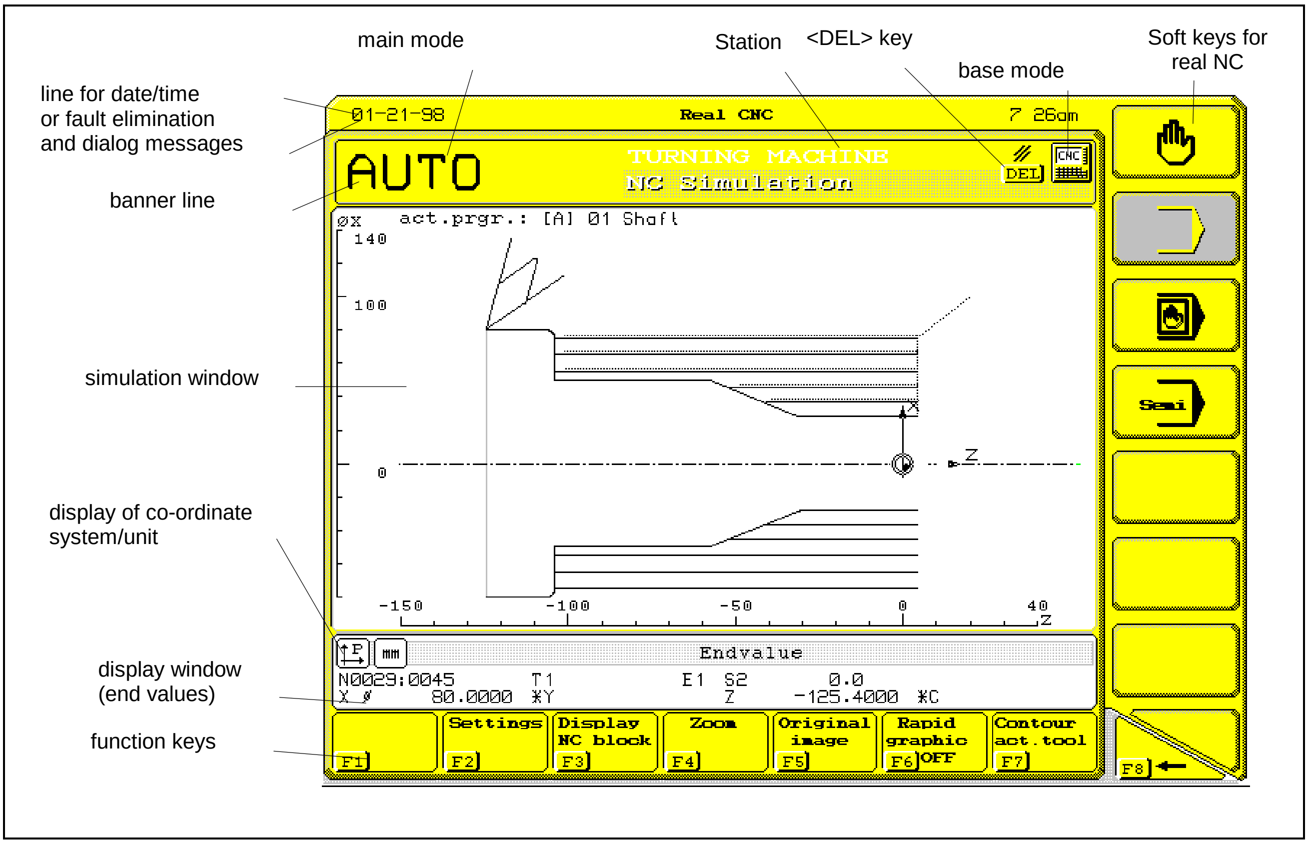


Fig. 1-3: Screen layout - on line (one view)

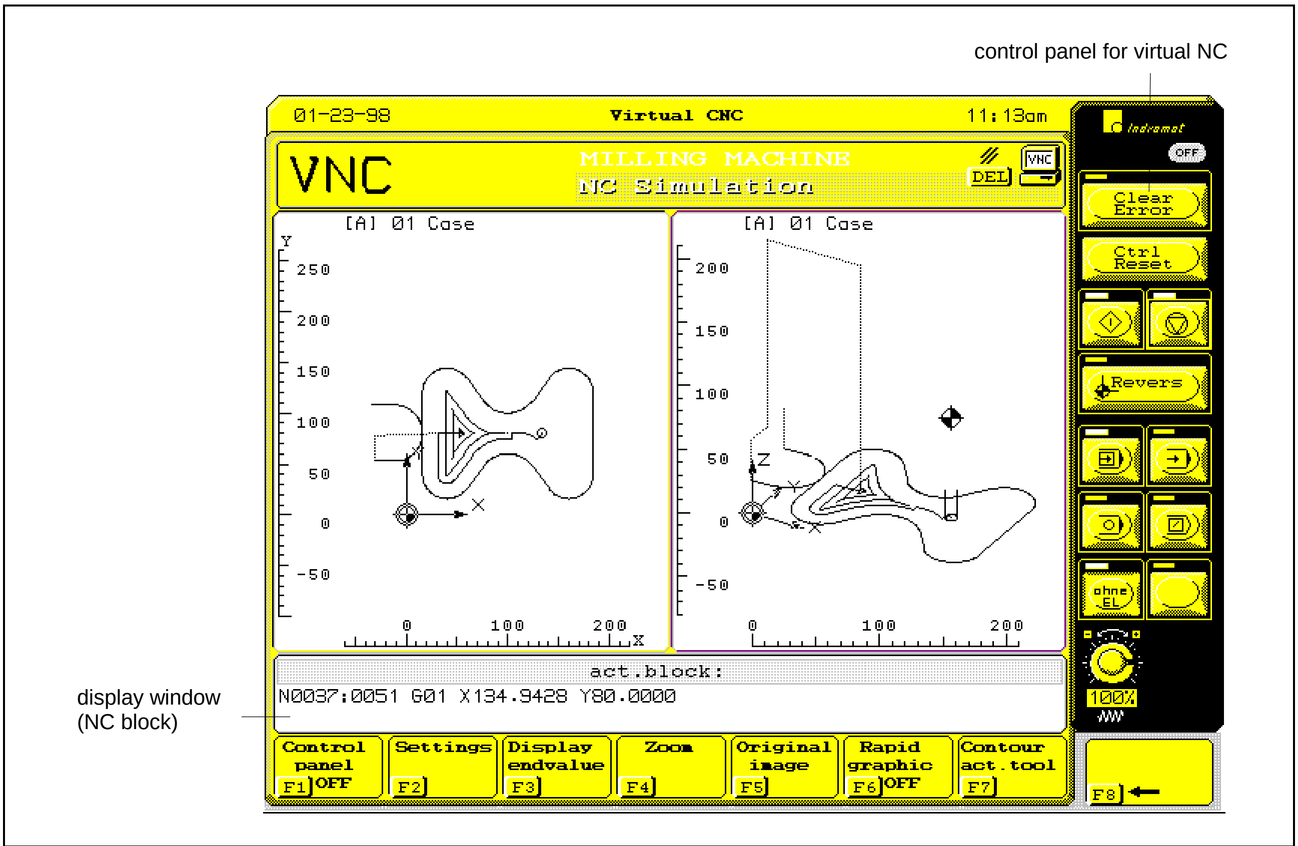


Fig. 1-4: Screen layout - off line (two views)

Banner line

Main mode, station name and the icon of the virtual or real NC are displayed in the banner line. The <DEL> key shows that the graphical representation of the machined contour may be deleted (see 3.1).

Simulation window

The simulation window is the part of the screen area that is reserved for the simulation graphics. Simulation is possible in one or two windows (e.g. in two views). In *multiple-window technique*, the simulation windows may be arranged horizontally or vertically. To a certain extent, separate selections can be specified for each window. The active window (to which the selections are related) is marked by a red frame.

The name of the active program is displayed in the upper part of the simulation window.

Display window

The display window shows the end values (end-of-block co-ordinates), the current block number, the current tool number T, and the current tool tip number E (*end value display*)

- and/or -

the text of the current NC block (*NC block display*).

Provided that there is sufficient space, both display variants are shown in the display window. If the space proves insufficient, the display variants can be toggled via the <F3> function key.

The co-ordinates may be displayed in two systems: in the *workpiece co-ordinate system* or in the *machine co-ordinate system*.

Workpiece co-ordinates: The co-ordinate values specify the position of the tool preset position (tool correction values included in calculation), related to the current zero offset, including rotation by phi, and in the current unit system mm/inch. In diameter programming, the co-ordinate of the axis of the meaning X appears in the diameter unit.

Machine co-ordinates**:** The co-ordinate values correspond to the absolute position of the tool carrier reference point with respect to the machine zero point (tool corrections not taken into account). They are not displayed in the diameter unit. The unit of measurement corresponds to the declaration in the machine parameters.

The co-ordinate system and the unit of measurement are documented by the familiar symbols.

In the display window, an output field is reserved for each NC axis. Depending on the available space, they are sorted, by axis meaning, in lines or columns. There is no correlation between the co-ordinate display and the display contents selected on the GUI base screen.

To a large extent, the axis identification corresponds to the designation that is used in the GUI position display:

Active axis: axis designation, followed by the diameter symbol

Example: X2 ∅

Inactive axis: dummy symbol ('*' followed by a letter according to the axis meaning)

Example: *C for 3rd rotary main axis.

What are the differences in the GUI base screen?

Spindles are an exception. Spindles with positioning capability are included in the co-ordinate display. In spindle mode, the dummy symbol that is used for the inactive rotary axis of a main spindle with rotary axis capability is replaced by the designation of the related spindle and its angular position.

Function keys

Function keys permit the required selections to be made and the representation to be influenced. The key assignments and the related key labels are invariable.

SPS soft keys

SPS soft keys are immediately connected with machine handling. They are only visible in on line simulation on the machine tool. SPS soft keys trigger switching signals that have an effect on the real NC and/or on the machine. Assignments and functionality of the SPS soft keys are defined by the machine manufacturer.

Control panel

In off line mode, the control panel is available for handling the virtual NC. The control panel contains all keys and controls that are required for automatic mode (start and stop keys, override, RESET, etc.).

1.5 Control Panel

Availability The control panel is the control element of the virtual NC. It is available in the GUI base screen and in all dialog boxes, including the NC simulation (exception: graphical NC editor GNE).

Handling The control panel is not visible after a change has been made into or from a GUI dialog box. Pressing the <ALT>+<S> hot key displays it. Pressing that hot key again or pressing the OFF key on the control panel causes the control panel to disappear. The control panel must be switched off when the selected dialog box requires an input to be made via the cursor keys.

Keys The following figure shows and names the keys that are available on the control panel. The system or station fault indicators are related to a real plant that has been assigned. They are only visible on the panel if such a fault has actually occurred.

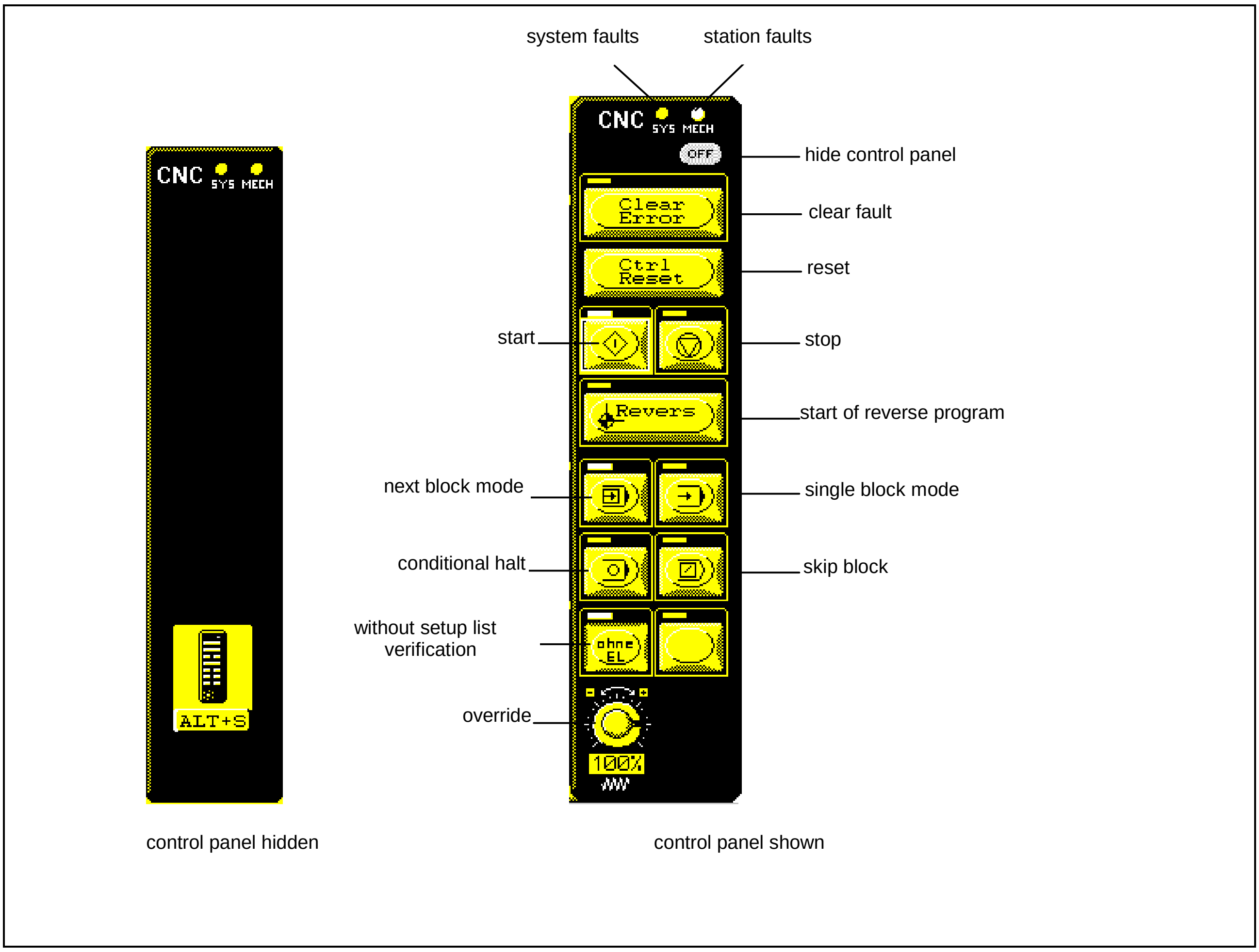


Fig. 1-5: Control panel

To control the panel, the required key must be selected via the cursor keys. The selected key is marked by a red frame. It is activated by pressing the <ENTER> key.

Override The override value is increased/decreased via the <+>- / <-> buttons.

Within NC simulation, the override performs the function of a feed override. Please note that the override position 120% selects the highest program execution speed possible (that is in no connection with the programmed feed rate). Outside of NC simulation, override modifies the (feed-independent) timing of the block change.

2 Graphical Representation

2.1 Graphical Conversion of the Movements of NC Axes and Spindles

This chapter is dedicated to the problem of which axes are taken into account in the graphical simulation representation.

linear main axes

In the graphical representation, the existing (maximum three) linear main axes (with the axis meanings X, Y and Z) are considered in a cartesian co-ordinate system.

If, within an NC program, other axes have dynamically the meaning X, Y or Z assigned, they will take the position of the axes of the base state.

rotary main axes

The rotary main axes are interpreted as rotation axes for the workpiece (*workpiece rotation axes*) such that the axis of the meaning A rotates around X, B rotates around Y, and C rotates around Z.

Irrespective of their axis meaning, the rotary axes that have been allocated to main spindles are considered as rotating around Z.

linear and rotary secondary axes

Axes of the meanings U, V, and W are graphically not represented. Merely their end positions are shown in the co-ordinate display. A secondary axis may temporarily have the meaning of a linear main axis assigned. It will then be simulated as a linear main axis.

Main spindles

In simulation, distinction is made between tool spindles (that accommodate and drive the tools) and workpiece spindles (rotating workpiece).

Within the main machining procedure of *turning*, at least one of the existing spindles is declared to be the workpiece spindle. (With multiple-spindle turning machines, these are up to two main spindles with rotary axis capability, or digital main spindles with allocated rotary axis, or two spindles of the same type.) A possible second workpiece spindle acts as the counter spindle. A spindle that is not included in that selection is declared to be a tool spindle.

In simulation, the angular position of the workpiece spindle(s) of a turning machine is interpreted as the movement of a rotary axis of the meaning C. This enables NC programs for turning, that contain subprocesses which have been programmed via spindle positioning, to be simulated like real rotary axis programming. The state of a workpiece spindle (rotation or standstill) has an effect on the representation of the motion graphics (see 2.4).

In the main machining procedure of *milling/boring*, each spindle is considered as a tool spindle. The spindle states are not taken into account in the graphics.

2.2 Co-Ordinate System and Co-Ordinate Transformation

Background information about views, co-ordinate systems, and the simulation of rotary axes is provided for the interested user and for solving problems.

Base co-ordinate system

The *base co-ordinate system* is a right-handed cartesian co-ordinate system whose abscissa points in the direction of the linear main axis of the meaning X, whose ordinate points in the direction of the linear main axis of the meaning Y, and whose applicate points in the direction of the linear main axis of the meaning Z. With respect to its orientation on the concrete machine, is has already been determined by the existence of two linear main axes. Due to its dependency on the arrangement of the linear main axes, it is space-invariant with respect to the machine (i.e. it does not rotate).

Views

A view is the two-dimensional map of a geometry in the base co-ordinate system onto the co-ordinate system of the image surface. The necessary co-ordinate transformation, which is based on parallel projection, is known as *image transformation*. In NC simulation, there are three orthogonal views (XY, ZX and YZ) available that are named after the axes of the base co-ordinate system that are parallel to the image plane. The arrangement of the axes of the base co-ordinate system on the image plane can be adjusted according to the installation position of the NC axes and/or the user's habits. In the 3-D view, which is another view, the user may modify the viewing angle as required during the execution time.

Viewing angle

The viewing angles of any spatial view are specified in a polar co-ordinate system.

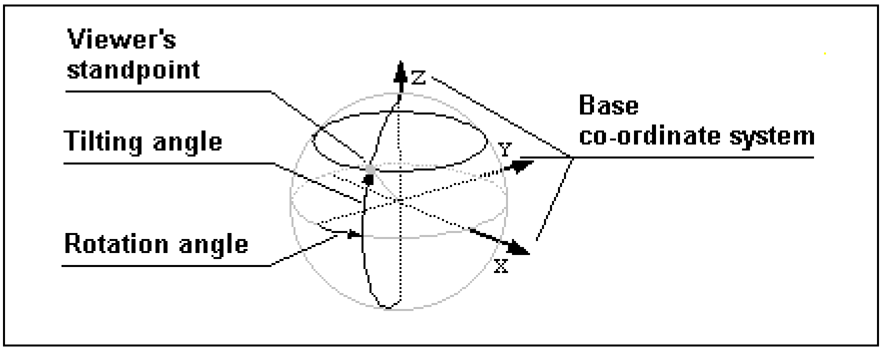


Fig. 2-1: Viewing angle in a polar co-ordinate system

The polar co-ordinate system possesses an analogy with the geographical latitude/longitude net. To support imagination, the polar co-ordinate system is arranged such that the „equator“ is parallel to the floor of the place where the machine tool is installed.

A change in the viewing angle, that corresponds to the geographical longitude, is caused by moving the viewer's standpoint around the machine. That angle is known as *rotation angle*. Expediently, the rotation angle of 0 degrees (that corresponds to the zero meridian in the geographical latitude/longitude net) is defined such that the main view of the machine can be seen from that position.

The modification of the angle that corresponds to the geographical latitude is obtained by raising or lowering the viewer's standpoint. This viewing angle is referred to as the *tilting angle*. The angle of 0 degrees is on the „equator plane“; 90 degrees select the top view („north pole“).

The location of the base co-ordinate system with respect to the polar co-ordinate system is variable. Taking the installation position of the NC axes into account, the user shall arrange it such that it obtains the described orientation with respect to the machine/installation location.

Rotary axes

If there a no workpiece rotation axes at a machine or are the workpiece rotation axes in a 0-degree position, the base co-ordinate system basically agrees with the co-ordinate system that is spanned by the linear main axes. If rotary axes are added, the workpiece changes its position relatively to the declared base co-ordinate system. There are two implementation variants for simulating a rotary movement:

Complete simulation

- The workpiece remains stationary on the screen, and NC axes and tool (i.e. the entire machine) rotate around the workpiece.
  This procedure permits a complete NC program to be simulated is a stationary image (no image changes for rotating the workpiece).
  The position of the rotary axis is known in the turning process (it runs through the machine zero point in X), and this type of main machining procedure usually performs simple machining in conjunction with rotary axes. The *complete simulation* is therefore reserved for the main machining procedure turning.
  The complete simulation requires an additional co-ordinate transformation that converts the (rotating) linear main axes into the base co-ordinate system. That transformation is determined by the current rotary axis position.

(*) Side-by-side simulation

- The workpiece rotates while the NC axes and the tool remain stationary. Albeit this procedure is closest to reality, it provides an unsteady image during rotary axis interpolation (the viewing angle onto the workpiece changes). It is intended to be used for the main machining procedure of milling/boring because the (compared with turning) more complex multiple-side machining procedures are mapped under a constant viewing angle. From the perspective of the NC simulation, the length of the rotary axes is not defined. Graphics that have been produced under different positions of the rotary axes can therefore not unambiguously be put in a geometric correlation. The result is that side-by-side simulation only shows the graphic that either has been produced under the current rotary axis position or is being produced. An overall impression of the workpiece cannot be provided.
  (*) Side-by-side simulation is in preparation.

Co-ordinate system

In the simulation window, co-ordinate axes are arranged in the horizontal and the vertical direction. When they run in parallel to the linear main axes, those axes have the corresponding axis identifications assigned and are structured according to the currently valid co-ordinate system and the current display variant (machine co-ordinates/workpiece co-ordinates). Otherwise, the co-ordinate axis only possesses a function as a scale. There is a co-ordinate trihedron in the origin that permits the position of the linear main axes to be deducted even if they are not parallel to the image co-ordinates.

With polar co-ordinate interpolation (G31), the co-ordinate system becomes a left-handed system if the axis parameter of the rotary axis Cxx.076 provides for a reversion.

2.3 Tool Representation

The represented tool graphic is dependent on the data of the tool list and the NC program. The chapter provides the interested user with a deeper insight into the connections and answers occurring problems.

Points at the tool

The tool graphics includes the representation of specific points and/or a graphic of the tool contour. Of the specific points, the tool carrier reference point is represented as 

and the tool setting point as • .

For the active tool T0, the tool carrier reference point is always visible. Otherwise it is only shown if it does not cover the rest of the tool graphics.

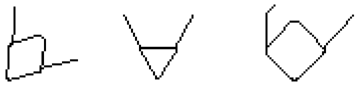
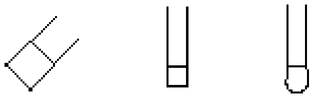
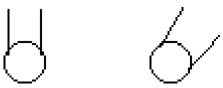
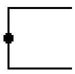
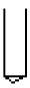
The tool setting point will not be shown as a marker if it disturbs the tool contour graphic (e.g. with a turning tool contour or a milling tool of a small diameter) or coincides with the tip of a tool (e.g. twist drill).

Tool contour

The tool contour depends on the base tool data, the tool tip data, the current tool tip number E, the data in the NC program (G groups), the machine parameters (e.g. existing spindles), the main machining procedure that has been selected in the simulation, and the viewing angle (image transformation).

Tool type

The represented base contour is referred to as the tool type (e.g. twist drill, radial outside recessing tool). It is not identical to the correction type of the tool list; it is internally defined on the basis of the above-mentioned data (except image transformation). The tool type that is determined by the simulation does not necessarily agree with the true type of the tool, and may change during the utilization of a tool and/or a tool tip. The following table shows the correlation between the tool type and the individual data items:

Tool groups and tool types	Dependence on data from tools list	Dependence on data from machine parameters, simulation adaptation, and NC program
Turning tool 	• Correction type 3 • Tool tip position different than 0 or tool tip radius >0.	• Main machining procedure of turning • G18 • Special conditions for existing tool spindle (see footnote (1)).
Two-tipped contour tool or recessing tool 	• Same as turning tool • There are exactly two different tips of the same radius. • Length dimensions and tool tip position match without contradiction.	Same as turning tool
Mushroom tool 	1 tool tip: same as turning tool, but tool tip radius >=3 mm 2 tool tips: same as two-tipped contour tool; the centers of both tool tip radii are identical	Same as turning tool
Center boring tool 	• Correction type 3 • Tool tip orientation 0 • Tool tip radius 0	• Main machining procedure of turning • G18 • Workpiece spindle rotates
Turning cutting edge drill 	• Correction type 3 • Exactly two different edges • One edge with tool tip orientation 0 • One edge with tool tip orientation different than 0, 5, and 7 • Length dimensions and tool tip position match without contradiction	Same as center boring tool
Bar stop 	• Correction type 3 • Tool tip orientation 0 • Tool tip radius 0	• Main machining procedure of turning • G18 • Workpiece spindle and tool spindle stopped
General boring tool 	Correction type 1 or 5 **- or -** correction type 2 or 4 with tool tip radius 0	See footnote (2) for orientation of the longitudinal tool axis.

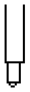
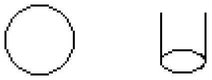
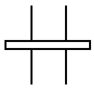
Tool groups and tool types	Dependence on data from tools list	Dependence on data from machine parameters, simulation adaptation, and NC program
Multi-diameter drill 	• Correction type 2 • There are exactly two tip edges of different length and same sign	See footnote (2) for orientation of the longitudinal tool axis
Milling tools 	• Correction type 2 or 4 • Tool tip radius >0	See footnote (2) for orientation of the longitudinal tool axis
Side-milling cutter 	• Correction type 3 • Tool tip radius >0	• Main machining procedure of turning • Tool spindle exists • G18

Fig. 2-2: Dependence criteria of the tool types

Peculiarities

(1) If the machine features a spindle for driven tools, and if the workpiece spindle is not rotating, a turning tool is only displayed for cutter radii that are smaller than 8 mm. Otherwise: Milling tool type.

(2) The orientation in the main planes is perpendicular to the interpolation plane (G group 4). After planes have been changed and after G40, it may differ from it for several blocks (e.g. moving to the tool change, milling circular arcs on different planes). The orientation of the longitudinal axis of the tool depends on the sign of the L3 dimension and on the direction of the length correction (G group 13).

(3) If a tool type cannot be determined that matches the tool geometry, only tool setting point and tool carrier reference point are displayed in the image.

(4) With turning tools, the viewing angle plays a special role. The tool contour will not be displayed if there is a acute angle between the ZX plane and the direction of observation. Tool setting point and tool carrier reference point are shown instead.

A tool graphic does not appear before the first motion block that follows a tool change or tool tip change.

⇒ **If possible, do not specify the tool tip position 0 in conjunction with a tool tip radius 0 for a turning tool.**

⇒ **If possible, set the spindle(s) to the required operating state before the first motion is performed after the tool change.**

⇒ **Activate the required interpolation plane before the first motion after the tool change.**

Tool lengths and tool tip radii

The geometry correction values and the offsets (*) are used for computing the tool graphic. Wear corrections and D corrections are not taken into account. The diameter of a tool that has not been determined or cannot be determined by entering a tool tip radius is defined inside the simulation. The same applies to tool tip angles and cutting plate sizes of turning tools.

(*) Including the offset in the computation is available from release level 17V02.

Multi-edge tools

If a tool has several tips and if the geometric edge data differs, the system tries to unite two different edges in one graphic. Such a two-edged tool has been implemented in the types of recessing tool, two-edged contour tool, mushroom tool, turning cutting edge drill, and multi-diameter drill.

Twin tools

A twin tool exists, if two physically different tools are addressed by one tool number and different tool tip numbers. Albeit this exception has been taken into account in the tool graphic, only the graphic that belongs to the current tool (NC word E) is visible at any one time.

2.4 Motion Graphics

The graphical representation forms of the movements are different for the individual machining technologies. This chapter is directed to the interested user and for answering questions in the problematic situations.

Wire model

A wire model is produced in the result of simulating motion blocks. It represents the programmed end-of-block co-ordinates that are interconnected by lines.

Note: The wire model is empty at the beginning of the simulation of a new NC program and after its modification. Thus, motion graphics will not be visible then.

Rapid traverse movements

Rapid traverse movements with G0 and tool correction modifications without motion produce a graph of the point-point line type. Within the main machining procedure of turning, and in conjunction with rotating workpiece spindles, rapid traverse movements in XY and YZ view (the Y positions at the beginning and at the end of the block are both 0) are not represented as a line.

Feed motions

Feed motions are always output as a full line.

Turning graphics

Turning contours as a type of feed motion have their own representation form. Due to its intrinsic rotation, it provides a better illustration of the produced geometry at the workpiece. With respect to the representation, they differ in the individual views:

- If the rotary axis runs parallel to the image plane (ZX view, YZ view, some 3-D views), the turning contour is produced at either side of the rotation center (mirrored at the rotation center). The true turning diameter can be read from the image. If the X axis is neither in the image plane nor perpendicular to it (3-D view), the programmed path must be seen as the third graph from the respective perspective.
- In the XY view, only cylinders (straight line interpolation with the same X co-ordinate to the beginning and to the end of the block) are represented with a full circle that is concentric to the rotation center. Machining a cylindrical thread yields a three-quarter circular arc.
- When radius correction is de-activated, any non-orthogonal 3-D view leads to two contours that run in the ZX plane and are mirrored at the rotation center. When radius correction is activated, two more contours will be produced in the YZ plane. The family of four line graphs is interconnected by a full circle at the beginning of the contour (equidistant opening) and by a concentric full circle at the end of the

contour (equidistant deselection). A thread obtains a concentric three-quarter circular arc at the beginning and at the end.

Auxiliary graphics - turning

Each feed movement (turning) produces an auxiliary graphic as a full circle that is concentric to the rotation center, and touches the current tool setting point.

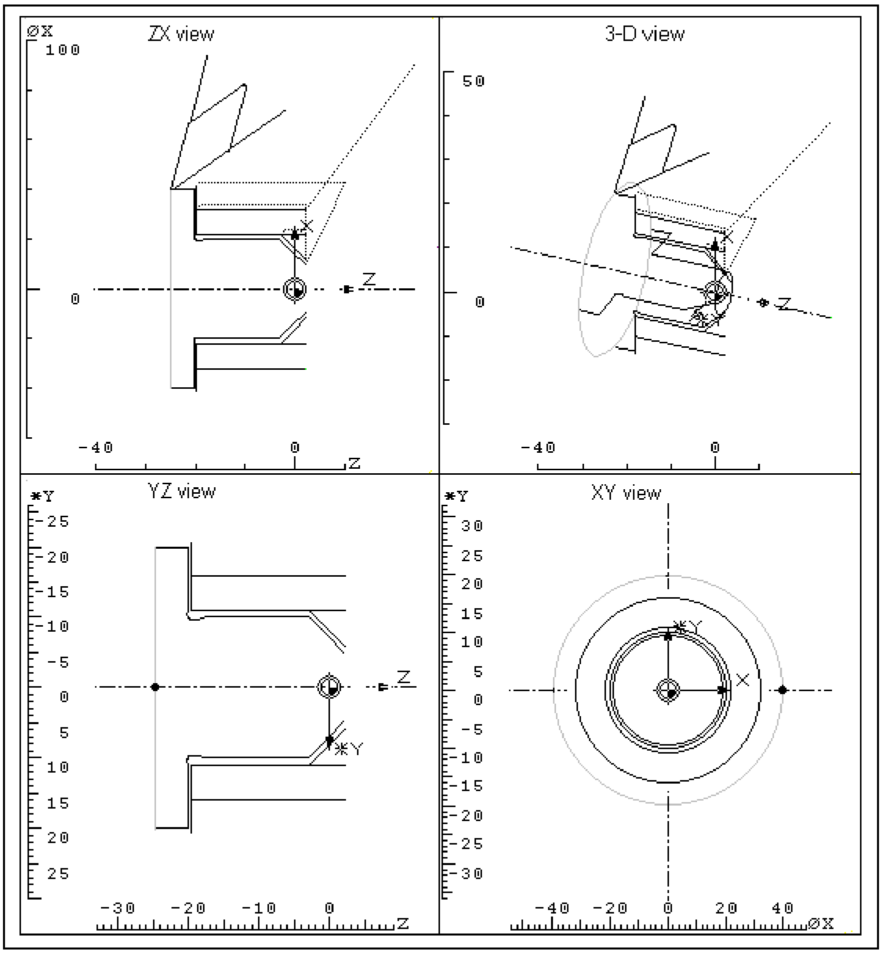


Fig. 2-3: Turning in four different views

If the specific turning graphic is not displayed as expected:

Causes

One or more technological requirements for turning have not been fulfilled.

⇒ Check whether interpolation plane G18 has been selected.

⇒ Check whether the workpiece spindle rotates.

⇒ If the turning machine has a Y axis: Check whether it is at position 0.

Feed motions milling/boring

Milling and boring merely produce simple full lines.

Boreholes

To make boreholes better visible in views in which the feed direction is perpendicular to the image plane (the movement merely produces a point), a marker is displayed for straight-line interpolation perpendicular to the interpolation plane and de-activated radius correction. This marker is + for a movement into the image plane, and ⊙ for a movement from the image plane.

Auxiliary graphics - milling

If the current tool belongs to correction type 2, 3, or 4, and has a tool tip radius that is greater than 0, and if a rotary axis does not interpolate in the block concerned, the surface that is covered by the cutter may (depending on a simulation setting) be made visible by a hatching. This hatched area is only displayed if the cutter diameter is shown as a circle. It consists of a family of circles of the tool diameter.

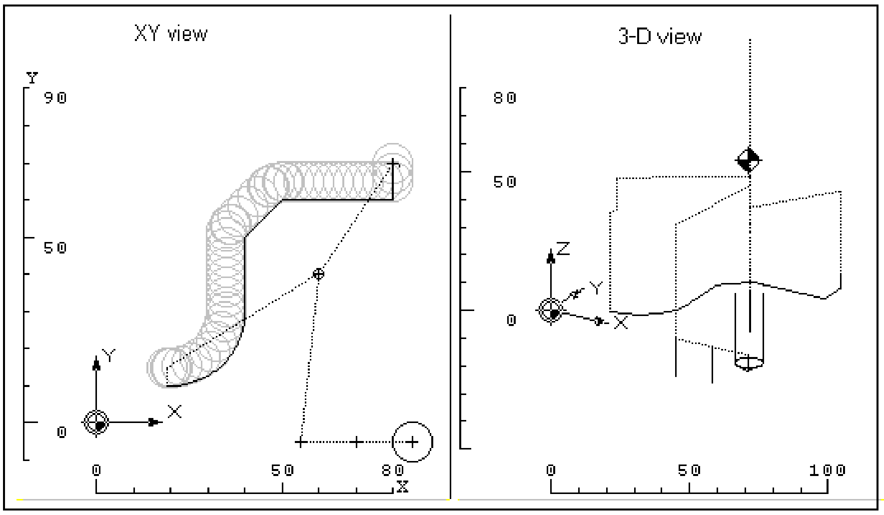


Fig. 2-4: Boring and milling graphics

Model file

The wire model is saved in a model file and is thus available for repeated image setup.

Note: Selecting the <DEL> key in the banner line deletes the wire model.

2.5 Image Dimensioning

This chapter explains the principles of defining the visible image segment. This knowledge is fundamental for understanding the image layout.

Image segment

The image segment is the part of the real machining image that is visible in the simulation window.

Image dimensioning

Image dimensioning stands for a true-to-scale conversion of the image and the definition of the image segment that is displayed in the simulation window.

Original image

The original image includes the image area that is defined inside the program without dialog input. The original image can be defined by three variants:

- By the travel range of the three linear main axes;
- by the map of the space that is used by the movement in the current NC program; or
- by the map of the space that encloses all movements in the NC program with the exception of the rapid traverse movements.

Determining the image boundaries

Unless it corresponds to the travel limits, the size of the original image depends on the concrete program. Thus, determining the image boundaries is necessary during the whole simulation. Besides the programmed path, the tool contour is also taken into account here.

Beginning of the simulation

At the beginning of the simulation, there cannot be any determined image boundaries yet. This is why the simulation of each NC program starts with the determined original image sizes of the last program to have been simulated.

Note: The last determined original image sizes are retained as long as an NC block with any motion or feed motion has been reached after the simulation has been started. Dimensioning is performed on the basis of the travel ranges if a determined original image size cannot be used in this case.

Zoom

Besides automatic image dimensioning, simulation permits an image segment to be selected by the user. There is a zoom function that permits the image to be enlarged.

Moving the image segment

Key combination <Ctrl>+<Cursor> (hot key) permits the image segment to be moved (see 3.2).

2.6 Simulating Cylinder Surface Machining

Peculiarities must be observed when the G32 command is used for simulating cylinder surface interpolation. This chapter is of particular interest to the users of machine tools that possess this special function.

Development simulation is in preparation.

Peculiarities

Development is another view that has not yet been mentioned. It has been developed particularly for cylinder co-ordinate interpolation using the NC command G32. Since development does not represent a view that can really be watched, various peculiarities in information processing and graphical display are valid here:

- The information about the block that is to be simulated is interpreted differently than in the usual simulation (rotary axis is assumed as being a linear axis) This is why a separate wire model shall be used for the development.

- The graphic used for development and other graphics cannot be accommodated in the same image. It must be displayed in a second simulation window (multiple-window technique); each effective radius RI in a separate image. If, in the course of the program execution, G32 is de-selected, the simulation window with the selected development is frozen. The window shows „G32 not active“ instead of the name of the active NC program.
- To obtain a representation in the plane, the cylinder surface must be „cut open“ at one point. Depending on the image segment, a graphical element that crosses the section line may be visible repeatedly and in parts.

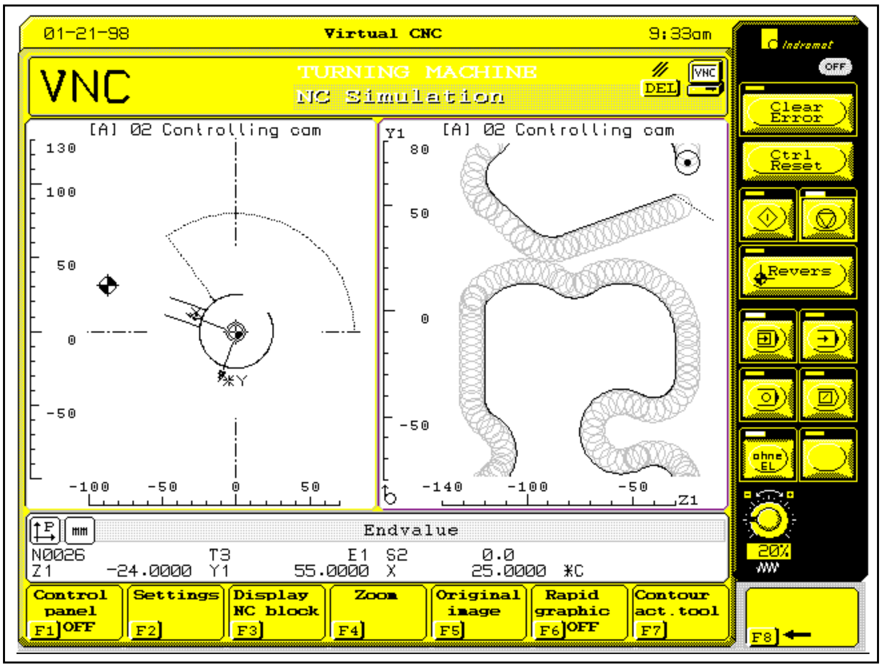


Fig. 2-5: Simulation of a development

Requirements for development simulation:

Requirements

- The station must possess a rotary axis.
- Development can only be selected in multiple-window technique.
- Development simulation is possible for only one rotary axis.

Image dimensioning

The maximum image size in the direction of the rotary axis is delimited by the circumference and, consequently, by the development radius RI.

Co-ordinate system

Irrespective of the setting of the axis parameter Cxx.076 (Direction for polar co-ordinate transformation), the simulation of a development is always performed in a right-handed co-ordinate system.

Like in an orthogonal view, any arrangement of the base co-ordinate system, that is described by the first and second axis address in the G20 block, is possible.

Selecting and de-selecting development

Note: The special processing of the NC information is interrupted once the „development“ view is de-selected. thus, the development-related wire model is no longer developed. Select multiple-window technique before you select the „development“ view.

3 Handling

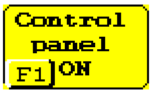
3.1 Function Keys

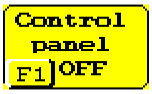
Description of the part of NC simulation handling that is performed via function keys.

Function key assignments

User or machine manufacturer cannot modify the function key assignments. Depending on the usability of the assigned function, a function key may be disabled. Some keys permit alternate states to be selected; they are provided with changing labels.

Control panel ON/OFF





Selecting the <F1> key toggles the control panel ON and OFF.

Only in the off line base mode, the control panel is available for controlling the virtual NC.

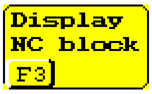
Alternatively, the <ALT>+<S> hot key may be used for this function.

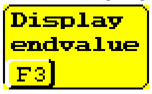
Settings

The <F2> function key permits further simulation settings and data adjustment to be made, that go beyond the <F3> through <F7> function keys.

A menu is displayed on the screen. The superimposed simulation graphic and the display window will not be updated before the „settings“ menu has been exited (see 3.3).

NC block display / end value display

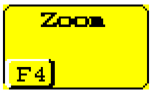




Selecting the <F3> key replaces the current contents of the display window with the NC block and/or with the end values (changing the display variant).

This key is disabled when block display and end value display are visible at the same time.

Zoom



The <F4> key permits the zoom function (enlargement of an image segment) to be activated in the active simulation window.
For this purpose, cross-hairs are displayed in the simulation window.

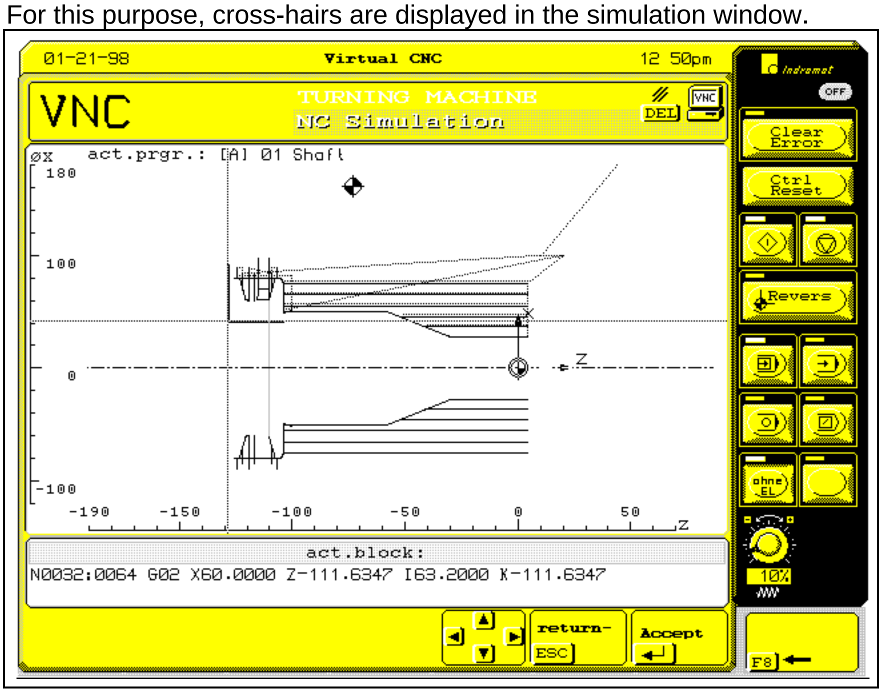


Fig. 3-1: Zoom function

Controlling the zoom function:

- Step 1: Use the cursor keys and position the cross-hairs such that they mark one of the corner points of the image segment you wish to enlarge;

  - or -

  press <ESC> to exit the zoom function.
- Step 2: Press the <ENTER> key to confirm the first corner point.
- Step 3: Use the cursor keys to expand or compress the appearing rectangle such that it frames the required image segment;

  - or -

  press <ESC> to continue with step 1.
- Step 4: Press <ENTER> to confirm the image segment.

Note: Pressing the <CTRL> key together with the cursor keys permits a fine positioning to be performed.

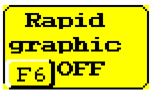
Original image

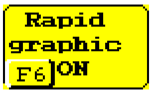
Selecting the <F5> key re-displays the image, that has been enlarged by the zoom function or modified by moving the image segment, in its original size.

The image size is determined by the currently effective original image variant and the simulated motion blocks (see 2.5).

The effect of the „original image“ key is restricted to the active simulation window.

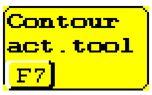
Rapid traverse graphic OFF/ON





The <F6> key is used for activating and de-activating the display of rapid traverse movements (point-point line type) in the active window.

Contour active tool/ overall contour



Pressing the <F7> key toggles the graphic, that is not allocated to the current tool number, ON and OFF. This function works on a per-window basis.

Note: „Contour active tool“ can only be used after the second tool after the start of the simulation has been changed in. Do not confuse this function with the effect of the <DEL> key.

<F8> key

The <F8> key can be selected at any time to abort the simulation and to return to the base screen.

<Menu>

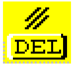
Selecting the <Menu> key (<F10> key on a PC) provides for a swift return to the GUI main menu.

<ESC>

In any menu item, pressing the <ESC> key causes a jump back by one level to be performed.

Analogous to <F8>, selecting <ESC> in the base simulation menu leads to a return to the GUI main menu.

<DEL>



Pressing the <DEL> key defines the beginning of an NC program.

The following functions are executed:

- Clearing the wire model and the screen (prior to a new program start). Only the graphic of the last block is retained.
- Provided that the original image size according to the travel range has not been set, the automatically determined image boundaries become effective in the new program run.
- Time measurement is reset (off line simulation).

Note: The displayed simulation graphic will irrevocably be lost when the <DEL> key is pressed.

<DEL> works simultaneously on both simulation windows.

<TAB>

When multiple-window technique is selected, the active window is marked by a red frame. Press the <TAB> key to change to the other window.

The window-related function keys and selections have an effect on the marked window.

3.2 Hot Key Functions

This chapter gives an overview of the available hot keys. Most hot keys are also active in all other GUI menus.

<ALT>+<H>
Hot key overview

Press the <ALT>+<H> key combination to display an overview of the hot key functions that are used in the simulation.

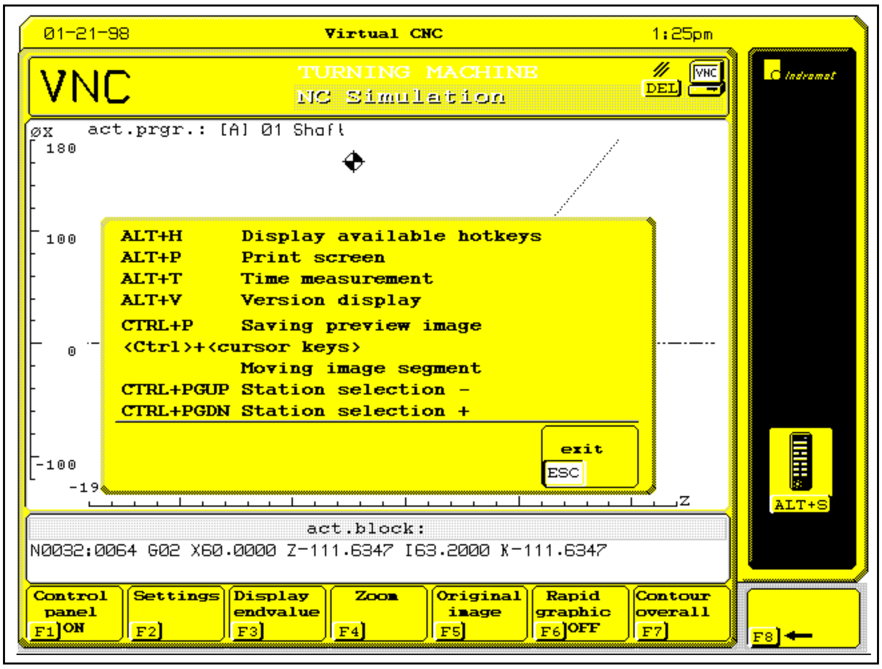


Fig. 3-2: Hot key overview

<ALT>+<P>
Screen dump

Press <ALT>+<P> to save the screen contents as a .bmp file on a diskette or a hard disk.

<ALT>+<V>
Version display

Press <ALT>+<V> to display the version number of the employed software (for service purposes).

<ALT>+<S>
Control panel

Pressing <ALT>+<S> toggles the control panel ON and OFF. The control panel does not exist in on line simulation.

(*)<ALT>+<T>
Time measurement

The <ALT>+<T> key combination provides access to the results of the time calculation from the start of the simulation and/or from pressing the <DEL> key to the last NC block to have been simulated. The actual machining time to be expected is estimated.

A list of the main and auxiliary times of each tool and in total is displayed.

Press the cursor keys up and down to scroll the display. Press <ESC> to exit the display. Time is only measured in off line simulation with override 100%. Acceleration and deceleration processes as well as times required for acknowledgement by the SPS are not considered.

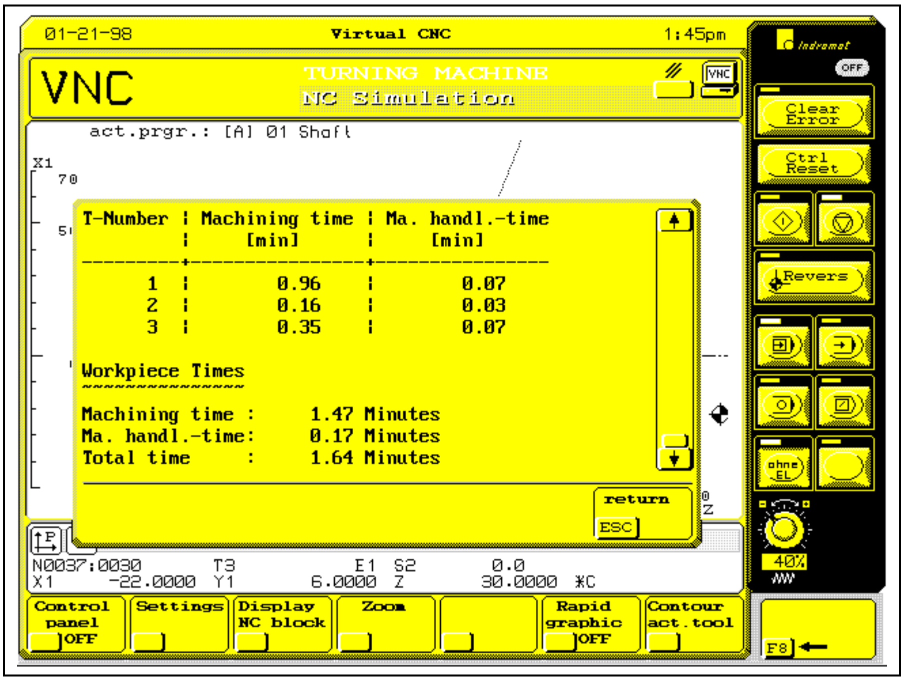


Fig. 3-3: Time measurement

(*) The „time measurement“ function is available from release level 17V02.

<CTRL>+<P>
Saving preview image

Press the <CTRL>+<P> key combination to save a preview image.

A preview image is a screen dump of the simulation window(s) that is representative of the execution of the NC program. An individual preview image can be generated and stored for each NC program .

The preview image may be displayed in the program preselection menu in order to support the operator in the selection.

The preview image should be created at the program end.

<CTRL>+<cursor key>
moving image segment

Use the <CTRL>+<cursor key> key combination to move the visible image segment.

This function is particularly significant

- if areas outside the travel range limits shall be made visible; or
- if, with activated zoom function, the tool gets outside the image segment and the segment shall swiftly follow the movement.

Pressing <F5> cancels the move in the original image.

In multiple-window technique, moving the image segment is only possible in the active window.

<CTRL>+<Page up>
<CTRL>+<Page down>
changing stations

A change is made to the next station that fulfills the requirements of a simulation (see 1.3).

Note: The wire model only acquires and displays the progress of the NC program execution if this is also visible in the display. The execution in the background is no longer tracked when the station is changed or the simulation is interrupted.

3.3 Settings

The chapter describes the options of influencing the graphical representation via the „Settings“ dialog box.

Menu „Settings“

The „Settings“ menu permits selections to be made that are additional to the simulation settings that can be addressed via the function keys. At the same time, it opens the access to data adaptation.

The scope of the menu varies according to the parameter record, the current selections, and the base mode.

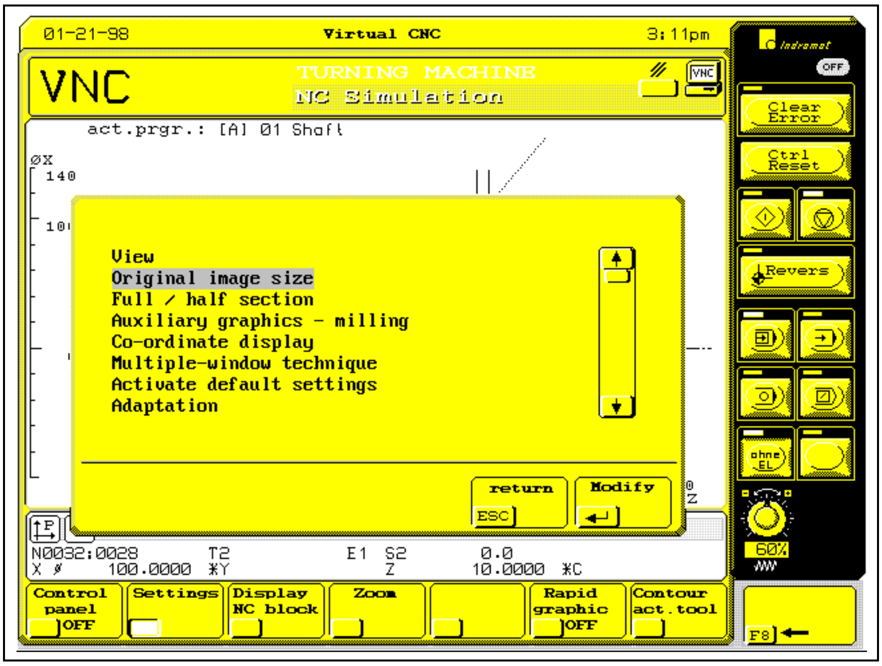


Fig. 3-4: Menu „Settings“

Use the cursor keys up and down to select the required setting; and press the <ENTER> key to confirm it.

Selection menus - layout

After a setting function has been activated, a selection menu is usually displayed that shows a uniform layout within the simulation.

The existing options are offered via graphic elements in a matrix arrangement. The graphic element that belongs to the current selection is marked by a blinking border; the selected graphic element is marked by a frame. The line beneath shows a help text that is related to the selected setting (see Fig. 3-5).

Use the cursor keys to select a setting, and press the <ENTER> key to confirm the selection. The new setting takes an immediate effect in the simulation window.

Note: When the simulation of a new NC program is started, the settings are active that have been selected as default settings in the data adaptation.

View

„View“ permits the viewing angle of the active window to be changed.

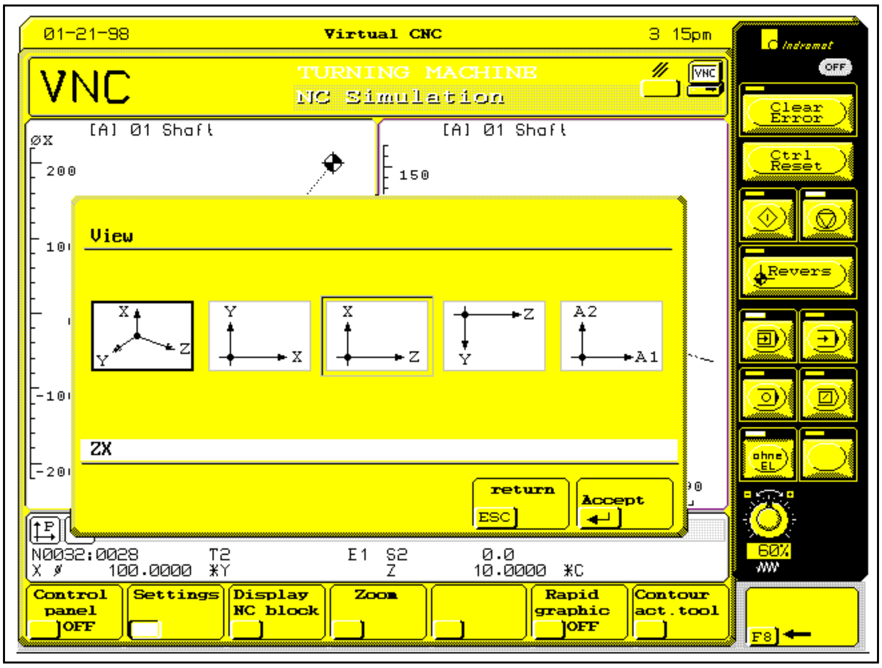


Fig. 3-5: Selection „view“

The views 3D, XY, ZX, YZ, and development can be selected. For two linear axes, the available menus are reduced to the planes spanned by those two axes. For a turning machine without Y axis, 3D, XY, and ZX are available. Special conditions apply to the simulation of the development (see 2.6).

When 3-D view is selected, a dialog box is displayed that permits the viewing angle to be entered. An additional auxiliary image is displayed that permits the movement of the observer's standpoint (red dot, beam of vision represented by a red line) to be optically monitored in the polar co-ordinate system.

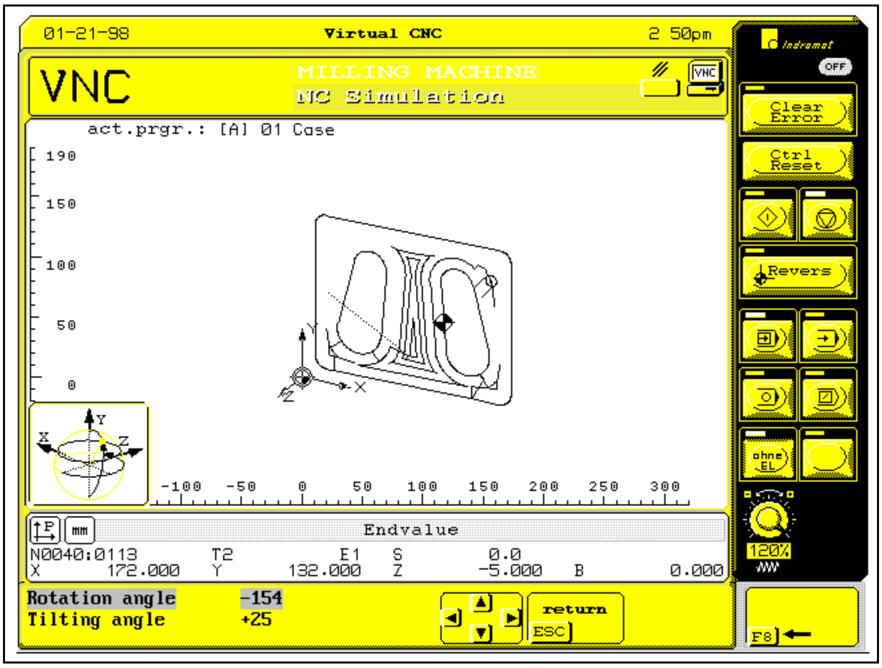


Fig. 3-6: Setting the viewing angles

The angles can be specified by entering numerical values that are confirmed by pressing the <ENTER> key (use the <TAB> key to change between the input fields for rotation and tilting angle).

- or -

via the cursor keys

<cursor left> decreases the rotation angle,

<cursor right> increases the rotation angle,

<cursor up> increases the tilting angle,

<cursor down> decreases the tilting angle.

Press <ESC> to terminate the input of the viewing angle.

Original image size

To define the original image size, that is related to the active simulation window, the following variants can be selected:

- Travel range limits
- All movements
- All movements except G0.

The last two options are based on the simulation-internal automatic determination of the image boundaries. These image boundaries only come into effect after corresponding motion blocks have been simulated. Otherwise, the travel range limits remain active as the original image size.

If the image boundaries have not yet been made valid by pressing the <DEL> key (start of an NC program), selecting an automatically determined original image size forces those image boundaries to be set.

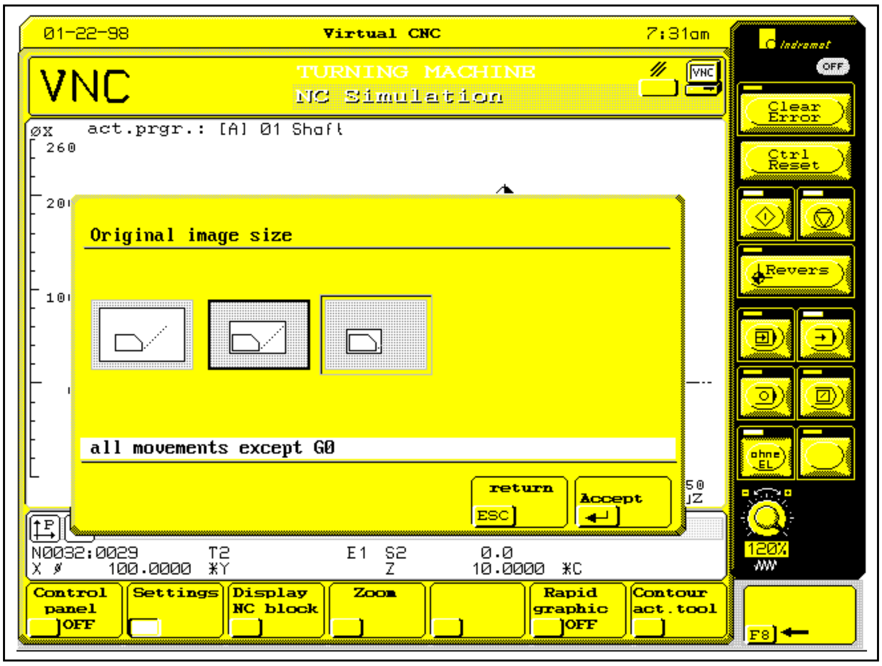


Fig. 3-7: Setting „Original image size“

Full / half section

This setting permits the representation in a half section to be selected or de-selected.

This setting function is only available in the main machining procedure of turning, when ZX view is selected, and if there is no tool spindle.

The half section setting produces an image in which the X-negative image section is not included in the image dimensioning (original image size) and in the graphic (feed movements).

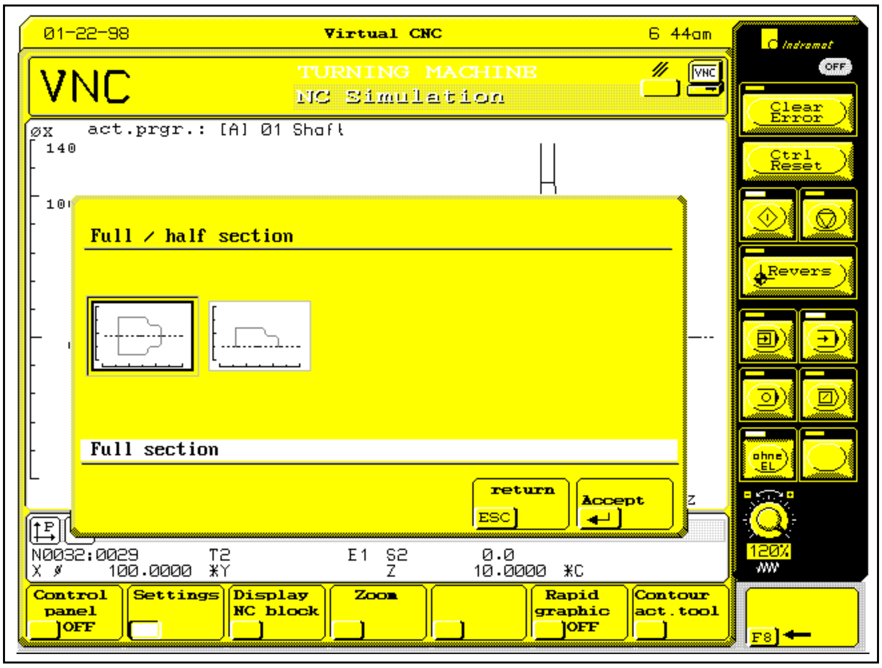


Fig. 3-8: Setting „Full/half section“

Auxiliary graphics - milling

The setting function „Auxiliary graphics - milling“ permits the hatching of the area that is covered by a milling tool in feed operation to be activated and de-activated in the active window.

The function is not executed if a tool spindle (main machining procedure of turning) is missing.

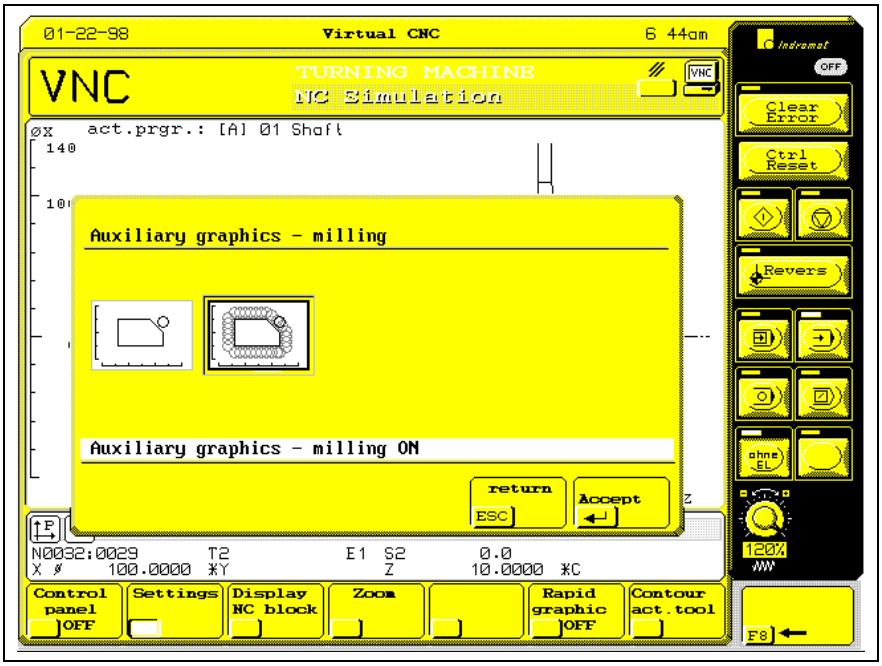


Fig. 3-9: Setting „Auxiliary graphics - milling“

Co-ordinate display

The setting „Co-ordinate display“ is used for toggling between workpiece co-ordinates and machine co-ordinates.

The selection has an effect in the display window (co-ordinate display) and in both simulation windows (structure of the co-ordinate axes). The setting does not have an effect on the GUI base screen.

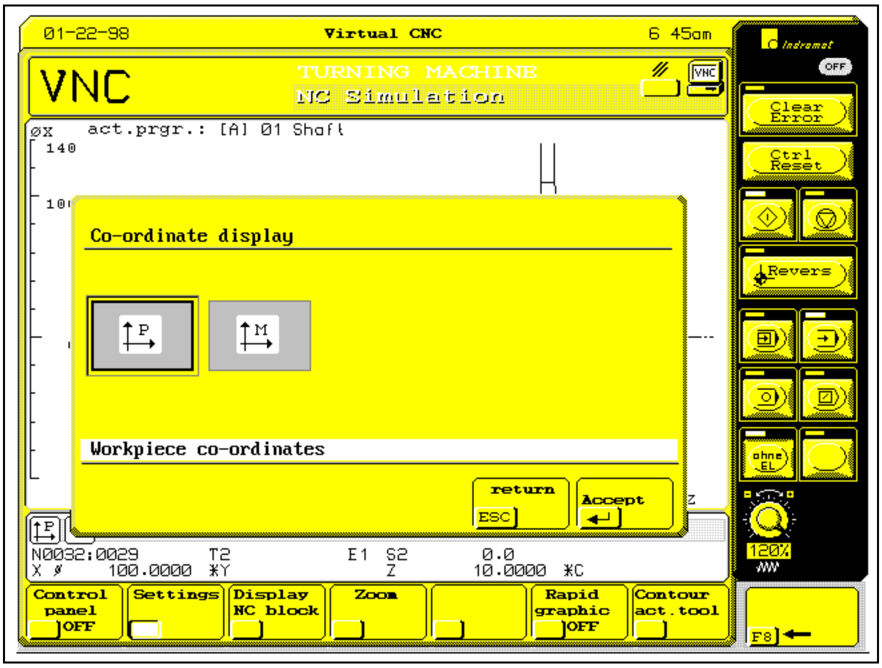


Fig. 3-10: Setting „Co-ordinate display“

Multiple-window technique

The „Multiple-window technique“ setting permits a second simulation window to be activated and de-activated.

The following options are available:

- one window,
- two windows side by side
- two windows on top of each other

The currently active window is retained when the second window is cleared (exception „Development“ view: the window that contains the development simulation is always the one that is cleared).

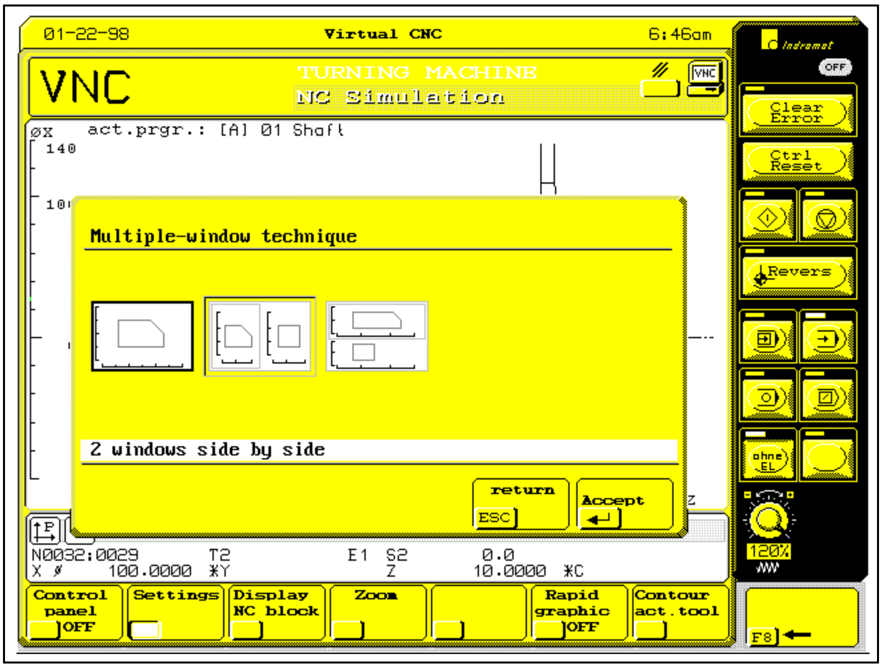


Fig. 3-11: Setting „Multiple-window technique“

Activate default settings

This menu item activates the settings of the active simulation window that have been entered in the adaptation.

For safety reasons, an additional dialog box is displayed that prevents an inadvertent activation of the default settings (selection via the cursor key and confirmation by pressing <ENTER>).

If there are default setting that cannot be implemented, a valid setting is selected within the simulation.

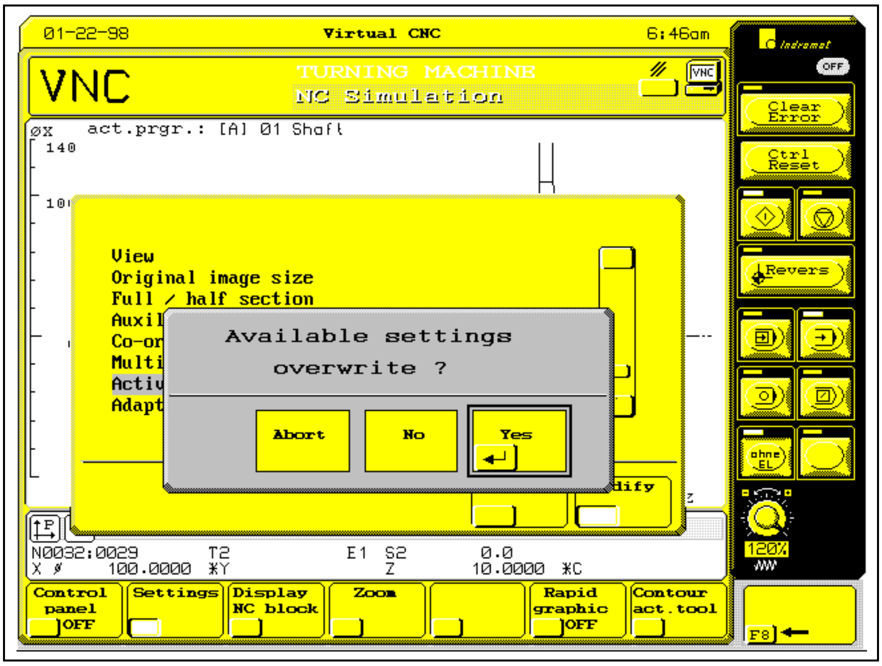


Fig. 3-12: Activate default settings

Adaptation The „Adaptation“ menu item enables the simulation to be specifically adapted to certain conditions and requirements.

4 Adaptation

4.1 General

Function

The adaptation is used for setting up the simulation according to the requirements that is placed upon the concrete station, and according to the requirements and the habits of the user.

Note: The entered data is cleared when the GUI is installed. Subsequently, the internally generated default values are valid.

Validity range

The adaptation data is valid with respect to station and plant (exception: the color selections are valid for all stations of a plant). The same adaptation data is valid for an allocated real/virtual plant.

The default settings can additionally be entered separately for each simulation window.

Menu adaptation

In contrast to the „Settings“ menu, all possible selections in adaptation are accessible to the user. This is independent of the fact whether or not the concrete input can be implemented at the station concerned, and taking all other data adaptations into account.

The following items can be adapted:

- the main machining procedure
- default settings
- the position of the co-ordinate systems on the screen
- the colors of the elements of the simulation graphics
- the markings of vertices with incomplete contours
- the downtime for changing tools (*)

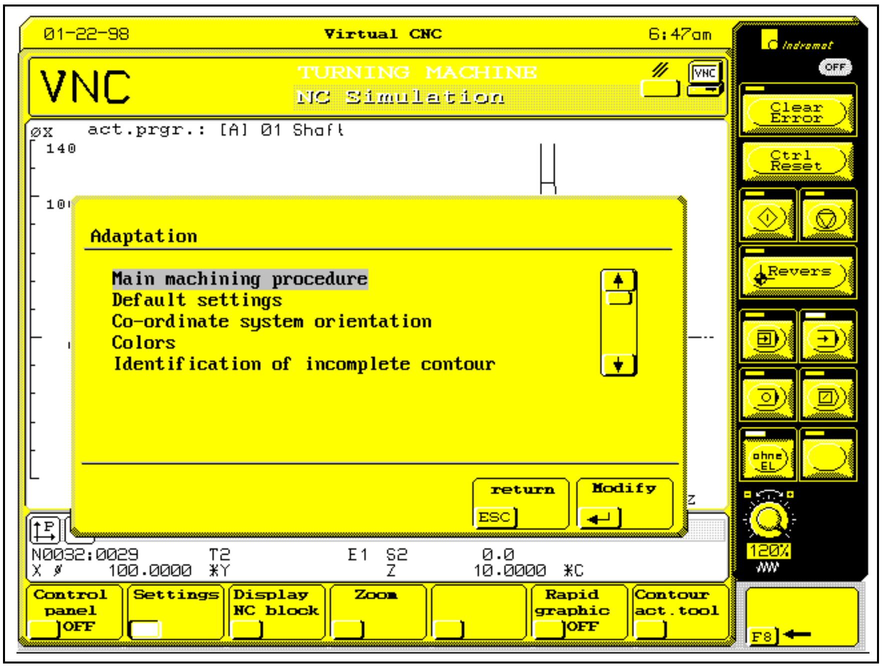


Fig. 4-1: Menu „Adaptation“

(*) This function is in preparation.

Use the cursor keys to select the group of data that is to be modified and press <ENTER> to confirm it. Press <ESC> to return to the „Settings“ menu.

Default setting

Once GUI has been installed, data adaptation has values pre-assigned. To do this, the main machining procedure is defined on the basis of the axes that are allocated to the station and of the default G commands, and the suitable entries are entered.

Note: Changing the parameter set leads to a new assignment of the „Co-ordinate system orientation“ adaptation and the default settings „View“ and „Full/half section“. This is done by allocating the most common assignments to the internally determined main machining procedure.

4.2 Main Machining Procedure

Adaptation of main machining procedure

The following main machining procedures are available:

- Milling/boring (machining prismatic parts)
- Turning (machining rotary parts)

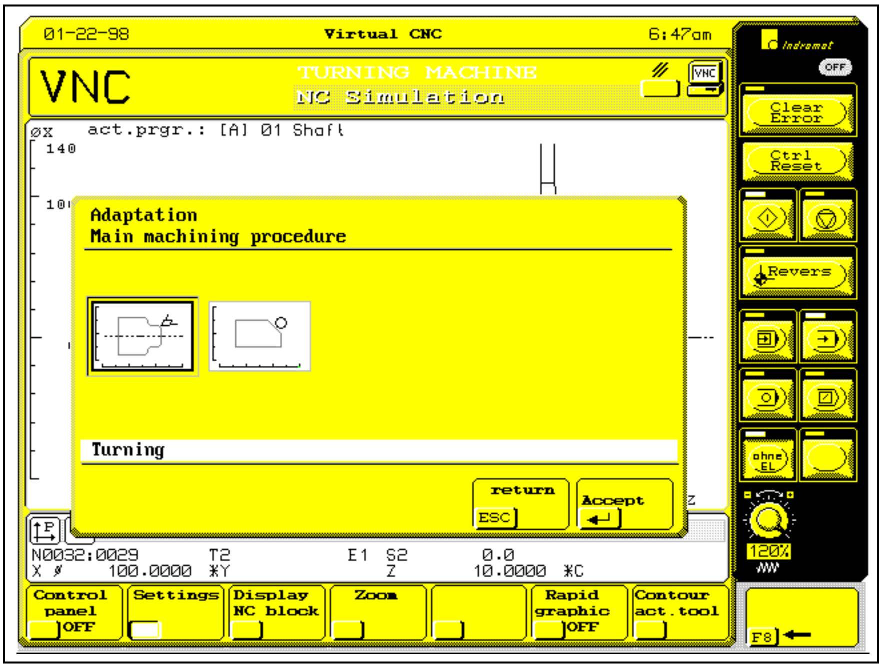


Fig. 4-2: Adaptation „Main machining procedure“

Differences in the main machining procedures

The following table shows the major differences from the perspective of the NC simulation:

Milling/boring	Turning
There is no rotation center	Dash-dotted line marks the rotation center
Correction type 3 is allocated to a milling tool type	With correction type 3 and G18: Display of turning tool or center boring tool
If there are only 2 primary axes, only the view onto those axes can be selected.	All views, except YZ, can be selected if only X and Z axes exist.

Milling/boring	Turning
Tool spindles only	At least 1 workpiece spindle
Only simple lines for milling and boring machining	Special representation and image dimensioning for turning
Sidewise simulation	Complete simulation

Fig. 4-3: Comparing the main machining procedures

Note: Changing the main machining procedure leads to clearing the wire model and the determined image boundaries. The values, that are most common for the procedure, are pre-assigned to the adaptation „Co-ordinate system orientation“ and to the default settings „View“ and „Full/half section“.

4.3 Default Settings

Default settings

„Default settings“ are the settings that are valid at the beginning of the simulation of a new NC program.

Default settings may also be activated via the „Activate default settings“ function from the „Settings“ menu.

Default settings menu

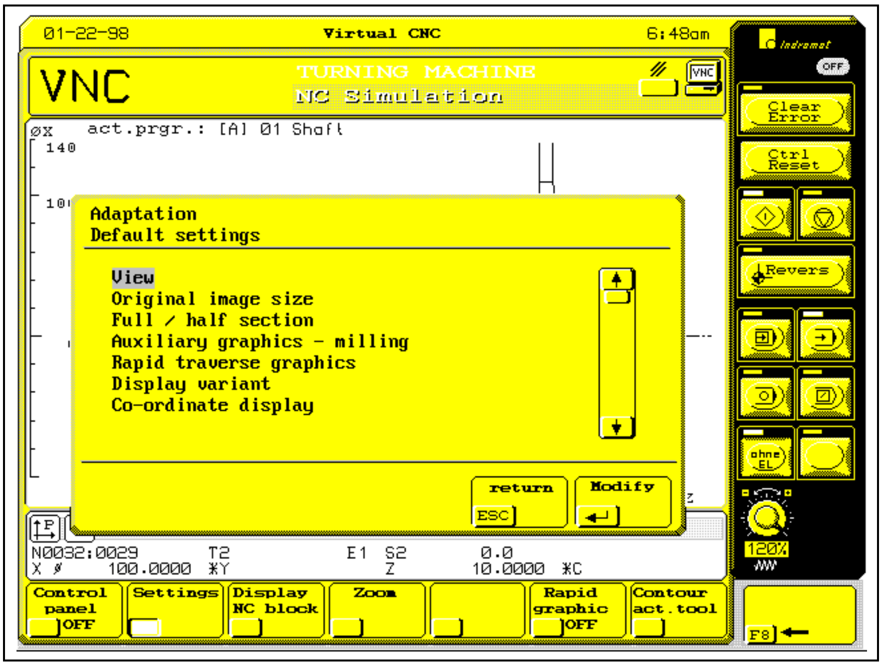


Fig. 4-4: Adaptation „Default settings“

The following default settings are possible:

- View
- Original image size
- Half/full section
- Auxiliary graphics - milling (ON/OFF)
- Rapid traverse graphics (OFF/ON)
- Display variant (end value display/NC block display)
- Co-ordinate display (workpiece co-ordinates/machine co-ordinates)

Validity of the default settings

Apart from the display variants, all specifications are related to a specific window.

In most points, the dialog is identical to the dialog in the „Settings“ menu and will therefore not be explained here. Merely the „View“ default setting possesses, in addition to the maximum of five possible views, an additional menu item that permits the default viewing angles in 3-D view to be entered.

Default viewing angle

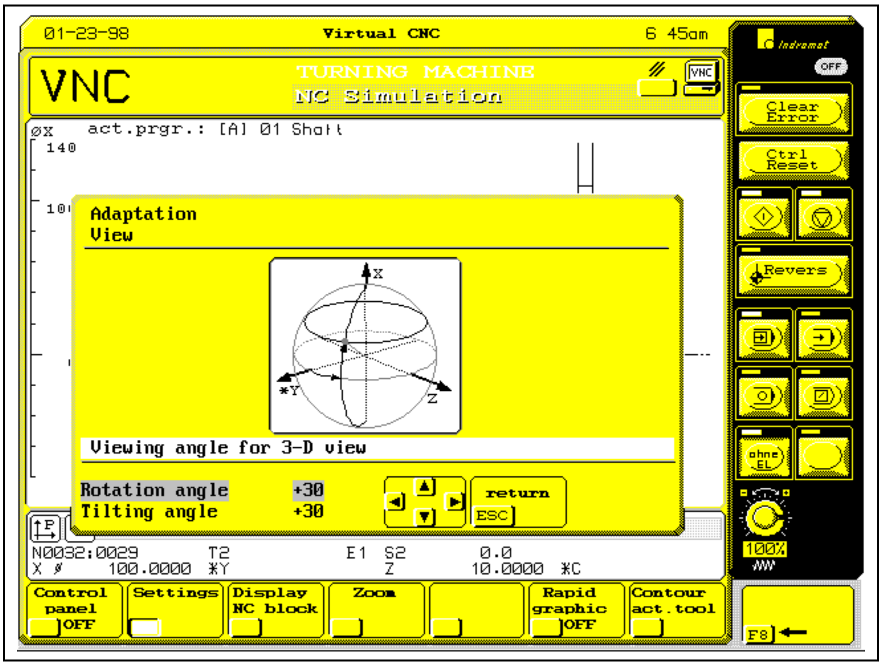


Fig. 4-5: Adaptation „Default viewing angle“

The default viewing angle can either be entered as an alphanumeric value (press <ENTER> to confirm angle value; press <TAB> to change between rotation angle and tilting angle), or be specified using the cursor keys. The change in the observer’s standpoint can be seen in the image above.

Press <ESC> to return to the „Adaptation - view“ menu.

4.4 Co-Ordinate System Orientation

Co-ordinate system orientation

The co-ordinate orientation enables a workpiece representation on the screen in the same view as the operator sees it at the machine. With respect to the 3-D view, the co-ordinate system orientation is the arrangement of the base co-ordinate system in the polar co-ordinate system that is used for defining the viewing angle.

Selecting the view for modifying the co-ordinate system orientation

A menu is available that offers all five views that exist for modifying the orientation of a co-ordinate system to be selected (cursor keys; confirmation via <ENTER>).

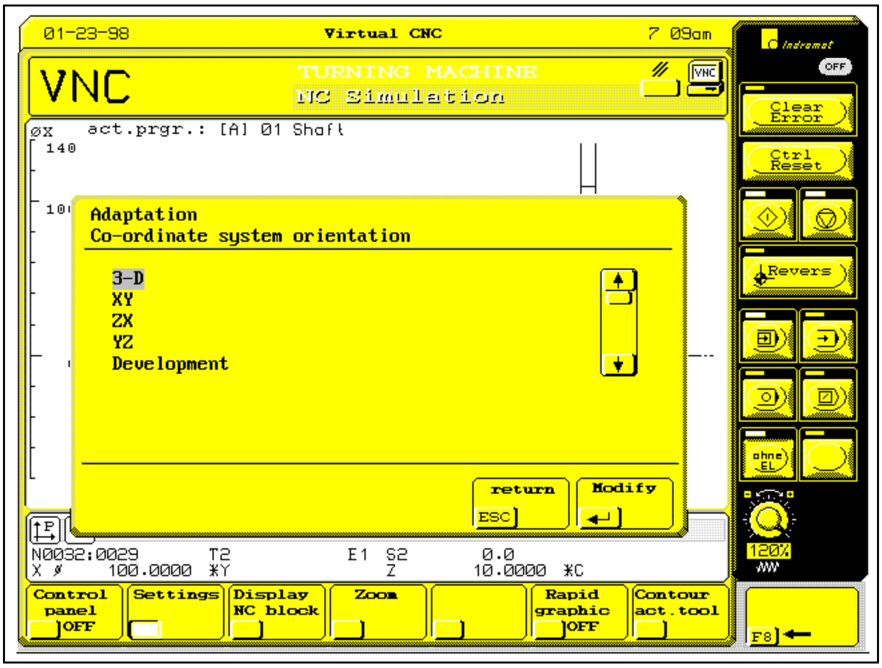


Fig. 4-6: Selection of the view for the adaptation „Co-ordinate system adaptation“

Modifying the co-ordinate system orientation

Supported graphically, the co-ordinate system orientation is selected via the cursor keys and subsequent confirmation via the <ENTER> key. The individual views of the selection are similar, and are represented exemplarily for the XY view.

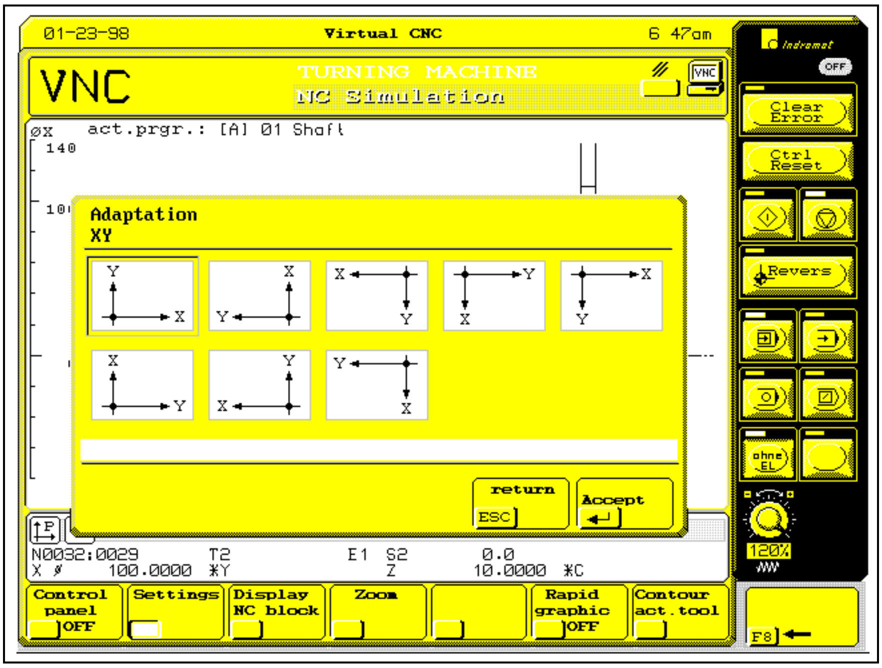


Fig. 4-7: Adaptation „Co-ordinate system adaptation“, example „XY view“

4.5 Colors

Colors

The colors of the following graphical elements can be specified separately:

- Tool
- Movements G1, G2, G3
- Rapid traverse movements
- Threads
- Co-ordinate system
- Auxiliary graphics

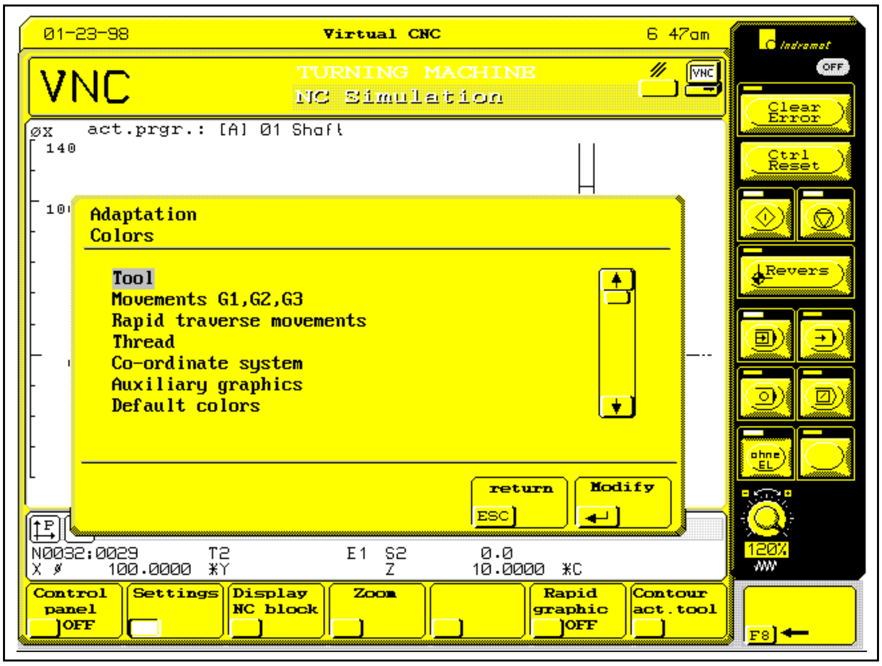


Fig. 4-8: Adaptation „Colors“ - element selection

Default colors

The additionally existing menu item „Default colors“ leads to a selection of colors that have internally been defined in the simulation and that are set after the GUI has been installed, for example.

Modifying the color

The color can be modified through a selection via the cursor keys and a subsequent confirmation with <ENTER>. The menu structure is the same for all graphical elements. The following figure shows a typical menu for the tool color.

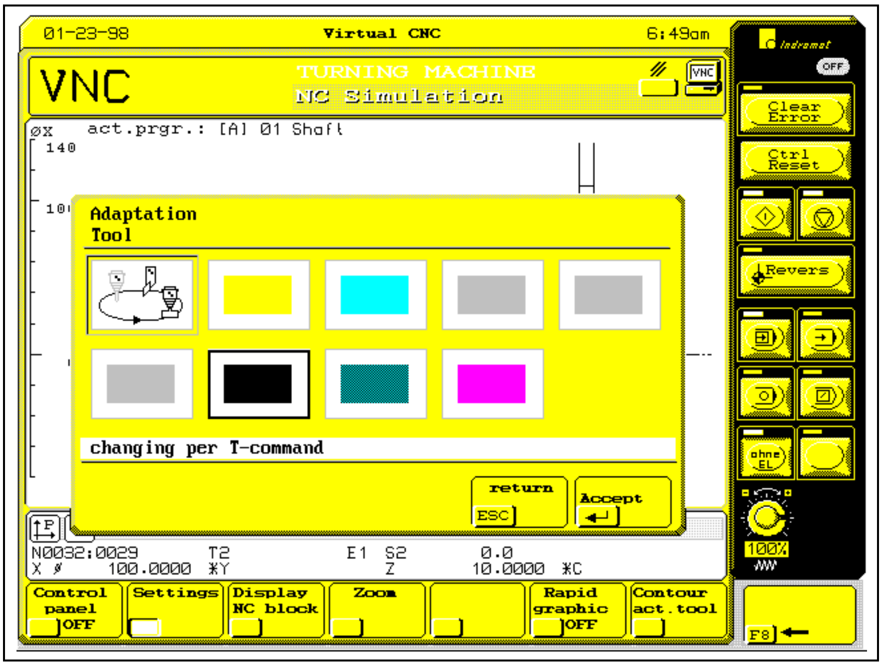


Fig. 4-9: Adaptation „Colors“; example „Tool“

Validity of the colors

The color assignment is valid for all stations of the current plant and of any allocated real/virtual plant.

4.6 Identification of Incomplete Contour

Lost blocks

NC blocks whose start and/or end co-ordinates are not completely known from the perspective of the NC simulation are referred to as blocks that are lost to simulation.

Lost blocks can be produced when simulation is exited and re-entered, when stations are changed during simulation, and, in particular, during on line simulation if block transition occures faster than NC simulation can follow.

Incomplete contour

An incomplete contour results from an incomplete simulation of motion blocks. The „Identification of incomplete contour“ menu permits vertices in those gaps to be marked for test purposes.

Menu scope

The following selections are possible:

- No marking
- Marking by dots
- Marking by arrows
  (the arrows are not visible if the direction of vision is in the interpolation plane).

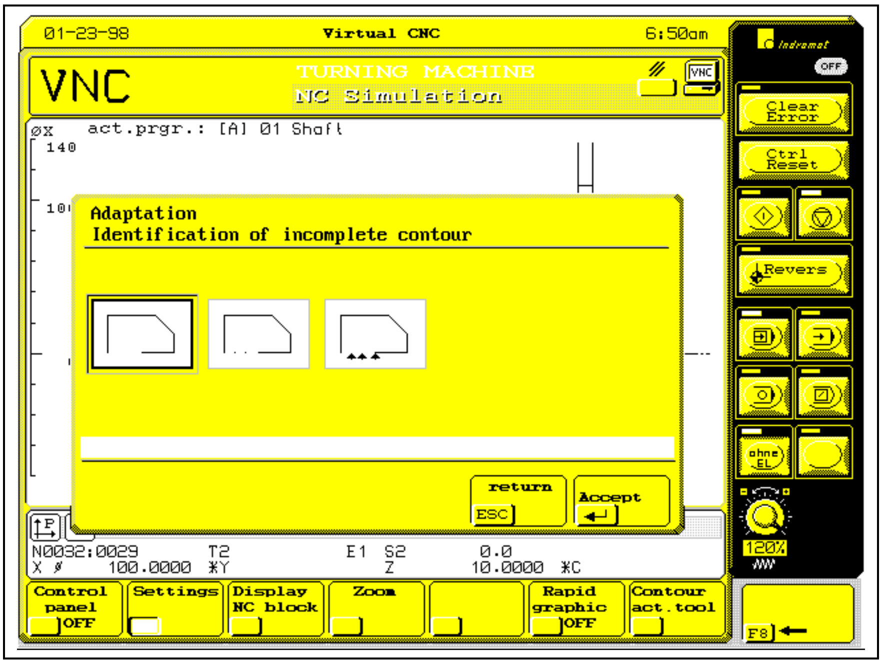


Fig. 4-10: Adaptation „Identification of incomplete contour“

4.7 Downtime for Changing Tools

(*) Downtime for changing tools

The downtime for changing tools is only taken into account during off line simulation. It is entered as a mean values in seconds; its default value is 1 s.

The time specified for changing tools influences the simulation speed and the results of the time measurement.

(*) This function is in preparation.

5 Appendix

5.1 Configuration File IND_DEV.INI

The configuration of the individual communication addresses and the device addresses, and the machining options are saved in the IND_DEV.INI file. The IND_DEV.INI file is in the \CONFIG directory of the MTC management structure and is equivalent to the STANDARD INI file of Microsoft Windows. It has the following structure:

Designator	Values	Meaning
[CommAddrx]	x = 1 .. 8	Communication address. Allocation of the communication channel of the function interface.
CommStr=	V24, port, baud rate, parity, interface type, packet counter or DMA, address, offset, length or SHM, channel no. [1 ..15]	Communications via serial RS232 interface, for example V24,COM1,19200,NONE,RS232,TCON Communications via serial RS485 interface, for example V24,COM2,19200,NONE,R485H,TCON With MT200, communication via a dual-port RAM requires a DMA channel. For example: DMA,$D000,$0000,$2000 Communication channel to the virtual MTC via a shared memory. For example: SHM,1
Timeout=	3500	[msec] Time-out value for the communication channel. A response from the controller must come inside that time.
or		
CommStr=	DPR, address, offset, length, RAM0, packet counter	Communication via a dual-port RAM. For example: MTC200 DPR,$D000,$0000,$2000,RAM0,TCOFF
PortAddr=	e.g. $31C	see 'Technical Documentation', Folder 4
PortVal=	e.g. $28	see 'Technical Documentation', Folder 4
Timeout=	3500	[msec] Time-out value for the communication channel. A response from the controller must come inside that time.
[DeviceAddrx]	**x = 0 .. 63**	**Device address; corresponds to the plant address of the MTC.**
DeviceName=	Device name, max. 32 characters	Name of the controller. For example: milling cell 1 or machining center 12T34.
DeviceTyp=	Device type; the permissible values have been defined by INDRAMAT	Controller type. For example: MTC200, MTCNC etc.
DeviceAssign=	0 .. 15 , NO	Allocation of the simulation pair. If a virtual MTC is employed, a pair must always be declared here. This allocates the virtual MTC to a real MTC.
DeviceStatus=	ON / OFF	Specifies whether the device is entered in the management structure of the function interface.
CommAddr=	1 .. 8	Allocation of the communication address. Corresponds to the [CommAddr1 .. 8] parameter.
PLC=	YES / NO	SPS support of the device. A virtual MTC does not have an SPS; consequently, this parameter must be set to NO.

Fig. 5-11: Structure of the IND_DEV.INI file

Example 1: Configuration of an MTC200 and a virtual MTC in the IND_DEV.INI file. Please note that the MTC200 always requires two communication addresses (in the following example these are the communication addresses 1 and 2). The virtual CNC is device01 (DeviceAddr1) that is allocated to the real device00 (DeviceAddr0).

[CommAddr1]	Communication address 1
CommStr=DPR,$D000,$0000,$2000,RAM0, TCON	Communication string dual-port RAM
PortAddr=$31C	Optional: port address
PortVal=$28	Optional: contents of the port address
Timeout=3500	Time-out value for communication
[CommAddr2]	Communication address 2
CommStr=DMA,$D000,$0000,$2000	Allocation of the DMA channel for the MTC controller
Timeout=3500	Time-out value for communication
[CommAddr3]	Communication address 3
CommStr=SHM,1	Shared memory for the virtual CNC
Timeout=3500	Time-out value for communication
[DeviceAddr0]	Device address
DeviceName=boring cell 12	Device name
DeviceTyp=MTC200	Device type
DeviceAssign=1	Allocation of the simulation pair
DeviceStatus=ON	ONLINE/OFFLINE channel
CommAddr=1	Allocated communication channel
PLC=YES	Support of SPS (Default = Yes)
[DeviceAddr1]	Device address
DeviceName=virtual boring cell	Device name
DeviceTyp=MTVNC	Device type
DeviceAssign=0	Allocation of the simulation pair
DeviceStatus=OFF	ONLINE/OFFLINE channel
CommAddr=3	Allocated communication channel
PLC=NO	Support of SPS (Default=Yes)

Example 2: Configuration of a virtual MTC in the IND_DEV.INI file (available from release level 17V02).

[CommAddr1]	Communication address 1
CommStr=SHM,1	Shared memory for the virtual CNC
Timeout=3500	Time-out value for communication
[DeviceAddr0]	Device address
DeviceName=virtual boring cell 12	Device name
DeviceTyp=MTVNC	Device type
DeviceAssign=NO	Allocation of the simulation pair
DeviceStatus=ON	ONLINE/OFFLINE channel
CommAddr=1	Allocated communication channel
PLC=NO	No SPS available (Default = NO)

6 Index

7 List of Figures

List of Customer Service Points

Germany

Sales area Center INDRAMAT GmbH D-97816 Lohr am Main Bgm.-Dr.-Nebel-Str. 2 Phone: 09352/40-0 Fax: 09352/40-4885	Sales area East INDRAMAT GmbH D-09120 Chemnitz Beckerstraße 31 Phone: 0371/3555-0 Fax: 0371/3555-230	Sales area West INDRAMAT GmbH D-40849 Ratingen Hansastraße 25 Phone: 02102/4318-0 Fax: 02102/41315	Sales area North INDRAMAT GmbH D-22085 Hamburg Fährhausstraße 11 Phone: 040/227126-16 Fax: 040/227126-15
Sales area South INDRAMAT GmbH D-80339 München Ridlerstraße 75 Phone: 089/540138-30 Fax: 089/540138-10	Sales area South-West INDRAMAT GmbH D-71229 Leonberg Böblinger Straße 25 Phone: 07152/972-6 Fax: 07152/972-727		INDRAMAT Service Hotline INDRAMAT GmbH Phone: D-0172/660 040 6 -or- Phone: D-0171/333 882 6

Customer service points in Germany

Europe

Austria G.L.Rexroth Ges.m.b.H. Geschäftsbereich INDRAMAT A-1140 Wien Hägelingasse 3 Phone: 1/9852540-400 Fax:1/9852540-93	Austria G.L.Rexroth Ges.m.b.H. Geschäftsbereich INDRAMAT A-4061 Pasching Randlstraße 14 Phone: 07229/64401-36 Fax: 07229/64401-80	Belgium Mannesmann Rexroth N.V.-S.A. Geschäftsbereich INDRAMAT B-1740 Ternat Industrielaan 8 Phone: 02/5823180 Fax: 02/5824310	Denmark BEC Elektronik AS DK-8900 Randers Zinkvej 6 Phone: 086/447866 Fax: 086/447160
England Mannesmann Rexroth Ltd. INDRAMAT Division Cirencester, Glos GL7 1YG 4 Esland Place, Love Lane Phone: 01285/658671 Fax: 01285/654991	Finnland Rexroth Mecman OY SF-01720 Vantaa Riihimiehentie 3 Phone: 0/848511 Fax: 0/846387	France Rexroth - Sigma S.A. Division INDRAMAT F-92632 Gennevilliers Cedex Parc des Barbanniers 4, Place du Village Phone: 1/41475430 Fax: 1/47946941	France Rexroth - Sigma S.A. Division INDRAMAT F-69634 Venissieux - Cx 91, Bd 1 Joliot Curie Phone: 78785256 Fax: 78785231
France Rexroth - Sigma S.A. Division INDRAMAT F-31100 Toulouse 270, Avenue de lardenne Phone: 61499519 Fax: 61310041	Italy Rexroth S.p.A. Divisione INDRAMAT I-20063 Cernusco S/N.MI Via G. Di Vittoria, 1 Phone: 02/92365-270 Fax: 02/92108069	Italy Rexroth S.p.A. Divisione INDRAMAT Via Borgomanero, 11 I-10145 Torino Phone: 011/7712230 Fax: 011/7710190	Netherlands Hydraudyne Hydrauliek B.V. Kruisbroeksestraat 1a P.O. Box 32 NL-5280 AA Boxtel Phone: 04116/51951 Fax: 04116/51483
Spain Rexroth S.A. Centro Industrial Santiago Obradors s/n E-08130 Santa Perpetua de Mogoda (Barcelona) Phone: 03/718 68 51 Telex: 591 81 Fax: 03/718 98 62	Spain Goimendi S.A. División Indramat Jolastokieta (Herrera) Apartado 11 37 San Sebastion, 20017 Phone: 043/40 01 63 Telex: 361 72 Fax: 043/39 93 95	Sweden AB Rexroth Mecman INDRAMAT Division Varuvägen 7 S-125 81 Stockholm Phone: 08/727 92 00 Fax: 08/64 73 277	Switzerland Rexroth SA Département INDRAMAT Chemin de l`Ecole 6 CH-1036 Sullens Phone: 021/731 43 77 Fax: 021/731 46 78
Switzerland Rexroth AG Geeschäftsbereich INDRAMAT Gewerbestraße 3 CH-8500 Frauenfeld Phone: 052/720 21 00 Fax: 052/720 21 11	Russia Tschudnenko E.B. Arsenia 22 153000 Ivanovo Rußland Phone: 093/22 39 633		

European customer service points without Germany

Outside Europe

Argentina Mannesmann Rexroth S.A.I.C. Division INDRAMAT Acassusso 48 41/7 1605 Munro (Buenos Aires) Argentina Phone: 01/756 01 40 01/756 02 40 Telex: 262 66 rexro ar Fax: 01/756 01 36	Argentina Nakase Asesoramiento Tecnico Diaz Velez 2929 1636 Olivos (Provincia de Buenos Aires) Argentina Argentina Telefon 01/790 52 30	Australia Australian Industrial Machenery Services Pty. Ltd. Unit 3/45 Horne ST Campbellfield VIC 2061 Australia Phone: 03/93 59 0228 Fax: 03/93 59 02886	Brazil Mannesmann Rexroth Automação Ltda. Divisão INDRAMAT Rua Georg Rexroth, 609 Vila Padre Anchieta BR-09.951-250 Diadema-SP Caixa Postal 377 BR-09.901-970 Diadema-SP Phone: 011/745 90 65 011/745 90 70 Fax: 011/745 90 50
Canada Basic Technologies Corporation Burlington Division 3426 Mainway Drive Burlington, Ontario Canada L7M 1A8 Phone: 905/335-55 11 Fax: 905/335-41 84	China Rexroth (China) Ldt. Shanghai Office Room 206 Shanghai Intern. Trade Centre 2200 Yanan Xi Lu Shanghai 200335 P.R. China Phone: 021/627 55 333 Fax: 021/627 55 666	China Rexroth (China) Ldt. Shanghai Parts & Service Centre 199 Wu Cao Road, Hua Cao Minhang District Shanghai 201 103 P.R. China Phone: 021/622 00 058 Fax: 021/622 00 068	China Rexroth (China) Ldt. 1430 China World Trade Centre 1, Jianguomenwai Avenue Beijing 100004 P.R. China Phone: 010/50 50 380 Fax: 010/50 50 379
China Rexroth (China) Ldt. A-5F., 123 Lian Shan Street Sha He Kou District Dalian 116 023 P.R. China Phone: 0411/46 78 930 Fax: 0411/46 78 932	Hong Kong Rexroth (China) Ldt. 19 Cheung Shun Street 1st Floor, Cheung Sha Wan, Kowloon, Honkong Phone: 741 13 51/-54 und 741 14 30 Telex: 3346 17 GL REX HX Fax: 786 40 19 786 07 33	India Mannesmann Rexroth (India) Ltd. INDRAMAT Division Plot. 96, Phase III Peenya Industrial Area Bangalore - 560058 Phone: 80/839 21 01 80/839 73 74 Telex: 845 5028 RexB Fax: 80/839 43 45	Japan Rexroth Co., Ltd. INDRAMAT Division I.R. Building Nakamachidai 4-26-44 Tsuzuki-ku, Yokohama 226 Japan Phone: 045/942-72 10 Fax: 045/942-03 41
Korea Rexroth-Seki Co Ltd. 1500-12 Da-Dae-Dong Saha-Gu, Pusan, 604-050 Phone: 051/264 90 01 Fax: 051/264 90 10	Korea Seo Chang Corporation Ltd. Room 903, Jeail Building 44-35 Yoido-Dong Youngdeungpo-Ku Seoul, Korea Phone: 02/780-82 07 ~9 Fax: 02/784-54 08	Mexico Motorización y Diseño de Controles, S.A. de C.V. Av. Dr. Gustavo Baz No. 288 Col. Parque Industrial la Ioma Apartado Postal No. 318 54060 Tlalnepantla Estado de Mexico Phone: 5/397 86 44 Fax: 5/398 98 88	
USA Rexroth Corporation INDRAMAT Division 5150 Prairie Stone Parkway Hoffman Estates, Illinois 60192 Phone: 847/645-36 00 Fax: 857/645-62 01	USA Rexroth Corporation INDRAMAT Division 2110 Austin Avenue Rochester Hills, Michigan 48309 Phone: 810/853-82 90 Fax: 810/853-82 90		

Customer service points outside Europe

Notes

Indramat