

Rexroth IndraMotion MTX 14VRS

Measuring Functions

Application Description

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Measuring Functions

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Table of Contents

	Page
1 About this documentation.....	5
1.1 Validity of the documentation.....	5
1.2 General information.....	5
1.3 Required and supplementing documentation.....	7
1.3.1 Selection/compilation.....	7
1.3.2 Configuration.....	7
1.3.3 Commissioning.....	8
1.3.4 Operation.....	9
1.3.5 Maintenance.....	9
1.3.6 OEM Engineering.....	10
1.3.7 AddOns.....	10
1.4 Use of the safety instructions.....	10
1.4.1 Structure of the safety instructions.....	10
1.4.2 Explaining signal words and safety alert symbol.....	11
1.4.3 Symbols used.....	12
1.4.4 Signal graphic explanation on the device.....	12
1.5 Names and abbreviations.....	12
1.6 Customer feedback.....	12
2 Important instructions on use.....	13
2.1 Intended use.....	13
2.1.1 Introduction.....	13
2.1.2 Areas of use and application.....	13
2.2 Unintended use.....	14
3 Introduction.....	15
4 Measuring cycle automatic.....	19
4.1 General information.....	19
4.2 General notes.....	19
4.2.1 General information.....	19
4.2.2 Abbreviations.....	22
4.3 Probe calibration.....	23
4.3.1 General information.....	23
4.3.2 Probe calibration for workpiece measuring.....	24
4.3.3 Probe calibration for tool measuring.....	36
4.4 Measurement.....	41
4.4.1 Tool measurement.....	41
4.4.2 Probe workpiece.....	45
4.5 Measuring value evaluation.....	73
4.5.1 General information.....	73
4.5.2 Terms.....	74
4.6 Processing compensation.....	86

Table of Contents

	Page
4.6.1 Workpiece compensation.....	86
4.6.2 Tool compensation.....	86
5 Developing an individual measuring cycle automatic.....	89
5.1 General information.....	89
5.2 Example: Creating a user-defined cycle for automatic.....	89
5.2.1 Task.....	89
5.2.2 Task steps.....	89
5.3 The basic cycle STP_PRBASE.....	93
5.3.1 General information.....	93
5.3.2 Basic cycle.....	93
5.4 SD variables for probe data.....	96
5.4.1 General information.....	96
5.4.2 SD variable structure "SysPrBase".....	97
5.4.3 SD variable structure "SysPrResult".....	98
5.4.4 SD variable structure "SysPrMan".....	100
5.4.5 Data input.....	106
6 Manual probing.....	109
6.1 General information.....	109
6.2 Calibrating the probe.....	111
6.2.1 M-key menu.....	111
6.2.2 Calibrating the probe point.....	111
6.2.3 Calibrating the probe adjusting ring.....	120
6.3 Probing the zero point using the probe.....	122
6.3.1 M-key menu.....	122
6.3.2 Zero point probing, point.....	122
6.3.3 Zero point probing, corner.....	126
6.3.4 Zero point probing, boring.....	132
6.3.5 Zero point probing, circular spigot.....	134
6.3.6 Zero point probing, groove.....	136
6.3.7 Zero point probing, land.....	144
6.3.8 Zero point probing, rectangular pocket.....	150
6.3.9 Zero point probing, rectangular spigot.....	153
6.3.10 Zero point probing, rotary axis.....	155
7 Commissioning.....	169
7.1 General information.....	169
7.2 Setting machine parameters.....	169
7.3 Setting drive parameters.....	169
7.4 PLC user program adjustment.....	171
7.4.1 General information.....	171
7.4.2 Activating/deactivating the probes.....	171
7.4.3 Collision monitoring for feed axes - PLC function block MT_AxProbeMon.....	172
7.4.4 Reactivation of Radio Probes.....	175

Table of Contents

	Page
7.4.5 PLC implementation example.....	176
7.5 SD variables.....	184
7.5.1 Standard structure.....	184
7.5.2 Structure expansion.....	185
7.6 Initialization screen.....	186
7.7 Mechanical installation examples.....	190
7.7.1 Probe installation examples.....	190
7.8 Electrical connection diagram example.....	192
 8 Service and support.....	 193
 Index.....	 195

1 About this documentation

1.1 Validity of the documentation

- Purpose of the documentation** This documentation describes the functions of the Rexroth IndraMotion MTX measuring cycles.
- Overview on target groups and product phases** In the following illustration, the framed activities, product phases and target groups refer to the present documentation.
- Example: The target group "Programmer" can "parameterize", "program", "configure" and "simulate" in the product phase "Engineering" using this documentation.

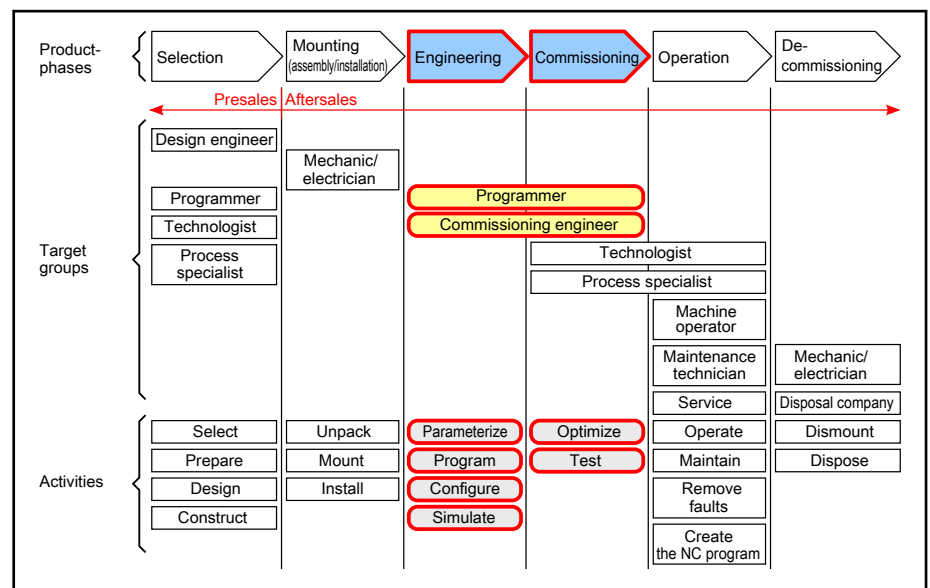


Fig. 1-1: Assigning this documentation to the target groups, product phases and target group activities

1.2 General information

The present manual supports you during the application/activation of various control functions.

It focuses on the procedures required for the parameterization.

This requires that the hardware of CNC, drives, PLC and voltage supply units are already integrated and checked according to your application documentation including wiring and accuracy. This refers especially to all safety-relevant features such as E-STOP circuits, release contacts, limit switches.

Ideally, the software of all Sercos drives is already commissioned. However, this is not imperative, since the control is able to configure any drives connected at startup via a parameter download. Thus, the fitting initialization files have to be available on the control.

To adjust the initialization files, have the corresponding documents available (such as lists with the necessary sercos parameter settings for all drives and drive documentation).

For a better overview, all functions are assigned to different superordinate topics (see "Table of Contents").

For each function, the following information is provided:

- Purpose or area of application

About this documentation

- Prerequisites/restrictions on use
- Interference options.

Numerous functions affect several domains at the same time (machine parameters, NC functions for programming, interface signals, etc.). Thus, many functions can also be described completely or partially in other manuals of this product.



Refer to the respective manual.

The following manuals supplement this manual:

- Machine parameters: "Rexroth IndraMotion MTX Machine Parameters"
- NC and CPL functions: "Rexroth IndraMotion MTX Programming Manual"
- Interface signals: "Rexroth IndraMotion MTX PLC Interface"

Furthermore, have the drive documentation at hand.

You require good knowledge of the

- standard user interface of the control
- Windows user interface of the PC control panel
- tools for the machine parameter configuration.

These tools can modify the control configuration. Therefore, you have to be familiar with all required tools!

⚠ CAUTION

Due to an incorrect or unintended use caused by insufficiently trained or untrained staff, serious damage to the machine, loss of data and even personal injury can result!

Thus, only qualified staff that is sufficiently trained may start and operate the system and set or modify configuration parameters!

The personnel also has to be able to detect the risks resulting from changing parameters and the inherent general risks of mechanical, electrical or electronic equipment.

Incorrect or unintended use by insufficiently trained or untrained staff can cause serious damage to the equipment! Bosch Rexroth is not liable for any of those damages and consequential damages caused.

1.3 Required and supplementing documentation

1.3.1 Selection/compilation

Documentation titles with type codes and part numbers

Rexroth IndraMotion MTX 14VRS System Description DOK-MTX***-SYS*DES*V14-PRRS-EN-P, R911342640 This documentation describes the Rexroth IndraMotion MTX control. It includes the designs, technical data, interfaces as well as the configuration of the control components.
Rexroth IndraMotion MTX 14VRS SafeLogic System Overview DOK-MTX***-SL**SYS*V14-PRRS-EN-P, R911341698 This documentation describes the use of the safety control SafeLogic in the IndraMotion MTX.

Tab. 1-1: MTX documentation overview - Selection/compilation

1.3.2 Configuration

Documentation titles with type codes and part numbers

Rexroth IndraMotion MTX 14VRS Machine Parameters DOK-MTX***-MA*PAR**V14-RERS-DE-P, R911342630 This documentation describes handling, design and modification of the Rexroth IndraMotion MTX parameters available. It also includes the functions of the NC configurator and its operation.
Rexroth IndraMotion MTX 14VRS PLC Interface DOK-MTX***-PLC*INT*V14-PRRS-DE-P, R911342622 This documentation describes interface signals and program function blocks for the integrated PLC.
Rexroth IndraMotion MTX Functional Description 14VRS Basics DOK-MTX***-NC*F*BA*V14-RERS-DE-P, R911342626 This documentation describes the functions of the Rexroth IndraMotion MTX basic functions. The basic commissioning steps and the control functions are provided as description and handling instruction.
Rexroth IndraMotion MTX Functional Description 14VRS Extension DOK-MTX***-NC*F*EX*V14-RERS-DE-P, R911342628 This documentation describes the extended functions of the Rexroth IndraMotion MTX. The basic commissioning steps and the control functions are provided as description and handling instruction.
Rexroth IndraMotion MTX Functional Description 14VRS Special Functions DOK-MTX***-NC*F*SP*V14-RERS-DE-P, R911342624 This documentation describes the special functions of the Rexroth IndraMotion MTX. The basic commissioning steps and the control functions are provided as description and handling instruction.
Rexroth IndraMotion MTX Free Form Surface Machining DOK-MTX***-FREEFORM***-APRS-DE-P, R911341435 This documentation describes the free-form surface machining process with the MTX control. CNC programs generated by a CAD/CAM system are the basis for the entire machining process. An overview of the following topics is provided: Description of the MTX or CNC functions for free-form surface machining, NC parameterization, basic conditions when generating CNC programs with CAM software.

About this documentation

Rexroth IndraWorks Energy Management Function Description

DOK-IWORKS-ENERGY*MGMT-RERS-DE-P, R911342511

This documentation describes the energy management.

Rexroth IndraMotion MTX Converting MTX Projects

DOK-MTX***-PROCONV****-PRRS-DE-P, R911342484

This documentation provides support during the conversion of IndraMotion MTX 1.x projects to MTX 2G. The conversion process is described and potential challenges during the conversion are identified.

Tab. 1-2: MTX documentation overview - Configuration

1.3.3 Commissioning

Documentation titles with type codes and part numbers

Rexroth IndraWorks 13VRS Simulation

DOK-IWORKS-SIMU****V13-APRS-DE-P, R911339256

This documentation describes the functions of the simulation components View3D, virtual control panel, virtual control and its operation in IndraWorks.

Rexroth IndraMotion MTX 14VRS Commissioning

DOK-MTX***-STARTUP*V14-CORS-DE-P, R911342620

This documentation describes the commissioning of the IndraMotion MTX control. Apart from a complete overview, commissioning and configuration of the axes and the user interface as well as the PLC data are described.

Rexroth IndraWorks 14VRS Basic Libraries IndraLogic 2G

DOK-IL*2G*-BASLIB**V14-LIRS-DE-P, R911343920

This documentation describes the system-comprehensive PLC libraries.

Rexroth IndraWorks 14VRS Field Buses

DOK-IWORKS-FB*****V14-APRS-DE-P, R911341485

This documentation describes field bus and local periphery connections supported by the systems IndraLogic XLC, IndraMotion MLC and IndraMotion MTX. This documentation focuses on the configuration, parameterization, commissioning and diagnostics of the different periphery connections. The documentation is the basis for the online help.

Rexroth IndraWorks 14VRS WinStudio

DOK-IWORKS-WINSTUD*V14-APRS-DE-P, R911341585

This "User Manual and Technical Reference Book" provides information for efficient working with the "Rexroth WinStudio"™ software. The document provides technical information and step-by-step instructions to create web-enabled HMI/SCADA programs.

Rexroth IndraWorks 14VRS Software Installation

DOK-IWORKS-SOFTINS*V14-CORS-DE-P, R911344286

This documentation describes the IndraWorks installation.

Rexroth IndraWorks 14VRS Engineering

DOK-IWORKS-ENGINEE*V14-APRS-DE-P, R911343566

This documentation describes the use of IndraWorks in which the Rexroth Engineering tools are integrated. It includes instructions on how to work with IndraWorks and how to operate the oscilloscope function.

Rexroth IndraWorks 12VRS FDT Container

DOK-IWORKS-FDT*CON*V12-APRS-DE-P, R911334398

This documentation describes the IndraWorks FDT Container functionality. It includes the activation of the functionality in the project and working with DTMs.

About this documentation

Rexroth IndraWorks 14VRS IndraLogic 2G PLC Programming System DOK-IWORKS-IL2GPRO*V14-APRS-DE-P, R911343571 This documentation describes the PLC programming tool IndraLogic 2G and its use. It includes the basic use, first steps, visualization, menu items and editors.
Rexroth IndraWorks 14VRS HMI DOK-IWORKS-HMI*****V14-APRS-DE-P, R911343569 This documentation describes the functions, configuration and operation of the user interfaces IndraWorks HMI Engineering and IndraWorks HMI Operation.

Tab. 1-3: MTX documentation overview - Commissioning

1.3.4 Operation

Documentation titles with type codes and part numbers

Rexroth IndraMotion MTX 09VRS Shop Floor Programming Turning and Milling DOK-MTX***-SF*PROG*V09-AWxx-DE-P, R911324377 This documentation describes the operation and programming of the graphic NC programming of turning and milling as well as the workpiece simulation.
Rexroth IndraMotion MTX 12VRS Block Pre-Run DOK-MTX***-BLK*RUN*V12-APRS-DE-P, R911334379 This documentation explains to the machine manufacturer how to setup the "Block pre-run" function at the machine for the end user.
Rexroth IndraMotion MTX 14VRS Programming Manual DOK-MTX***-NC**PRO*V14-RERS-DE-P, R911342634 This documentation describes the standard programming of the Rexroth IndraMotion MTX control. Apart from the basics of NC programming, the use of NC functions according to DIN 66025 as well as the NC functions with high-level language syntax and CPL functions are described.
Rexroth IndraMotion MTX 14VRS Standard NC Operation DOK-MTX***-NC*OP***V14-APRS-DE-P, R911342632 This documentation describes the operation of the standard user interface of the NC control of the Rexroth IndraMotion MTX. It includes the operation of the interface, the NC program development as well as the tool management.
Rexroth IndraMotion MTX 14VRS Standard NC Cycles DOK-MTX***-NC*CYC**V14-PRRS-DE-P, R911342638 This documentation describes the application of the standard cycles of the different technologies for Rexroth IndraMotion MTX control.

xx Corresponding edition

Tab. 1-4: MTX documentation overview - Operation

1.3.5 Maintenance

Documentation titles with type codes and part numbers

Rexroth IndraMotion MTX 11VRS Diagnostic Messages DOK-MTX***-DIAGMES*V11-RExx-DE-P, R911332311 This documentation provides an overview on errors, warnings and messages in the Rexroth IndraMotion MTX control.
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xx Corresponding edition

Tab. 1-5: MTX documentation overview - Maintenance

About this documentation

1.3.6 OEM Engineering

Documentation titles with type codes and part numbers

Rexroth IndraMotion MTX 13VRS Automation Interface DOK-MTX***-AUT*INT*V13-APRS-DE-P, R911337274 This documentation describes the script-based access to IndraWorks project data via the Automation Interface. Different objects including code examples are described. The Automation Builder is also described in this manual.
Rexroth IndraMotion MTX 09VRS Integration of OEM Applications DOK-MTX***-DEV*KIT*V09-AWxx-DE-P, R911324355 This documentation describes the integration of OEM applications in the IndraWorks MTX as well as the communication via the industrial standard OPC.
Rexroth IndraMotion MTX 14VRS OPC Communication DOK-MTX***-OPC*COM*V14-PRRS-DE-P, R911342636 This documentation describes the syntax and the structure of the items for the communication with Bosch Rexroth devices.
Rexroth IndraMotion MTX 14VRS OPC UA Communication DOK-MTX***-OPC*UA**V14-APRS-DE-P, R911342513 This documentation describes the OPC UA communication of the IndraMotion MTX.

xx Corresponding edition
Tab. 1-6: MTX documentation overview - OEM Engineering

1.3.7 AddOns

Documentation titles with type codes and part numbers

Rexroth IndraMotion MTX 11VRS Action Recorder DOK-MTX***-ACR*****V11-APxx-DE-P, R911329943 This documentation describes the MTX action recorder. It includes the installation and commissioning as well as interface signals, application and operation.
Rexroth IndraMotion MTX efficiency workbench 14VRS MTX cta, MTX ega DOK-MTX***-EWB*****V14-APRS-DE-P, R911343916 This documentation describes the mode of operation and the area of application of the analysis tool IndraMotion MTX cta and IndraMotion MTX ega.
Rexroth IndraMotion MTX Remote Condition Monitoring DOK-MTX***-RCM*****V01-APRS-DE-P, R911334383 This documentation describes the operation of the Remote Condition Monitoring System.
Rexroth IndraMotion MTX visIREC DOK-MTX***-VISIREC*V01-APRS-DE-P, R911344242 This documentation describes the analysis tool visIREC. The visIREC is used to optimize the free-form surface machining process. 2D or 4D display of path-related data. 2D or 4D display of coordinate-related data. Analyzing critical areas (path and orientation deviation). Comparing the programmed and interpolated NC blocks.

xx Corresponding edition
Tab. 1-7: MTX documentation overview - AddOns

1.4 Use of the safety instructions

1.4.1 Structure of the safety instructions

The safety instructions are structured as follows:

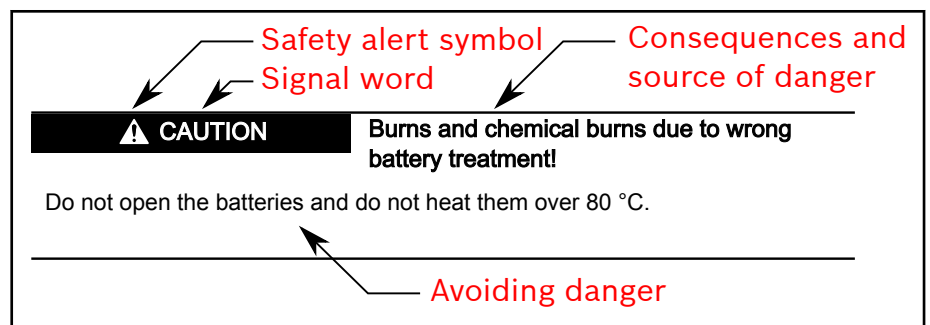


Fig. 1-2: Structure of the safety instructions

1.4.2 Explaining signal words and safety alert symbol

The safety instructions in this documentation contain specific signal words (danger, warning, caution, notice) and, if necessary, a safety alert symbol (according to ANSI Z535.6-2006).

The signal word is used to draw attention to the safety instruction and also provides information on the severity of the hazard.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words danger, warning and caution is used to alert the reader to personal injury hazards.

DANGER

In the event of non-compliance with this safety instruction, death or serious injury **will** occur.

WARNING

In the event of non-compliance with this safety instruction, death or serious injury **will** occur.

CAUTION

In the event of non-compliance with this safety instruction, minor or moderate injury can occur.

NOTICE

In the event of non-compliance with this safety instruction, material damage can occur.

About this documentation

1.4.3 Symbols used

Hints are represented as follows:



This is an information.

Tips are represented as follows:



This is a tip.

1.4.4 Signal graphic explanation on the device



Prior to the installation and commissioning of the device, refer to the device documentation.

1.5 Names and abbreviations

Term	Explanation
IWE	IndraWorks Engineering
IWO	IndraWorks Operation
OWL	Optical waveguide
NC	Numerical Control
OEM	Original Equipment Manufacturer
Profibus	Communication connection
Sercos	Communication connection
MTB	Machine tool builder

Tab. 1-8: Names and abbreviations used

1.6 Customer feedback

Bosch Rexroth highly appreciates feedback or suggestions for improvement by our customers. Please email your feedback about the documentations to Feedback.Documentation@boschrexroth.de. Comments can be inserted in the electronic PDF document. The PDF file can then be send to the address mentioned above.

2 Important instructions on use

2.1 Intended use

2.1.1 Introduction

Bosch Rexroth products are developed and manufactured according to the state-of-the-art. The products are tested prior to delivery to ensure operating safety and reliability.

The products may only be used as intended. If they are not used as intended, situations occur that result in damage to property or injury to persons.



Bosch Rexroth shall not assume any warranty, liability or payment of damages in case of damage resulting from a non-intended use of the products; the use shall solely bear all risks from unintended use of the products.

Before using Bosch Rexroth products, the following requirements have to be met to guarantee the intended use of the products:

- Anybody dealing with Bosch Rexroth products in any way is obliged to read and consent to the relevant safety instructions and the intended use.
- Hardware products may not be altered and have to remain in their original state; i.e. no structural changes are permitted. The decompilation of software products or the alteration of source codes is not permitted.
- Do not install or operate damaged or faulty products.
- It has to be ensured that the products have been installed as described in the relevant documentation.



Ensure that the data present in the control or entered or read in by the user is correct before applying it to exclude unwanted axis motion. It can be the following invalid or old data:

- Part programs
- ZO tables
- Compensation tables
- Tool tables
- Permanent CPL variables
- Remanent PLC data
- Permanent system data

2.1.2 Areas of use and application

The Rexroth IndraMotion MTX control is used to

- program contour and machining technology (path feed, spindle speed, tool change) of a workpiece.
- guide a machining tool along a programmed path.

Feed drives, spindles and auxiliary axes of a machine tool are activated via sercos interface.

Important instructions on use



This additionally requires I/O components for the integrated PLC which - together with the actual CNC - control the machining process as a whole and also monitors this process with regard to technical safety.

It may only be operated with the explicitly specified hardware component configurations and combinations and only with the software and firmware specified in the appropriate documents and functional descriptions.

The Rexroth IndraMotion MTX provides the perfect CNC system solution for cutting and forming for the following technologies:

- Turning
- Milling
- Drilling
- Grinding
- Bending
- Nibbling
- Punching
- Contour cutting
- Handling

2.2 Unintended use

The use of the Rexroth IndraMotion MTX in application areas other than those specified or described in the documentation and technical data is considered as "unintended".

The Rexroth IndraMotion MTX must not be used if ...

- it is subjected to operating conditions not corresponding to the specified ambient conditions. Operation under water, under extreme temperature fluctuations or under extreme maximum temperatures is prohibited.
- the intended applications have not expressly been released by Bosch Rexroth. Therefore, please read the information given the general safety instructions!
- The Rexroth IndraMotion MTX may not be used in systems or machines connected to the internet via an unsecure network connection. Otherwise, malfunctions or a control failure can result due to unauthorized access.

3 Introduction

Prerequisites	• IndraDrive control units CSB, CDB, CSH • IndraDrive Firmware from MPx07, MPx17 • Functional package Servo enabled for each measuring axis
Working with this description	<i>This description is divided into 4 chapters:</i> • chapter 4 "Measuring cycle automatic" on page 19 • chapter 5 "Developing an individual measuring cycle automatic" on page 89 • chapter 6 "Manual probing" on page 109 • chapter 7 "Commissioning" on page 169
Measuring task steps	<i>Four consecutive steps have to be following to use the measuring cycles:</i> 1. Calibrating the probe 2. Recording measured values at measured positions Providing measured results, e.g. boring center point and boring diameter 3. <i>Evaluating the measurement results and correction values:</i> • Monitoring the allowance and tolerance ranges with appropriate reaction in the process, outputting messages via the NC program • Determining the correction values depending on the dimensional deviation 4. <i>Processing the determined correction values in the NC user program:</i> • Assigning the correction values to programmed zero point offsets • Detecting rejected parts or rework Additionally measured to control the status: Protection of the probe against collision and monitoring of probe malfunctions.
	 To use the described measuring cycles, the MT_AxProbeMon function block has to be integrated in the PLC user program or a function has to be provided by the user. MT_AxProbeMon generates signals to be evaluated in the PLC user program. The PLC user program has to ensure monitoring of the probe and facilitate post-triggering at the radio probe.
Structure of the measuring cycles	The described measuring cycles are not based on parameterizable NC sub-routines. Call a so-called basic measuring cycle STP_PRBASE as NC sub-routine for the different measuring task steps. The measuring cycles use SD variables in IndraMotion MTX to record and evaluate the measured values. The SD variables defined for the measuring cycles are described in chapter 7.5 "SD variables" on page 184.
Input mask tables	Input masks facilitate programming and operation of the measuring tasks. Each of the cycles has an individual input mask. Within the mask, the cycle parameters are explained with comments and graphics. For the measuring cycles of the manual operation mode, the masks in OP2 Prepare F3 Zero point measurement are available. For the measuring cycles of the automatic operation mode, the masks in the NC-Editor are available with <F5> "Input assistance", <F2>, "NC cycle".

Introduction

A mask facilitates tabular input of the required and optional parameters and transmits the syntax and the parameters from the table to the NC-Editor. The cycle call is inserted at the current cursor position in the NC-Editor.

Change parameters of an already programmed cycle using the same input mask.

In [chapter 4 "Measuring cycle automatic" on page 19](#), the same steps of the measuring task steps are executed. Initially, the probe calibration is explained. Subsequently, the measurement, followed by the evaluation and processing of the information is described.

The measuring cycles are the standard solution for recurring measuring tasks. To solve special measuring tasks, individual user-defined measuring cycles can be developed or a compatible standard solution in the standard NC-Editor can be adjusted to the special measuring task, see [chapter 5 "Developing an individual measuring cycle automatic" on page 89](#).

To commission the measuring cycles or individual measuring cycles, a PLC function block is available as standard solution. Furthermore, certain parameters have to be adjusted in drive and control. A detailed description can be found in [chapter 7 "Commissioning" on page 169](#).

The individual measuring cycles are explained using the following specifications:

- Overview display (one or several figures):
The figures show the overview screens in an operating interface
- Syntax:
Syntax explanation, especially the mandatory and optional parameters in the cycle call. The parameters are identified by a maximum of a 3-digit code. Mandatory parameters are put in squared brackets (e.g. measuring distance <PRD>) in the syntax explanation. Optional parameters are additionally put in curly brackets (e.g. safety distance {<SDI>}). In the actual call, the parameters are not put in brackets individually but are only separated by semicolons. Mandatory parameters have to be assigned with a value in each measuring cycle call. No values have to be assigned to optional parameters.
- Input variables:
Transfer parameters to the measuring cycles
- Runtime variables:
Depending on the measuring cycle, local valid runtime parameters are created. The parameters can be read for diagnostics during commissioning.
- Output variables:
List of SD variables written with values within the measuring cycles or within the basic measuring cycle STP_PRBASE.
- Sequence:
Measuring cycle sequence description, partially with graphics.
- Programming Example:
Compact, conclusive programming example with abstracted dimensioned drawing.

See also [chapter 4 "Measuring cycle automatic" on page 19](#).

Probe geometry The foot offsets for the lengths are always read out from the SD variables.

Introduction

If the SD variable TOOL has the value TRUE, the geometry data "Length" and "Radius" are taken from the tool database. These values have to be enabled using G47.

If the SD variable TOOL has the value FALSE, the geometry data "Length" and "Radius" are taken from the SD variable. These values are automatically calculated by the cycle.

Specify the probe sphere center as tool length of the probe.

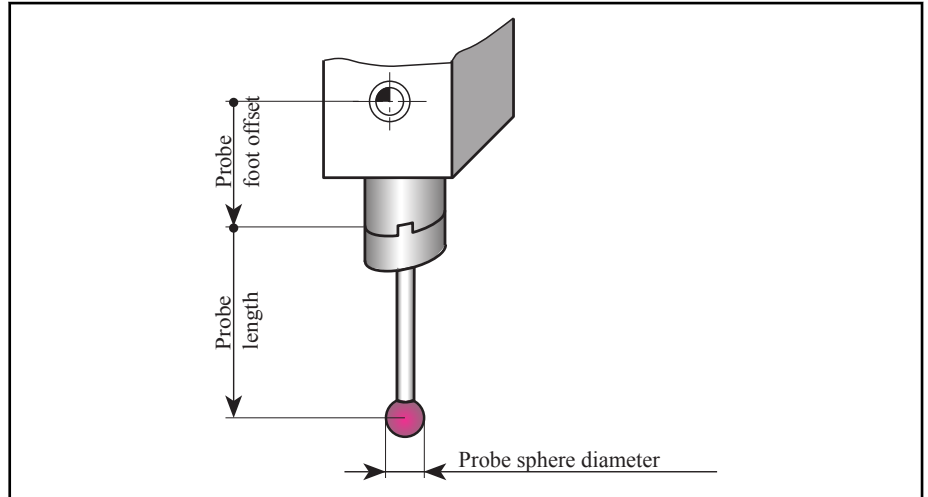


Fig. 3-1: Measuring the probe length

4 Measuring cycle automatic

4.1 General information

Functions	<i>The following functions are provided:</i>
	• <i>Calibrate tool probe</i> – G311 Tool length – G315 Tool radius • <i>Probe tool</i> – G301 Tool length – G303 Tool radius • <i>Calibrate workpiece probe</i> – G317 at a known point – G318 in an adjusting ring – G319 at a spigot • <i>Probe workpiece</i> – G321 Point – G323 Workpiece available, check – G324 Boring – G327 Spigot – G329 Land – G331 Groove – G333 Angle • <i>Measuring value evaluation</i> – G541 Tolerance monitoring – G542 Averaging – G543 Percentage compensation

4.2 General notes

4.2.1 General information

Spindle orientation	For spindles with servo functionality, a spindle orientation is to be programmed before calling a measuring cycle. For measuring, the spindle is to be oriented to the same position that was already used for calibrating (e. g. M19 S0). This way, a higher measuring accuracy can be achieved. The value orientation value of the spindle can also be read out from the variable SD.SysPrbase.PROBE[n].ANGLE if it was stored there after calibration. As for spindles without servo functionality, no spindle orientation is available, after switching in the probe, the respective calibration cycle is to be called to ensure proper calibration.
SD variable RUNS	The variable specifies the number of measurements after calibration. The part programmer has the possibility to recalibrate automatically after a specific number of measurements. This can also take place according to the time passed as the calibration time is also saved.
Measuring position and measuring distance	In the cycle call, a measuring position and the length of the measuring distance are entered. Starting point and end point of the measuring distance are

Measuring cycle automatic

calculated within the described measuring cycles. The signed starting point lies half the measuring distance in front of the programmed (expected) measuring position. The signed end point half the measuring distance behind the programmed measuring position. The following figure illustrates this relation.

The described measuring cycles expect triggering of the probe within the measuring distance. However, if the probe is triggered in front of the starting point or not triggered up to the end point, an error message is usually returned.

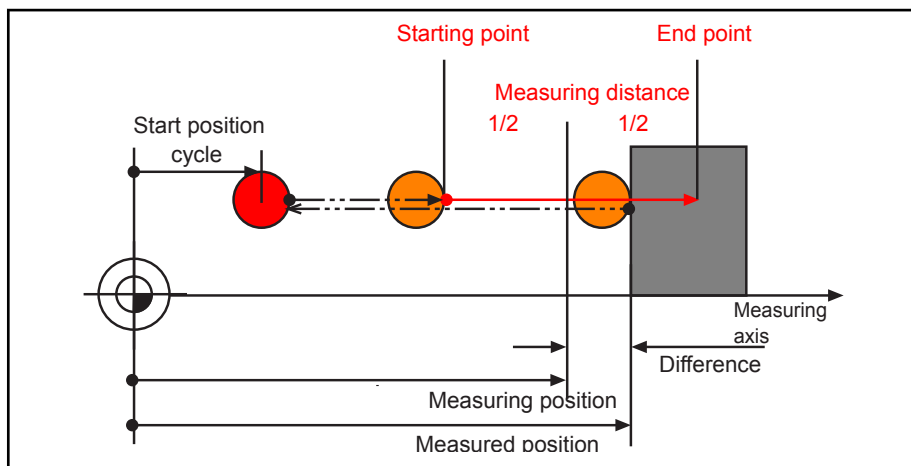


Fig. 4-1: Basic cycle sequence

Infeed and retraction

For the calibration of workpiece probes as well as for measuring workpieces, a standard motion sequence for infeed and retraction is implemented. This sequence can be adjusted by entering safety distance, retraction height, in-feed feed and retraction feed for each measuring task.

Measuring cycle automatic

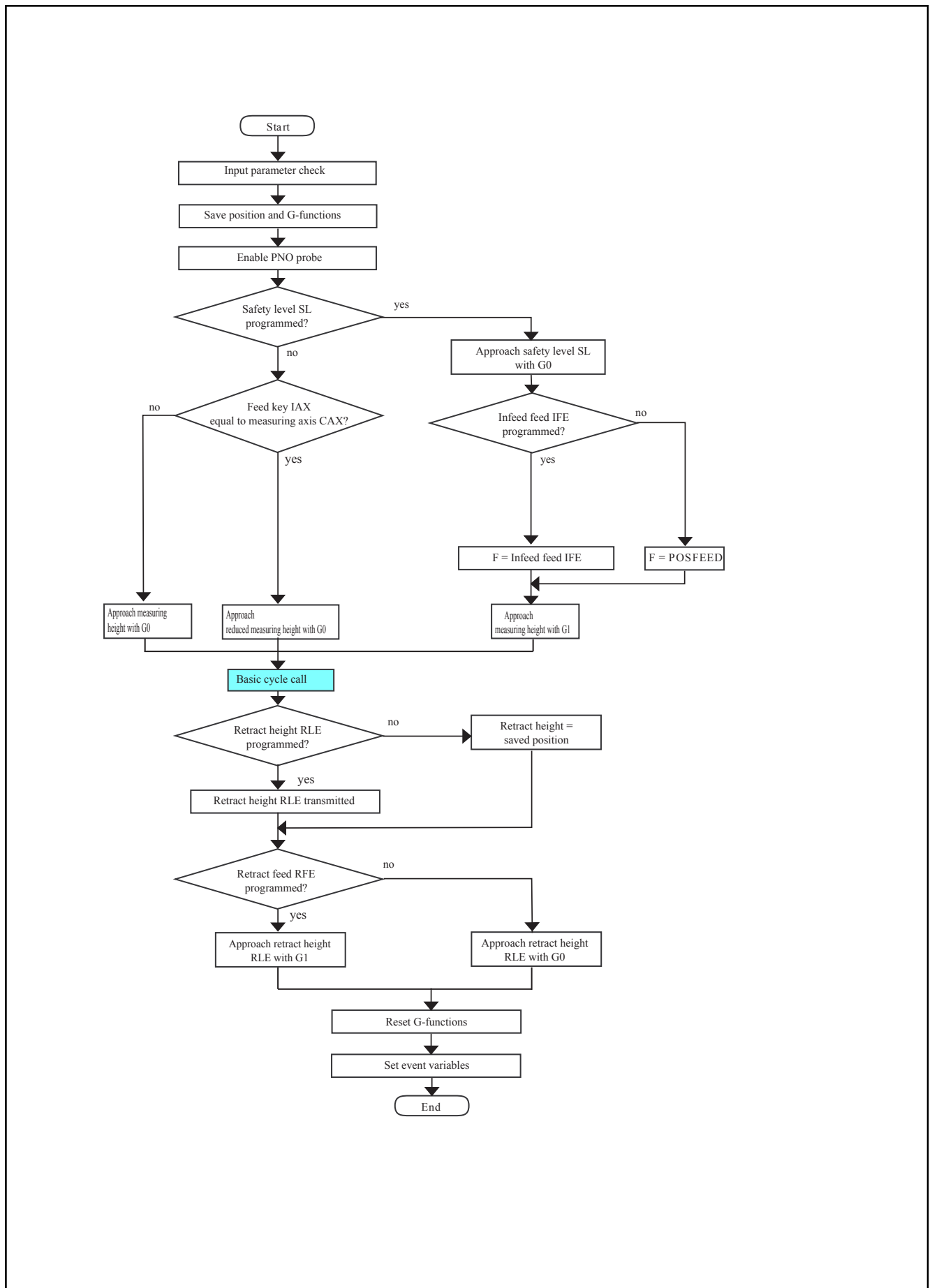


Fig. 4-2: Infeed and retraction sequence

Measuring cycle automatic

- NC axes** The measuring cycles use the channel axes 1-3 for measuring and auxiliary motion. If required, several axes can be added. However, please note that the system data structure has to be adjusted.
- Returns** The measuring cycles return the measuring results usually on global variables (valid until program end). Some, particularly calibration cycles, save their results in the form of permanent system data.

4.2.2 Abbreviations

Abbreviation	Description
ADI	Actual dimension
ANG	Set angle
BDI	Boring diameter
CA1	Center of 1st measuring axis
CA2	Center of 2nd measuring axis
CAX	Calibration axis
CDI	Calibration distance
CFE	Calibration feed
CLE	Calibration height
COB	Compensation limit
CPO	Calibrating position
CX1	Calibration axis 1
CX2	Calibration axis 2
DIA	Diameter
DIF	Differential dimension
DIS	Distance
EXV	Empirical value
GCE	Groove center
GW	Groove width
IAX	Infeed axis number
IFE	Infeed feed
LMV	Average value of the last measurement
LOL	Lower limit
LTO	Lower deviation
MC	Remeasure center?
NCE	Land center
NDI	Nominal dimension
NWI	Land width
PA1	Name of the 1st measuring axis
PA2	Name of the 2nd measuring axis

Measuring cycle automatic

Abbreviation	Description
PAX	Name of the measuring axis
PCL	Partial compensation limit
PCV	Percentage compensation value
PDI	Measuring distance
PFE	Measuring feed
PLE	Measuring height
PNO	Probe number
PP1	Main axis position
PP2	Secondary axis position
PPO	Measuring position
RDI	Ring diameter
RFE	Retraction feed
RLE	Retraction height
SCE	Spigot center
SCF	Scaling factor
SL	Safety level
SO	Spindle orientation command
SP	Spindle identifier
SST	Spindle stop command
TOC	Tolerance center
UPL	Upper limit
UTO	Upper deviation

Tab. 4-1: Abbreviations

4.3 Probe calibration

4.3.1 General information

Prior to actual measurements, a probe has to be calibrated for the axis and the direction of the measuring task at any known point of a measuring standard (zero tool) or a workpiece. In this respect, the switching offset of the probe is determined. The determined switching offset can be used in the measuring cycles for calculative compensation of a measured value to achieve a precise measuring result.

A probe has to be recalibrated after:

- Initial commissioning
- Changing the stylus
- Changing the measuring feed
- Temperature range at the machine

Measuring cycle automatic

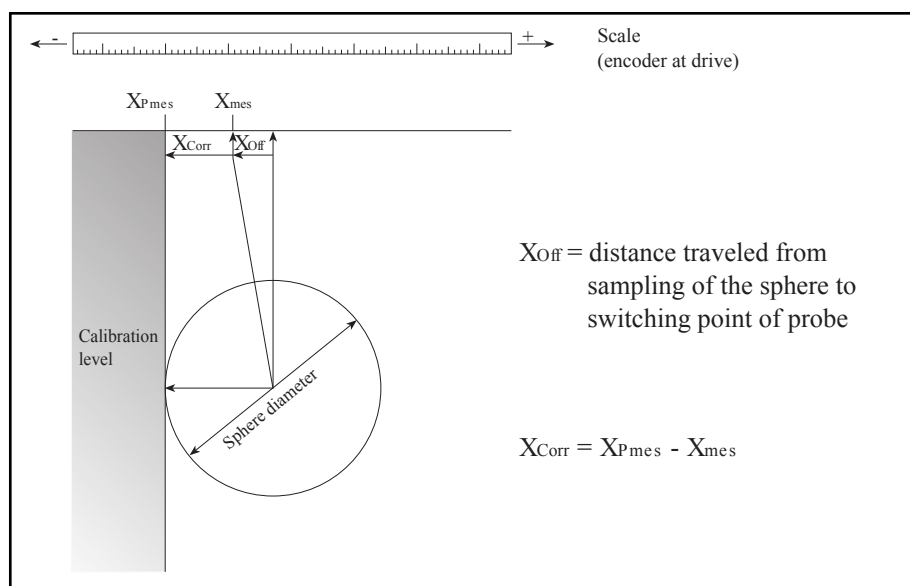


Fig. 4-3: Switching offset calibration

4.3.2 Probe calibration for workpiece measuring

G317 Calibrate probe - Point

Syntax G317 (PNO<pno>, IAX=<iax>, CDI<cdi>, CFE<cfe>, CLE<cle>, CAX<cax>, CPO<cpo>{, SL<sl>}{, IFE<ife>}{, RLE<rle>}{, RFE<rfe>})

Brief description The "Calibrate probe - Point" (G317) cycle defines the switching offset of a workpiece probe. The probe is calibrated for an axis and a direction. The calibration can also be carried out at any known point of a measuring standard (zero tool) or a workpiece.

Overview

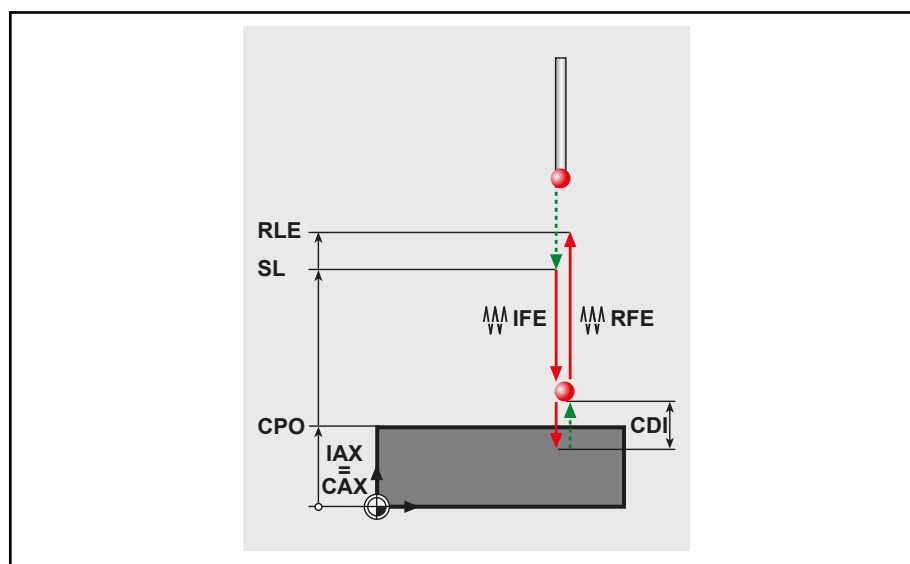


Fig. 4-4: Overview: Calibrate probe - Point with calibration axis equal to infeed axis

Measuring cycle automatic

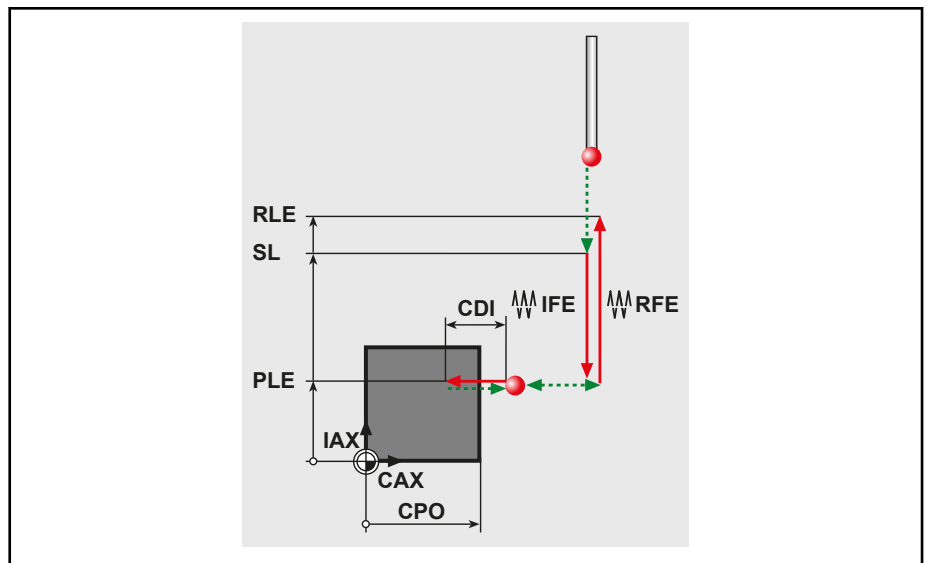


Fig. 4-5: Overview: Calibrate probe - Point with calibration axis unequal to infeed axis

Parameters

Parameters	Designation	Properties		Values	Pre-assignment/Range
PNO	Probe number	Mandatory		INTEGER	1..2
IAX	Infeed axis	Mandatory		STRING	8
SL	Safety level	Optional		REAL	Absolute
IFE	Infeed feed	Optional		REAL	mm/min
CLE	Calibration height	Mandatory	If infeed axis unequal to calibration axis	REAL	Absolute
		Optional	If infeed axis equal to calibration axis		
RLE	Retraction height	Optional		REAL	Absolute
RFE	Retraction feed	Optional		REAL	mm/min
CDI	Calibration distance	Mandatory		REAL	Relative
CFE	Calibration feed	Mandatory		REAL	mm/min
CAX	Calibration axis	Mandatory		STRING	8
CPO	Calibrating position	Mandatory		REAL	Absolute

Tab. 4-2: Parameter call

Measuring cycle automatic

Result variables

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].Parameter			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction (1 = positive, 2 = negative)			
Parameters	Description	Values	Area
CALI	Calibrated	BOOL	TRUE..FALSE
VAL	Switching offset	REAL	
FEED	Calibration feed	REAL	
PRPOS	Switching position MCS	REAL	
YEAR	Year: YYYY	STRING	4
DATE	Day and month: DD:MM	STRING	5
TIME	Time: HH.MM.SS	STRING	8
RUNS	Number of measurements	INTEGER	

Tab. 4-3: Output values

Description

If no safety level is specified, the infeed takes place with rapid traverse on the calibration height or, if infeed axis and calibration axis are equal, directly to the starting point of the calibration distance. If a safety level is specified, the probe is first positioned there in rapid traverse. Afterwards, the probe moves to calibration height with G1 and the infeed feed to enable plunging at reduced velocity.

The measuring process is now traveled by the basic cycle. Afterwards, the probe is repositioned at the initial position. Afterwards, the output variables are stored in the permanent system variables and the "Number of measurements" (RUNS) variable is set to the value 0 in the SysPrResult structure.

Finally, the infeed axis is retracted. If no retraction height is specified, positioning takes place in rapid traverse to the initial cycle position. If a retraction height is specified, it is moved to in rapid traverse or, if a retraction feed is additionally specified, with G1 and this feed value.

The cycle resets the modal functions of the groups ABS/REL (G90/G91), interpolation (G0/G1/G2/G3/G5/G6) and feed programming (G93/G94/G95) to their initial state prior to the cycle.

Procedure/processing

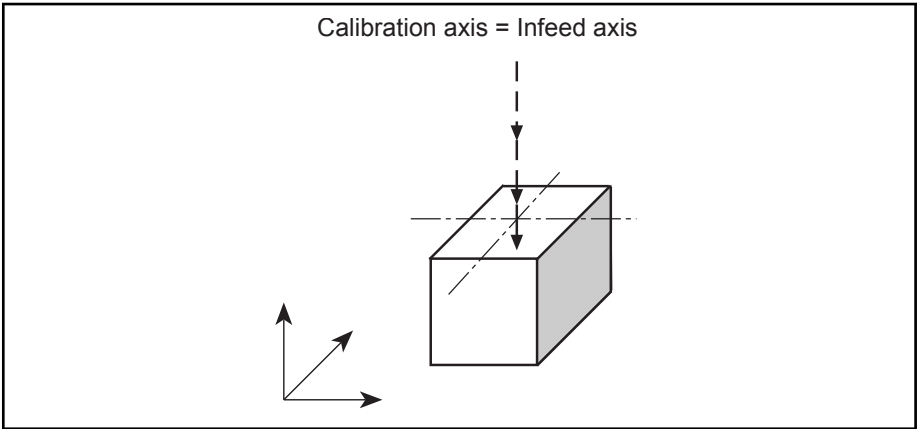


Fig. 4-6: Traversing motion: Calibrate probe - Point

Measuring cycle automatic

Example

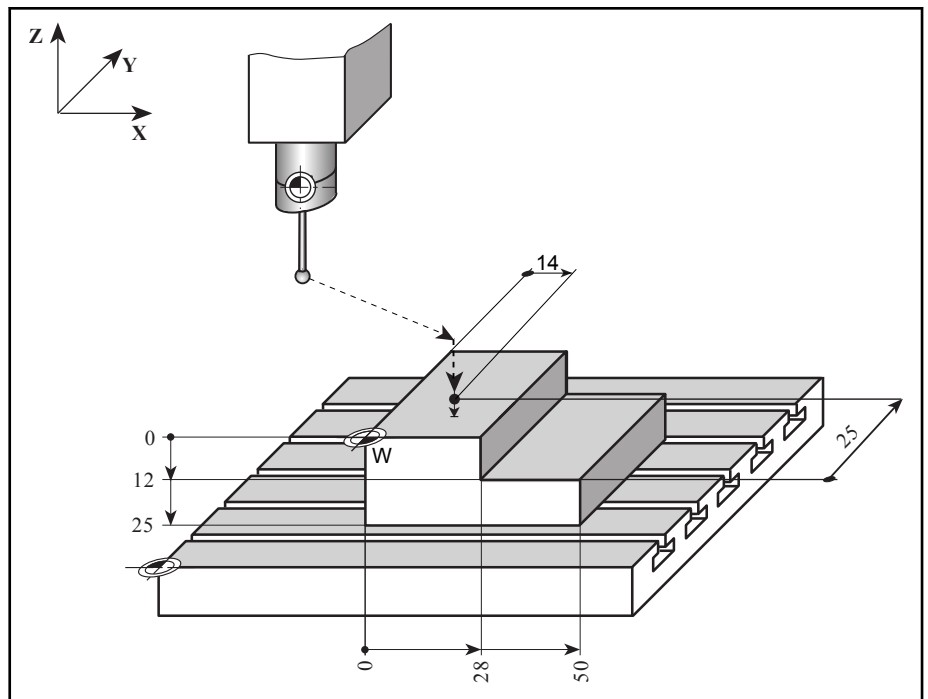


Fig. 4-7: Example: Calibrate probe - Point
Calibration - Point

```

;-----
;----- Calibration at known point on the workpiece -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T999 M6              ;load Probel
N30 ED1 M97              ;Probel ON and enable edge
N40 G47 G54 G0 X14 Y25 Z100 M19 S0 ;enable tool length and ZPO
                                ;call cycle
N50 G317(PNO1, IAX Z, SL20,IFE3000, CDI-10, CFE500, CAX Z, CPO0)
N60 G0 Z100              ;retracting
N70 M30

```

G318 Calibrate probe - Adjusting ring

Syntax G318 (PNO<pno>, IAX <iax>, CDI<cdi>, CFE<cfe>, CLE<cle>,
CX1 <cx1>, CX2 <cx2>, CA1<ca1>, CA2<ca2>, RDI<rdi>
{, SL<sl>}{, IFE<ife>}{, RLE<rle>}{, RFE<rfe>}{, MC<mc>}
{, SP <sp>, SO <so>})

Brief description With the "Calibrate probe - Adjusting ring" (G318) cycle, the probe is calibrated in an adjusting ring for the main and secondary axis respectively for positive and negative direction.

Measuring cycle automatic

Overview

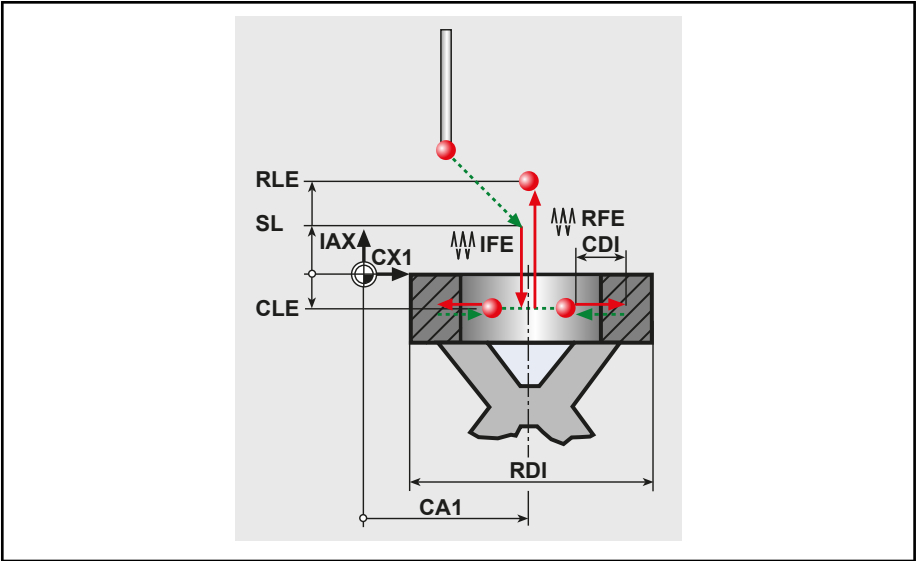


Fig. 4-8: Overview 1: Calibrate probe - Adjusting ring

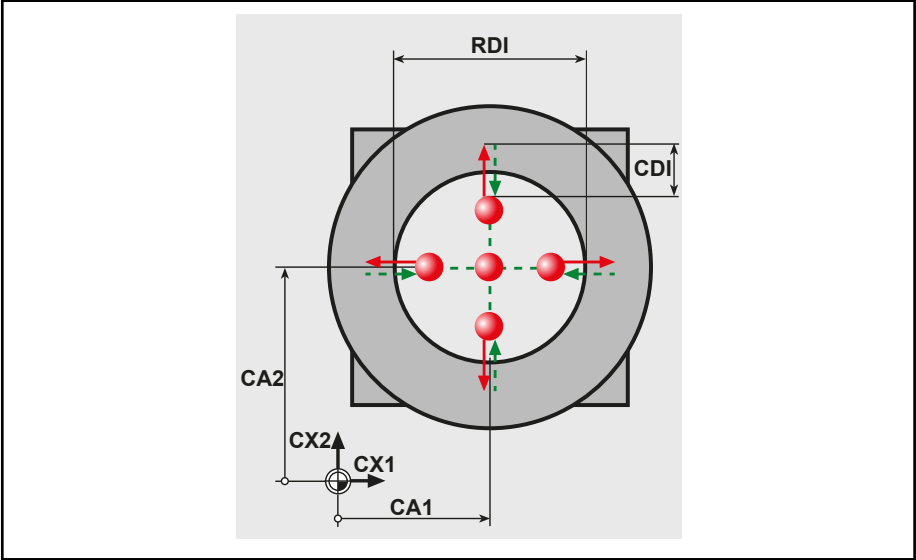


Fig. 4-9: Overview 2: Calibrate probe - Adjusting ring

Parameters

Parameters	Designation	Properties	Values	Pre-assign-ment/Range
PNO	Probe num-ber	Mandatory	INTEGER	1..2
IAX	Infeed axis	Mandatory	STRING	8
SL	Safety dis-tance	Optional	REAL	Absolute
IFE	Infeed feed	Optional	REAL	Absolute
CLE	Calibration height	Mandatory	REAL	Absolute
RLE	Retraction height	Optional	REAL	Absolute

Measuring cycle automatic

Parameters	Designation	Properties		Values	Pre-assignment/Range
RFE	Retraction feed	Optional		REAL	mm/min
CDI	Calibration distance	Mandatory		REAL	Relative
CFE	Calibration feed	Optional		REAL	mm/min
CX1	Calibration axis 1 (main axis)	Mandatory		STRING	8
CX2	Calibration axis 2 (secondary axis)	Mandatory		STRING	8
CA1	Center of calibration axis 1	Mandatory		REAL	Absolute
CA2	Center of calibration axis 2	Mandatory		REAL	Absolute
RDI	Diameter	Mandatory		REAL	
MC	Remeasure center?	Optional		INTEGER	1 Yes (pre-assigned) 2 No
SP	Spindle identifier	Optional	Specify together with SO	STRING	8, pre-assigned "no reversal measurement on remeasure center"
SO	Command for spindle orientation	Optional	Specify together with SP	STRING	8

Tab. 4-4: Parameter call

Result variables

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].Parameter			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction (1 = positive, 2 = negative)			
Parameters	Description	Values	Area
CALI	Calibrated	BOOL	TRUE..FALSE
VAL	Switching offset	REAL	
FEED	Calibration feed	REAL	

Measuring cycle automatic

SD.SysPrResult.CAL[n].AXIS[j].DIR[j].Parameter			
PRPOS	Switching position MCS	REAL	
YEAR	Year: YYYY	STRING	4
DATE	Day and month: DD:MM	STRING	5
TIME	Time: HH.MM.SS	STRING	8
RUNS	Number of measurements	INTEGER	
#RESULT1	Center in axis 1	REAL	
#RESULT2	Center in axis 2	REAL	

Tab. 4-5: Output values

Description

If the safety level is not specified, infeed takes place first to the ring center and then in rapid traverse to calibration height. If a safety level is specified, the probe is first positioned there in rapid traverse. Afterwards, the probe moves to calibration height with G1 and the infeed feed to enable plunging at reduced velocity.

If the position of the ring center is not exactly known, MC2 is to be programmed. In this case, the exact position of the ring center is measured first. To prevent measuring errors due to uncalibrated probes, SP and SO are to be programmed. With these specifications, measuring errors are minimized by turning the spindle in measuring direction (reversal measurement). The center is determined by four measuring steps.

Now, the switching offsets are determined in four axis directions (without spindle orientation) and afterwards positioned to the center of the adjusting ring. Afterwards, the output variables are stored in the permanent system variables and the "Number of measurements" (RUNS) variable is set to the value 0 in the SysPrResult structure.

Finally, the infeed axis is retracted. If no retraction height is specified, positioning takes place in rapid traverse to the initial cycle position. If a retraction height is specified, it is moved to in rapid traverse or, if a retraction feed is additionally specified, with G1 and this feed value.

The cycle resets the modal functions of the groups ABS/REL (G90/G91), interpolation (G0/G1/G2/G3/G5/G6) and feed programming (G93/G94/G95) to their initial state prior to the cycle.

Measuring cycle automatic

Procedure/processing

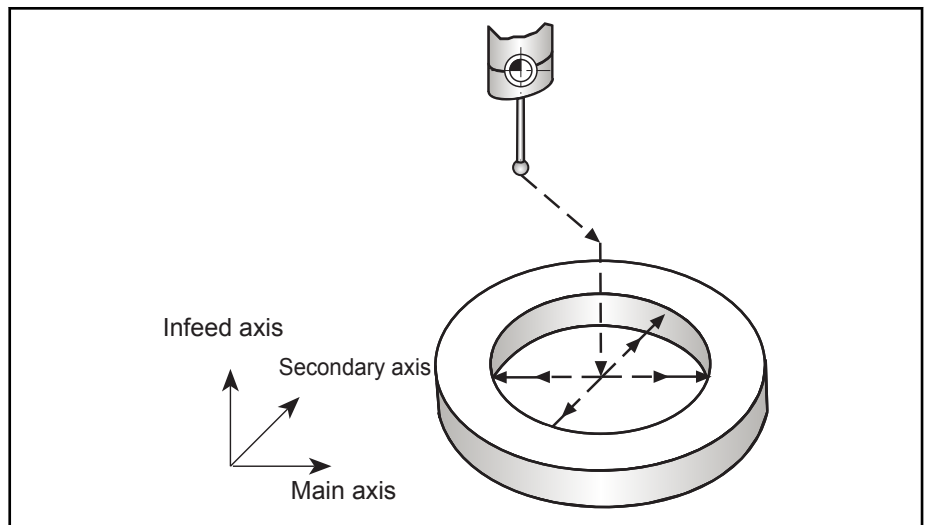


Fig. 4-10: Traversing motion: Calibrate probe - Adjusting ring

Example

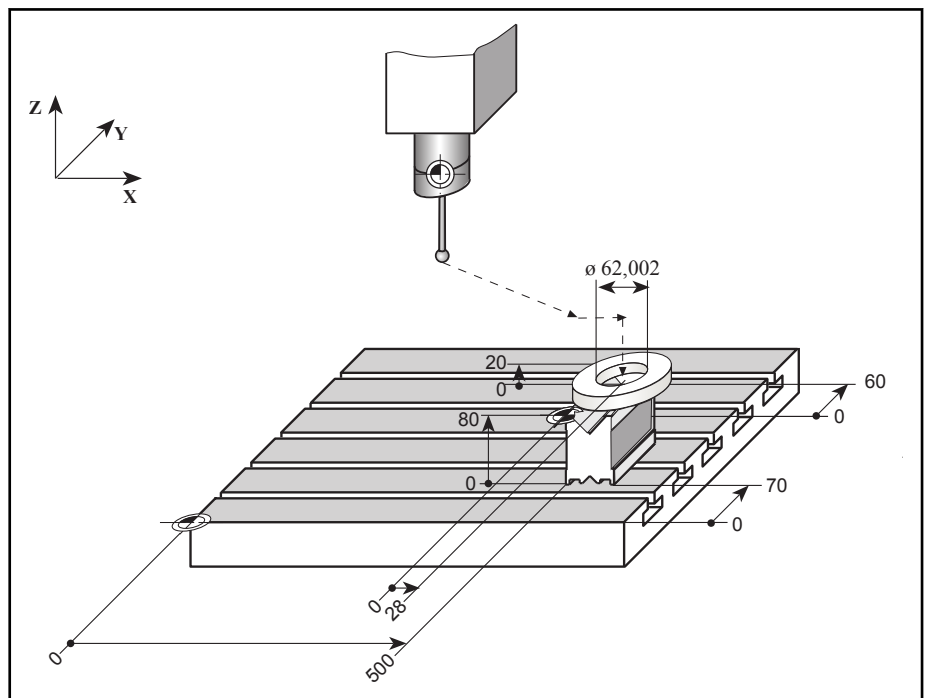


Fig. 4-11: Example: Calibrate probe - Adjusting ring

Calibration - Adjusting ring

```

;----- Calibrating X and Y in an adjusting ring -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T999 M6 ;load Probel
N30 ED1 M97 ;Probel ON and enable edge
N40 G47 G55 ;enable tool length and ZPO
N50 G0 X0 Y0 Z160 M19 S=0 ;approaching
;call cycle
N60 G318 (PNO1,IAX Z, SL20, IFE3000, CLE-31, RLE0, RFE1000,
CDI6, CFE500, CX1 X, CX2 Y, CA1 28, CA2 80, RDI62.005)
N60 G0 Z100 ;retracting
N70 M30

```

G319 Calibrate probe - Spigot

Syntax G319 (PNO<pno>, IAX <iax>, CDI<cdi>, CFE<cfe>, CLE<cle> ,

Measuring cycle automatic

CX1 <cx1>, CX2 <cx2>, CA1<ca1>, CA2<ca2>, DIA<dia>
{, SL<sl>}{, IFE<ife>}{, RLE<rle>}{, RFE<rfe>}{,MC<mc>}
{, SP <sp>, SO <so>}}

Brief description With the "Calibrate probe - Spigot" (G319) cycle, the probe is calibrated at a spigot with exactly known diameter for the main and secondary axis respectively for positive and negative direction.

Overview

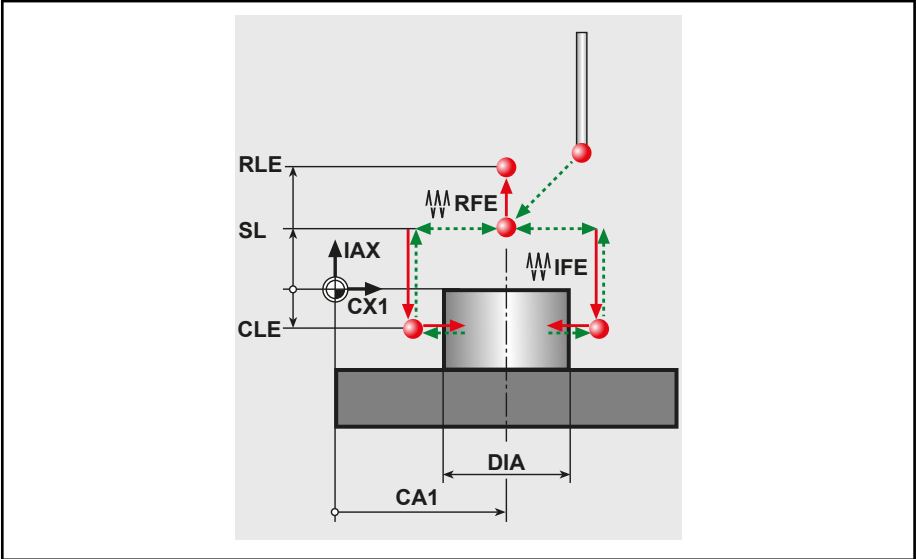


Fig. 4-12: Overview 1: Calibration - Spigot

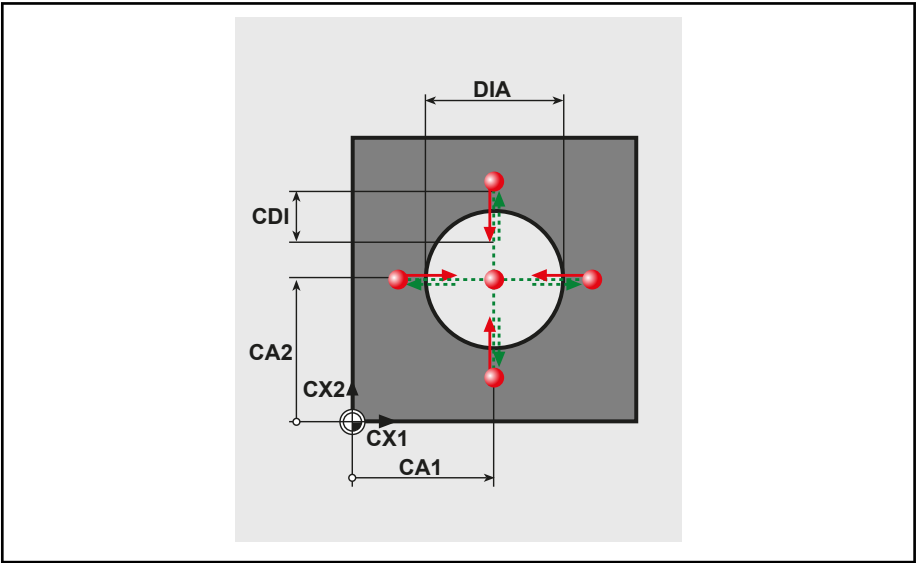


Fig. 4-13: Overview 2: Calibration - Spigot

Parameters

Parameters	Designation	Properties	Values	Pre-assign- ment/Range
PNO	Probe num- ber	Mandatory	INTEGER	1..2
IAX	Infeed axis	Mandatory	STRING	8
SL	Safety dis- tance	Optional	REAL	Absolute

Measuring cycle automatic

Parameters	Designation	Properties		Values	Pre-assignment/Range
IFE	Infeed feed	Optional		REAL	Absolute
CLE	Calibration height	Mandatory		REAL	Absolute
RLE	Retraction height	Optional		REAL	Absolute
RFE	Retraction feed	Optional		REAL	mm/min
CDI	Calibration distance	Mandatory		REAL	Relative
CFE	Calibration feed	Optional		REAL	mm/min
CX1	Calibration axis 1 (main axis)	Mandatory		STRING	8
CX2	Calibration axis 2 (secondary axis)	Mandatory		STRING	8
CA1	Center of calibration axis 1	Mandatory		REAL	Absolute
CA2	Center of calibration axis 2	Mandatory		REAL	Absolute
DIA	Diameter	Mandatory		REAL	
MC	Remeasure center?	Optional		INTEGER	1 Yes (pre-assigned) 2 No
SP	Spindle identifier	Optional	Specify together with SO	STRING	8, pre-assigned "no reversal measurement on remeasure center"
SO	Command for spindle orientation	Optional	Specify together with SP	STRING	8

Tab. 4-6: Parameter call

Result variables

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].Parameter
[n] 1..2 Probe number
[i] 1..3 Axis number
[j] 1..2 Direction (1 = positive, 2 = negative)

Measuring cycle automatic

SD.SysPrResult.CAL[n].AXIS[j].DIR[j].Parameter			
Parameters	Description	Values	Area
CALI	Calibrated	BOOL	TRUE..FALSE
VAL	Switching offset	REAL	
FEED	Calibration feed	REAL	
PRPOS	Switching position MCS	REAL	
YEAR	Year: YYYY	STRING	4
DATE	Day and month: DD:MM	STRING	5
TIME	Time: HH.MM.SS	STRING	8
RUNS	Number of measurements	INTEGER	
#RESULT1	Center in axis 1	REAL	
#RESULT2	Center in axis 2	REAL	

Tab. 4-7: Output values

Description

At the beginning of the cycle, positioning takes place in rapid traverse by means of the spigot center on the safety level. Afterwards, the probe moves to the first measuring point with G1 and to calibration height with infeed feed to enable plunging at reduced velocity.

If the position of the spigot center is not exactly known, MC2 is to be programmed. In this case, the exact position of the center is measured first. To prevent measuring errors due to uncalibrated probes, SP and SO are to be programmed. With these specifications, measuring errors are minimized by turning the spindle in measuring direction (reversal measurement). The center is determined by four measuring steps.

Now, the switching offsets are determined in four axis directions (without spindle orientation) and afterwards positioned to the center of the spigot. Afterwards, the output variables are stored in the permanent system variables and the "Number of measurements" (RUNS) variable is set to the value 0 in the SysPrResult structure.

Finally, the infeed axis is retracted. If no retraction height is specified, positioning takes place in rapid traverse to the initial cycle position. If a retraction height is specified, it is moved to in rapid traverse or, if a retraction feed is additionally specified, with G1 and this feed value.

The cycle resets the modal functions of the groups ABS/REL (G90/G91), interpolation (G0/G1/G2/G3/G5/G6) and feed programming (G93/G94/G95) to their initial state prior to the cycle.

Measuring cycle automatic

Procedure/processing

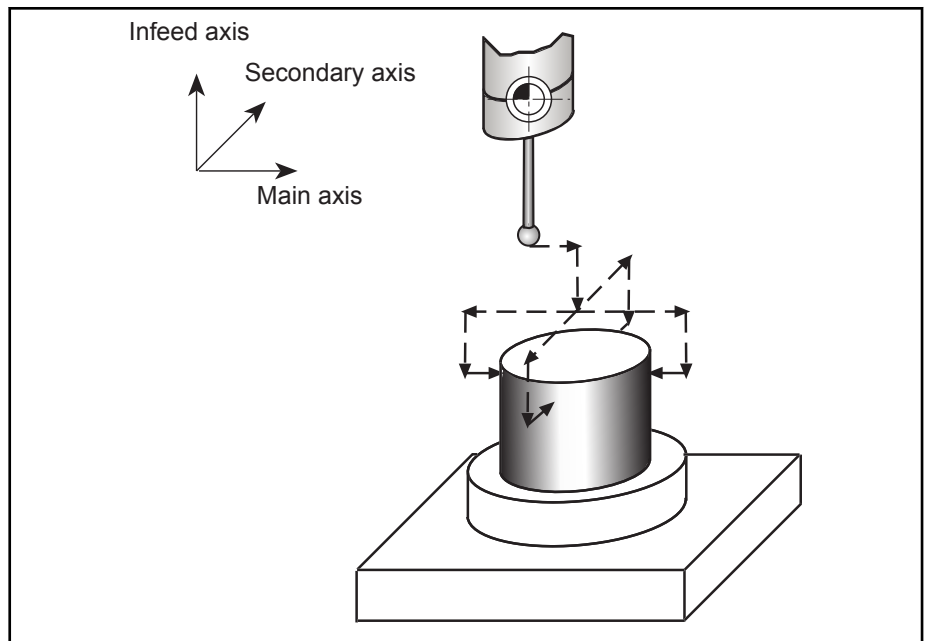


Fig. 4-14: Traversing motion: Calibrate spigot

Example

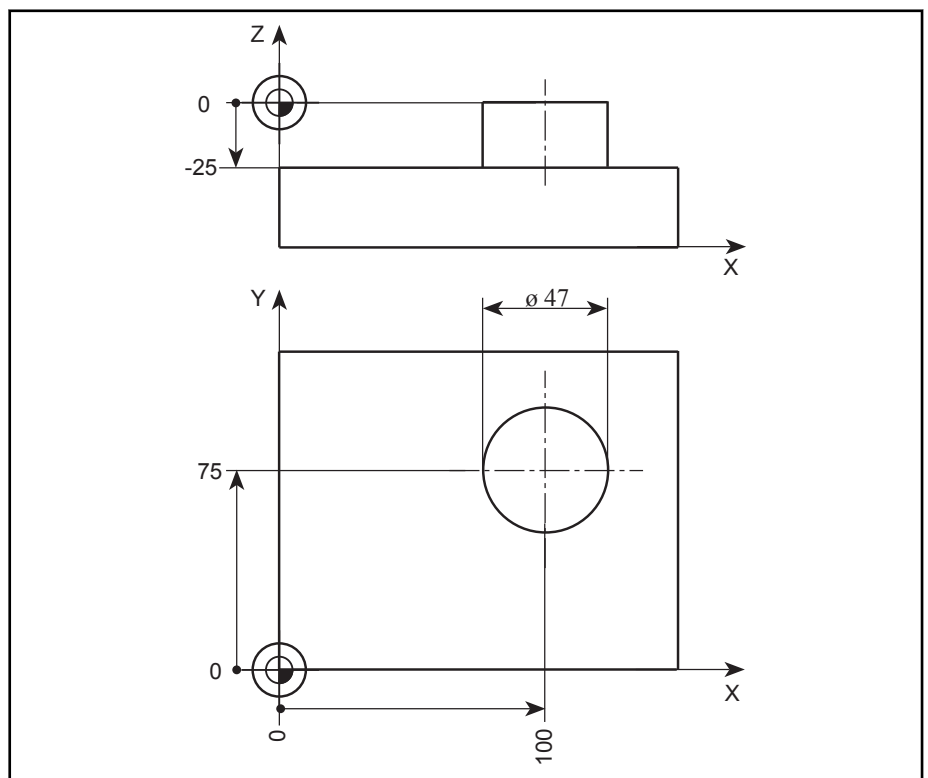


Fig. 4-15: Example: Calibrate spigot
Calibrate spigot

```

;-----
;----- Probe spigot D47 -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T999 M6              ;load Probel
N30 ED1 M97              ;Probel ON and enable edge
N40 M19 S=0
N50 G47 G54 X0 Y0 Z150 ;enable tool length and ZPO

```

Measuring cycle automatic

```
;call cycle
N60 G319 (PNO2, IAX Z, SL10, CLE-10, CDI20, CFE500, CX1 X, CX2 Y,
      CA1 100, CA2 75, DIA47.000)
;displaying measurement results on the screen
1 PRN#(0,"calibration value X+ : ####.## X- : ####.##",
      SD.SysPrResult.CAL[2].AXIS[1].DIR[1].VAL,
      SD.SysPrResult.CAL[2].AXIS[1].DIR[1].VAL)
2 PRN#(0,"calibration value Y+ : ####.## Y- : ####.##",
      SD.SysPrResult.CAL[2].AXIS[2].DIR[1].VAL,
      SD.SysPrResult.CAL[2].AXIS[2].DIR[1].VAL)
N70 G0 Z100           ;retracting
N80 M30
```

4.3.3 Probe calibration for tool measuring

G311 Calibrate probe - Tool length

Syntax G311 (CAX <cax>, CDI<cdi>, CFE<cfe>, PNO<pno>{, SL<sl>})

Brief description The "Calibrate probe - Tool length" (G311) cycle determines the switching offset for the selected axis direction by sampling a tool probe with a measuring standard (zero tool).

Overview

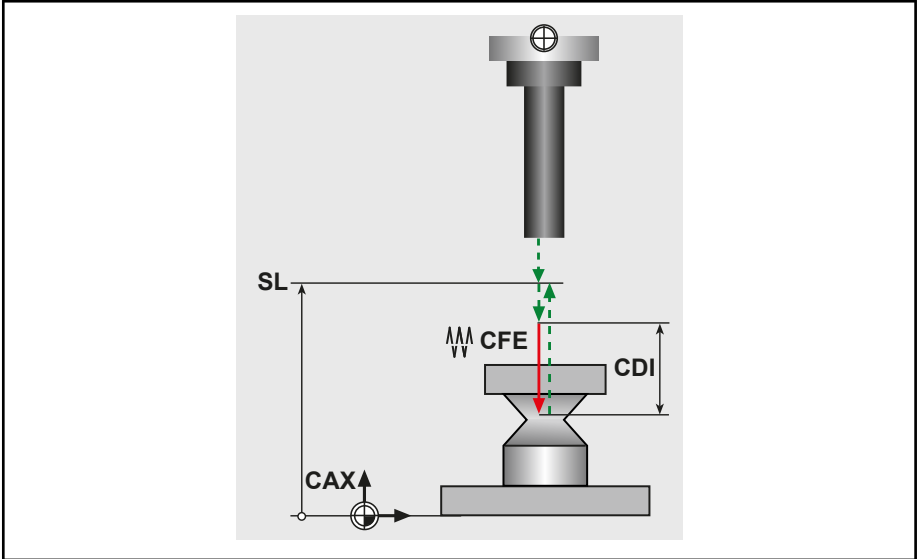


Fig. 4-16: Overview: Calibrate probe - Tool length

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
SL	Safety level	Optional	REAL	Absolute
CAX	Calibration axis	Mandatory	STRING	8
CDI	Calibration distance (the sign defines the calibration direction)	Mandatory	REAL	Relative
CFE	Calibration feed	Mandatory	REAL	mm/min
PNO	Probe number	Mandatory	INTEGER	1..2

Tab. 4-8: Parameter call

Result variables

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].Parameter
[n] 1..2 Probe number
[i] 1..3 Axis number

Measuring cycle automatic

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].Parameter			
[j] 1..2 Direction (1 = positive, 2 = negative)			
Parameters	Description	Values	Area
CALI	Calibrated	BOOL	TRUE..FALSE
VAL	Switching offset	REAL	
FEED	Calibration feed	REAL	
PRPOS	Switching position MCS	REAL	
YEAR	Year: YYYY	STRING	4
DATE	Day and month: DD:MM	STRING	5
TIME	Time: HH.MM.SS	STRING	8
RUNS	Number of measurements	INTEGER	

Tab. 4-9: Output values

Description

The G311 cycle calibrates the probe for tool length measurement. For this purpose, a measuring standard (zero tool) with known length is to be loaded and activated. The initial position has to be approached prior to the cycle as the cycle is only triggered in motions in the direction of the calibration axis. If a safety level is programmed, the zero tool moves in rapid traverse to this absolute workpiece coordinate. Afterwards, the tool is positioned in rapid traverse over the probe.

If no safety level is programmed, it is immediately positioned over the probe. During positioning over the measuring system, the basic offsets and cutting lengths are already taken into consideration. Afterwards, the zero tool is monitored and moves with positioning feed up to the measuring system by half the calibration distance. The following calibration distance is traveled with calibration feed. If the probe deflects within the calibration distance, the switching offset value, the machine coordinate (without compensation and coordinate offset), the calibration feed, the status "calibrated" on "TRUE", the year, date and time are written to the system data. Additionally, the number of measurements is set to zero. Otherwise, the message "Position not found" is returned and the status "calibrated" is set to "FALSE". Now, the infeed axis is retracted in rapid traverse. It is either moved to the initial position or the position of the programmed safety level.

Measuring cycle automatic

Example

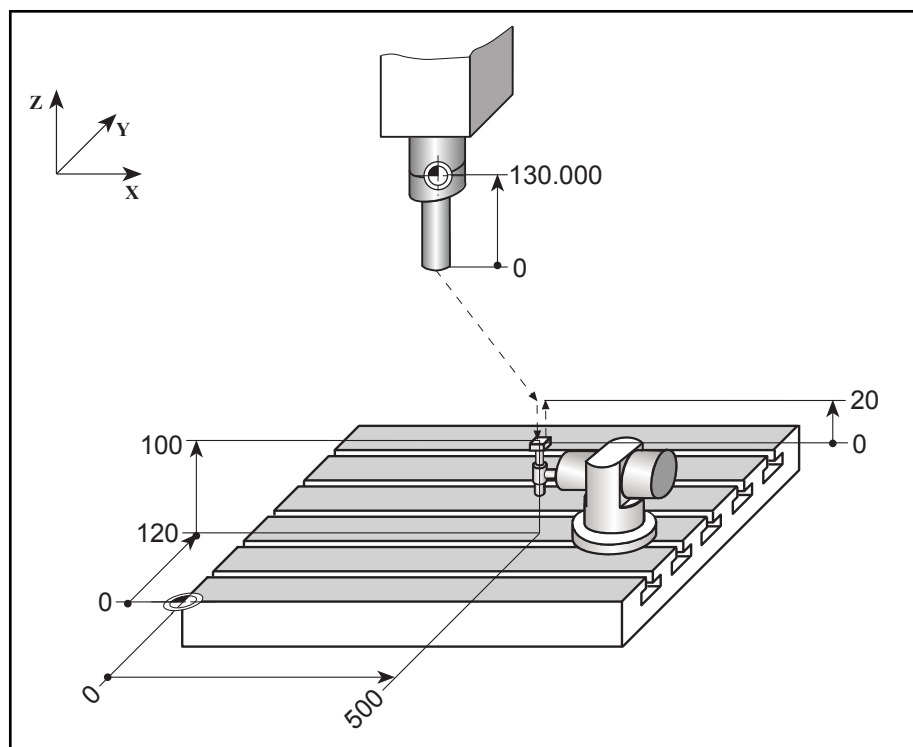


Fig. 4-17: Example: Calibrate probe - Tool length
Calibration - Tool length

```

;-----
;----- Calibrating tool length with zero tool -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T24 M6 ;load zero tool
N30 ED1 M99 ;Probe2 ON and enable edge
N40 G47 G53 ;tool length ON, enable ZPO
N50 G0 X500 Y120 Z120 M19 S=0 ;approaching
;call cycle
N60 G311 (SL 10, CAX Z, CDI -20, CFE 500, PNO 2)
N70 G0 Z100 ;retracting
;displaying measurement results on the screen
1 WAIT
2 ERG=SD.SysPrResult.CAL[2].AXIS[3].DIR[2].VAL
3 PRN#(0,"calibration value Z- : ####.####",ERG)
N80 M30

```

G315 Calibrate probe - Tool radius

Syntax G315 (CAX <cax>, CDI<cdi>, CFE<cfe>, PNO<pno>{, SL<sl>})

Brief description The "Calibrate probe - Tool radius" (G315) cycle determines the switching offset of this probe for this axis direction by sampling a tool probe with a measuring standard (zero tool).

Measuring cycle automatic

Overview

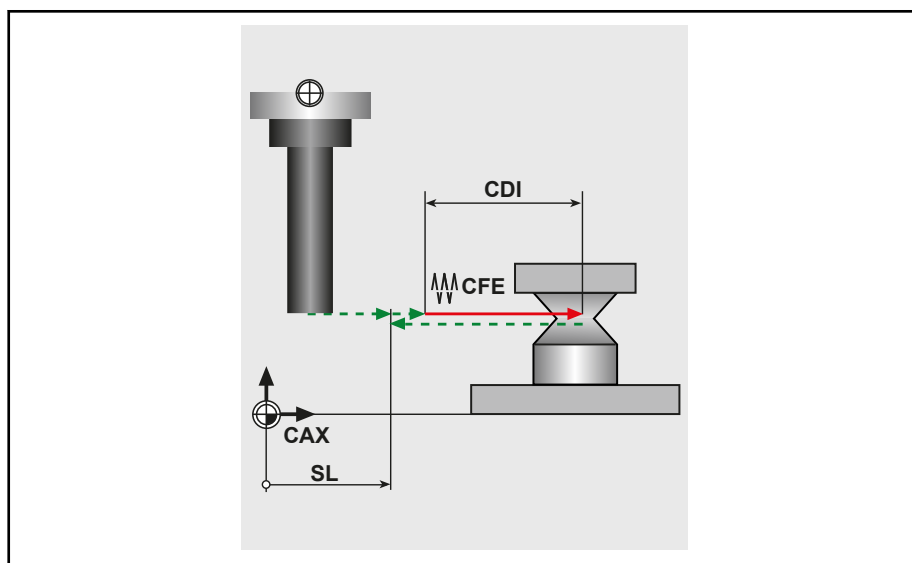


Fig. 4-18: Overview: Calibrate probe - Tool radius

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
SL	Safety level	Optional	REAL	Absolute
CAX	Calibration axis	Mandatory	STRING	1..8
CDI	Calibration distance (the sign defines the calibration direction)	Mandatory	REAL	Relative
CFE	Calibration feed	Mandatory	REAL	mm/min
PNO	Probe number	Mandatory	INTEGER	1..2

Tab. 4-10: Parameter call

Result variables

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].Parameter			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction (1 = positive, 2 = negative)			
Parameters	Description	Values	Area
CALI	Calibrated	BOOL	TRUE..FALSE
VAL	Switching offset	REAL	
FEED	Calibration feed	REAL	
PRPOS	Switching position MCS	REAL	
YEAR	Year: YYYY	STRING	4
DATE	Day and month: DD:MM	STRING	5
TIME	Time: HH.MM.SS	STRING	8
RUNS	Number of measurements	INTEGER	

Tab. 4-11: Output values

Measuring cycle automatic

Description The G315 cycle calibrates the probe for tool radius measurement. For this purpose, a measuring standard (zero tool) with known radius is to be loaded. If a safety level is programmed, the zero tool moves to this absolute work-piece coordinate on the selected axis. Afterwards, the cycle positions the non-measuring axis of the level to the center of the tool probe.

If no safety level is specified, the zero tool moves immediately in rapid traverse to the center of the tool probe on the non-measuring axis. This traversing motion is not monitored. For this reason, it is always recommended to specify a safety distance to prevent a collision of the tool with the probe. Afterwards, the zero tool is monitored and moves with positioning feed up to the probe by half the calibration distance. During this, the basic offsets and cutting lengths are already taken into consideration. Afterwards, the zero tool travels over the calibration distance with calibration feed. If the probe deflects, the switching offset value, the machine coordinate (without compensation and coordinate offset), the calibration feed and the status "calibrated" are written to the system data.

The retraction motion of the measuring axis is also monitored and takes place with positioning feed. It is either moved to initial position or the position of the programmed safety level.

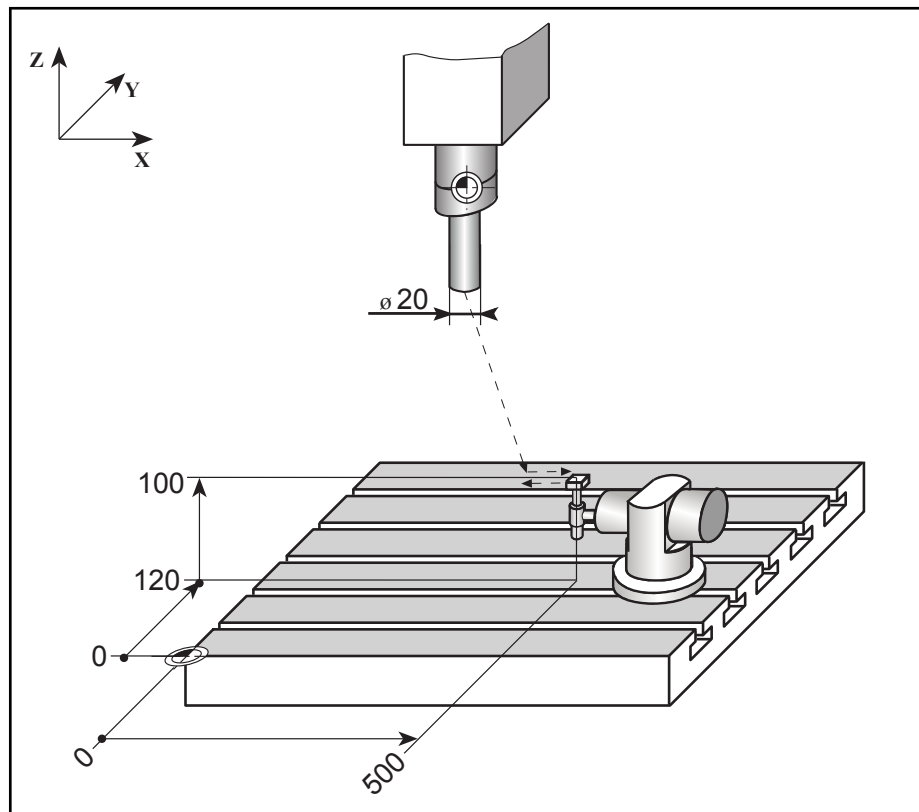
Example

Fig. 4-19: Example: Calibrate probe - Tool radius

Calibration - Tool radius

```

;-----
;----- Calibrating tool radius with zero tool -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZP0 table
N20 T24 M6              ;load zero tool
N30 ED1 M99             ;Probe2 ON and enable edge
N40 G47 G53             ;tool length ON, enable ZP0
N50 G0 X400 Y120 Z90 M19 S=0 ;approaching
;call cycle

```

Measuring cycle automatic

```
N60 G315 (SL 450, CAX X, CDI 20, CFE 500, PNO 2)
N70 G0 Z100 ;retracting
;displaying measurement results on the screen
1 WAIT
2 ERG=SD.SysPrResult.CAL[2].AXIS[1].DIR[1].VAL
3 PRN#(0,"calibration value X+ : ####.####",ERG)
N80 M30
```

4.4 Measurement

4.4.1 Tool measurement

G301 Tool length measurement

Syntax G301 (PNO<pno>, PAX<pax>, PDI<pdi>{, SL<sl>}{, PFE<pfe>}
{, SST <sst>})

Brief description The "Probe tool length" (G301) cycle determines the respective tool length by sampling a tool probe with a tool. The resulting tool length is stored in the SysPrResult structure.

Overview

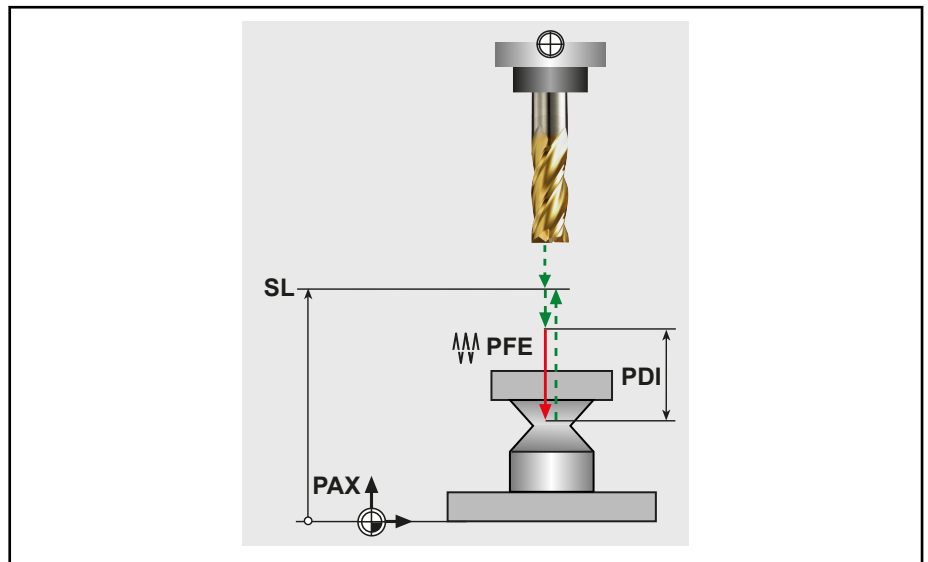


Fig. 4-20: Overview: Probe tool

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
SL	Safety level (optional)	Optional	REAL	Absolute
PAX	measuring axis	Mandatory	STRING	8
PDI	Measuring distance (the sign defines the measuring direction)	Mandatory	REAL	Relative
PFE	Measuring feed (optional)	Optional	REAL	mm/min
SST	Spindle stop command	Optional	STRING	4
PNO	Probe number	Mandatory	INTEGER	1..2

Tab. 4-12: Parameter call

Measuring cycle automatic

Result variables

SD.SysPrResult.Parameter[i]			
[i] 1..3 Axis number			
Parameters	Description	Values	Area
AXISRES[1..3]	Measured value	REAL	

Tab. 4-13: Output values

Description Prior to the cycle call, the respective initial position to the measuring system is to be approached as the cycle only travels in the direction of the measuring axis. If the tool is to be measured in rotating state, the spindle has to be activated first against the cutting direction. If no safety level is programmed, it is immediately positioned over the probe at the starting position of the measuring distance.

If a safety level is programmed, the tool moves to this absolute workpiece coordinate on the infeed axis in rapid traverse. During positioning over the measuring system, the basic offsets and cutting lengths are already taken into consideration. Afterwards, the measuring system is monitored and moves with positioning feed up to the measuring system by half the measuring distance. If a measuring feed is specified, the following measuring distance is traveled with it. If no measuring feed is programmed, the cycle automatically applies the respective calibration feed from the SysPrResult structure. As soon as the probe deflects, the effective length of the tool is also written to this structure and the spindle is stopped if the SST parameter was programmed.

The retraction motion of the infeed axis also monitors and guides the tool with positioning feed. It is either moved to initial position or the position of the programmed safety level.

Example

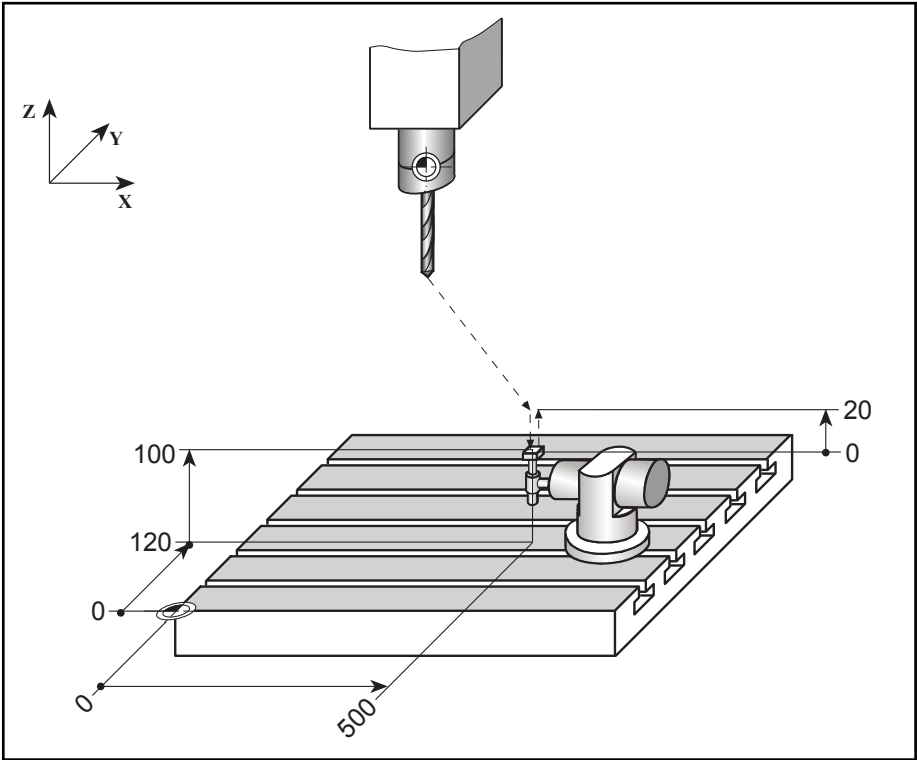


Fig. 4-21: Example: Probe tool length

Measuring cycle automatic

Probe tool length

```

;-----
;----- Probe tool length drill T24 -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T24 M6              ;load zero tool
N30 ED1 M99             ;Probe2 ON and enable edge
N40 G47 G53             ;tool length ON, enable ZPO
N50 G0 X500 Y120 Z120 S200 M4 ;approaching
;call cycle
N60 G301 (SL20, PAX Z, PDI-20, SST M5, PNO2)
N70 G0 Z100             ;retracting
;displaying measurement results on the screen
1 WAIT
2 ERG=SD.SysPrResult.AXISRES[3]
3 PRN#(0,"calibration value Z : ####.####",ERG)
N80 M30

```

G303 Probe tool radius

Syntax G303 (PNO<pno>, PAX <pax>, PDI<pdi>{, SL<sl>}{, PFE<pfe>}
{, SST <sst>})

Brief description The "Probe tool length" (G303) cycle determines the effective tool radius by sampling a tool probe with a tool. The resulting tool radius is stored in the SysPrResult structure.

Overview

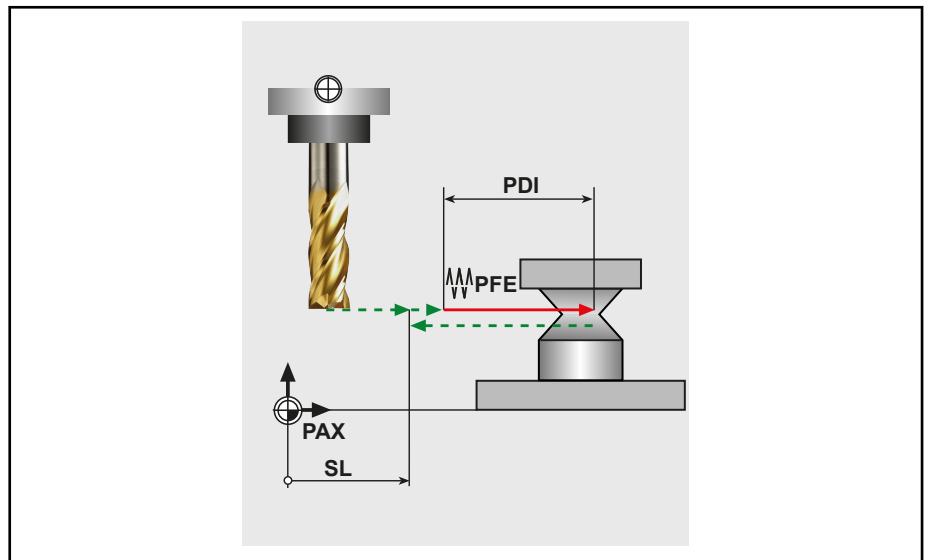


Fig. 4-22: Overview: Probe tool radius

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
SL	Safety level (optional)	Optional	REAL	Absolute
PAX	measuring axis	Mandatory	STRING	8
PDI	Measuring distance (the sign defines the measuring direction)	Mandatory	REAL	Relative
PFE	Measuring feed (optional)	Optional	REAL	mm/min
SST	Spindle stop command	Optional	STRING	5
PNO	Probe number	Mandatory	INTEGER	1..2

Tab. 4-14: Parameter call

Measuring cycle automatic

Result variables

SD.SysPrResult.Parameter[i]			
[i] 1..3 Axis number			
Parameters	Description	Values	Area
AXISRES[1..3]	Measured value	REAL	

Tab. 4-15: Output values

Description The cycle G303 determines the effective radius of a tool in the spindle. If the tool is to be measured in rotating state, the spindle has to be activated first against the cutting direction. If a safety level is programmed, the tool moves to this absolute workpiece coordinate on the selected axis.

Afterwards, the cycle positions the non-measuring axis of the level in the center of the tool probe. If no safety level has been programmed, the tool travels immediately in rapid traverse on the non-measuring axis to the center of the tool probe. This traversing motion is not monitored. For this reason, it is recommended to always specify a safety level to prevent collision of the tool with the probe. Afterwards, the tool is monitored and moves with positioning feed up to the probe by half the measuring distance. During this, the basic offsets and cutting lengths are already taken into consideration. If a measuring feed is specified, the following measuring distance is traveled with it. If no measuring feed is programmed, the cycle automatically applies the respective calibration feed from the SysPrResult structure. As soon as the probe deflects, the effective radius of the tool is also written to the SysPrResult structure and the spindle is stopped if the SST parameter was programmed.

The retraction motion of the measuring axis is also monitored and takes place with positioning feed. It is either moved to the initial position or to the safety level.

Example

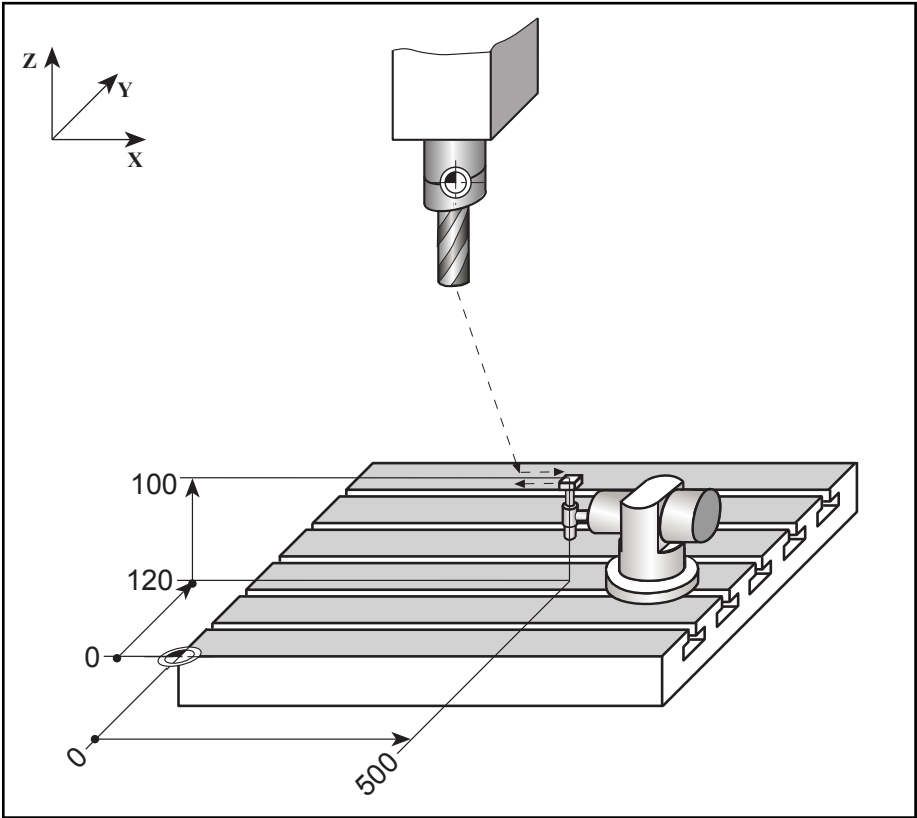


Fig. 4-23: Example: Probe tool radius

Probe tool radius

```

;-----
;----- Probe tool radius milling cutter D20 -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T24 M6               ;load zero tool
N30 ED1 M99              ;Probe2 ON and enable edge
N40 G47 G53              ;tool length ON, enable ZPO
N50 G0 X450 Y120 S200 M4 ;approaching
;call cycle
N60 G303 (SL450, PAX X, PDI10, SST M5, PNO2)
N70 G0 Z100              ;retracting
;displaying measurement results on the screen
1 WAIT
2 ERG=SD.SysPrResult.AXISRES[1]
3 PRN#(0,"Tool radius: ####.####",ERG)
N80 M30

```

4.4.2 Probe workpiece

G321 Probe point

Syntax G321 (PNO<pno>, IAX <iax>, PLE<ple>, PAX <pax>, PDI<pdi>,),
PPO<ppo>{, SL<sl>}{, IFE<ife>}{, RLE<rle>}{, RFE<rfe>}{, PFE<pfe>})

Brief description With the "Probe point" (G321) cycle, any point of the workpiece can be measured, i.e. its coordinates determined. The measuring results are stored in the global output variables #RESULT1 to #RESULT2 and the output variable "RUNS" is increased by a value of 1.

Overview

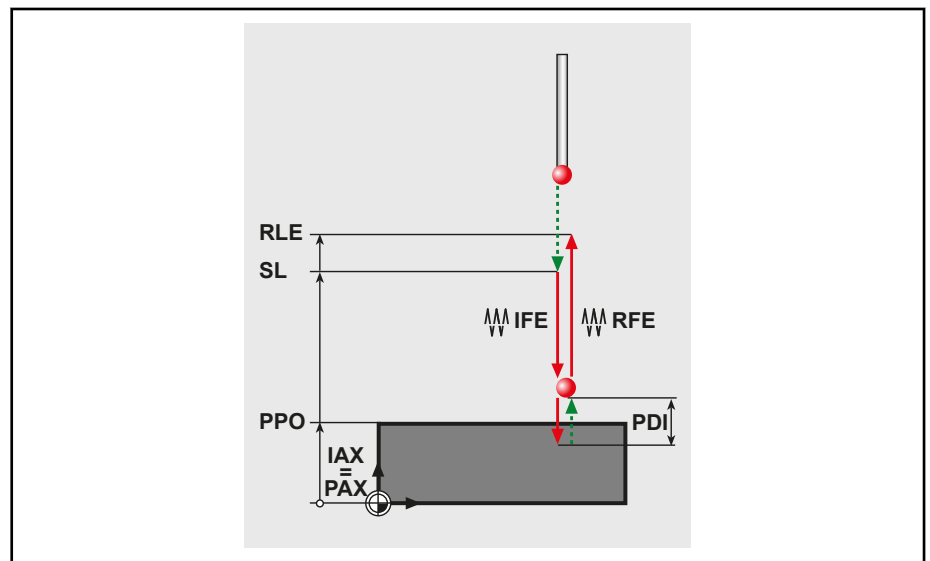


Fig. 4-24: Overview: Probe point with measuring axis equal to infeed axis

Measuring cycle automatic

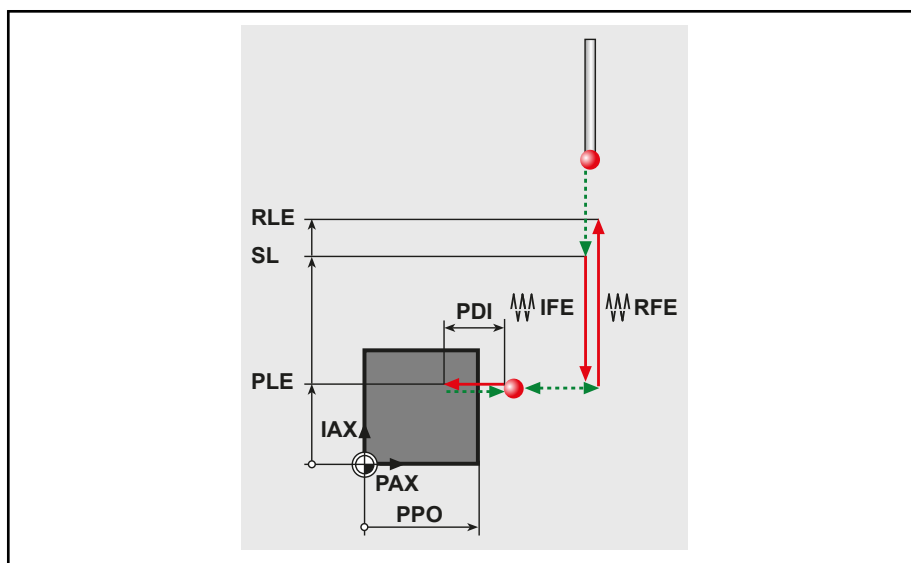


Fig. 4-25: Overview: Probe point with measuring axis unequal to infeed axis

Parameters

Parameters	Designation	Properties		Values	Pre-assignment/Range
PNO	Probe number	Mandatory		INTEGER	1..2
IAX	Infeed axis	Mandatory		STRING	8
SL	Safety level	Optional		REAL	Absolute
IFE	Infeed feed	Optional		REAL	mm/min
PLE	Measuring height	Mandatory	If infeed axis unequal to measuring axis	REAL	Absolute
		Optional	If infeed axis equal to measuring axis		
RLE	Retraction height	Optional		REAL	Absolute
RFE	Retraction feed	Optional		REAL	mm/min
PDI	Measuring distance	Mandatory		REAL	Relative
PFE	Measuring feed	Optional		REAL	mm/min
PAX	measuring axis	Mandatory		STRING	8
PPO	Measuring position	Mandatory		REAL	Absolute

Tab. 4-16: Parameter call

Measuring cycle automatic

Result variables

SD.SysPrResult.Parameter[i]			
[i] 1..3 Axis number			
Parameters	Description	Values	Area
AXISRES[1..3]	Intermediate results	REAL	

Tab. 4-17: Runtime variable

Parameters	Description	Values	Area
#RESULT1	Measured value	REAL	
#RESULT2	Position difference	REAL	

Tab. 4-18: Output values 1

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction (1 = positive, 2 = negative)			
Parameters	Description	Values	Area
RUNS	Number of measurements	INTEGER	

Tab. 4-19: Output values 2

Description

The cycle enables to include a workpiece coordinate point with the probe system. Prior to calling, a suitable initial position is to be approached, particularly on axes other than the infeed or measuring axis. If no safety level is specified, the infeed takes place with rapid traverse on the measuring height or, if infeed axis and measuring axis are equal, directly to the starting point of the measuring distance. If a safety level is specified, the probe is first positioned there in rapid traverse. Afterwards, the probe moves to measuring height with G1 and the infeed feed to enable plunging at reduced velocity.

Then, the actual measuring process takes place. If no measuring feed is programmed, the cycle automatically applies the respective calibration feed the axis was calibrated with. Afterwards, the "Measured value" (#RESULT1) and the "Position difference" (#RESULT2) output variables are stored in the global variables and the "Number of measurements" (RUNS) variable increased by a value of 1 in the SysPrResult structure. Afterwards, the probe is repositioned at the initial position.

At the cycle end, the infeed axis is returned. If no retraction height is specified, positioning takes place in rapid traverse to the initial cycle position. If a retraction height is specified, it is moved to in rapid traverse or, if a retraction feed is additionally specified, with G1 and this feed value.

The cycle resets the modal functions of the groups ABS/REL (G90/G91), interpolation (G0/G1/G2/G3/G5/G6) and feed programming (G93/G94/G95) to their initial state prior to the cycle.

Measuring cycle automatic

Procedure/processing

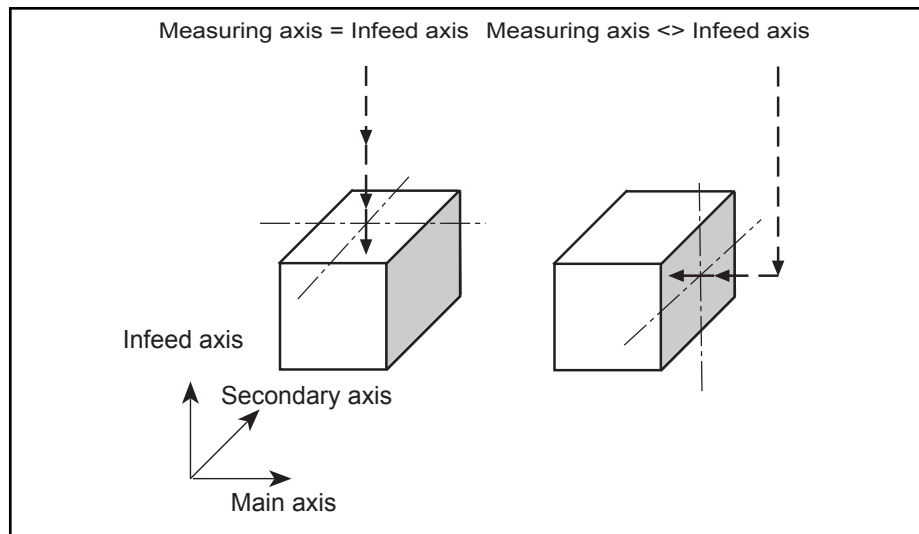


Fig. 4-26: Traversing motion: Probe point

Example

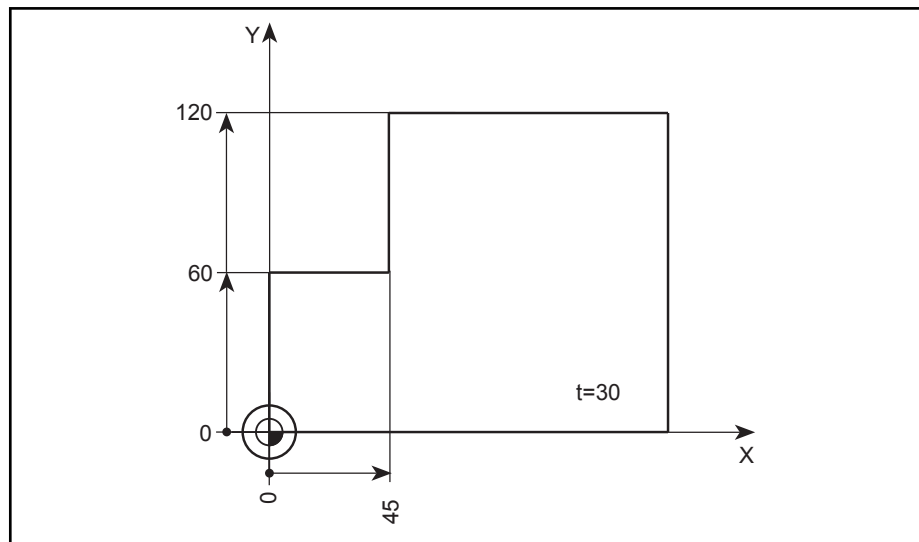


Fig. 4-27: Example: Probe point

Probe point

```

;-----
;----- Probe point -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T999 M6              ;load zero tool
N30 ED1 M97              ;Probel ON and enable edge
N40 G47 G54 G0 X20 Y75 Z50 M19 S0 ;enable tool length and ZPO
;call cycle
N50 G321 (PNO1, IAX Z, SL10, IFE3500, PLE-10,PDI5, PFE500,PAX X,
      PPO45)
;displaying measurement results on the screen
1 PRN#(0,"Measured value : ####.## Diff : ####.##", #RESULT1,#RESULT2)
N60 X-100 Y100 Z100      ;retracting
N70 M30

```

G323 Check workpiece availability

Syntax G323 (PNO<pno>, IAX <iax>, PLE<ple>, PAX <pax>, PDI<pdi>, PPO<ppo>, {, SL<sl>}{, IFE<ife>}{, RLE<rle>}{, RFE<rfe>}{, PFE<pfe>})

Brief description The "Check workpiece availability" (G323) cycle enables checking whether a part is clamped or a hole or other properties are available. The test result is

Measuring cycle automatic

stored in the global output variable #RESULT?. If a part was detected, the measuring results are available in the global output variables #RESULT1 to #RESULT2 for further processing.

Overview

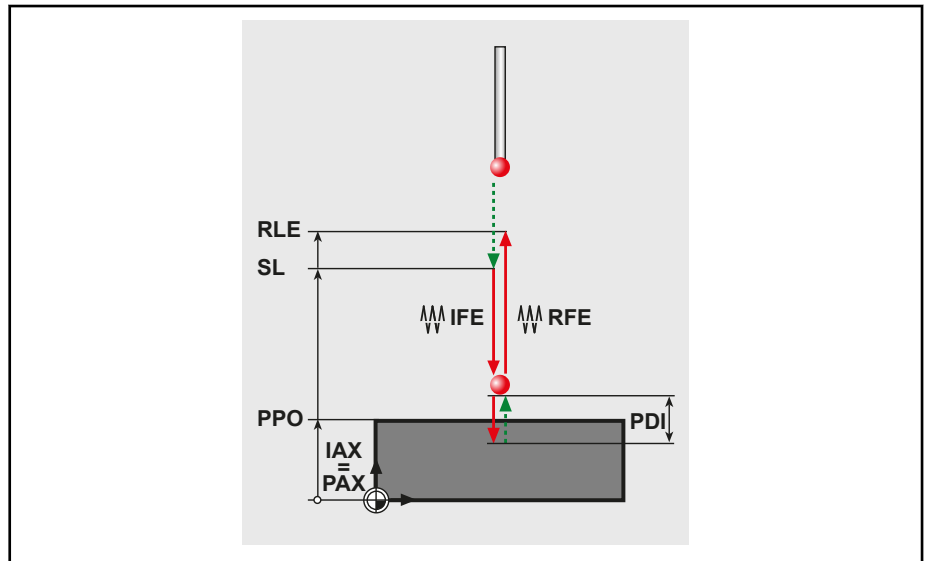


Fig. 4-28: Overview: Check workpiece availability with test axis equal to infeed axis

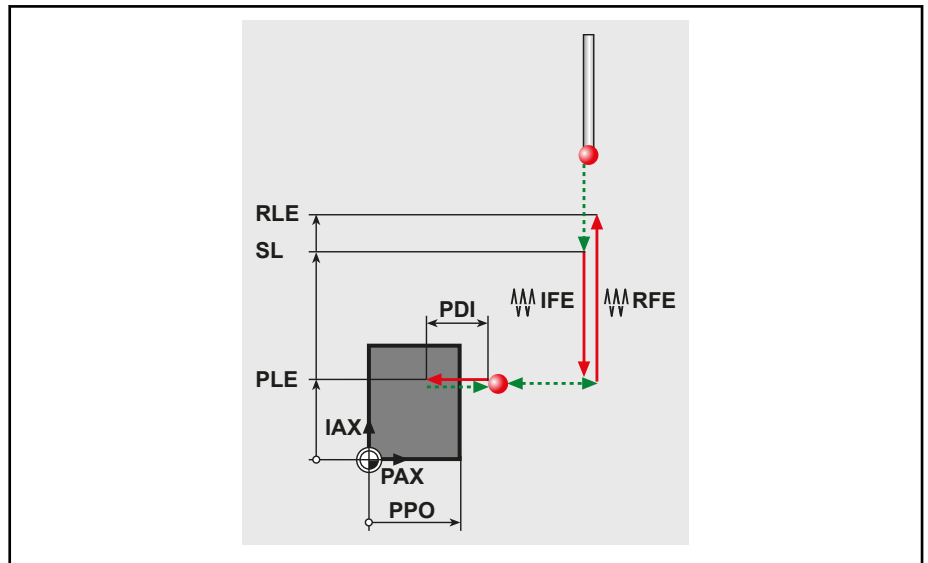


Fig. 4-29: Overview: Check workpiece availability with test axis unequal to infeed axis

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
PNO	Probe number	Mandatory	INTEGER	1..2
IAX	Infeed axis	Mandatory	STRING	8
SL	Safety level	Optional	REAL	Absolute
IFE	Infeed feed	Optional	REAL	mm/min

Measuring cycle automatic

Parameters	Designation	Properties		Values	Pre-assignment/Range
PLE	Test height	Mandatory	if infeed axis unequal to measuring axis	REAL	Absolute
		Optional	if infeed axis equal to measuring axis		
RLE	Retraction height	Optional		REAL	Absolute
RFE	Retraction feed	Optional		REAL	mm/min
PDI	Test distance	Mandatory		REAL	Relative
PFE	Test feed	Optional		REAL	mm/min
PAX	Test axis name	Mandatory		STRING	8
PPO	Test position	Mandatory		REAL	Absolute

Tab. 4-20: Parameter call

Result variables

SD.SysPrResult.Parameter[i]			
[i] 1..3 Axis number			
Parameters	Description	Values	Area
AXISRES[1..3]	Intermediate results	REAL	

Tab. 4-21: Runtime variable

Parameters	Description	Values	Area
#RESULT?	Part available	BOOL	TRUE..FALSE
#RESULT1	Measured value	REAL	
#RESULT2	Position difference	REAL	

Tab. 4-22: Output values 1

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction (1 = positive, 2 = negative)			
Parameters	Description	Values	Area
RUNS	Number of measurements	INTEGER	

Tab. 4-23: Output values 2

Description

Prior to calling, a suitable initial position is to be approached, particularly on axes other than the infeed or test axis. If no safety level is specified, the infeed takes place with rapid traverse on the test height or, if infeed axis and

Measuring cycle automatic

test axis are equal, directly to the starting point of the test distance. If a safety level is specified, the probe is first positioned there in rapid traverse. Afterwards, the probe moves to test height with G1 and the infeed feed to enable plunging at reduced velocity.

Then, the actual test/measuring process takes place. If no test feed is programmed, the cycle automatically applies the respective calibration feed the axis was calibrated with. Afterwards, the #RESULT? to #RESULT2 output variables are stored in the global variables and the "Number of measurements" (RUNS) variable is increased by a value of 1 in the SysPrResult structure. The probe returns to the initial position.

At the cycle end, the infeed axis is retracted. If no retraction height is specified, positioning takes place in rapid traverse to the initial cycle position. If a retraction height is specified, it is moved to in rapid traverse or, if a retraction feed is additionally specified, with G1 and this feed value.

The cycle resets the modal functions of the groups ABS/REL (G90/G91), interpolation (G0/G1/G2/G3/G5/G6) and feed programming (G93/G94/G95) to their initial state prior to the cycle.

Example

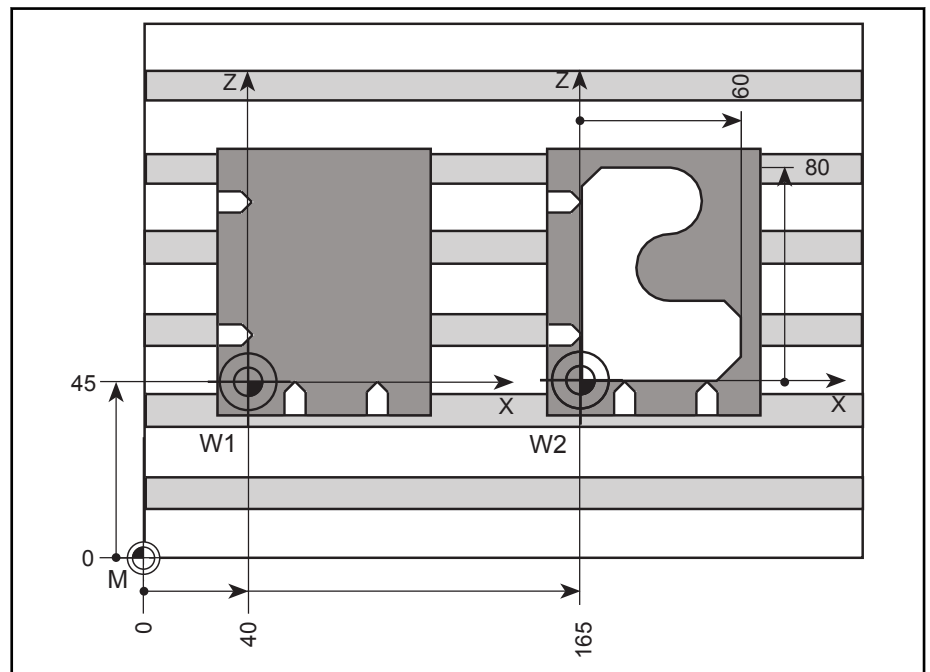


Fig. 4-30: Example: Check workpiece availability

Check workpiece availability

```

;-----
;----- Check if workpiece is available -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T999 M6              ;load tool
N30 ED1 M97              ;Probel ON and enable edge
N40 G47 G54 G0 X30 Y10 Z150 M19 S0 ;enable tool length and ZPO
;Clamping device1 G54 Check if workpiece is available
;call cycle
N60 G323(PNO1, IAX Z, PDI80,PAX Z, PPO0)
;Display test result G54 on screen
1 IF #RESULT?=TRUE THEN : PRN#(0,"Zero point 1 Workpiece detected")
1 ELSE : PRN#(0,"Zero point 1 - No workpiece detected") ENDIF
N70 G0 Z150              ;retracting in Z
;Clamping device 2 G55 Check if workpiece is available
N80 G55 X30 Y10          ;Positioning at 2. device
;call cycle
N100 G323(PNO1, IAX Z, PDI80,PAX Z, PPO0)

```

Measuring cycle automatic

```

N110 G0 Z150 ;retracting in Z
;Display test result G55 on screen
2 IF #RESULT?=TRUE THEN : PRN#(0,"Zero point 2 Workpiece detected")
2 ELSE : PRN#(0,"Zero point 2 - No workpiece detected") ENDIF
N120 Z150 ;retracting in Z
N130 M30

```

G324 Probe boring

Syntax G324 (PNO<pno>, IAX <iax>, PLE<ple>, PDI<pdi>,
PA1 <pa1>, PA2 <pa2>, CA1<ca1>, CA2<ca2>, BDI<bdi>
{, SL<sl>}{, IFE<ife>}{, RLE<rle>}{, RFE<rfe>}{, PFE<pfe>})

Brief description The "Probe boring" (G324) cycle measures a boring parallel to the axis by determining the diameter and center. The measuring results are stored in the global output variables #RESULT1 to #RESULT9 and the output variable "RUNS" is increased by a value of 4.

Overview

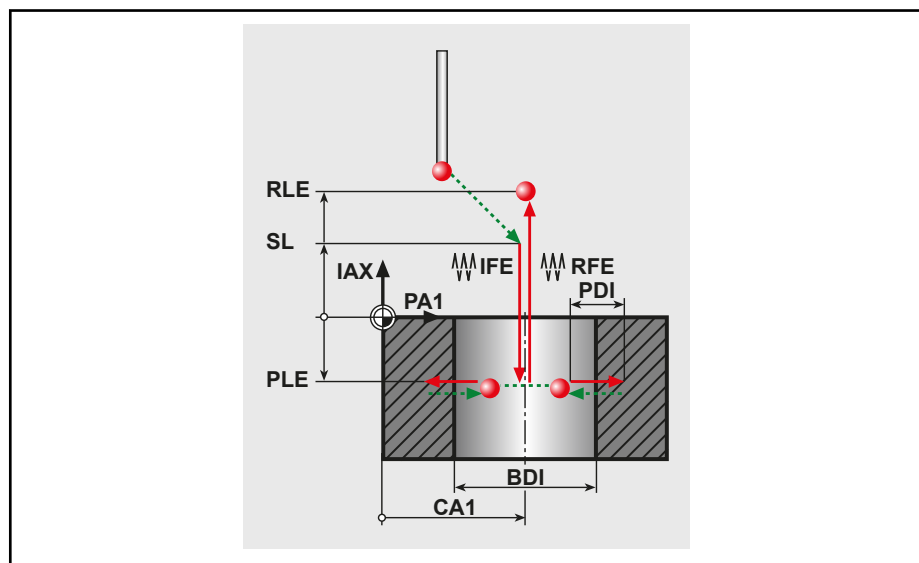


Fig. 4-31: Overview: Probe boring (infeed)

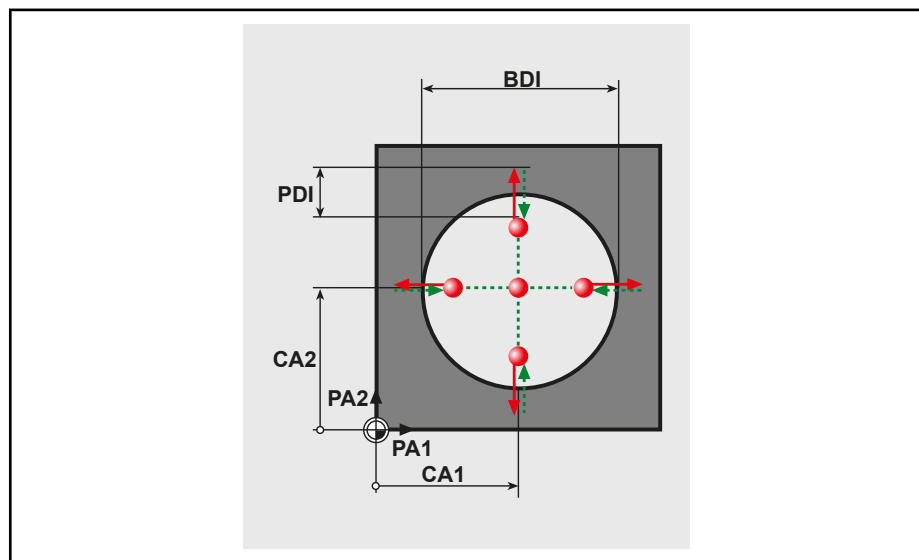


Fig. 4-32: Overview: Probe boring (measuring level)

Measuring cycle automatic

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
PNO	Probe number	Mandatory	INTEGER	1..2
IAX	Infeed axis	Mandatory	STRING	8
SL	Safety level	Optional	REAL	Absolute
IFE	Infeed feed	Optional	REAL	Absolute
PLE	Measuring height	Mandatory	REAL	Absolute
RLE	Retraction height	Optional	REAL	Absolute
RFE	Retraction feed	Optional	REAL	mm/min
PDI	Measuring distance	Mandatory	REAL	Relative
PFE	Measuring feed	Optional	REAL	mm/min
PA1	Measuring axis 1 (main axis)	Mandatory	STRING	8
PA2	Measuring axis 2 (secondary axis)	Mandatory	STRING	8
CA1	Center of 1st measuring axis	Mandatory	REAL	Absolute
CA2	Center of 2nd measuring axis	Mandatory	REAL	Absolute
BDI	Diameter	Mandatory	REAL	

Tab. 4-24: Parameter call

Result variables

SD.SysPrResult.Parameter[i]			
[i] 1..3 Axis number			
Parameters	Description	Values	Area
AXISRES[1..3]	Intermediate results	REAL	

Tab. 4-25: Runtime variable

Parameters	Description	Values	Area
#RESULT1	Position measuring axis 1 positive	REAL	
#RESULT2	Position measuring axis 1 negative	REAL	
#RESULT3	Position measuring axis 2 positive	REAL	
#RESULT4	Position measuring axis 2 negative	REAL	
#RESULT5	Center of measuring axis 1	REAL	
#RESULT6	Center of measuring axis 2	REAL	
#RESULT7	Difference center of measuring axis 1	REAL	
#RESULT8	Difference center of measuring axis 2	REAL	
#RESULT9	Boring diameter	REAL	

Tab. 4-26: Output values 1

Measuring cycle automatic

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction (1 = positive, 2 = negative)			
Parameters	Description	Values	Area
RUNS	Number of measurements	INTEGER	

Tab. 4-27: Output values 2

Description If no safety level is programmed, the infeed takes place in rapid traverse on measuring height. If a safety level is specified, the probe is first positioned there in rapid traverse. Afterwards, the probe moves to measuring height with G1 and the infeed feed to enable plunging at reduced velocity. The measuring process is now traveled by the basic cycle for each axis and direction. Afterwards, the probe is repositioned at the center of the boring.

Then, measuring takes place by means of four axis-parallel measuring steps. If no measuring feed is programmed, the cycle automatically applies the respective calibration feed the axis was calibrated with. Afterwards, the #RESULT1 to #RESULT9 output variables are stored in the global variables and the "Number of measurements" (RUNS) variable is increased by a value of 4 in the SysPrResult structure.

At the cycle end, the infeed axis is retracted. If no retraction height is specified, positioning takes place in rapid traverse to the initial cycle position. If a retraction height is specified, it is moved to in rapid traverse or, if a retraction feed is additionally specified, with G1 and this feed value.

The cycle resets the modal functions of the groups ABS/REL (G90/G91), interpolation (G0/G1/G2/G3/G5/G6) and feed programming (G93/G94/G95) to their initial state prior to the cycle.

Measuring cycle automatic

Example

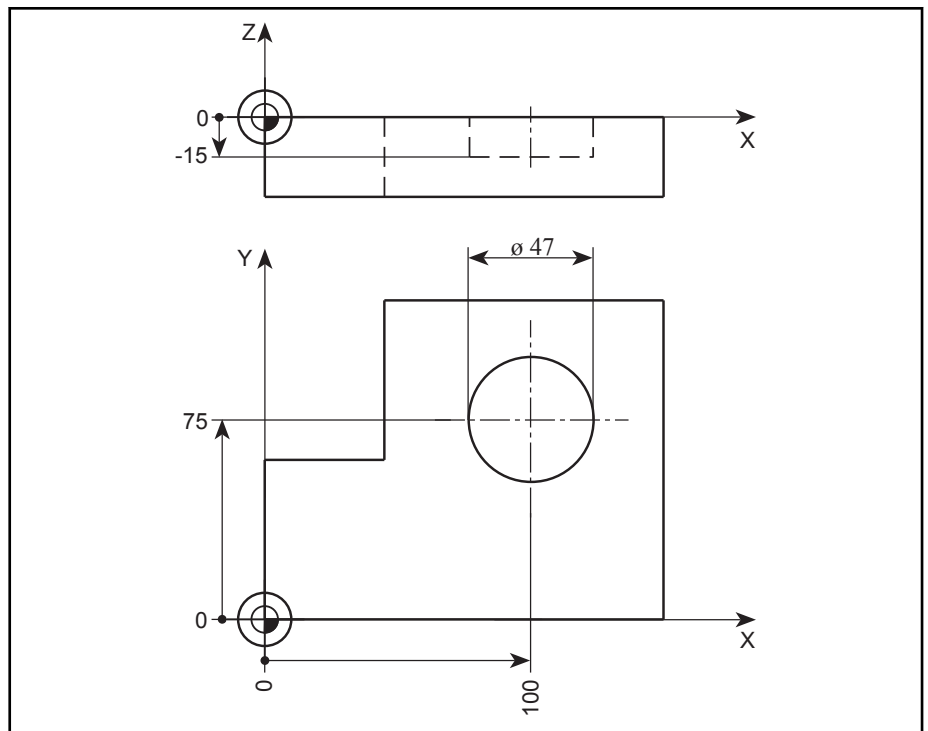


Fig. 4-33: Example: Probe boring
Probe boring

```

;-----
;----- Probe boring D47 -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T999 M6              ;load tool
N30 ED1 M97              ;Probel ON and enable edge
N40 G47 G54 X100 Y75 Z20 ;enable tool length and ZPO
;call cycle
N50 G324 (PNO1,IAX Z, SL20, IFE5000, PLE-10, PDI6, PA1 X, PA2 Y,
CA1 100,CA2 75, BDI47)
;displaying measurement results on the screen
1 PRN#(0,"Measured value X+ : ####.## X- : ####.##",#RESULT1,#RESULT2)
2 PRN#(0,"Measured value Y+ : ####.## Y- : ####.##",#RESULT3,#RESULT4)
3 PRN#(0,"Center point X: ####.## Y : ####.##",#RESULT5,#RESULT6)
4 PRN#(0,"Difference X: ####.## Y : ####.##",#RESULT7,#RESULT8)
5 PRN#(0,"Diameter : ####.##",#RESULT9)
N60 GO Z100              ;retracting
N70 M30

```

G327 Probe spigot

Syntax G327 (PNO<pno>, IAX <iax>, PLE<ple>, PDI<pdi>,
PA1 <pa1>, PA2 <pa2>, CA1<ca1>, CA2<ca2>, DIA<dia>
{, SL<sl>}{, IFE<ife>}{, RLE<rle>}{, RFE<rfe>}{, PFE<pfe>})

Brief description The "Probe spigot" (G327) cycle measures a spigot in parallel to the axis by determining the diameter and the center of the spigot. The measuring results are stored in the global output variables #RESULT1 to #RESULT9 and the output variable "RUNS" is increased by a value of 4.

Measuring cycle automatic

Overview

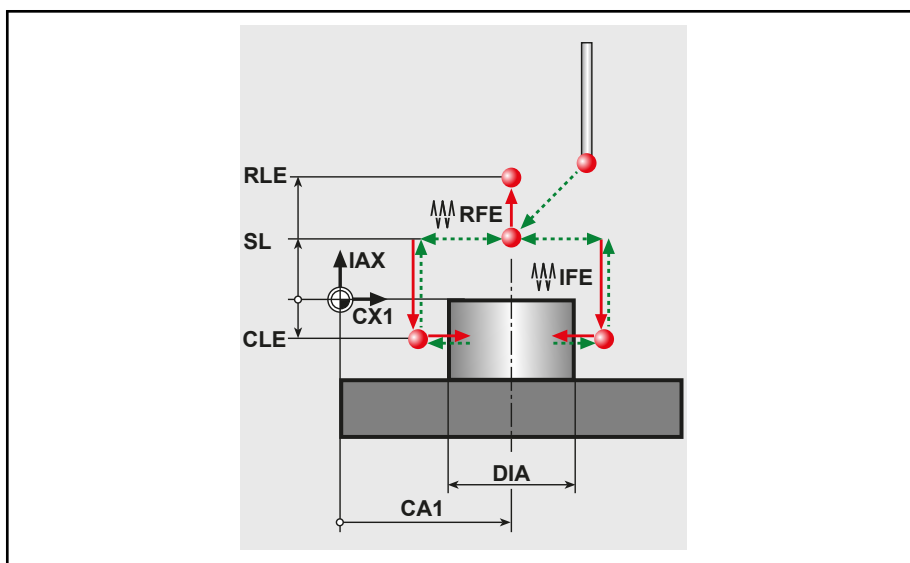


Fig. 4-34: Overview: Probe spigot (infeed)

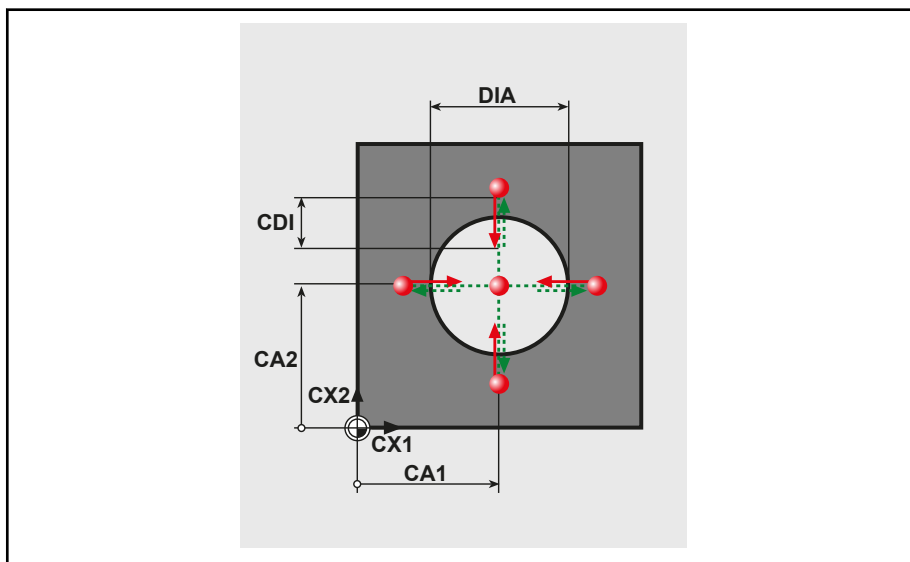


Fig. 4-35: Overview: Probe spigot (measuring level)

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
PNO	Probe number	Mandatory	INTEGER	1..2
IAX	Infeed axis	Mandatory	STRING	8
SL	Safety distance	Optional	REAL	Absolute
IFE	Infeed feed	Optional	REAL	Absolute
PLE	Measuring height	Mandatory	REAL	Absolute
RLE	Retraction height	Optional	REAL	Absolute
RFE	Retraction feed	Optional	REAL	mm/min
PDI	Measuring distance	Mandatory	REAL	Relative
PFE	Measuring feed	Optional	REAL	mm/min

Measuring cycle automatic

Parameters	Designation	Properties	Values	Pre-assignment/Range
PA1	Measuring axis 1 (main axis)	Mandatory	STRING	8
PA2	Measuring axis 2 (secondary axis)	Mandatory	STRING	8
CA1	Center of 1st measuring axis	Mandatory	REAL	Absolute
CA2	Center of 2nd measuring axis	Mandatory	REAL	Absolute
DIA	Diameter	Mandatory	REAL	

Tab. 4-28: Parameter call

Result variables

SD.SysPrResult.Parameter[i]			
[i] 1..3 Axis number			
Parameters	Description	Values	Area
AXISRES[1..3]	Intermediate results	REAL	

Tab. 4-29: Runtime variable

Parameters	Description	Values	Area
#RESULT1	Position measuring axis 1 positive	REAL	
#RESULT2	Position measuring axis 1 negative	REAL	
#RESULT3	Position measuring axis 2 positive	REAL	
#RESULT4	Position measuring axis 2 negative	REAL	
#RESULT5	Center of measuring axis 1	REAL	
#RESULT6	Center of measuring axis 2	REAL	
#RESULT7	Difference center of measuring axis 1	REAL	
#RESULT8	Difference center of measuring axis 2	REAL	
#RESULT9	Spigot diameter	REAL	

Tab. 4-30: Output values 1

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction (1 = positive, 2 = negative)			
Parameters	Description	Values	Area
RUNS	Number of measurements	INTEGER	

Tab. 4-31: Output values 2

Measuring cycle automatic

Description If no safety level is programmed, positioning takes place to the center in rapid traverse on the measuring axis. If a safety level is specified, the probe is first positioned there in rapid traverse over the spigot center.

Afterwards, the probe moves to measuring height during every measuring step for each axis and direction with G1 and the infeed feed to enable plunging at reduced velocity. Now, the actual measuring takes place before the probe is positioned over the center of the spigot.

If no measuring feed is programmed, the cycle automatically applies the respective calibration feed the axis was calibrated with. Afterwards, the #RESULT1 to #RESULT9 output variables are stored in the global variables and the ""Number of measurements"" (RUNS) variable is increased by a value of 4 in the SysPrResult structure.

At the cycle end, the infeed axis is returned. If no retraction height is specified, positioning takes place in rapid traverse to the initial cycle position. If a retraction height is specified, it is moved to in rapid traverse or, if a retraction feed is additionally specified, with G1 and this feed value.

The cycle resets the modal functions of the groups ABS/REL (G90/G91), interpolation (G0/G1/G2/G3/G5/G6) and feed programming (G93/G94/G95) to their initial state prior to the cycle.

Procedure/processing

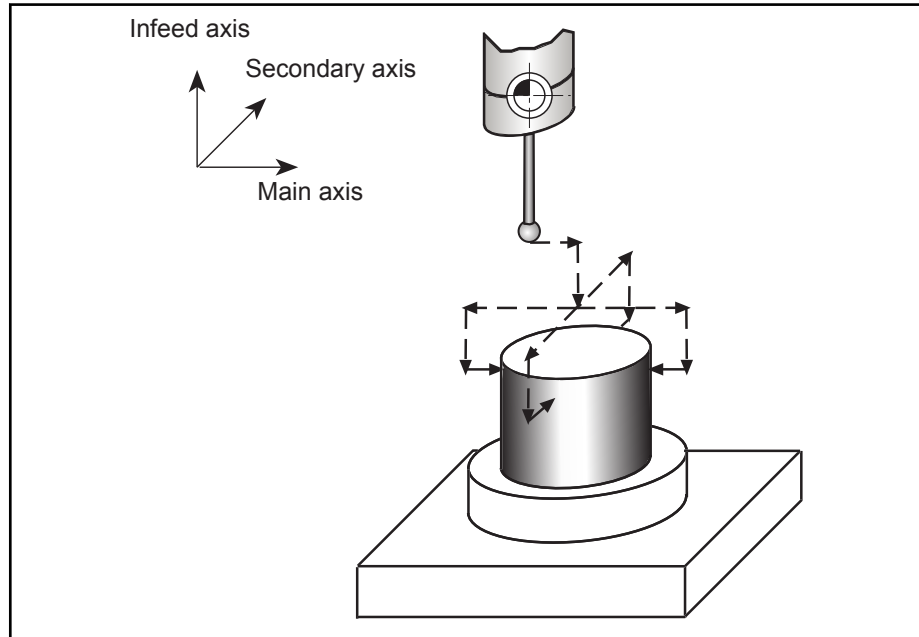


Fig. 4-36: Traversing motion: Probe spigot

Measuring cycle automatic

Example

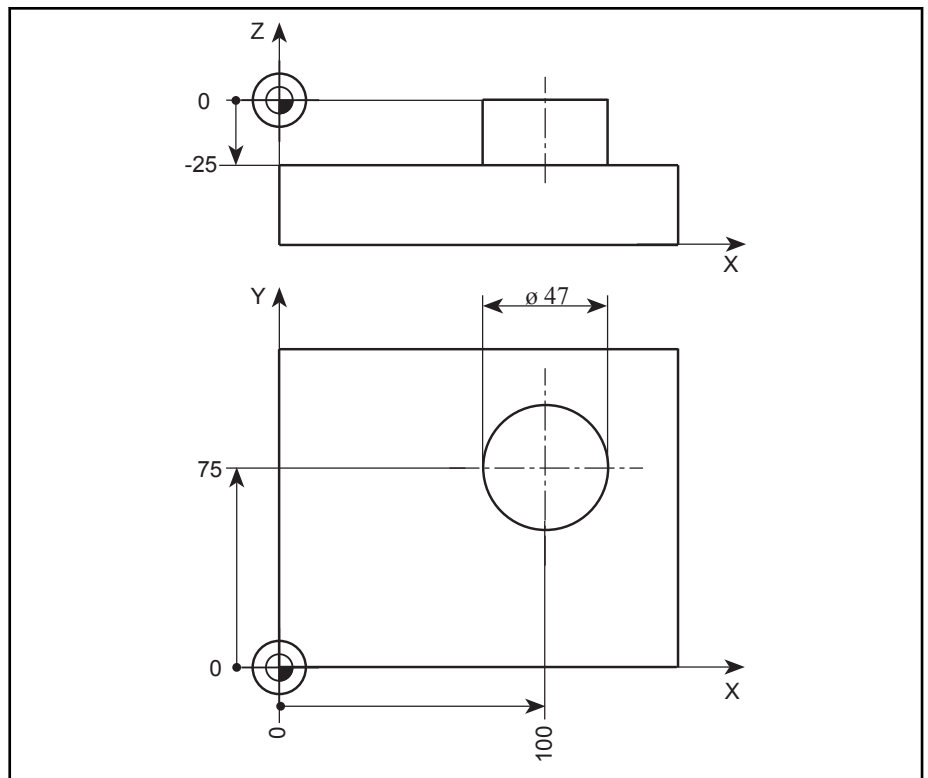


Fig. 4-37: Example: Probe spigot
Probe spigot

```

;-----
;----- Probe spigot D47 -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T999 M6             ;load tool
N30 ED1 M97             ;Probel ON and enable edge
N40 M19 S=0
N50 G47 G54 X0 Y0 Z150 ;enable tool length and ZPO
;call cycle
N60 G327 (PNO1, IAX Z, SL20, IFE1500, PLE-10, PDI10, PA1 X, PA2 Y,
CA1 100,CA2 75, DIA47)
;displaying measurement results on the screen
1 PRN#(0,"Measured value X+ : ####.## X- : ####.##", #RESULT1,#RESULT2)
2 PRN#(0,"Measured value Y+ : ####.## Y- : ####.##", #RESULT3,#RESULT4)
3 PRN#(0,"Center point X: ####.## Y : ####.##", #RESULT5,#RESULT6)
4 PRN#(0,"Difference X: ####.## Y : ####.##", #RESULT7,#RESULT8)
5 PRN#(0,"Diameter : ####.##", #RESULT9)
N70 G0 Z100 ;retracting
N80 M30

```

G329 Probe land

Syntax G329 (PNO<pno>, IAX <iax>, PLE<ple>, PDI<pdi>, PAX<pax>, NCE<nce>, NWI<nwi>{, SL<sl>}{, IFE<ife>}{, RLE<rle>}{, RFE<rfe>}{, PFE<pfe>})

Brief description The "Probe land" (G329) cycle measures a land in parallel to the axis by determining its width and center. The measuring results are stored in the global output variables #RESULT1 to #RESULT5 and the output variable "RUNS" is increased by a value of 2.

Measuring cycle automatic

Overview

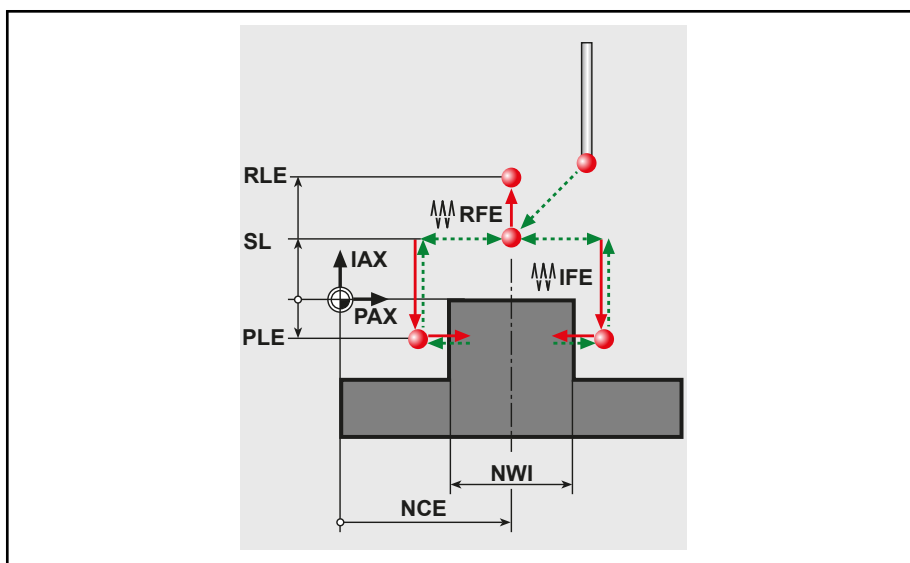


Fig. 4-38: Overview: Probe land (infeed)

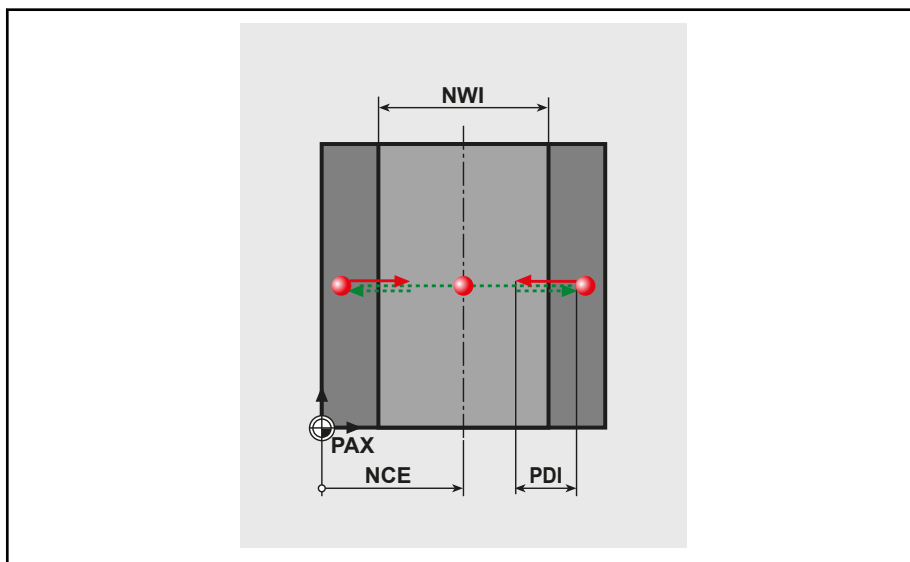


Fig. 4-39: Overview: Probe land (measuring level)

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
PNO	Probe number	Mandatory	INTEGER	1..2
IAX	Infeed axis	Mandatory	STRING	8
SL	Safety level	Optional	REAL	Absolute
IFE	Infeed feed	Optional	REAL	Absolute
PLE	Measuring height	Mandatory	REAL	Absolute
RLE	Retraction height	Optional	REAL	Absolute
RFE	Retraction feed	Optional	REAL	mm/min
PDI	Measuring distance	Mandatory	REAL	Relative
PFE	Measuring feed	Optional	REAL	mm/min

Measuring cycle automatic

Parameters	Designation	Properties	Values	Pre-assignment/Range
PAX	measuring axis	Mandatory	STRING	8
NCE	Land center	Mandatory	REAL	Absolute
NWI	Land width	Mandatory	REAL	Relative

Tab. 4-32: Parameter call

Result variables

SD.SysPrResult.Parameter[i]			
[i] 1..3 Axis number			
Parameters	Description	Values	Area
AXISRES[1..3]	Intermediate results	REAL	

Tab. 4-33: Runtime variable

Parameters	Description	Values	Area
#RESULT1	Position positive	REAL	
#RESULT2	Position negative	REAL	
#RESULT3	Land center	REAL	
#RESULT4	Land center difference	REAL	
#RESULT5	Land width	REAL	

Tab. 4-34: Output values 1

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction (1 = positive, 2 = negative)			
Parameters	Description	Values	Area
RUNS	Number of measurements	INTEGER	

Tab. 4-35: Output values 2

Description

Prior to the cycle, a suitable position is to be approached at the axis not included in the motion sequence. If no safety level is programmed, positioning takes place to the land center in rapid traverse on the measuring axis. If a safety level is specified, the probe is first positioned there in rapid traverse over the land center. Afterwards, the probe moves to measuring height with G1 and the infeed feed to enable plunging at reduced velocity.

Measuring sequences in both directions follow. If no measuring feed is programmed, the cycle automatically applies the respective calibration feed the axis was calibrated with. Afterwards, the #RESULT1 to #RESULT5 output variables are stored in the global variables and the "Number of measurements" (RUNS) variable is increased by a value of 2 in the SysPrResult structure. Afterwards, the probe is positioned over the land center.

At the cycle end, the infeed axis is returned. If no retraction height is specified, positioning takes place in rapid traverse to the initial cycle position. If a

Measuring cycle automatic

retraction height is specified, it is moved to in rapid traverse or, if a retraction feed is additionally specified, with G1 and this feed value.

The cycle resets the modal functions of the groups ABS/REL (G90/G91), interpolation (G0/G1/G2/G3/G5/G6) and feed programming (G93/G94/G95) to their initial state prior to the cycle.

Procedure/processing

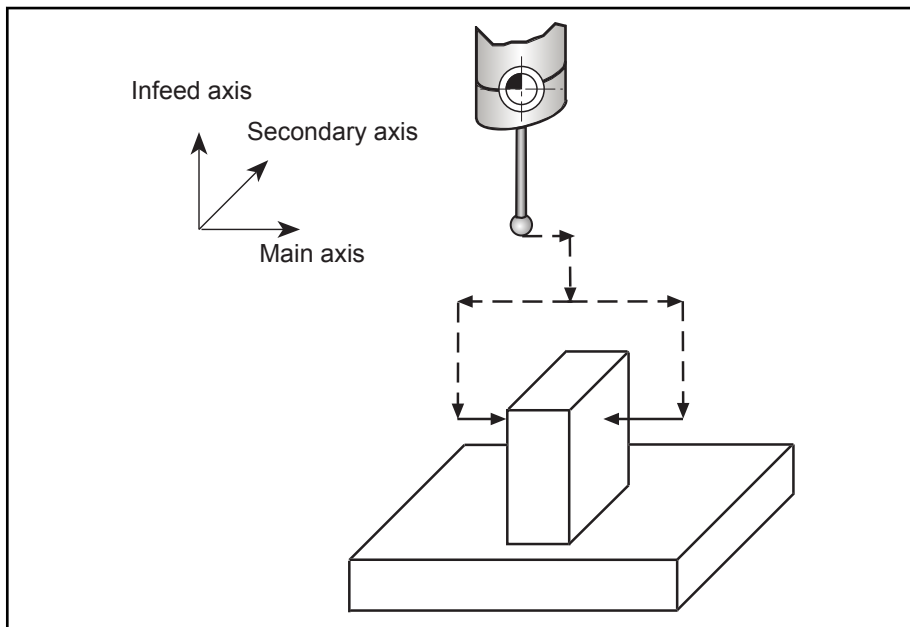


Fig. 4-40: Traversing motion: Probe land

Example

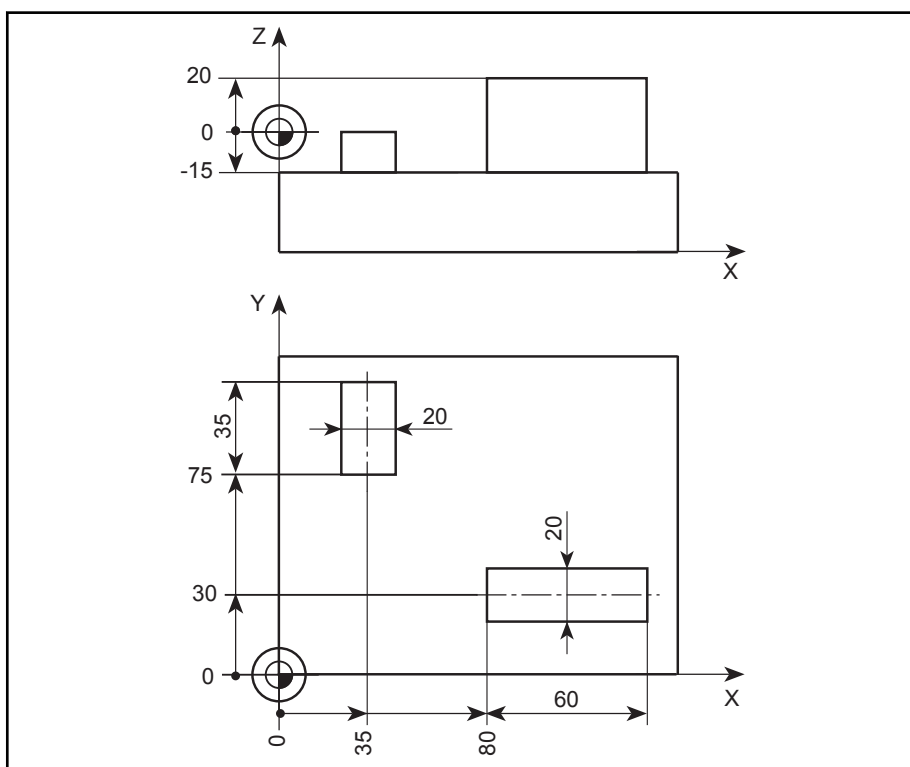


Fig. 4-41: Example: Probe land

Measuring cycle automatic

Probe land

```

;-----
;----- Probe lands with a width of 20 -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T999 M6             ;load tool
N30 ED1 M97             ;Probel ON and enable edge
N40 G47 G54 X110 Y30 Z30 M19 S=0;enable tool length and ZPO
;Probe Land 1 at X110 Y30
;call cycle
N50 G329 (PNO1, IAX Z, SL30, PLE15, PDI10, PAX Y, NCE30, NWI20)
;displaying measurement results Land 1 on the screen
1 PRN#(0,"Pos: ####.### Neg: ####.###",#RESULT1,#RESULT2)
2 PRN#(0,"Center probed: ####.###",#RESULT3)
3 PRN#(0,"Center difference: ####.###",#RESULT4)
4 PRN#(0,"Land width : ####.###",#RESULT5)
N60 G0 Y92.5            ;Positioning
;Probe Land 2 at X35 Y92.5
;call cycle
N70 G329 (PNO1, IAX Z, SL30, PLE-5, PDI10, PAX X, NCE35, NWI20)
;displaying measurement results Land 2 on the screen
5 PRN#(0,"Pos: ####.### Neg: ####.###",#RESULT1,#RESULT2)
6 PRN#(0,"Center probed: ####.###",#RESULT3)
7 PRN#(0,"Center difference: ####.###",#RESULT4)
8 PRN#(0,"Land width : ####.###",#RESULT5)
N80 G0 Z100             ;retracting
N90 M30

```

G331 Probe groove

Syntax G331 (PNO<pno>, IAX <iax>, PLE<ple>, PDI<pdi>, PAX<pax>, GCE<nce>, GWI<nwi>{, SL<sl>}{, IFE<ife>}{, RLE<rle>}{, RFE<rfe>}{, PFE<pfe>})

Brief description The "Probe groove" (G331) cycle measures a groove in parallel to the axis and determines the width and the center. The measuring results are stored in the global output variables #RESULT1 to #RESULT5 and the output variable "RUNS" is increased by a value of 2.

Overview

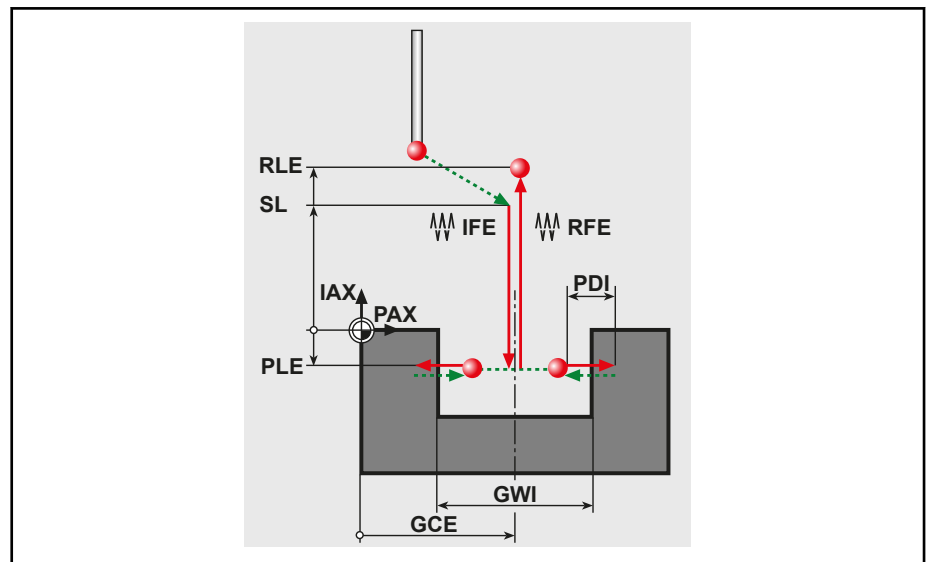


Fig. 4-42: Overview: Probe groove (infeed)

Measuring cycle automatic

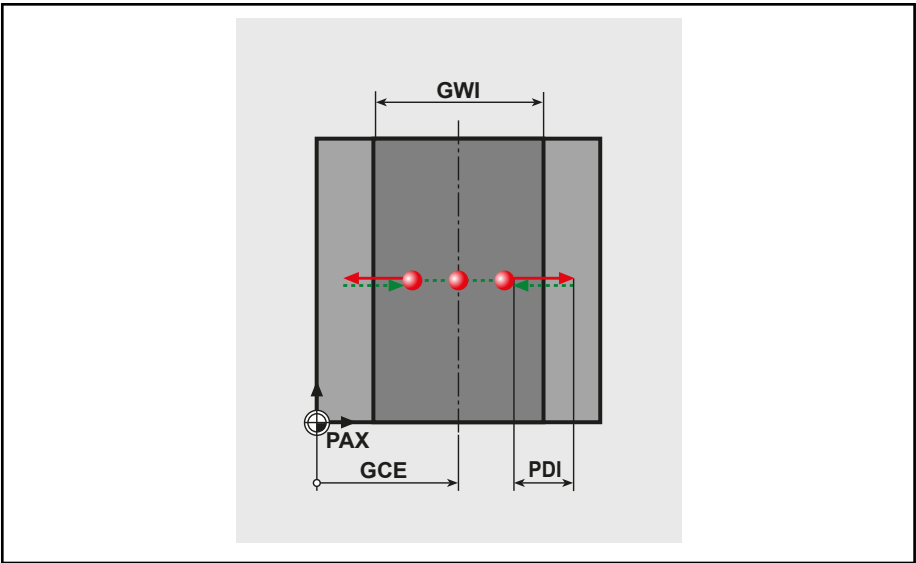


Fig. 4-43: Overview: Probe groove (measuring level)

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
PNO	Probe number	Mandatory	INTEGER	1..2
IAX	Infeed axis	Mandatory	STRING	8
SL	Safety level	Optional	REAL	Absolute
IFE	Infeed feed	Optional	REAL	Absolute
PLE	Measuring height	Mandatory	REAL	Absolute
RLE	Retraction height	Optional	REAL	Absolute
RFE	Retraction feed	Optional	REAL	mm/min
PDI	Measuring distance	Mandatory	REAL	Relative
PFE	Measuring feed	Optional	REAL	mm/min
PAX	measuring axis	Mandatory	STRING	8
GCE	Groove center	Mandatory	REAL	Absolute
GWI	Groove width	Mandatory	REAL	Relative

Tab. 4-36: Parameter call

Result variables

SD.SysPrResult.Parameter[i]			
[i] 1..3 Axis number			
Parameters	Description	Values	Area
AXISRES[1..3]	Intermediate results	REAL	

Tab. 4-37: Runtime variable

Parameters	Description	Values	Area
#RESULT1	Position positive	REAL	
#RESULT2	Position negative	REAL	

Measuring cycle automatic

#RESULT3	Groove center	REAL	
#RESULT4	Groove center difference	REAL	
#RESULT5	Groove width	REAL	

Tab. 4-38: Output values 1

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction (1 = positive, 2 = negative)			
Parameters	Description	Values	Area
RUNS	Number of measurements	INTEGER	

Tab. 4-39: Output values 2

Description

Prior to the cycle, a suitable position is to be approached at the axis not included in the motion sequence. If no safety level is specified, the infeed takes place in rapid traverse on measuring height. If a safety level is specified, the probe is first positioned there in rapid traverse. Afterwards, the probe moves to measuring height with G1 and the infeed feed to enable plunging at reduced velocity. Now, the measuring sequence is executed in both directions. Afterwards, the probe is positioned over the groove center.

If no measuring feed is programmed, the cycle automatically applies the respective calibration feed the axis was calibrated with. Afterwards, the #RESULT1 to #RESULT5 output variables are stored in the global variables and the "Number of measurements" (RUNS) variable is increased by a value of 2 in the SysPrResult structure.

At the cycle end, the infeed axis is returned. If no retraction height is specified, positioning takes place in rapid traverse to the initial cycle position. If a retraction height is specified, it is moved to in rapid traverse or, if a retraction feed is additionally specified, with G1 and this feed value.

The cycle resets the modal functions of the groups ABS/REL (G90/G91), interpolation (G0/G1/G2/G3/G5/G6) and feed programming (G93/G94/G95) to their initial state prior to the cycle.

Procedure/processing

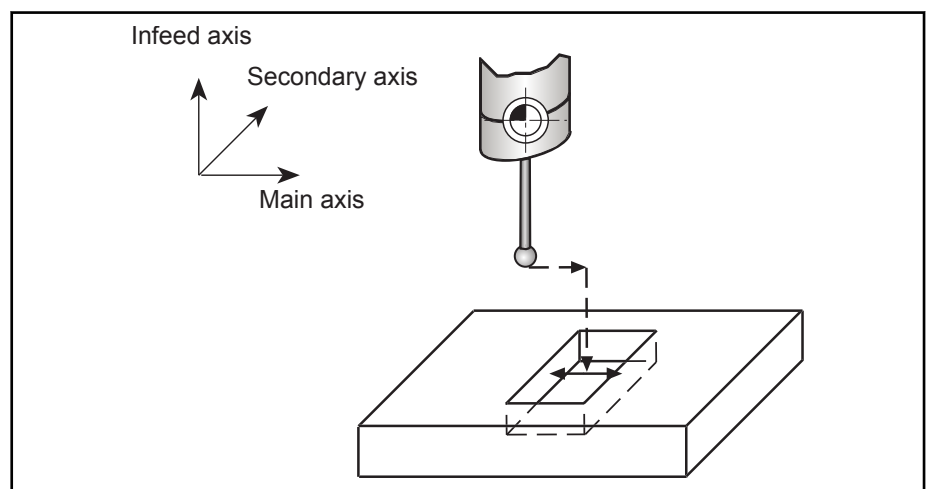


Fig. 4-44: Traversing motion: Probe groove

Measuring cycle automatic

Example

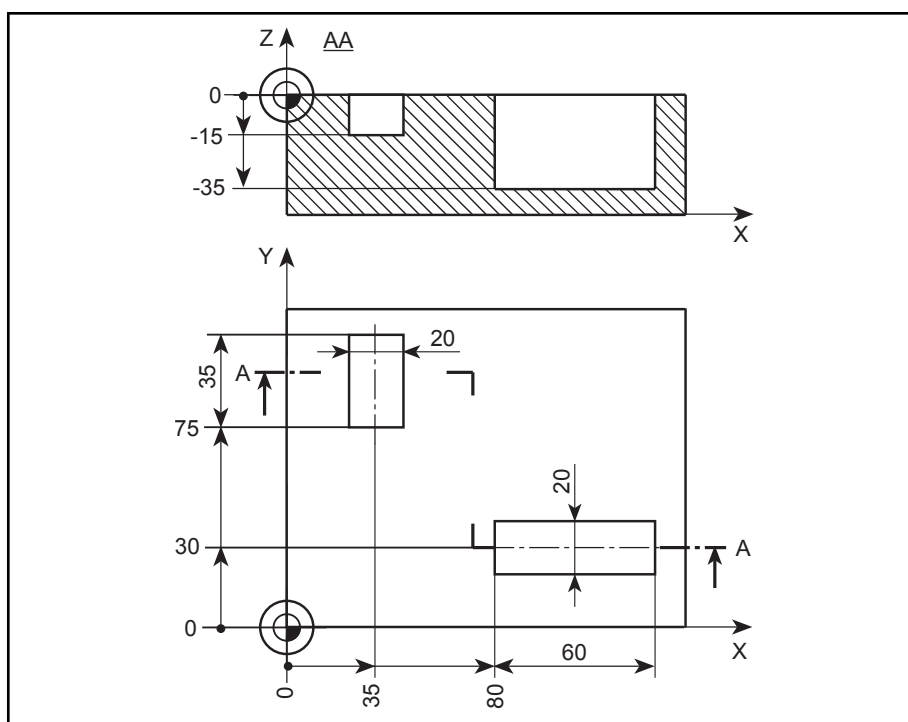


Fig. 4-45: Example: Probe groove

Probe groove

```

;-----
;----- Probe slots with a width of 20 -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T999 M6              ;load tool
N30 ED1 M97              ;Probel ON and enable edge
N40 M19 S=0
N50 G47 G54 X110 Y30 Z10 ;enable tool length and ZPO
;Probe Slot 1 at X110 Y30
;call cycle
N60 G331 (PNO1, IAX Z, SL5, PLE-15, PDI10, PAX Y, GCE30, GWI20)
;displaying measurement results Slot 1 on the screen
1 PRN#(0,"Pos: ####.### Neg: ####.###",#RESULT1,#RESULT2)
2 PRN#(0,"Center probed: ####.###",#RESULT3)
3 PRN#(0,"Center difference: ####.###",#RESULT4)
4 PRN#(0,"Slot width : ####.###",#RESULT5)
N70 G0 Y92.5              ;Positioning
;Probe Slot 2 at X35 Y92.5
N80 G331[1,3,,, -7.5,,, 6,, 1,35,20]
;call cycle
G331 (PNO1, IAX Z, SL5, PLE-7.5, PDI10, PAX X, GCE30, GWI20)
;displaying measurement results Slot 2 on the screen
5 PRN#(0,"Pos: ####.### Neg: ####.###",#RESULT1,#RESULT2)
6 PRN#(0,"Center probed: ####.###",#RESULT3)
7 PRN#(0,"Center difference: ####.###",#RESULT4)
8 PRN#(0,"Slot width : ####.###",#RESULT5)
N90 G0 Z100              ;retracting
N100 M30

```

G333 Probe angle

Syntax G333 (PNO<pno>, IAX <iax>, PLE<ple>, PDI<pdI>,
PA1 <pa1>, PA2 <pa2>, PP1<pp1>, PP2<pp2>, DIS<dis>, ANG<ang>
{, SL<sl>}{, IFE<ife>}{, RLE<rle>}{, RFE<rfe>}{, PFE<pfe>})

Brief description With the "Probe angle" (G333) cycle, the angle of a flat surface can be measured. In this respect, the angle and the angle difference are determined. The measuring results are stored in the global output variables #RESULT1 to #RESULT2 and the output variable "RUNS" is increased by a value of 2.

Measuring cycle automatic

Overview

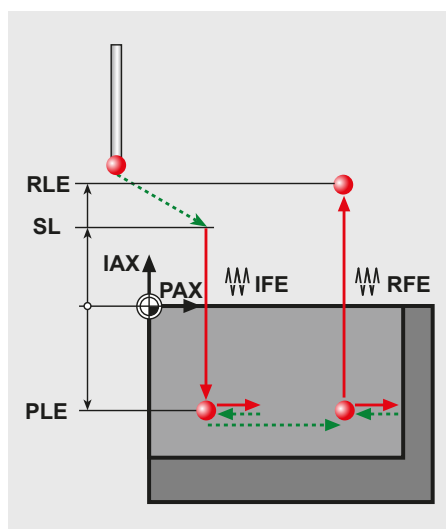


Fig. 4-46: Overview: Probe angle (infeed)

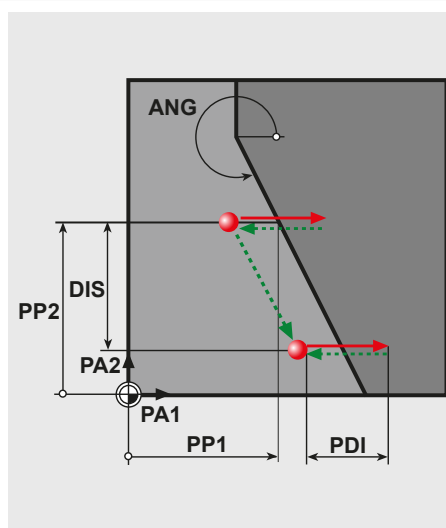


Fig. 4-47: Overview: Probe angle ($225^\circ \leq \text{ANG} < 315^\circ$)

Measuring cycle automatic

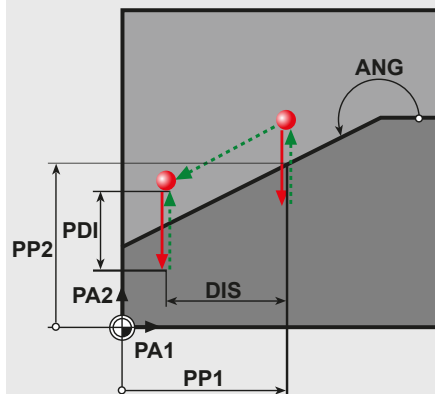


Fig. 4-48: Overview: Probe angle ($135^\circ \leq ANG < 225^\circ$)

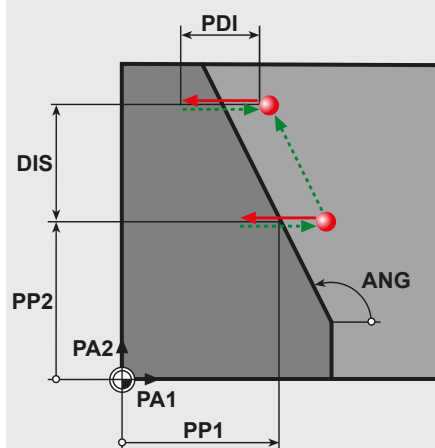


Fig. 4-49: Overview: Probe angle ($45^\circ \leq ANG < 135^\circ$)

Measuring cycle automatic

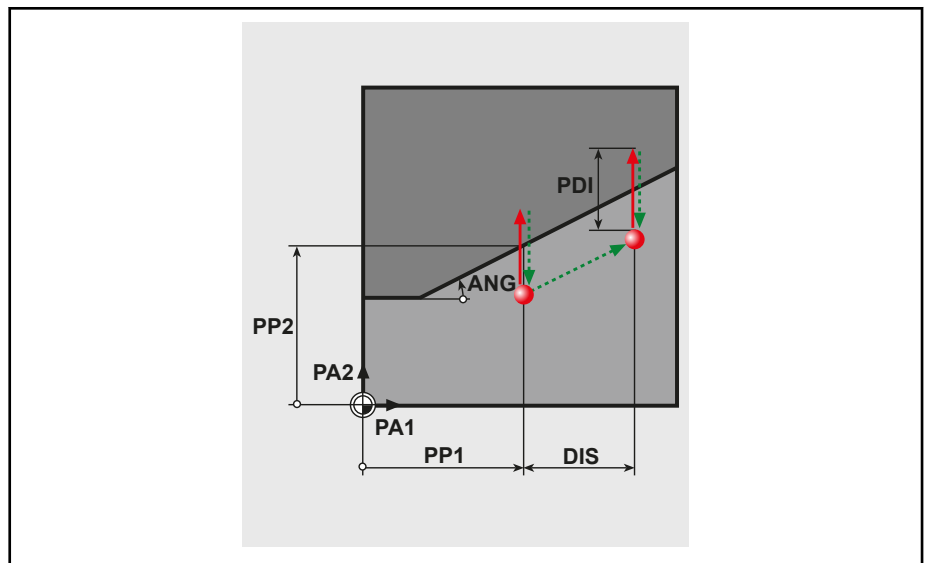


Fig. 4-50: Overview: Probe angle ($-45^\circ \leq \text{ANG} < 45^\circ$)

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
PNO	Probe number	Mandatory	INTEGER	1..2
IAX	Infeed axis	Mandatory	STRING	8
SL	Safety distance	Optional	REAL	Absolute
IFE	Infeed feed	Optional	REAL	Absolute
PLE	Measuring height	Mandatory	REAL	Absolute
RLE	Retraction height	Optional	REAL	Absolute
RFE	Retraction feed	Optional	REAL	mm/min
PDI	Measuring distance	Mandatory	REAL	Relative
PFE	Measuring feed	Optional	REAL	mm/min
PA1	Measuring axis 1 (main axis)	Mandatory	STRING	8
PA2	Measuring axis 2 (secondary axis)	Mandatory	STRING	8
PP1	Main axis position	Mandatory	REAL	Absolute
PP2	Secondary axis position	Mandatory	REAL	Absolute
DIS	Distance	Mandatory	REAL	Relative
ANG	Angle	Mandatory	REAL	Degree

Tab. 4-40: Parameter call

Result variables

SD.SysPrResult.Parameter[i]			
[i] 1..3 Axis number			
Parameters	Description	Values	Area
AXISRES[1..3]	Intermediate results	REAL	

Tab. 4-41: Runtime variable

Measuring cycle automatic

Parameters	Description	Values	Area
#RESULT1	Measured angle	REAL	
#RESULT2	Angle difference	REAL	

Tab. 4-42: Output values 1

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction (1 = positive, 2 = negative)			
Parameters	Description	Values	Area
RUNS	Number of measurements	INTEGER	

Tab. 4-43: Output values 2

Description

The measuring direction is defined by the set angle. The probe is positioned over the calculated starting point of the first measuring distance and afterwards on the measuring height. If no safety level is specified, both traversing motions are executed in rapid traverse. If a safety level is specified, the probe is first positioned there in rapid traverse. Afterwards, the probe moves to measuring height with G1 and the infeed feed to enable plunging at reduced velocity.

Now, the two measurements are executed. Between the measurements, the axes are moved incrementally with safety feed to the resulting starting position of the second measuring distance (see figure above).

If no measuring feed is programmed, the cycle automatically applies the respective calibration feed the axis was calibrated with. Afterwards, the #RESULT1 to #RESULT2 output variables are stored in the global variables and the "Number of measurements" (RUNS) variable is increased by a value of 2 in the SysPrResult structure.

At the cycle end, the infeed axis is returned. If no retraction height is specified, positioning takes place in rapid traverse to the initial cycle position. If a retraction height is specified, it is moved to in rapid traverse or, if a retraction feed is additionally specified, with G1 and this feed value.

The cycle resets the modal functions of the groups ABS/REL (G90/G91), interpolation (G0/G1/G2/G3/G5/G6) and feed programming (G93/G94/G95) to their initial state prior to the cycle.

Angle specifications

The reference axis for the angle is always the main axis (PA1) of the measuring level. The angle line always passes through point (PP1/PP2). The absolute angle to the main axis defines whether the workpiece is on the left or right side of this angle line.

Measuring cycle automatic

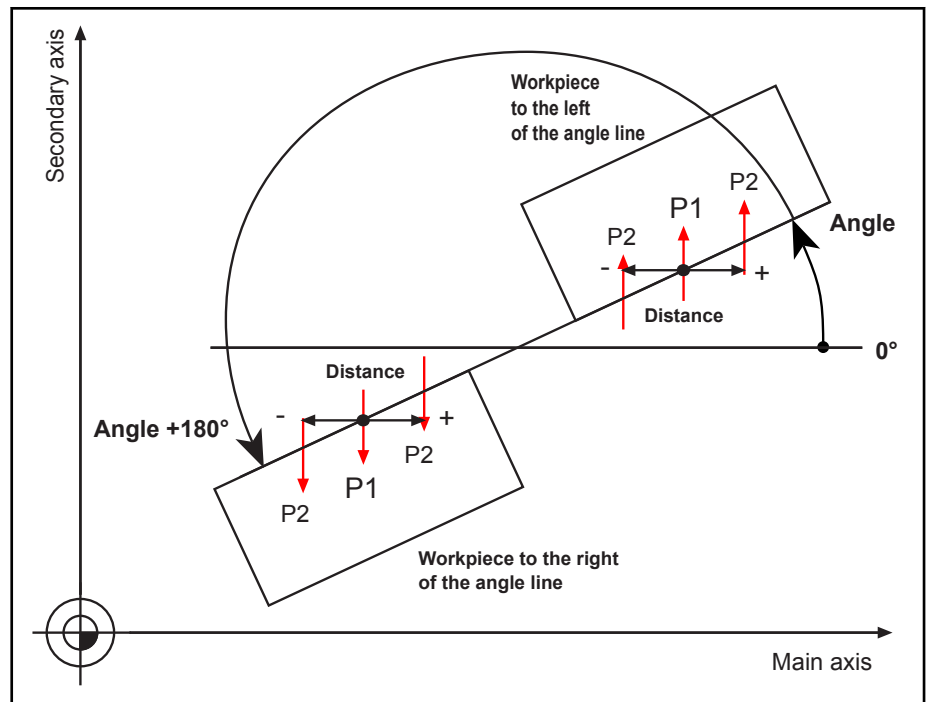


Fig. 4-51: Angle reference and angle line

Procedure/processing

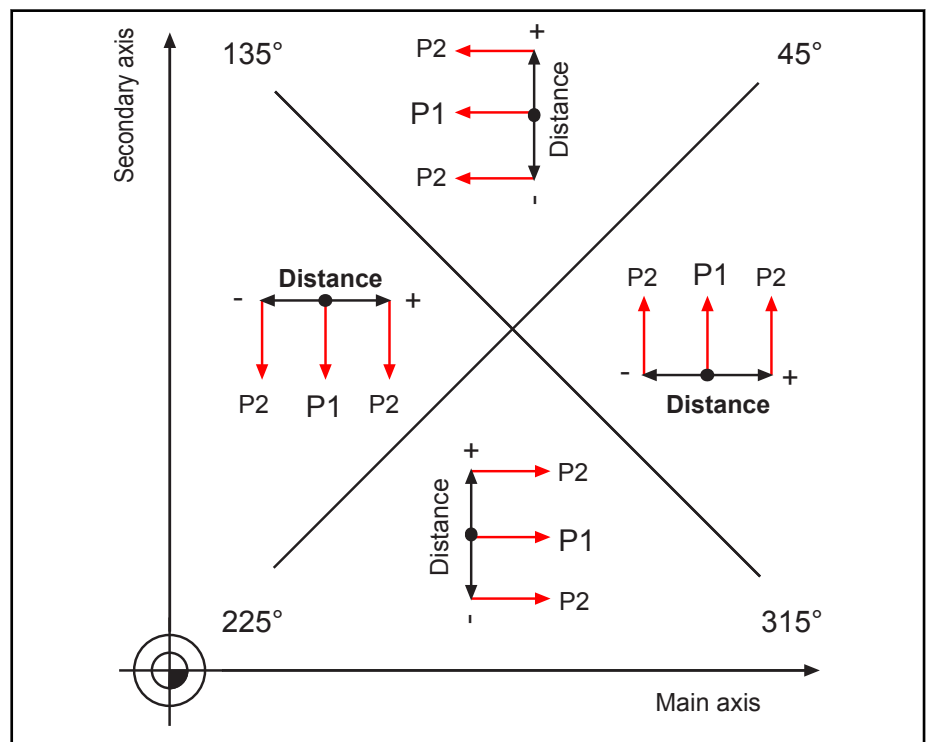


Fig. 4-52: Angle ranges

Example 1 Probe angle XY

Measuring cycle automatic

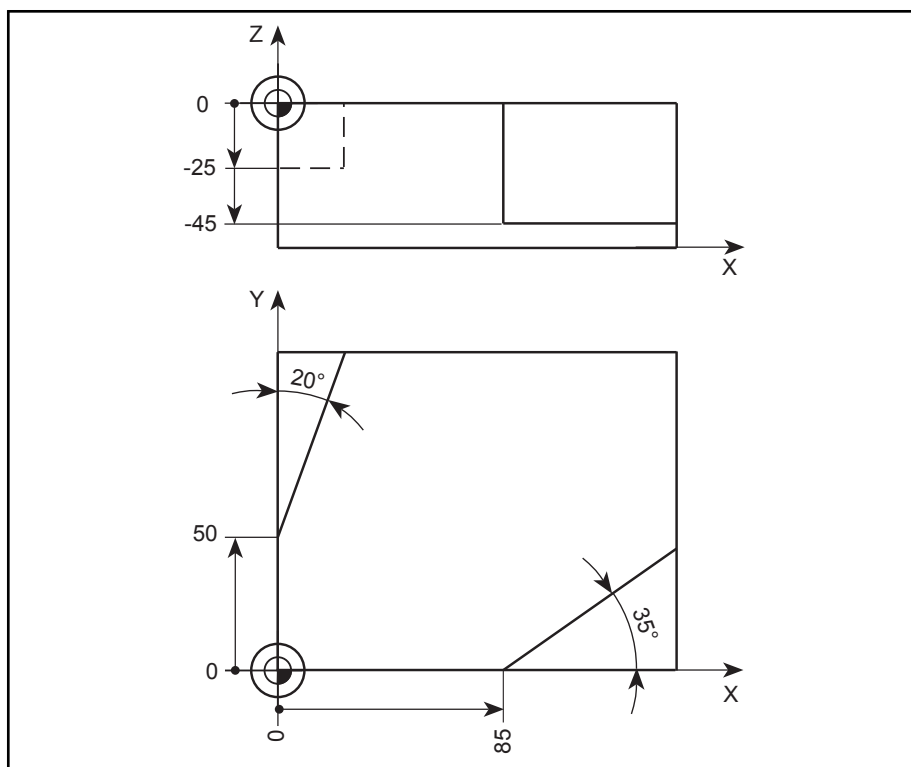


Fig. 4-53: Example: Probe angle XY

Probe angle XY

```

;-----
;----- Probe angle XY -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T999 M6              ;load tool
N30 ED1                  ;enable edge
N40 G47 G54 X100 Y-20 Z50 ;enable tool length and ZPO
;call cycle
N50 G333 (PNO1, IAX Z, SL10, IFE3000, PLE-25, PDI10, PA1 X, PA2 Y,
PP1 90, PP2 3.501, DIS30, ANG35)
;displaying measurement results of angle 35° on the screen
1 PRN#(0,"Probed angle: ####.###°",#RESULT1)
2 PRN#(0,"Angle difference: ####.###°",#RESULT2)
N60 G0 X-20 Y60          ;Positioning
;call cycle
N70 G333 (PNO1, IAX Z, SL10, IFE3000, PLE-15, PDI10, PA1 X, PA2 Y,
PP1 3.64, PP2 60, DIS30, ANG250)
;displaying measurement results of angle 250° (20°) on the screen
3 PRN#(0,"Probed angle: ####.###°",#RESULT1)
4 PRN#(0,"Angle difference: ####.###°",#RESULT2)
N80 G0 Z100 M30          ;retracting

```

Example 2 Probe angle XY

Measuring cycle automatic

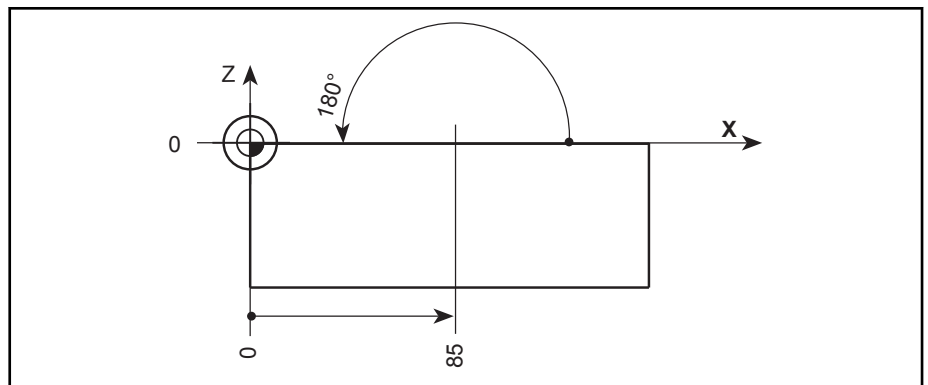


Fig. 4-54: Example: Probe angle XY
Probe angle XY

```

;-----
;----- Probe angle ZX -----
;-----
N10 ZOTSEL(MYTABLE.ZOT) ;select ZPO table
N20 T999 M6              ;load tool
N30 ED1                  ;enable edge
N40 G0 G47 G54 X85 Y20 Z50 ;enable tool length and ZPO
;call cycle
N50 G333 (PNO1, IAX Z, SL50, IFE3000, PLE0, PDI-10, PA1 X, PA2 Z,
PP1 85, PP2 0, DIS30, ANGI80)
;displaying measurement results of angle 180° on the screen
1 PRN#(0,"Probed angle: ####.###°",#RESULT1)
2 PRN#(0,"Angle difference: ####.###°",#RESULT2)
N60 G0 X-20 Y60          ;Positioning
N70 G0 Z100 M30          ;retracting

```

4.5 Measuring value evaluation

4.5.1 General information

After recording one or several measuring positions, the measuring results can be evaluated. The compensation values for each measuring position are calculated according to the measuring results. Operating instructions and error messages are generated according to the measuring results.

The calculated compensations are to be taken into consideration by the user in the processing program during processing. Depending on the requirement, the values can be offset against the programmed dimensions with zero offset or directly with the tool data.

For evaluation, measuring results can be directly processed in evaluation cycles directly after recording. For this, the evaluation cycles have to be called in the processing program.

Depending on the required compensation process, the following evaluation cycles are available:

- G341 Tolerance monitoring
Determination of the differential dimension between actual dimension (from measuring value recording) and the center of the specified tolerance field. During this, limit values that can be defined via variables are checked and error and alarm messages returned.
- G342 Averaging
Determination of the compensation value by means of evaluated averaging of the differential dimension taking limit values and an evaluation of the differential dimension into account.
- G343 Percentage compensation

Measuring cycle automatic

Determination of the compensation value in form of a percentage evaluation of the differential dimension taking limit values into account limit values.

A full determination of the compensation value always includes the following cycle calls:

- Measured value recording, e.g. the "Probe boring" cycle
- Measuring data monitoring, e.g. the "Measuring data monitoring" cycle
- Compensation value determination, e.g. the "Averaging" or "Percentage compensation" cycle

4.5.2 Terms

General Information

For measuring value evaluation, determination of compensation values and monitoring of different limit values to generate messages, the tolerance limits illustrated in the following figures are defined.

The "nominal dimension" as well as "the top deviation" and the "lower deviation" define a tolerance field for the workpiece dimensions (gray range).

As ideal set dimensions for the workpiece, the center of the tolerance field applies. These dimensions are referred to as "tolerance center". The tolerance center is symmetrically assigned to tolerance ranges. This makes it easier to handle the values.

The tolerance ranges are defined by NC variables and are taken into consideration in monitoring of measured data and in determination of compensation values.

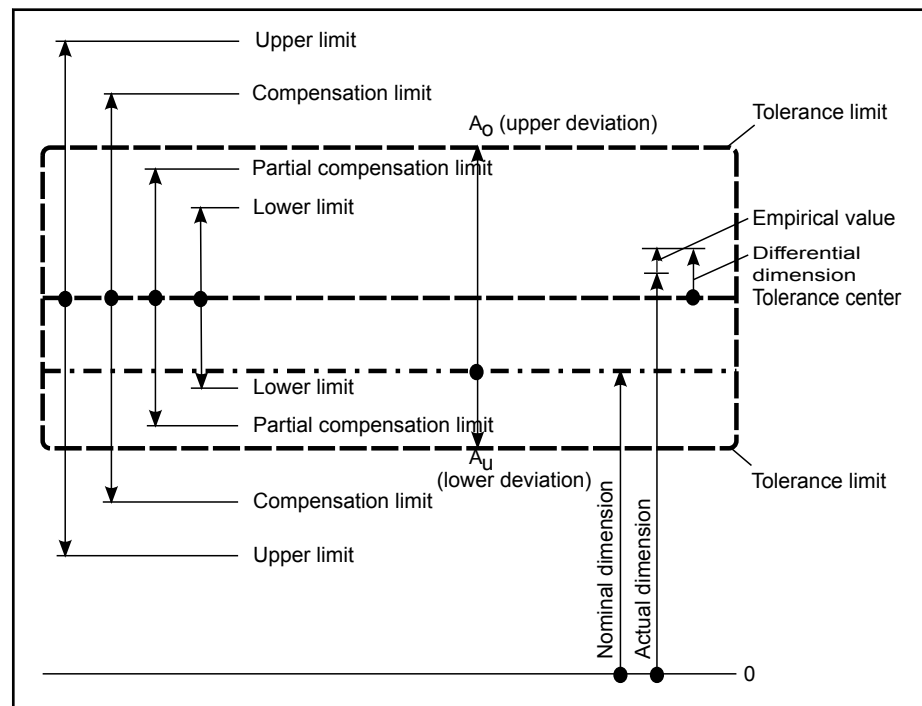


Fig. 4-55: Terms

Nominal dimension Dimensions specified in the drawing the tolerance limit specifications A_0 and A_u refer to.

Lower deviation A_u

Measuring cycle automatic

Upper deviation A_o	The upper deviation A_o and the lower deviation A_u define the tolerance limit according to the nominal dimension for the actual dimension corrected by the empirical value to comply with tolerance requirements. The following applies: $\text{Maximum dimension} = \text{nominal dimension} + A_o$ $\text{Minimum dimension} = \text{nominal dimension} + A_u$
Tolerance center	The tolerance center defines the point in the center of the defined tolerance limits A_o and A_u according to the nominal dimension. All tolerance limits refer to the tolerance center and apply symmetrically to it. The following applies: $\text{Tolerance center} = \text{Nominal dimension} + \frac{A_o + A_u}{2}$
Actual dimension	The actual dimension of one of the measured values provided by one of the cycles described under chapter 4 "Measuring cycle automatic" on page 19 and which was recorded partially by the measuring system during measuring.
Empirical value	The empirical value compensates the difference of the measured values between the internal measurement by means of the the measuring system (refer to actual dimension) and an external reference measurement, e.g. by means of a measuring unit. The empirical value can be stored as a variable for every measuring position. It is applied as an additive to the nominal value.
	 The empirical value is not taken into consideration before the measuring data monitoring cycle.
Differential dimension	The differential dimension is the calculated difference between the actual dimension corrected by the empirical value and the tolerance center. Respectively, it specifies at least theoretically the dimensions to be corrected to achieve the ideal state, the tolerance center: $\text{Differential dimension} = \text{act. dim.} + \text{empirical value} - \text{tolerance center}$
Upper limit	The upper limit is a limit value that is only used for diagnostics. If this value is exceeded, no compensation is applied. If this is the case, it can be assumed that the measurement was not carried out successfully due to a critical error in application programming (e. g. incorrect measuring position) or in probe mechanics. The cycle is stopped with an error. The following NC message is returned: "Inadmissibly high dimensional deviation".
Compensation limit	The compensation limit is a limit value that is only used for diagnostics. If this value is exceeded, no compensation is applied. This value may be exceeded due to excessive tool wear. The dimensions are only compensated under the compensation limit. The cycle is stopped with an error. The following NC message is returned: "CHECK TOOL".
Tolerance limit	The tolerance limit is a control dimension without any influence on compensation value determination. The tolerance limit restricts the tolerance field defined by A_o and A_u according to the tolerance center. The comparison with the actual dimension under consideration of the empirical value provides the information whether the workpiece dimensions are within the required tolerance.

Measuring cycle automatic

Partial compensation limit

If the recorded dimension is between the tolerance limit and the compensation limit, the NC warning message "[Over dimension] (differential dimension > 0)" or "[Under dimension] (differential dimension < 0)" is returned.

The program is interrupted. After acknowledging the message, the program can be continued. Workpiece compensation is still permitted.

If the differential dimension exceeds the partial compensation limit and lies under the compensation limit, a full compensation is carried out. The compensation value corresponds to the full differential dimension.

In the range between the partial compensation limit and the lower limit, the determined differential dimension of a measuring point is provided to an evaluation in the compensation value determination cycle (STP_VALCAM, STP_VALCPR). Respectively, no full compensation is carried out.

Lower limit

The lower limit is a range in which no compensation is carried out. The occurring deviations (differential dimensions) are statically distributed in this tolerance band. By means of a targeted compensation of processing, no improvement of dimensional accuracy could be achieved.

If compensations are applied by means of averaging, the determined differential dimension is applied for averaging.



All tolerance limits referring to the tolerance center, are always set as inputs for measuring data monitoring and compensation value determination with a positive sign. The upper deviation A_o and the lower deviation A_u have to be entered with the correct sign (according to the nominal dimension).

G541 Tolerance monitoring**Syntax**

G541 (NDI<ndi>, UTO<uto>, LTO<lto>, UPL<upl>, COB<cob>, ADI<adi>, EXV<exv>)

Brief description

The tolerance monitoring (G541) cycle monitors and checks the previously measured values (actual dimensions) according to their tolerance limits and writes the results to global output variables. These are available in NC programs for further processing.

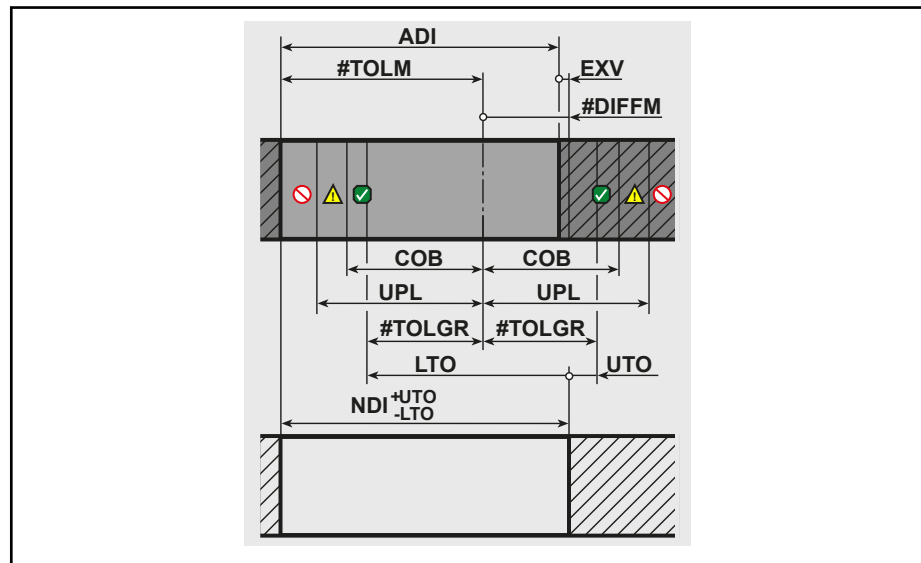
Overview

Fig. 4-56: Tolerance monitoring overview

Measuring cycle automatic

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
NDI	Nominal dimension	Mandatory	REAL	
UTO	Upper deviation	Mandatory	REAL	
LTO	Lower deviation	Mandatory	REAL	
UPL	Upper limit	Mandatory	REAL	
COB	Compensation limit	Mandatory	REAL	
ADI	Actual dimension	Mandatory	REAL	
EXV	Empirical value	Mandatory	REAL	

Tab. 4-44: Parameter call

Result variables

Parameters	Description	Values	Area
#TOLM	Tolerance center	REAL	
#DIFFM	Differential dimension	REAL	
#TOLGR	Tolerance limit	REAL	
#VALCHK	Dimensional accuracy	INTEGER	0..4

Tab. 4-45: Output values

#VALCHK: Dimensional accuracy 0..4

Dimensional accuracy = 0	The determined actual dimension under consideration of the empirical value lies within the tolerance field $A_o - A_u$. This means, the workpiece accuracy required by the tolerance specifications was achieved.
Dimensional accuracy = 1	The differential dimension lies between the tolerance limit and the compensation limit. The admissible range according to the tolerance field $A_o - A_u$ was exceeded but can be corrected. Cycle interruption with the NC warning [Over dimension]. Continuing the cycle is possible.
Dimensional accuracy = 2	The differential dimension lies between the tolerance limit and the compensation limit. The admissible range according to the tolerance field $A_o - A_u$ was dropped below but can be corrected. Cycle interruption with the NC message [Under dimension]. Continuing the cycle is possible.
Dimensional accuracy = 3	The differential dimension is over the upper limit. No further compensation value can be determined. The cycle is interrupted with the NC error message [Check tool] and cannot be continued. A serious error has occurred.
Dimensional accuracy = 4	The differential dimension is over the compensation limit. No further compensation value can be determined. The cycle is interrupted with the NC error message "Inadmissibly high dimensional deviation" and cannot be continued. A serious error has occurred during measuring value determination or at the workpiece.

Description

The measuring data monitoring (G541) cycle monitors and checks the measured values (actual dimensions) determined from the cycles according to the tolerance limits described under [chapter 4.5.2 "Terms" on page 74](#).

Measuring cycle automatic

In this subroutine, the differential dimension is defined under consideration of the empirical value for a measuring point. It can be applied as input value for the compensation value determination cycles "Averaging" (G542) or "Percentage compensation" (G543) and the determined dimensional accuracy to further influence the main program sequence (reworking/rejected parts).

At runtime, warnings and error messages with respect to the tolerance limits are returned. If the differential dimension exceeds the upper limit, the control switches to stop state and the error message "Inadmissibly high dimensional deviation" is returned. If the differential dimension exceeds the compensation limit, the error message "Check tool" is returned and the control switches to stop state. If the differential dimension is negative, the "Under dimension" warning message is returned. If the differential dimension is positive, the "Over dimension" warning message is displayed. If the differential dimension and the tolerance limit are equal, no message is displayed. The following flow chart illustrates the cycle logics.

Procedure/processing

Measuring cycle automatic

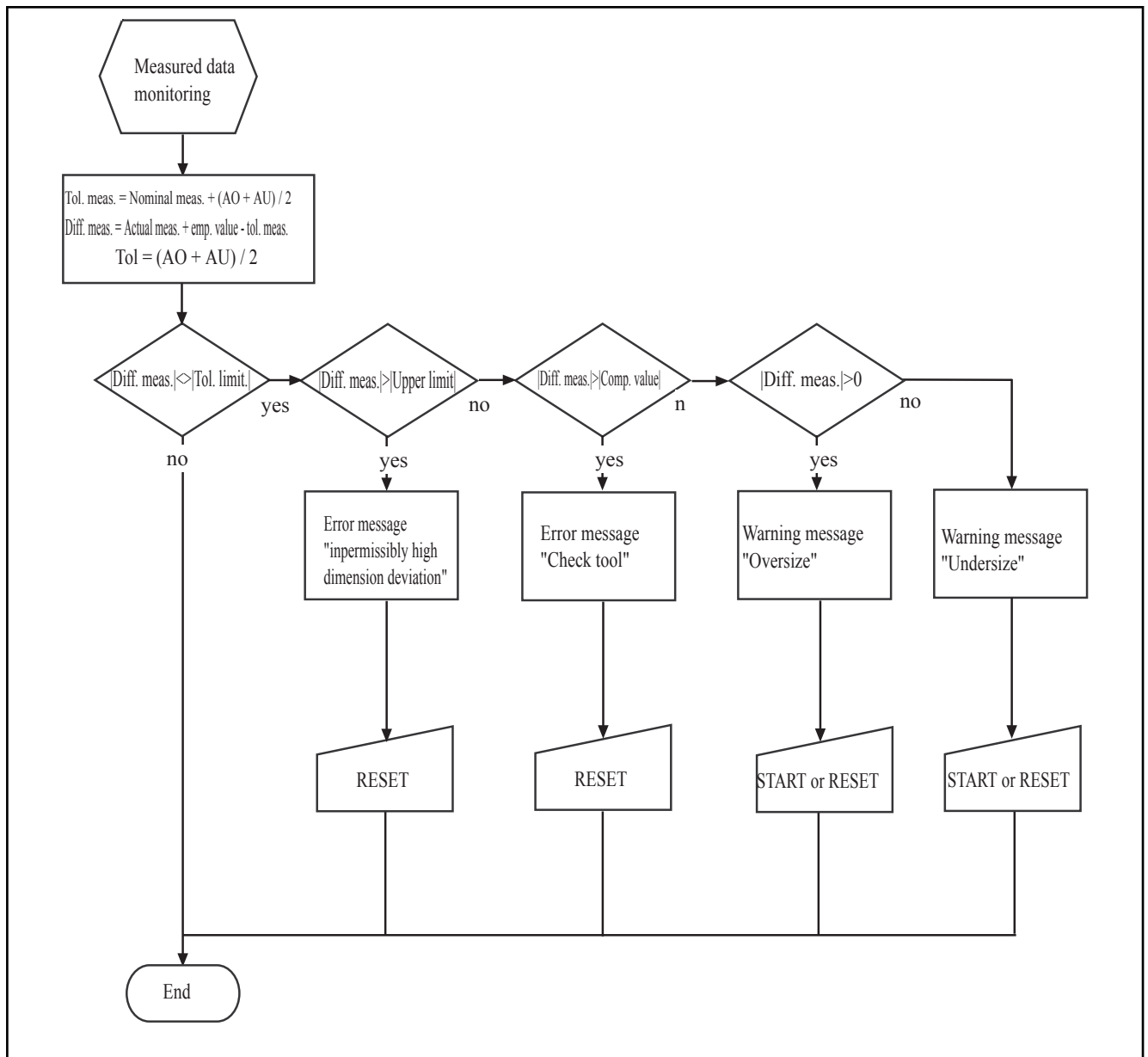


Fig. 4-57: Flow chart: Tolerance monitoring

Measuring cycle automatic

Example

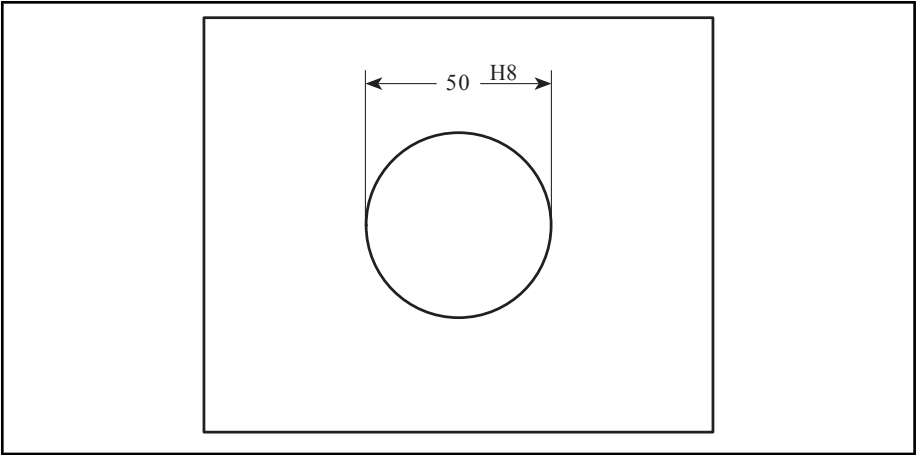


Fig. 4-58: Programming example: Tolerance monitoring
Tolerance monitoring

```

N10 G341 (NDI50, UTO0.039, LTO0, UPL0.1, COB0.05,
        ADI50.02,EXV0)

```

After processing of this NC program, the output variables are assigned the following values:
Tolerance center #TOLM: 50.0195
Differential dimension #DIFFM: 0.0005
Tolerance limit #TOLGR: 0.195
Dimensional accuracy #VALCHK: 0

G542 Averaging

Syntax G542 (DIF<dif>, LMV<lmv>, SCF<scf>, COB<cob>, PCL<pcl>, LOL<lol>)
Brief description The "Averaging" (G342) cycle determines the effective compensation value at a measuring point by evaluated averaging.

Overview

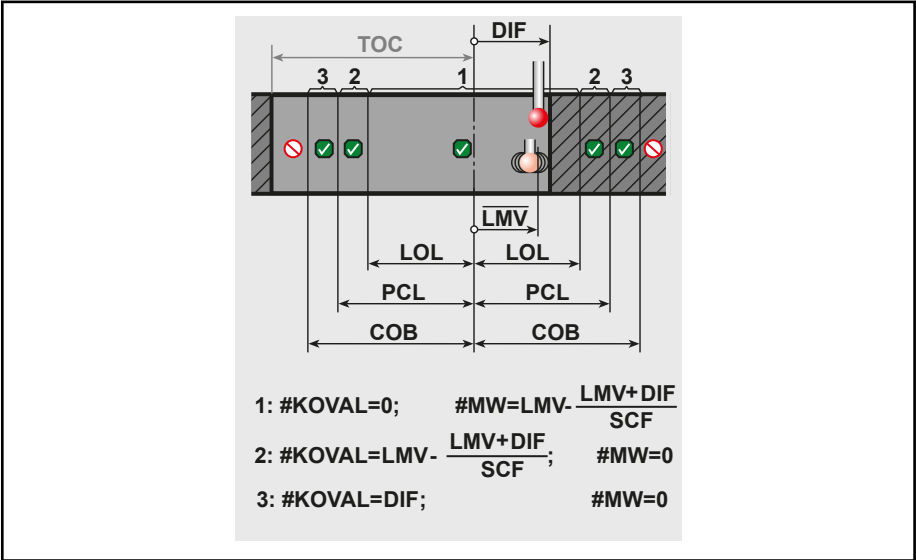


Fig. 4-59: Averaging overview

Measuring cycle automatic

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
DIF	Differential dimension	Mandatory	REAL	
LMV	Average value of the last measurement	Mandatory	REAL	
SCF	Scaling factor	Mandatory	REAL	
COB	Compensation limit	Mandatory	REAL	
PCL	Partial compensation limit	Mandatory	REAL	
LOL	Lower limit	Mandatory	REAL	

Tab. 4-46: Parameter call

Result variables

Parameters	Description	Values	Area
#MW	New average	REAL	
#KOVAL	Dimensional compensation	REAL	

Tab. 4-47: Output values

#VALCHK: Dimensional accuracy 0..4

Dimensional accuracy = 0	The determined actual dimension under consideration of the empirical value lies within the tolerance field $A_o - A_u$. This means, the workpiece accuracy required by the tolerance specifications was achieved.
Dimensional accuracy = 1	The differential dimension lies between the tolerance limit and the compensation limit. The admissible range according to the tolerance field $A_o - A_u$ was exceeded but can be corrected. Cycle interruption with the NC warning [Over dimension]. Continuing the cycle is possible.
Dimensional accuracy = 2	The differential dimension lies between the tolerance limit and the compensation limit. The admissible range according to the tolerance field $A_o - A_u$ was dropped below but can be corrected. Cycle interruption with the NC message [Under dimension]. Continuing the cycle is possible.
Dimensional accuracy = 3	The differential dimension is over the upper limit. No further compensation value can be determined. The cycle is interrupted with the NC error message [Check tool] and cannot be continued. A serious error has occurred.
Dimensional accuracy = 4	The differential dimension is over the compensation limit. No further compensation value can be determined. The cycle is interrupted with the NC error message "Inadmissibly high dimensional deviation" and cannot be continued. A serious error has occurred during measuring value determination or at the workpiece.

Description

The Averaging (G542) cycle determines the effective compensation value at a measuring point by evaluated averaging by means of the measured values recorded at this measuring point. If the differential dimension exceeds the compensation limit, no compensation value is returned and the control reports "Compensation limit exceeded". If the value of the differential dimension is between the partial compensation limit and the compensation limit, the compensation value is equal to the differential dimension. The average value

Measuring cycle automatic

is set to zero. If the differential dimension is below the partial compensation limit, the average value is recalculated with the scaling factor. In this respect, if the new average value is below the lower limit, the compensation value is zero. Otherwise, the compensation value and the average value are reset to zero. The following flow chart illustrates the cycle logics.

Procedure/processing

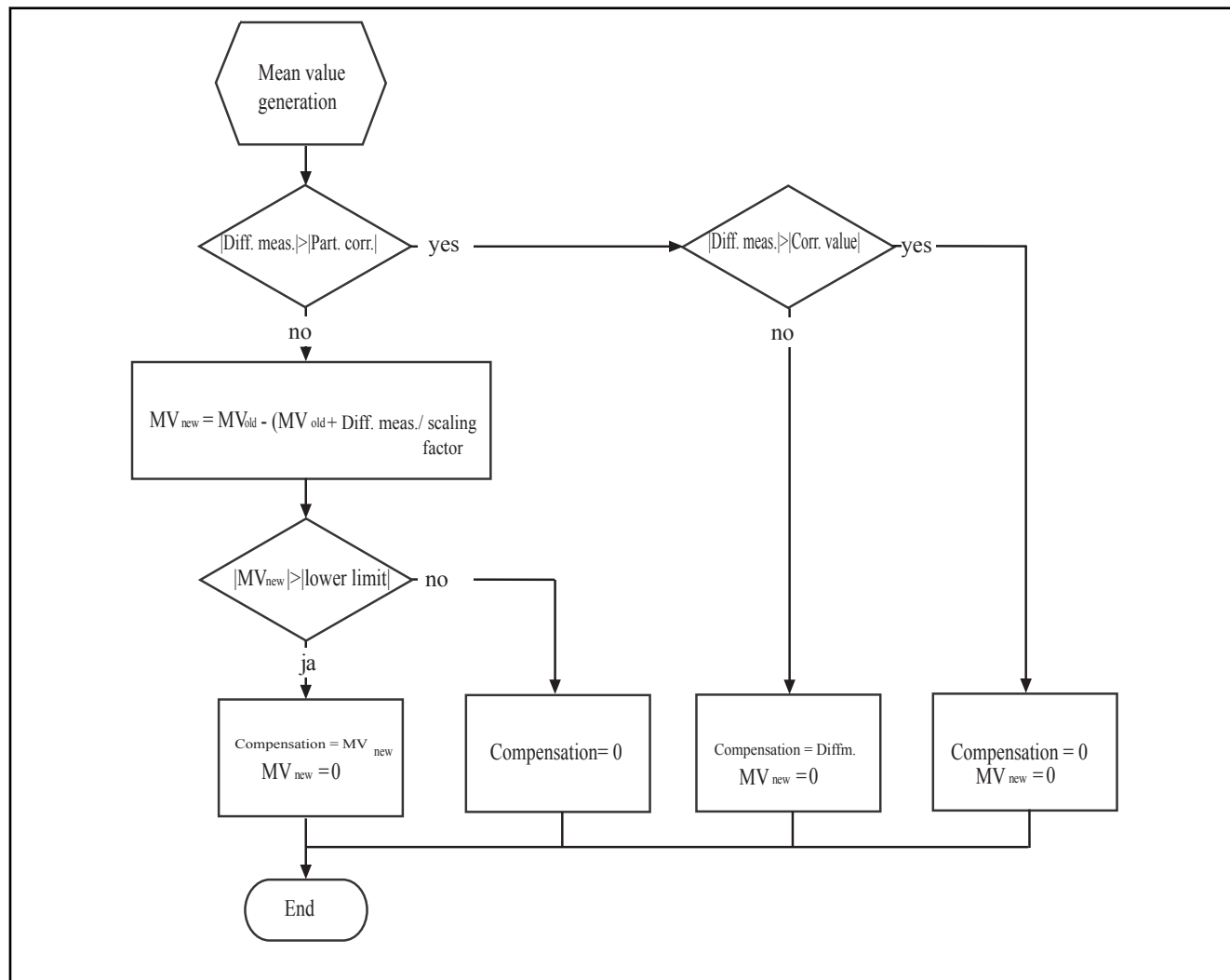


Fig. 4-60: Flow chart: Averaging

Measuring cycle automatic

Example

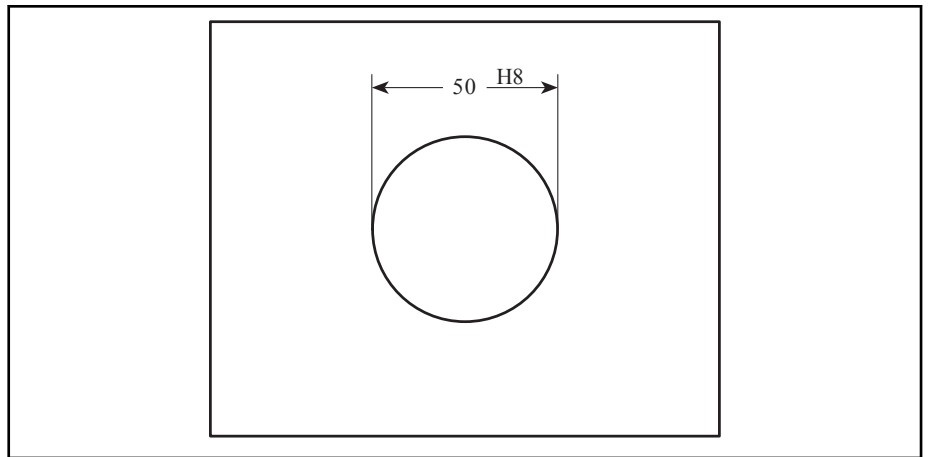


Fig. 4-61: Programming example: Averaging Average

```
N10 G542 (DIF0.009, LMV0.020, SCF90, CBB0.039, PCL0.030,
        LOL0.010)
```

After processing of this NC program, the output variables are assigned the following values:

New average #MW -0.0061

Dimensional compensation #KOVAL 0

G543 Percentage compensation

Syntax G543 (DIF<dif>, PCV<pcv>, COB<cob>, PCL<pcl>, LOL<lol>)
Brief description The "Percentage compensation" (G543) program determines the compensation value for a differential dimension.

Overview

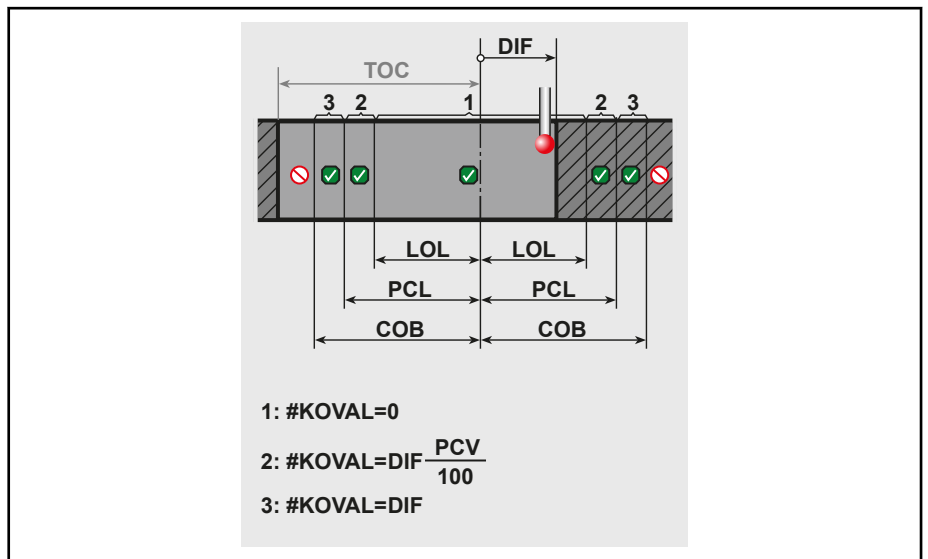


Fig. 4-62: Percentage compensation overview

Measuring cycle automatic

Parameters

Parameters	Designation	Properties	Values	Pre-assignment/Range
Parameters	Differential dimension	Mandatory	REAL	
DIF	Percentage compensation value	Mandatory	REAL	
PCV	Compensation limit	Mandatory	REAL	
COB	Partial compensation limit	Mandatory	REAL	
PCL	Lower limit	Mandatory	REAL	
LOL	Lower limit	Mandatory	REAL	

Tab. 4-48: Parameter call

Result variables

Parameters	Description	Values	Area
#KOVAL	Dimensional compensation	REAL	

Tab. 4-49: Output values

Description

The Percentage compensation (G543) cycle determines the effective compensation value for a measuring point by percentage evaluation of the measuring value recorded for a measuring point under consideration of the empirical value.

For percentage compensation, the following has to apply:

Between the partial compensation limit and the compensation limit, a full compensation applies. Under the lower limit, no compensation applies.

If the differential dimension is below the lower limit, the compensation value of the global #KOVAL variable is assigned zero. If the differential dimension is between the lower limit and the partial compensation limit, the #KOVAL returns the differential dimension under consideration of the percentage compensation value. If the differential dimension is between the partial compensation limit and the compensation limit, the differential dimension is assigned to #KOVAL without any compensation. If the differential dimension exceeds the compensation limit, the control switches to stop state and the error message "Rejected part" is returned. The following flow chart illustrates the cycle logics.

Procedure/processing

Measuring cycle automatic

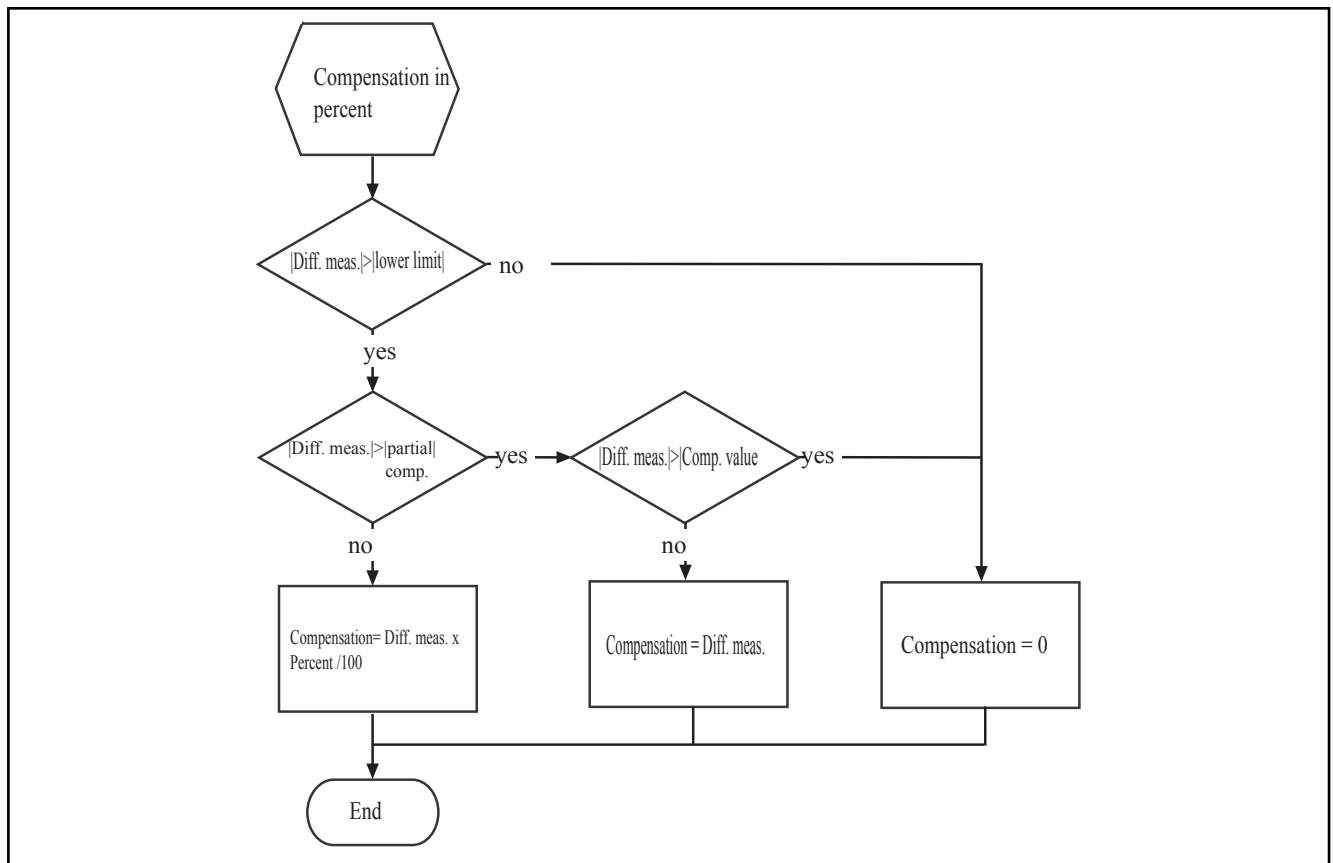


Fig. 4-63: Flow chart: Percentage compensation

Example

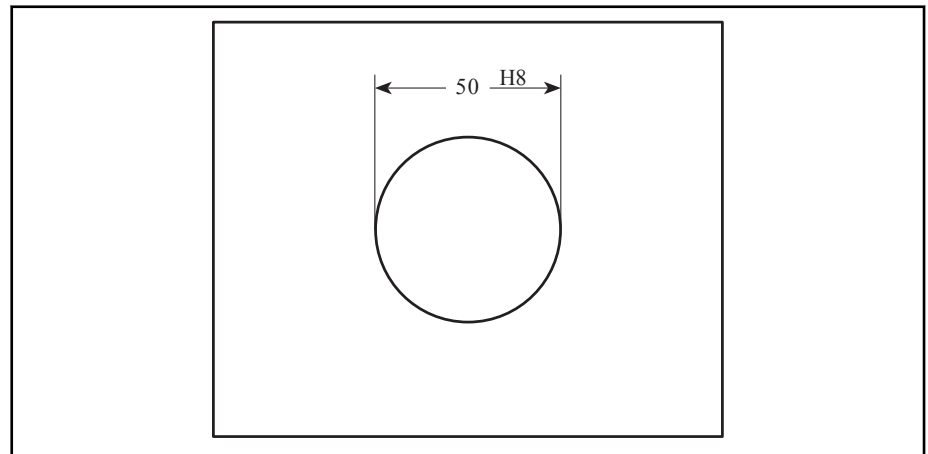


Fig. 4-64: Programming example: Percentage compensation value
Percentage compensation

N10 G543 (DIF0.009, PCV90, COB0.039, PCL0.030, LOL0)

After processing of this NC program, the output variable is assigned the following value:

Dimensional compensation #KOVAL -0.0081

Measuring cycle automatic

4.6 Processing compensation

4.6.1 Workpiece compensation

General Information

Incorrect workpiece dimensions are corrected depending on the error cause.

The following two methods are most common:

- Zero point offset (all dimensions in one axis)
- Position offset (individual dimension) by adding a compensation value

Zero point

Zero point offset

```
1 KORR=0.5 ;user variable with content of a compensation value
N10 ZOTSEL(/mnt/BRC_DEMO/Fraesen/MYTABLE.zot)
N20 G54 X0 ;NPV G54 Correct axis X
1 ZOT("X",54)=ZOT("X",54)+KORR
N30 X0 ;retract compensation
```

Position

Position offset

```
1 CORR=0.05 ;user variable with content of a compensation value
N190 (MSG FINISH EXTERNAL CONTOUR)
N200 G0 X90 Z10 S250 M4
N210 G0 G42 G96 X80 Z0 RND(0.1)
N220 G1 X[140+KORR] CHL(0.5) ;External diameter compensation
N230 G1 Z-25 RND(1.2)
N240 G1 X200 CHL(1)
N250 G40 G1 Z-30 CHL()
N260 G0 Z100
```

4.6.2 Tool compensation

General Information

Prior to their initial use, tools are only roughly measured on a tool presetter and then automatically, exactly measured in the machine. Additionally, tools have to be measured again due to the wear occurring during processing. In the following examples for length and radius, the tool in sector 2 position 1 is corrected.

Length

Tool compensation- length

```
1 CORR=0.3 ;user variable with content of a compensation value
N10 T[1]
N20 G47 Z0
1 WAIT
;Reading out L3 Sector2 Position1 from database
2 L3_OLD!=DBTAB("/DBT1/Rec.UD.Ed[1].Geo.L3",2,1)
;Writing compensation L3 Sector2 Position1 in database
3 DBTAB("/DBT1/Rec.UD.Ed[1].Geo.L3",2,1)=L3_OLD!+KORR
;Writing compensation L3 to control
4 DCT(3,1,0)=DCT(3,1,0)+CORR
N30 Z0 ;retract compensation
```

Radius

Tool compensation - radius

```
1 CORR=0.05 ;user variable with content of a compensation value
N10 T[4] ;Load milling cutter D50
```

Measuring cycle automatic

```
N20 ED1 ;Select Edge1
N30 G47 G0 X-30 Y-30 Z10 S4500 M3
N40 Z-5
N50 G1 G42 X0 Y0 F1000 ;establish radius compensation
N60 X50 ;contour machining with radius compensation
N70 G40 X80 Y0 ;remove radius compensation
N80 Z10
1 WAIT
;Reading out R Sector 2 Position1 from database
2 R_OLD:=DBTAB("/DBT1/Rec.UD.Ed[1].Geo.Rad",2,1)
;Writing compensation R Sector2 Position1 in database
3 DBTAB("/DBT1/Rec.UD.Ed[1].Geo.Rad",2,1)=R_OLD!+KORR
;Writing compensation R to control
4 DCT(4,1,0)=DCT(4,1,0)+KORR
N90 G0 X-30 Y-30 Z10
N100 Z-5
N110 G1 G42 X0 Y0 F1000 ;establish radius compensation
N120 X50 ;contour machining with new radius compensation
N130 G40 X80 Y0 ;remove radius compensation
N140 Z10 M5 M30
```

5 Developing an individual measuring cycle automatic

5.1 General information

To process special measuring tasks, individual measuring cycles can be created as extension to the listed sample solutions. It is recommended, to use the STP_PRBASE measuring cycle which is also called within the sample solutions.

In the following section, a special measuring task is given as example. The task is solved by an individual measuring cycle and an individual input mask. Subsequently, the basic cycle STP_PRBASE as well as the SD variable PRBASE_t is then explained in detail.

5.2 Example: Creating a user-defined cycle for automatic

5.2.1 Task

Creating a cycle to probe the offset

5.2.2 Task steps

General information

- Define a file name
- Define input variables
- Define output variables
- Generating a subroutine
- Generate an input mask
- Functional test

Define a file name

The file name is defined with MSHOULDER.

Define input variables

Parameter	Manda- tory	Type	Area	Description	
PNO	Yes	INTEGER	1..2	Probe number	
IAX	Yes	STRING	8	Infeed axis	
SDI	No	REAL	REAL	Safety distance	ABS
IFE	No	REAL	REAL	Infeed feed	mm/min
PLE	Yes/No	REAL	REAL	Measuring height	ABS
	Yes	If infeed axis(IAX) unequal to measuring axis(PAX)			
	No	If infeed axis(IAX) equal to measuring axis(PAX)			
RLE	No	REAL	REAL	Retraction height	ABS
RFE	No	REAL	REAL	Retraction feed	mm/min
PDI	Yes	REAL	REAL	Measuring distance	REL
PFE	No	REAL	REAL	Measuring feed	mm/min
PAX	Yes	STRING	8	measuring axis	
PPO	Yes	REAL	REAL	Measuring position	ABS

Developing an individual measuring cycle automatic

Parameter	Mandatory	Type	Area	Description	
MAX	Yes	STRING	8	Traversing axis	
DIS				Position distance in the traversing axis	REL
SDT	Yes	REAL	REAL	Offset depth	REL

Define output variables

Parameter	Type	Area	Description
#RESULT1	REAL	REAL	Measured value1
#RESULT2	REAL	REAL	Difference measured value1
#RESULT3	REAL	REAL	Measured value2
#RESULT4	REAL	REAL	Difference measured value2
#RESULT5	REAL	REAL	Offset dimension with sign

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction 1=positive 2= negative			
Parameter	Type	Area	Description
RUNS	INTEGER	INTEGER	Number of measurements

Generating a subroutine

Solution: The basic cycle is called twice. The first position is the position approached before the cycle call. The second position is the distance defined by the input variables "DIS". The results of the two measurements are offset against one another and provided in the global output variables #RESULT1 to #RESULT5 for evaluation.

Program excerpt:

*Subroutine**Program:*

```

;---- 1. subroutine call---
10560 CALL STP_PRBASE[PPO!,PDI!,FEED!,PAXNO%,PNO%,1,0,0]
10570 #RESULT1=SD.SysPrResult.AXISRES[PAXNO%]
10580 #RESULT2=PPO!-#RESULT1
;---- 2. approach measuring position
N1040 G91 G1 [AXP(MAXNO%,DIS!)] F[ZFEED!]
N1050 [AXP(IAAXNO%,SDT!)] F[ZFEED!]
N1060 G90
;---- 2. subroutine call ---
10590 CALL STP_PRBASE[PPO!+SDT!,PDI!,FEED!,PAXNO%,PNO%,1,0,0]
10600 #RESULT3=SD.SysPrResult.AXISRES[PAXNO%]
10610 #RESULT4=PPO!+SDT!-#RESULT3 : #RESULT5=#RESULT3-#RESULT1

```

Entire subroutine:

Entire subroutine

```

(ADR_PARA)
(%SRUnEntry%=NO)
10000 SRLOCK%=SD.SysChSRun.LockTargBlock : SD.SysChSRun.LockTargBlock=1 : GOTO .NOCOM
;-----
; program: MSHOULDER

```

Developing an individual measuring cycle automatic

```
; author : Mustermann
; version: 1.0.00
; date : 09/01/2014
;
;-- Interface: -----
; MSHOULDER (PNO, IAX, SL, IFE, PLE, RLE, RFE, PDI, PFE, PAX, PPO, MAX, DIS, SDT)
;
; Parameter:
; PNO% = probe number          mandatory 1..2
; IAX$ = infeed axis           mandatory max. 8 characters
; SL! = safety distance        optional standard=output position
; IFE! = infeed                optional >0, Standard=SD.SysPrBase.PROBE[PNO%].POSFEED
; PLE! = measuring height      mandatory if IAX$<>PAX$
; RLE! = retracting height     optional Standard=SL!
; RFE! = retracting feed       optional Standard=rapid traverse
; PDI! = measuring distance    mandatory <>0
; PFE! = measuring feed        optional >0,
;                               Standard=SD.SysPrResult.CAL[PNO%].AXIS[PAXNO%].DIR[<Richtung>].FEED
; PAX$ = measuring axis        mandatory max. 8 characters
; PPO! = measuring position    mandatory
; MAX$ = traversing axis       mandatory max. 8 characters
; DIS! = distance              mandatory <>0
; SDT! = depth mandatory
;
; error messages: "Mandatory parameter not programmed"
; "Value range exceeded! Valid range ..."
; "Invalid axis name in parameter ..."
; "Measuring distance = 0 invalid"
; warning messages: "Measuring feed unequal to calibration feed"
; subroutines: 1 STP_PRBASE
;-----
10010 .NOCOM
10020 WAIT
10030 DIM IAX$(9) : DIM PAX$(9) : DIM MAX$(9)
10040 IF IAX$=NUL THEN SETERR(4433,"IAX") ENDIF
10050 IF PAX$=NUL THEN SETERR(4433,"PAX") ENDIF
10060 IF MAX$=NUL THEN SETERR(4433,"MAX") ENDIF
;---- AXINF: from the name (ID on number)
10070 CHAN%=SD(8)
10080 IAXNO%=AXINF(IAX$,1,CHAN%,11,ERRNO)
10090 IF ERRNO <> 0 THEN SETERR(4463,"IAX") ENDIF
10100 PAXNO%=AXINF(PAX$,1,CHAN%,11,ERRNO)
10110 IF ERRNO <> 0 THEN SETERR(4463,"PAX") ENDIF
10120 MAXNO%=AXINF(MAX$,1,CHAN%,11,ERRNO)
10130 IF ERRNO <> 0 THEN SETERR(4463,"MAX") ENDIF
;---- Save basic offset in the infeed feed on variable BO3!
10140 BO3!=SD.SysPrBase.PROBE[PNO%].GEO.BO[IAXNO%]
;---- save current position ---
10150 SAD!=WCS(IAXNO%)
;---- Checking the input parameters ---
10160 IF PPO!=NUL THEN SETERR(4433,"PPO") ENDIF
10170 IF SL!<>NUL THEN SAD!=SL!-BO3! ENDIF
10180 IF PDI!=NUL THEN SETERR(4433,"PDI") ENDIF
10190 IF PDI!=0 THEN SETERR(4438,"PDI") ENDIF
10200 IF PNO%=NUL THEN SETERR(4433,"PNO") ENDIF
10210 IF DIS!=NUL THEN SETERR(4433,"DIS") ENDIF
10220 IF SDT!=NUL THEN SETERR(4433,"SDT") ENDIF
;---- obtain measuring direction from signs of the measuring distance PDI
10230 IF PDI!>0 THEN DIR%=1 : DIRFAC!=1 ELSE DIR%=2 : DIRFAC!=-1 ENDIF
;---- Provide infeed feed ZFEED!
10240 ZFEED!=SD.SysPrBase.PROBE[PNO%].SAVFEED
10250 IF IFE!<>NUL THEN
10260 IF IFE!<=0 THEN SETERR(4311,"IFE>0") ENDIF
10270 ZFEED!=IFE!
10280 ENDIF
;---- Provide measuring feed FEED!
10290 FEED!=SD.SysPrResult.CAL[PNO%].AXIS[PAXNO%].DIR[DIR%].FEED
10300 IF PFE!<>NUL THEN IF PFE!<>FEED! THEN
10310 IF PFE!<=0 THEN SETERR(4311,"PFE>0") ENDIF
10320 FEED!=PFE!
10330 WAIT
; Warning "Measuring feed unequal to calibration feed"
10340 SETWARN(4442)
10350 ENDIF ENDIF
10360 IF RFE!<>NUL THEN
10370 IF RFE!<=0 THEN SETERR(4311,"RFE>0") ENDIF
10380 ENDIF
10390 IF IAXNO%=PAXNO% THEN
10400 IF SD.SysPrBase.PROBE[PNO%].TOOL=FALSE THEN
10410 BALLRAD!=SD.SysPrBase.PROBE[PNO%].GEO.R
10420 ELSE
10430 BALLRAD!=TCV("RAD")
10440 ENDIF
```

Developing an individual measuring cycle automatic

```

10450 KRM!=ABS(PDI!/2)+BALLRAD!
10460 MH!=PPO!-KRM!*DIRFAC!-BO3! 10470 ELSE
10480 IF PLE!=NUL THEN SETERR(4433,"PLE") ENDIF
10490 MH!=PLE!-SD.SysPrBase.PROBE[PNO%].GEO.BO[IAXNO%]
10500 ENDIF
;---- Save G-functions ---
10510 DIM RELABS$(3) : DIM RAP$(3) : DIM GF_FEED$(3)
10520 RELABS$=NCF("G90") : RAP$=NCF("G00") : GF_FEED$=NCF("G94") : F!=SD(5,1,2)
;---- Probe ON
N1000 [SD.SysPrBase.PROBE[PNO%].LOG.AUXON] G94 G90
10530 IF SL!<>NUL THEN
; Use absolute approach for safety distance infeed axis
N1010 G0 [AXP(IAXNO%,SAD!)]
; use absolute approach for measuring height with G1 infeed axis
N1020 G1 [AXP(IAXNO%,MH!)] F[ZFEED!]
10540 ELSE ; use absolute approach for measuring height with G0 infeed axis
N1030 G0 [AXP(IAXNO%,MH!)]
10550 ENDIF
;---- subroutine call ---
10560 CALL STP_PRBASE[PPO!,PDI!,FEED!,PAXNO%,PNO%,1,0,0]
10570 #RESULT1=SD.SysPrResult.AXISRES[PAXNO%]
10580 #RESULT2=PPO!-#RESULT1
;---- Approach second measuring position
N1040 G91 G1 [AXP(MAXNO%,DIS!)] F[ZFEED!]
N1050 [AXP(IAXNO%,SDT!)] F[ZFEED!]
N1060 G90
;---- 2. subroutine call ---
10590 CALL STP_PRBASE[PPO!+SDT!,PDI!,FEED!,PAXNO%,PNO%,1,0,0]
10600 #RESULT3=SD.SysPrResult.AXISRES[PAXNO%]
10610 #RESULT4=PPO!+SDT!-#RESULT3 : #RESULT5=#RESULT3-#RESULT1
;---- delete warning message ---
10620 CLRWARN(,4442)
;---- Retract ---
10630 IF RLE!=NUL THEN RPOS!=SAD! ELSE RPOS!=RLE!-BO3! ENDIF
10640 IF RFE!=NUL THEN N1070 G0 [AXP(IAXNO%,RPOS!)]
10650 ELSE N1080 G1 [AXP(IAXNO%,RPOS!)] F[RFE!]
10660 ENDIF
;---- Restore G-functions ---
N1090 [RELABS$] [RAP$] [GF_FEED$] F[F!]
10670 WAIT
10680 SD.SysChSRun.LockTargBlock=SRLOCK%

```

Generate an input mask

The input mask "Probe Point" has been copied and adjusted.

Entry screen

```

;--- Measure offset ---
;/%CHBEGIN%
;/%GROUP% PROBE WP MILL
;/%LANG% MTXCyclesProbe
;/%NAME% Measure offset
;/%P% %%PNO INT[1..2] %TN0154% %VALID%MAND
;/%P% %%IAX STRING[8] %TN0134% %VALID%MAND
;/%P% %%SL %TN0170%
;/%P% %%IFE REAL[0.001..999] %TN0136%
;/%P% %%PLE %TN0152%
;/%P% %%RLE %TN0166%
;/%P% %%RFE REAL[0.001..999] %TN0164%
;/%P% %%PDI %TN0148% %VALID%MAND
;/%P% %%PFE REAL[0.001..999] %TN0150%
;/%P% %%PAX STRING[8] %TN0146% %VALID%MAND
;/%P% %%PPO %TN0160% %VALID%MAND
;/%P% %%MAX STRING[8] traversing axis %VALID%MAND
;/%P% %%DIS distance of traversing axis %VALID%MAND
;/%P% %%SDT depth of offset %VALID%MAND
;/%GF% MSHOULDER_H1.jpg %TN0045%
;/%C% #RESULT1 = measured value1
;/%C% #RESULT2 = difference measured value1
;/%C% #RESULT3 = measured value2
;/%C% #RESULT4 = Difference measured value2
;/%C% #RESULT5 = offset measure with sign
;/%N% MSHOULDER(%P%)
;/%CHEND%

```

The file C0.jpg is provided as template to create user-defined graphics.

For more information to create cycle input masks, see "Rexroth IndraMotion MTX 13VRS Commissioning".

Developing an individual measuring cycle automatic

Functional test Create a main program to test different transfer parameters. The transfer parameters have to be changed using the input mask.

Example main program, probe offset:

Functional test

```
N10 $1
;-----
; measure offset at workpiece
;-----
N20 T999 M6
N30 ED1
N40 G47
N50 M97 ; workpiece probe ON
N60 G54 G0 X120 Y0 Z100
N70 MSHOULDER (PNO2, IAX Z, IFE1500, PDI-20, PAX Z, PPO0, MAX X, DIS34, SDT-30)
1 PRN#(0,"1. measured value: ####.#### Diff: ####.####",#RESULT1,#RESULT2)
2 PRN#(0,"2. measured value: ####.#### Diff: ####.####",#RESULT3,#RESULT4)
3 PRN#(0,"offset: ###.###",#RESULT5)
N80 M98 ; workpiece probe OFF
N90 M30
```

5.3 The basic cycle STP_PRBASE

5.3.1 General information

The cycle task consists in probing a point, returning the measurement result as measured value or to write it as switching offset.

The probe base offsets of the SD variables are automatically taken into consideration. In the initialization variables, it is specified whether the probe length and its radius/cube edge lengths are taken from the tool management or also from the SD variables for calculation.

Additionally, it is possible in this cycle to resume travelling of the measuring distance following a probe error (e.g. by reset) without cancelling the NC program

The input variable probe number is limited to the value 2. The input variable axis number and the output variable AXISRES are limited to the value 3 and mirror the first 3 channel axes. If required, these limits can be raised (see [chapter 7 "Commissioning" on page 169](#)).

5.3.2 Basic cycle



As the basic cycle is not supported by an input mask with graphics, no corresponding short designations are used.

Syntax
Input variables

STP_PRBASE(P1,P2,P3,P4%,P5%,P6%,P7%,P8%,P9\$)

Parameter	Mandatory	Type	Area	Description
P1	Yes	REAL	REAL	Position
P2	Yes	REAL	REAL	Measuring/calibration distance
P3	Yes	REAL	REAL	Measuring/calibration feed
P4%	Yes	INT	1..3	Axis
P5%	Yes	INT	1..2	Probe number
P6%	Yes	INT	0..2	Calibrate/probe/reversal measurement
P7%	Yes	INT	0..1	Probe tool radius/tool length

Developing an individual measuring cycle automatic

Parameter	Mandatory	Type	Area	Description
P8%	NO	INT	0..1	Probe/check
P9\$	NO	STRING	8	Spindle stop command

Initialization variables

SD.SysPrResult.CAL[n].AXIS[i].DIR[j].Parameter			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction 1=positive 2= negative			
Parameter	Type	Area	Description
CALI	BOOL	TRUE..FALSE	Calibrated
VAL	REAL	REAL	Switching offset
FEED	REAL	REAL	Calibration feed
PRPOS	REAL	REAL	Switching position MCS

Output variables

SD. SysPrResult.CAL[n].AXIS[i].DIR[j].Parameter			
[n] 1..2 Probe number			
[i] 1..3 Axis number			
[j] 1..2 Direction 1=positive 2= negative			
Parameter	Type	Area	Description
CALI	BOOL	TRUE..FALSE	Calibrated
VAL	REAL	REAL	Switching offset
FEED	REAL	REAL	Calibration feed
PRPOS	REAL	REAL	Switching position MCS
YEAR	STRING	4	Year: YYYY
DATE	STRING	5	Day and month: DD:MM
TIME	STRING	8	Time: HH.MM.SS
RUNS	INT	INT	Number of measurements
Probe (P6=1)			
SD. SysPrResult.AXISRES[i]			
[i] 1..3 Axis number			
Parameter	Type	Area	Description
AXISRES	REAL	REAL	Measured value
Reversal measurement (P6=2)			
Parameter	Type	Area	Description
#RESULT!	DOUBLE	DOUBLE	Measured value

Error messages

- Position not found

Developing an individual measuring cycle automatic

- Probe deflected during positioning
- Position not programmed
- Measuring distance not programmed
- Feed not programmed
- Axis not programmed
- Probe number invalid
- Probe no.: Axis: Direction: Not calibrated
- Tool length correction is not active
- Parameter P6 has to have value 0, 1 or 2
- Measuring distance or sphere radius too large
- Invalid starting position or measuring distance sign incorrect!

Sequence The probe approaches the starting position with positioning feed from its initial position. The probe always positions half the measuring distance (P2) before the command position (P1). The sphere radius, the tool or probe length as well as the geometries of a table probe are taken into consideration. Approaching of the starting position by the cycle is monitored. If the probe is deflected while approaching the starting position, the axis is decelerated with maximum delay and a language-dependent error message is reported. This serves as probe and collision protection.

Measurement is started after the starting position has been approached. The sign of the measuring distance (P2) determines the direction of motion of the axis. The probe travels the specified measuring distance with the specified measuring feed (P3).

If no measuring feed is programmed, the cycle uses the calibration feed to increase measuring accuracy. If a deviating measuring feed is programmed, the cycle outputs a warning without interrupting the measurement.

When triggering the probe, the axis is decelerated with maximum negative acceleration. Distance to go is deleted. The position at which the probe is triggered is saved in the variable AXISRES[n] (sdprbase.xsd structure) during the measurement. During reversal measurement, the position is saved in the global variable #RESULT! and during the calibration, the position is saved in the variable VAL of the corresponding axis and direction (also structure sdprbase.xsd). The status "calibrated", the calibration velocity and the machine coordinate position are also saved. All parameters influencing the resulting value (probe and tool length, probe sphere and basic offsets) have already been removed. If a radio probe switches off on the measuring distance to prolong the battery life, the cycle approaches the starting position again. Thus, it is ensured that the axis reaches the programmed velocity at any rate.

Subsequently, the probe which is also monitored travels back to its initial position. The use case with the probe being positioned on the table and the tool in the spindle is almost identical and is therefore not explained in detail.

Developing an individual measuring cycle automatic

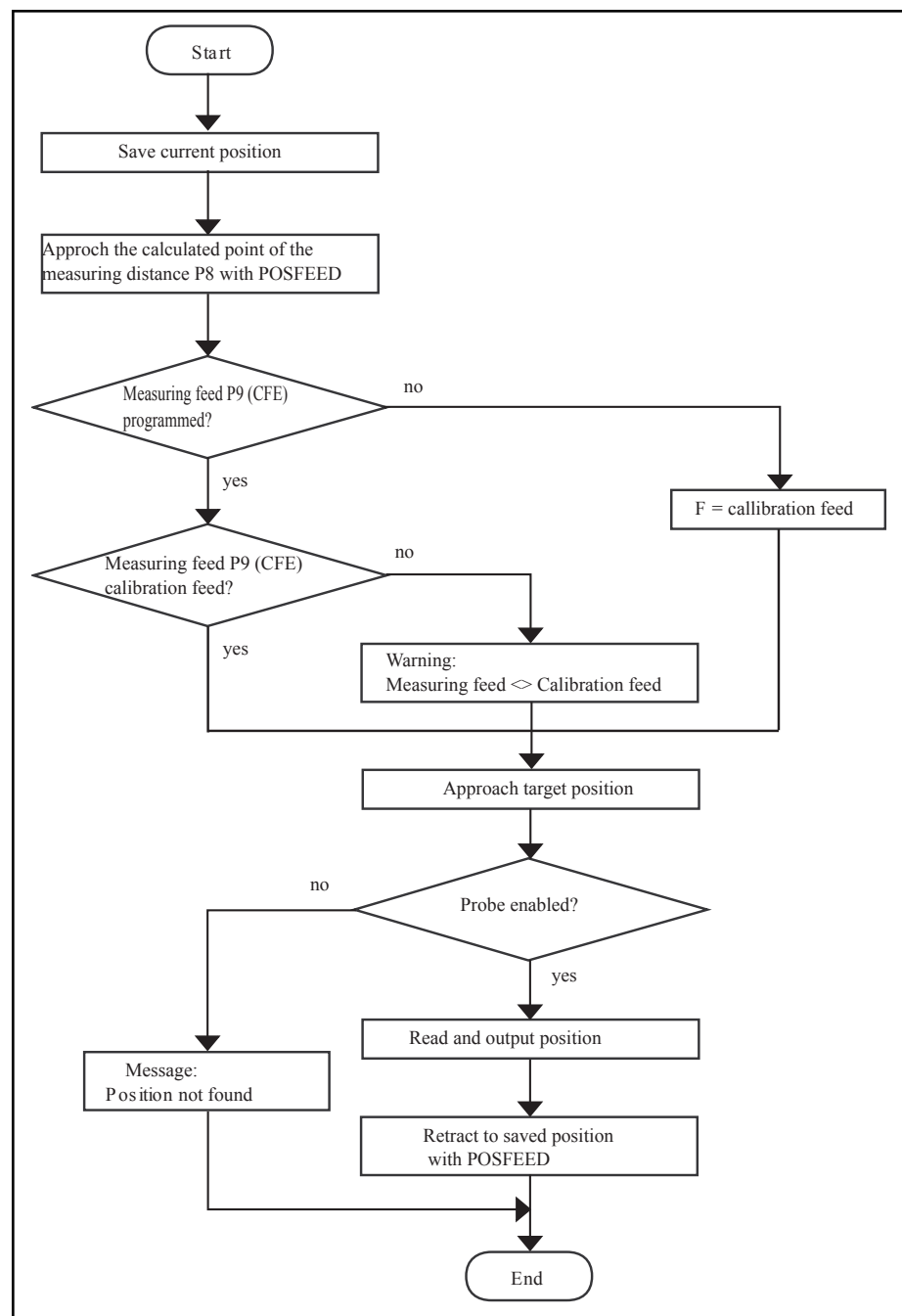


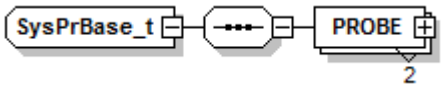
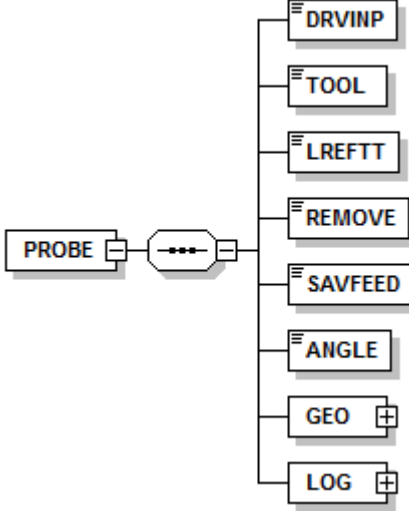
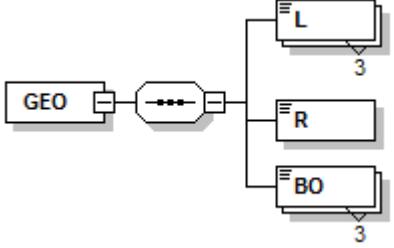
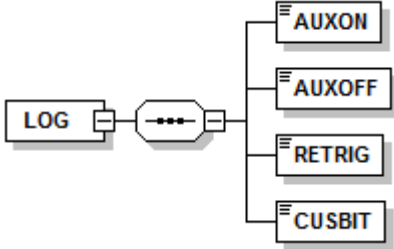
Fig. 5-1: Basic cycle sequence in the measuring axis

5.4 SD variables for probe data

5.4.1 General information

In the following structures, the geometry data of a tool probe, the positioning velocity, the auxiliary functions, the calibration values as well as the measurement results are stored. The variable names are SD.SysPrBase, SD.SysPrResult and SD.SysPrMan.

5.4.2 SD variable structure "SysPrBase"

SysPrBase_t			
		PROBE	See "PROBE" on page 98
SysPrBase_t/PROBE			
		DRVINP	Int_t See "DRVINP" on page 98
		TOOL	xs:Boolean See "TOOL" on page 98
		LREFTT	xs:Boolean See "LREFTT" on page 98
		REMOVE	Int_t See "REMOVE" on page 98
		SAVFEED	xs:float See "SAVFEED" on page 98
		ANGLE	xs:float See "ANGLE" on page 98
		GEO	See "GEO" on page 98
		LOG	See "LOG" on page 98
SysPrBase_t/PROBE/GEO			
		L	xs:float See "L" on page 98
		R	xs:float See "R" on page 98
		BO	xs:float See "BO" on page 98
SysPrBase_t/PROBE/GEO			
		AUXON	isoLatin1String See "AUXON" on page 98
		AUXOFF	isoLatin1String See "AUXOFF" on page 98
		RETRIG	xs:Boolean See "RETRIG" on page 98
		CUSBIT	isoLatin1String See "CUSBIT" on page 98

Tab. 5-1: SD.SysPrBase

The structured variable of type SysPrBase_t contains the structure PROBE which is instantiated twice. The structured variable of type SysPrResult_t contains a three times instantiated variable AXISRES of type Real and the substructure CAL that has been instantiated twice. In the substructure, the switching offset values are saved by the calibration cycle. By means of this variable, individual measuring cycles can be realized for automatic operation.

Developing an individual measuring cycle automatic

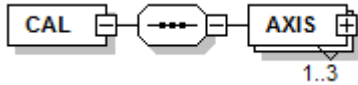
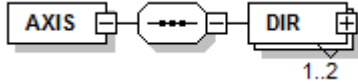
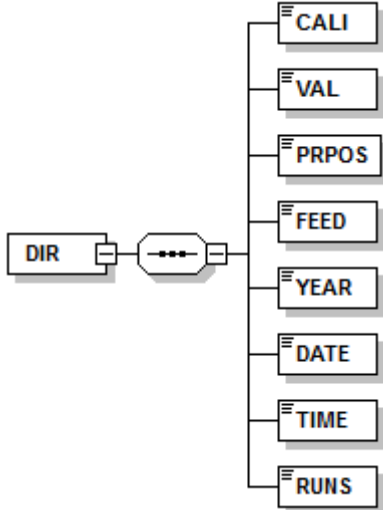
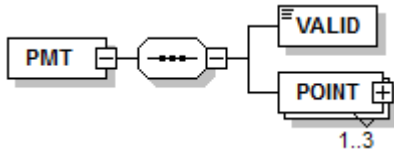
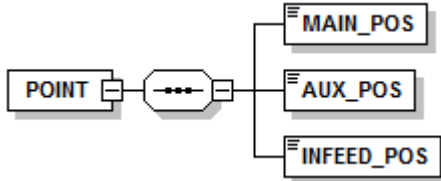
For more information about the syntax and the variables for manual operation, refer to the following table "Scheme SD.SysPrMan".

PROBE	The PROBE structure is divided into the substructures GEO and LOG.
DRVINP	If the variable DRVINP is assigned with value "1", the measuring blocks are travelled with G75.1 in the NC program, in case of "2", G75.2 is used.
TOOL	If the variable TOOL is assigned with the value "false", the data of the substructure GEO are evaluated (see fig. 5-4 "HMI commissioning screen 2" on page 107). If the value is "true", the data is read out of the active CPU memory (see fig. 5-3 "HMI commissioning screen 1" on page 107).
LREFTT	If the variable LREFTT is assigned with the value "true", the probe length is related to the tool tip. If the value is assigned with "false", the length refers to the sphere center point.
REMOVE	If the variable REMOVE is assigned with the value "0", the probe is retracted with G00. G01 is used if the value "1" is used and G75.x for the value "3".
SAVFEED	The velocity is entered in mm/min in the float variable SAVFEED with which the cycles are positioned in the probe or the tool. The variable does not correspond to the measurement or calibration velocity during probing. The variable has to be programmed separately in the respective cycle.
ANGLE	The float variable ANGLE is prepared for the orientation angle of the spindle (only applies to spindles with servo functionality).
GEO	The substructure GEO is prepared in case a tool probe is installed in the working space.
L	The respective probe lengths are entered in the float variables L[1..3].
R	The float value R stands for the probe sphere radius.
BO	The float variables BO[1..3] (base offset <axis number>) represent the probe coordinates in the workspace (probe base offset).
LOG	The substructure LOG is intended for PLC communication as well as auxiliary functions.
AUXON	The M-functions to enable the probe are stored in the string variable AUXON.
AUXOFF	The M-functions to disable the probe are stored in the string variable AUX-OFF.
RETRIG	If the probe has to be retriggered, "true" has to be entered in the Bool variable RETRIG. This only applies to radio probes.
CUSBIT	The string variable CUSBIT (custom bit) is used for communication between NC-kernel and PLC. The variable is also only required for retriggerable probes. In the attachment 2 and attachment 4, the probe that is used and a corresponding PLC program section are listed.

5.4.3 SD variable structure "SysPrResult"

SysPrResult_t			
	CAL	See "CAL" on page 99	
	AXISRES	xs:float	See "AXISRES" on page 99
	PMT	See "PMT" on page 99	

Developing an individual measuring cycle automatic

SysPrResult_t/CAL			
	AXIS	See "CAL" on page 99	
SysPrResult_t/CAL/AXIS			
	DIR	1..2 direction (1 = positive, 2 = negative)	
SysPrResult_t/CAL/AXIS/DIR			
	CALI	xs:Boolean	See "CALI" on page 100
	VAL	xs:float	See "VAL" on page 100
	PRPOS	xs:float	See "PRPOS" on page 100
	FEED	xs:float	See "FEED" on page 100
	YEAR	isoStrYear_t	See "YEAR" on page 100
	DATE	isoStrDate_t	See "DATE" on page 100
	TIME	isoStrTime_t	See "TIME" on page 100
	RUNS	xs:unsignedInt	See "RUNS" on page 100
SysPrResult_t/PMT			
	VALID	xs:Boolean	
	POINT		
SysPrResult_t/PMT/POINT			
	MAIN_POS	xs:float	
	AUX_POS	xs:float	
	INFEED_POS	xs:float	

Tab. 5-2: SD.SysPrResult

AXISRES In the AXISRES variable, the measurement results of the cycles of the respective axis are stored.

PMT In the PMT substructure, the respective measurement result of the cycle is written for measurement of an inclined plane.

CAL In the CAL substructure, the switching offset values for each axis (AXIS[1..3]) are written in positive and negative axis direction (DIR[1,2]) by the calibration cycle.

Developing an individual measuring cycle automatic

- CALI

As soon as the calibration cycle has been completed successfully for the corresponding axis direction, the Bool value CALI is set to "true". The measuring cycles check whether the probe is calibrated for the corresponding axis direction by querying this variable.
- VAL

The switching offset values are saved in the corresponding float variable VAL.
- PRPOS

Simultaneously, the switching point is saved in machine coordinates in the float variable PRPOS.
- FEED

The used calibration rate is saved in the float variable FEED.
- YEAR

Calibration year string length 4 [YYYY]
- DATE

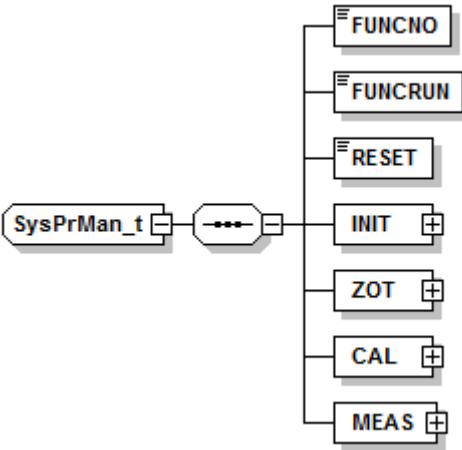
Calibration day and month string length 5 [DD.MM]
- TIME

Calibration time string length 8 [HH.MM.SS]
- RUNS

Number of measurements after the calibration. Unsigned integer: Is set to 0 by the calibration and increased by 1 during the measurement after each cycle.

5.4.4 SD variable structure "SysPrMan"

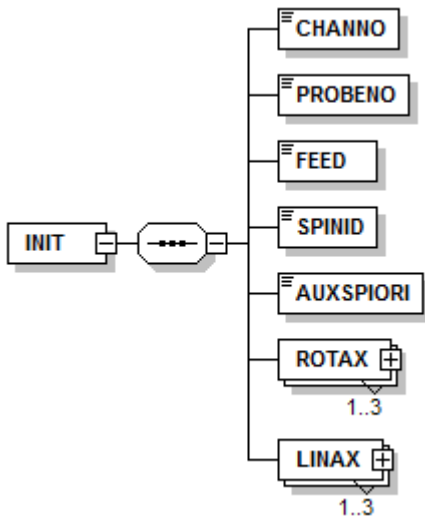
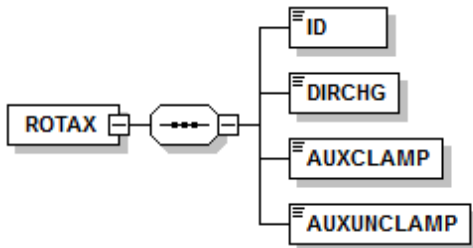
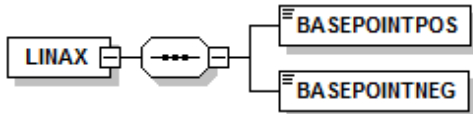
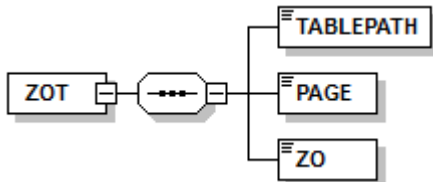
SysPrMan_t



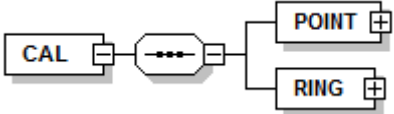
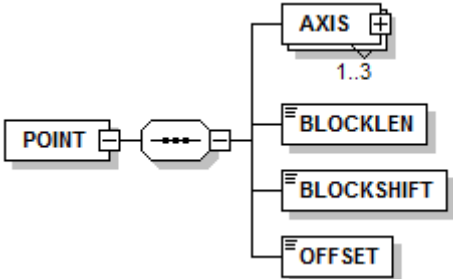
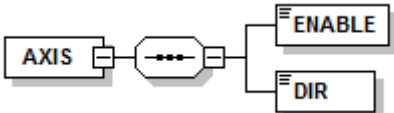
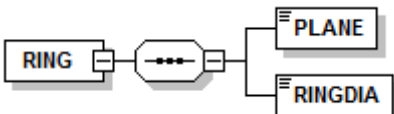
FUNCNO	Int_t	
FUNCRUN	Boolean_t	
RESET	Boolean_t	
INIT	Basic settings	
ZOT	Target description (zero point offset)	
CAL	Calibration settings	
MEAS	Measurement settings	

SysPrMan_t/INIT

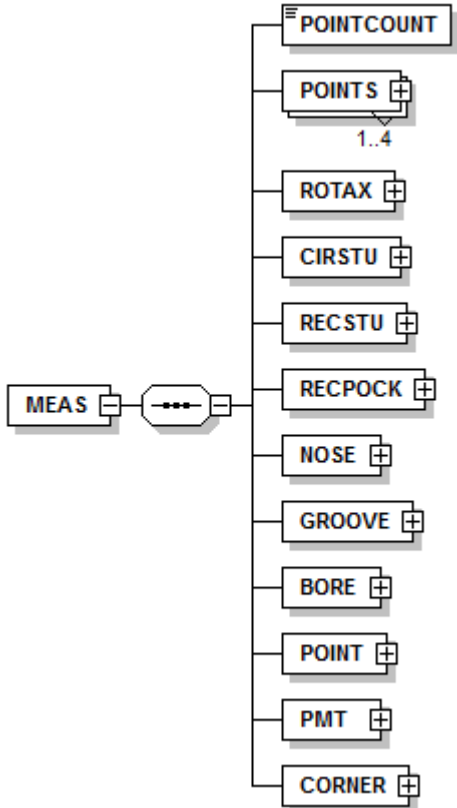
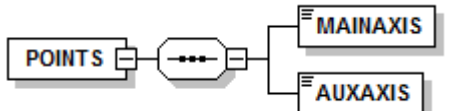
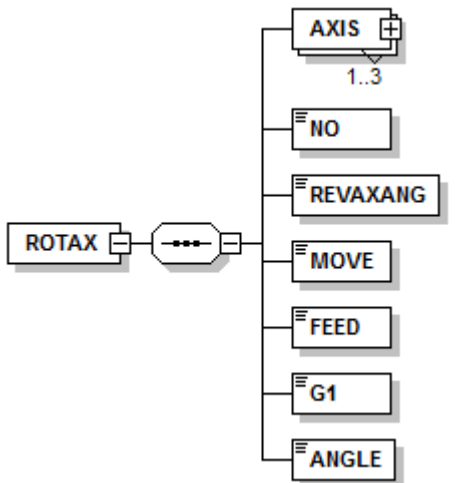
Developing an individual measuring cycle automatic

	CHANNO	Int_t	Channel number (see fig. 5-2 " Probe initialization of manual functions" on page 106
	PROBENO	Int_t	Probe number (see fig. 5-2 " Probe initialization of manual functions" on page 106
	FEED	Float_t	Calibration and measuring feed (see fig. 5-2 " Probe initialization of manual functions" on page 106
	SPINID	isoLatin1String	Spindle ID (see fig. 5-2 " Probe initialization of manual functions" on page 106)
	AUXSPIORI	isoLatin1String	Auxiliary function for spindle orientation (see fig. 5-2 " Probe initialization of manual functions" on page 106
	ROTAX	Rotary axis settings	
	LINAX	Linear axis settings	
SysPrMan_t/INIT/ROTAX			
	ID	isoLatin1String	Rotary axis ID (see fig. 5-2 " Probe initialization of manual functions" on page 106)
	DIRCHG	xs:Boolean	Direction of rotation (see fig. 5-2 " Probe initialization of manual functions" on page 106).
	AUXCLAMP	isoLatin1String	Auxiliary function for clamps (see fig. 5-2 " Probe initialization of manual functions" on page 106
	AUXUNCLAMP	isoLatin1String	Auxiliary function for unclamping (see fig. 5-2 " Probe initialization of manual functions" on page 106
SysPrMan_t/INIT/LINAX			
	BASEPOINT-POS	Float_t	Positive calibration position of the linear axis on the machine (see fig. 5-2 " Probe initialization of manual functions" on page 106
	BASEPOINT-NEG	Float_t	Negative calibration position of the linear axis on the machine (see fig. 5-2 " Probe initialization of manual functions" on page 106
SysPrMan_t/ZOT			
	TABLEPATH	isoLatin1String	Path and name of the zero point table
	PAGE	Int_t	Zero point offset block
	ZO	Int_t	Zero offset
SysPrMan_t/CAL			

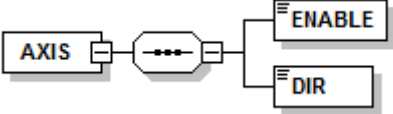
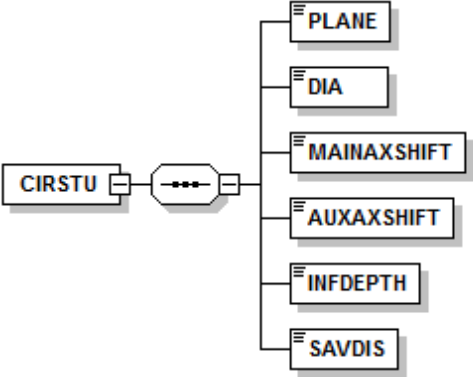
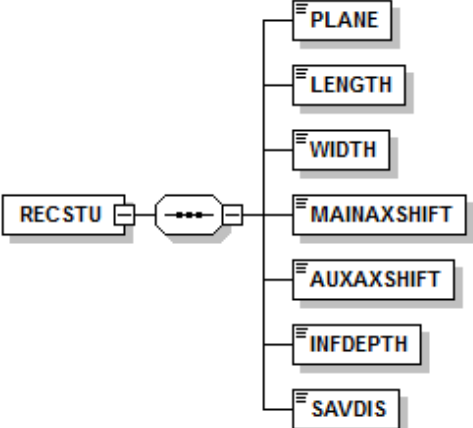
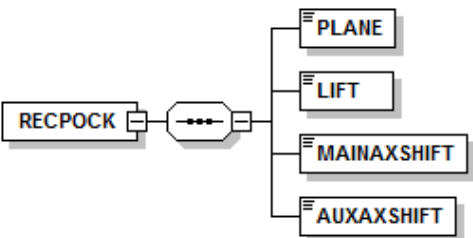
Developing an individual measuring cycle automatic

	POINT	Calibrate point	
	RING	Calibrate in ring	
SysPrMan_t/CAL/POINT			
	AXIS	Calibration axis and direction: A or B or C	
	BLOCKLEN	Float_t	End measure length
	BLOCKSHIFT	Float_t	Offset
	OFFSET	Boolean_t	With or without zero point offset
SysPrMan_t/CAL/POINT/AXIS			
	ENABLE	Boolean_t	
	DIR	Boolean_t	Calibration direction
SysPrMan_t/CAL/RING			
	PLANE	isoLatin1String	Interpolation level
	RINGDIA	Float_t	Calibration ring diameter
SysPrMan_t/MEAS			

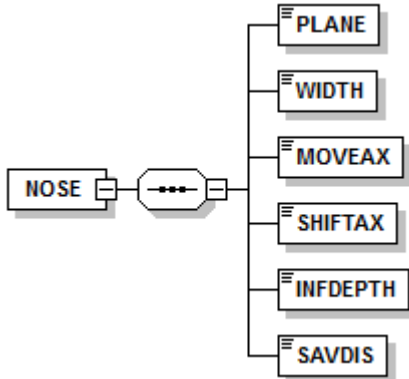
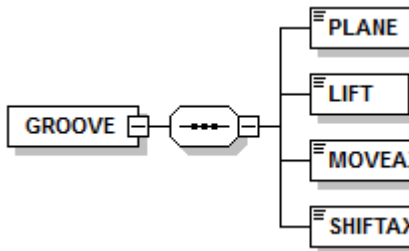
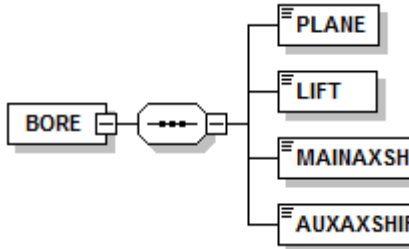
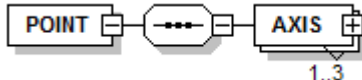
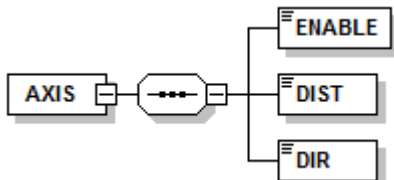
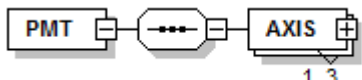
Developing an individual measuring cycle automatic

	<table><tr><td>POINTCOUNT</td><td>Int_t</td><td>Measuring point counter</td></tr><tr><td>POINTS</td><td colspan="2">Maximum 4 measuring points</td></tr><tr><td>ROTAX</td><td colspan="2">ZP probe rotary axis</td></tr><tr><td>CIRSTU</td><td colspan="2">ZP probe circular spigot</td></tr><tr><td>RECSTU</td><td colspan="2">ZP probe rectangular spigot</td></tr><tr><td>RECPOCK</td><td colspan="2">ZP probe (rectangular) pocket</td></tr><tr><td>NOSE</td><td colspan="2">ZP probe land</td></tr><tr><td>GROOVE</td><td colspan="2">ZP probe groove</td></tr><tr><td>BORE</td><td colspan="2">ZP probe boring</td></tr><tr><td>POINT</td><td colspan="2">ZP probe point</td></tr><tr><td>PMT</td><td colspan="2">Probe inclined plane</td></tr><tr><td>CORNER</td><td colspan="2" rowspan="2">ZP probe corner</td></tr></table>	POINTCOUNT	Int_t	Measuring point counter	POINTS	Maximum 4 measuring points		ROTAX	ZP probe rotary axis		CIRSTU	ZP probe circular spigot		RECSTU	ZP probe rectangular spigot		RECPOCK	ZP probe (rectangular) pocket		NOSE	ZP probe land		GROOVE	ZP probe groove		BORE	ZP probe boring		POINT	ZP probe point		PMT	Probe inclined plane		CORNER	ZP probe corner	
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CORNER	ZP probe corner																																				
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AUXAXIS	Float_t	Secondary axis																																			
SysPrMan_t/MEAS/ROTAX																																					
	<table><tr><td>AXIS</td><td colspan="2">Measuring axis and direction: A or B or C</td></tr><tr><td>NO</td><td>Int_t</td><td>Rotary axis: A=1 or B=2 or C=3</td></tr><tr><td>REVAXISANG</td><td>isoLatin1String</td><td>Reference axis</td></tr><tr><td>MOVE</td><td>Boolean_t</td><td>Traverse rotary axis</td></tr><tr><td>FEED</td><td>Float_t</td><td>Measuring feed</td></tr><tr><td>G1</td><td>Boolean_t</td><td>Positioning mode rotary axis</td></tr><tr><td>ANGLE</td><td>Float_t</td><td>Set angle</td></tr></table>	AXIS	Measuring axis and direction: A or B or C		NO	Int_t	Rotary axis: A=1 or B=2 or C=3	REVAXISANG	isoLatin1String	Reference axis	MOVE	Boolean_t	Traverse rotary axis	FEED	Float_t	Measuring feed	G1	Boolean_t	Positioning mode rotary axis	ANGLE	Float_t	Set angle															
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MOVE	Boolean_t	Traverse rotary axis																																			
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G1	Boolean_t	Positioning mode rotary axis																																			
ANGLE	Float_t	Set angle																																			
SysPrMan_t/MEAS/ROTAX/AXIS																																					

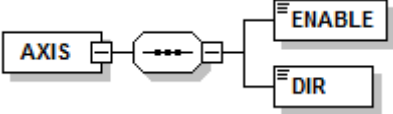
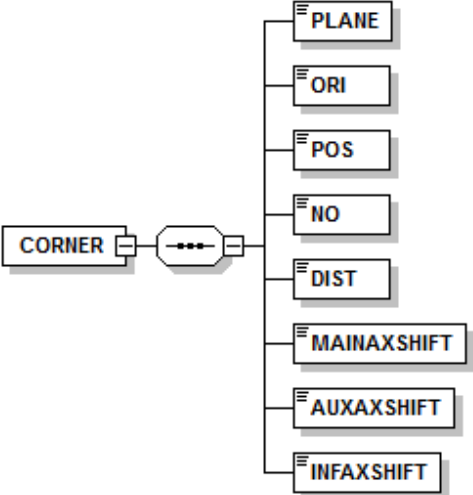
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	ENABLE	Boolean_t	
	DIR	Boolean_t	Measuring direction
SysPrMan_t/MEAS/CIRSTU			
	PLANE	isoLatin1String	Interpolation level
	DIA	Float_t	Spigot diameter
	MAINAXSHIFT	Float_t	Main axis offset
	AUXAXSHIFT	Float_t	Auxiliary axis offset
	INFDEPTH	Float_t	Feed increment till measuring height
	SAVDIS	Float_t	Safety distance
SysPrMan_t/MEAS/RECSTU			
	PLANE	isoLatin1String	Interpolation level
	LENGTH	Float_t	Length
	WIDTH	Float_t	Width
	MAINAXSHIFT	Float_t	Main axis offset
	AUXAXSHIFT	Float_t	Auxiliary axis offset
	INFDEPTH	Float_t	Feed increment till measuring height
	SAVDIS	Float_t	Safety distance
SysPrMan_t/MEAS/RECPOC			
	PLANE	isoLatin1String	Interpolation level
	LIFT	Boolean_t	Obstacle in pocket
	MAINAXSHIFT	Float_t	Main axis offset
	AUXAXSHIFT	Float_t	Auxiliary axis offset
SysPrMan_t/MEAS/NOSE			

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	PLANE	isoLatin1String	Interpolation level
	WIDTH	Float_t	Land width
	MOVEAX	Int_t	measuring axis
	SHIFTAX	Float_t	Offset
	INFDEPTH	Float_t	Feed increment till measuring height
	SAVDIS	Float_t	Safety distance
SysPrMan_t/MEAS/GROOVE			
	PLANE	isoLatin1String	Interpolation level
	LIFT	Boolean_t	Obstacle in groove
	MOVEAX	Int_t	measuring axis
	SHIFTAX	Float_t	Offset
SysPrMan_t/MEAS/BORE			
	PLANE	isoLatin1String	Interpolation level
	LIFT	Boolean_t	Obstacle in boring
	MAINAXSHIFT	Float_t	Main axis offset
	AUXAXSHIFT	Float_t	Auxiliary axis offset
SysPrMan_t/MEAS/POINT			
	AXIS	Measuring axis and direction: X or Y or Z	
SysPrMan_t/MEAS/POINT/AXIS			
	ENABLE	Boolean_t	
	DIST	Float_t	Offset
	DIR	Boolean_t	Measuring direction
SysPrMan_t/MEAS/PMT			
	AXIS	Measuring axis and direction: X or Y or Z	
SysPrMan_t/MEAS/PMT/AXIS			

Developing an individual measuring cycle automatic

	ENABLE	Boolean_t	
	DIR	Boolean_t	Direction
SysPrMan_t/MEAS/CORNER			
	PLANE	isoLatin1String	Interpolation level
	ORI	Boolean_t	Position: External or internal
	POS	Boolean_t	Position: Top or bottom
	NO	Int_t	Corner number: C1,C2,C3,C4
	DIST	Float_t	Offset
	MAINAXSHIFT	Float_t	Main axis offset
	AUXAXSHIFT	Float_t	Auxiliary axis offset
	INFAXSHIFT	Float_t	Infeed axis offset

Tab. 5-3: SD.SysPrMan

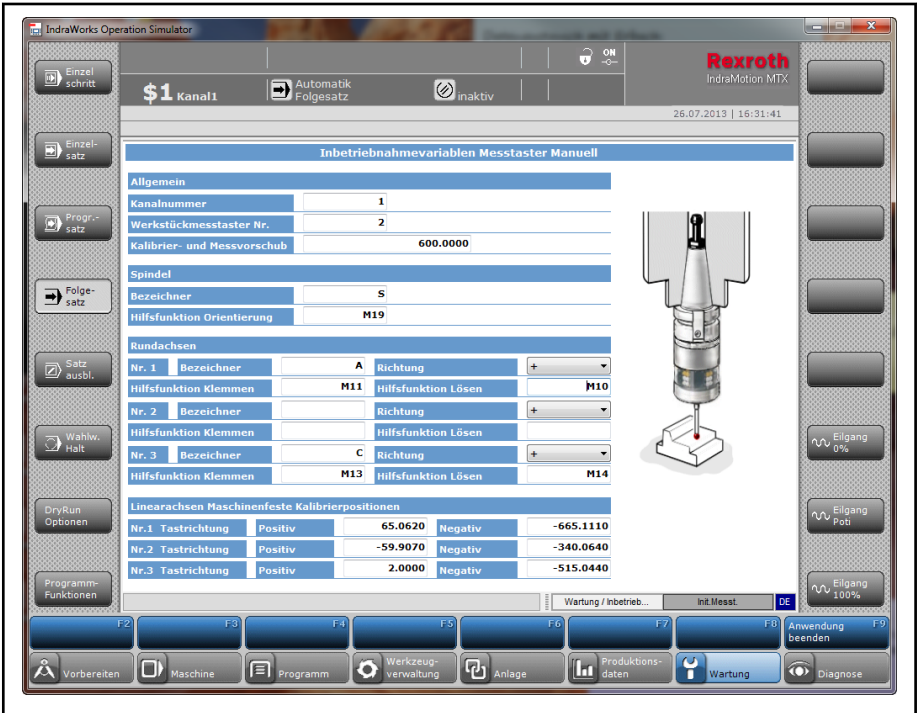


Fig. 5-2: Probe initialization of manual functions

5.4.5 Data input

The following options are available to enter and display SD variables:

- **Data input with variable list**
The SD variable values can be displayed and edited in a variable list.
- **Data input via commissioning image in the maintenance operating area**

Developing an individual measuring cycle automatic

The SD variable values for initialization can be displayed and edited in a commissioning image. This screen contains the variables required to commission a probe.

Use <OP8> for the call.

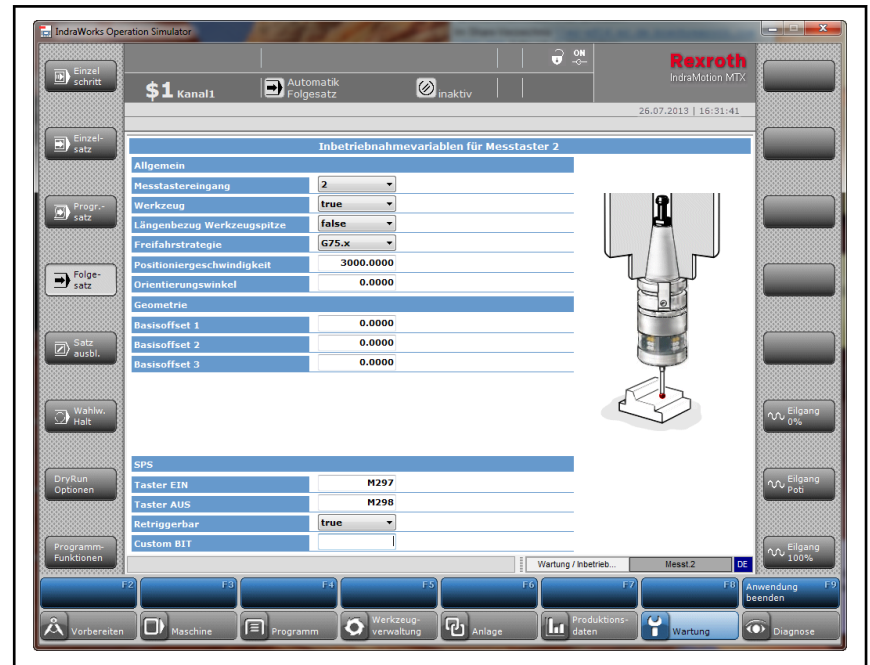


Fig. 5-3: HMI commissioning screen 1

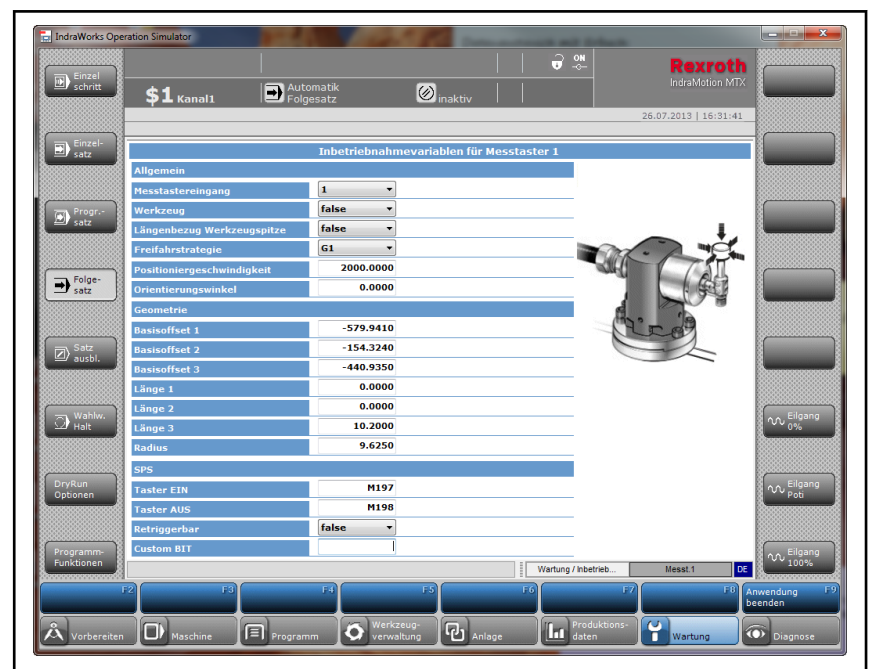


Fig. 5-4: HMI commissioning screen 2

6 Manual probing

6.1 General information

Functions *The following functions are provided:*

- *Probe workpiece zero point*
 - Point
 - Corner
 - Boring
 - Circular spigot
 - Groove
 - Land
 - Rectangular pocket
 - Rectangular pin
 - Rotary axis
- *Calibrating a workpiece probe*
 - at a known point
 - in an adjusting ring

Preparation The probe has to be loaded via MDI before using the described measuring functions.

Only a single calibrated ball is used in the measurement program. The tool edge and the tool length compensation assigned to the ball have to be enabled before starting the measurement.

The probe has to be enabled before jogging to ensure an active collision monitoring during jogging.

- Sequence**
1. Press the OP key "Prepare" in the "Manual" operation mode
 2. Press the F-key of the measuring task group ("Probe zero point", "Calibrate probe" etc.)
 3. Left-click to select the measuring task
 4. In case of many measuring tasks, a zero point can be included in the chain dimensioning or a zero point is the objective for storing the result. In these cases, keys are available to select a zero point table. Select the zero point table using <F5> "Select Table". See the following information
 5. The input table is completed with the parameter values required for the measuring task. The displayed graphics provides support and can change after an input



The key <F2> "Start Program" is enabled after all required parameters have been entered and only in the "Jog" mode and starts the measurement.

6. Before starting the measurement, check the initial position or a safe initial position has to be manually approached (see graphics)

Manual probing



Only now press <F2> "Start Program" to apply the parameters in the NC. The parameters are then available for the next measuring task.

7. Execute program with NC start. The message "Program is running" is displayed

Some measuring function required multiple manual positioning between the measuring steps (e.g. zero point probe rotary axis or probing at an internal contour with obstacle). The different initial positions for the measuring steps are displayed by the number 1 to 2 or 1 to 4 in the graphics. The first initial position for point 6 is the number 1. After a measuring step, the program stops and the operator is prompted by a message to manually approach the next position. The respective positions have to correspond to the displayed graphics with regard to axis direction and sequence. After the next position has been set, execute NC start again. Repeat until all measuring steps have been executed.

8. After the measuring steps and calculations have been completed, the program stops and the measuring result is displayed. The result is applied after actuating NC start again

Zero point table Select a zero point table with <F5> "Select Table".

The name of the selected zero point table is displayed in the "selected zero point table" field in the position display.

The active zero point table is the selected zero point table by using <F6> "Apply Current Table".

The axis names in the zero point table have to correspond to the configured axis names.

Position display Display the current position values and the zero point table instead of a supported text using <F7> "Position Display". In case of a changed zero point table, the position and zero point table display is automatically displayed.

Spindle orientation In case of measuring task with alternating probing in positive and negative axis direction, the probe can be turned in the new measuring direction by means of spindle orientation so that the switching offset (calibration value) does not affect the measurement result. This procedure is called reversal measurement and facilitates accurate measurement even if a noncalibrated probe is used.

The spindle is only oriented in case of an active edge number 1. In case of a cross probe, it is assumed that the foremost calibrating ball is assigned to edge 1. Only for this measuring ball, the reversal measurement can be performed.

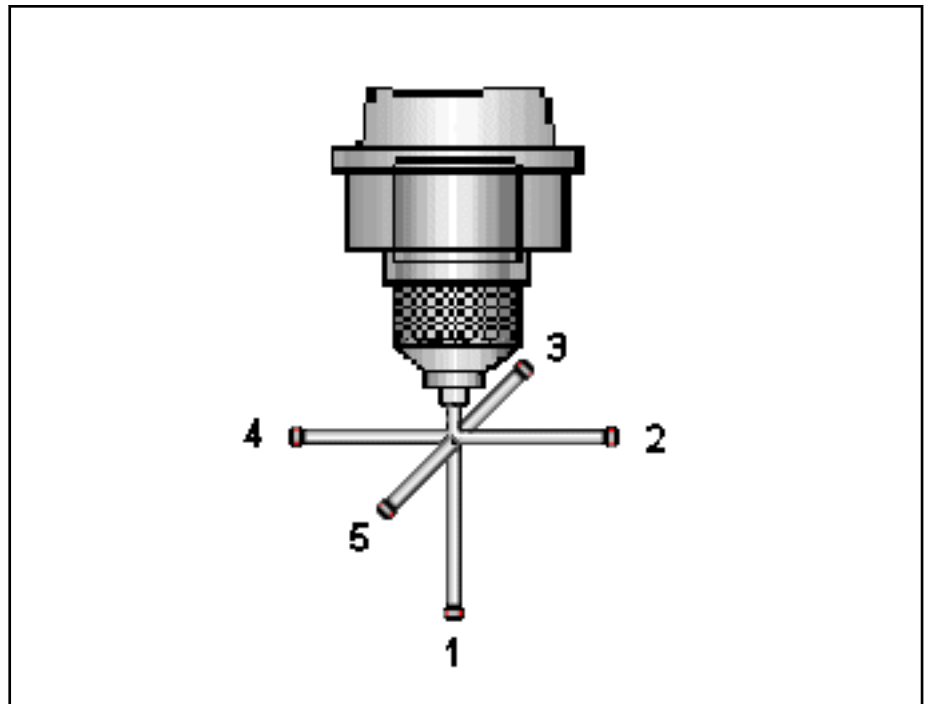


Fig. 6-1: Edge numbers at the cross probe

6.2 Calibrating the probe

6.2.1 M-key menu

Prepare <OP1>

F-key pad 1

- <F8> Calibrate Probe

M-Key level 1

- <M1> Calibrate Point
- <M2> Calibrate Ring

6.2.2 Calibrating the probe point

Brief description The cycle "Calibrating probe point" determines the calibration value for an axis and a direction. A known point is measured and the switching offset is saved depending on the measuring direction (positive/negative).

Manual probing

Overview figure

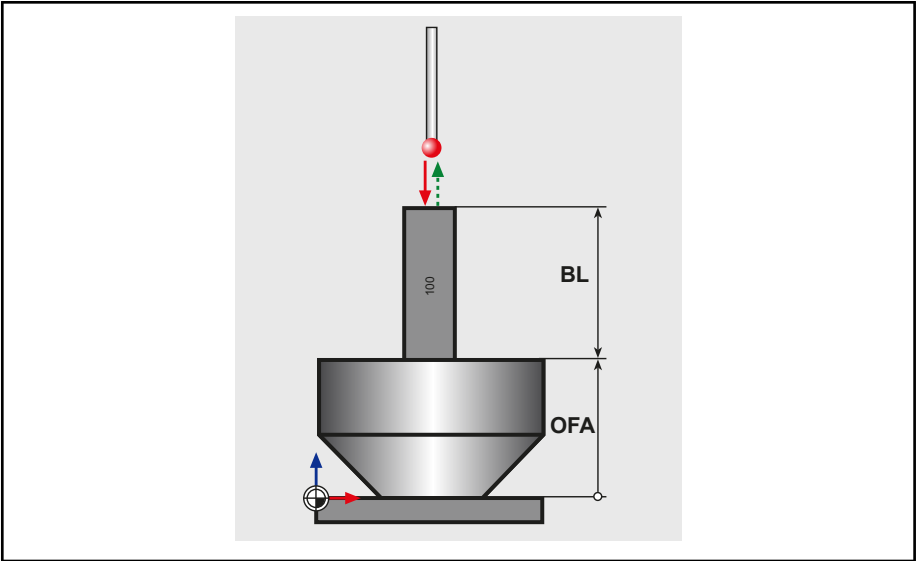


Fig. 6-2: *Calibrating the probe, point with with zero point and with distance*
There are 3 calibration options:

- With zero point and a distance
- With zero point without distance (= 0)
- Without zero point without distance (= 0)

Depending on the inputs, a special graphic is displayed and different parameters are shown/hidden.

- Sequence**
1. Press <M1> "Calibrate Point"
 2. Adjust feed if required
 3. Optionally, a distance and a finishing dimension length can be entered
 4. Select with or without zero point
Only in case of selection with zero point: Select zero point and group
Select <F6> "Apply Active Table" or <F5> "Select Table"
 5. Press <F2> "Start Program"
 6. Press NC start (program is running)
The determined calibration value as well as the axis and the direction are displayed in the diagnostic line
 7. Press NC start
The calibration value is applied

Input field

Parameters	Name	Properties	Values	Range
CAX	Calibration axis and direction		X- X+ Y- Y+ Z- Z+	
BL	Length of finishing dimension		REAL	

Manual probing

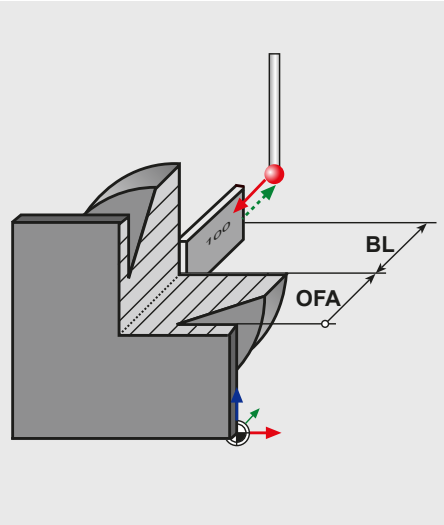
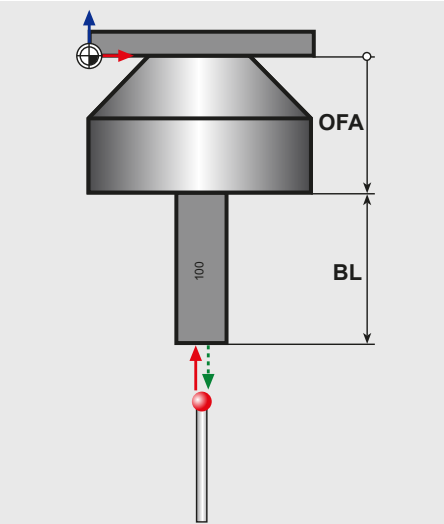
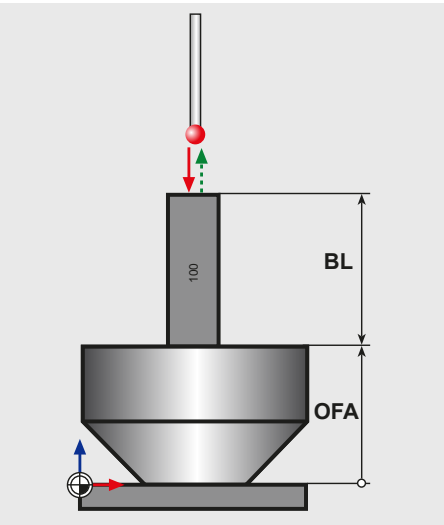
Parameters	Name	Properties	Values	Range
OFU	Include zero offset		Yes No	
OFA	Offset	if OFU = yes	REAL	
ZO	Zero offset	if OFU = yes	G54 G55 G56 G57 G58 G59	Absolute
PAGE	ZO bank	if OFU = yes	INTEGER	1...5
CFE	Calibration feed		REAL	mm/min, >0

Tab. 6-1: Input field calibrating probe, point

Graphic field The following graphics are displayed depending on the inputs.

Manual probing

Selection	Graphic
X+	
X-	
Y+	

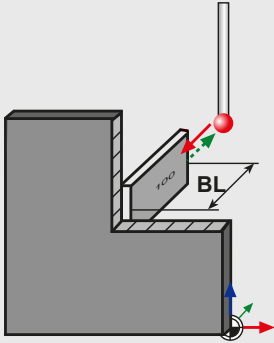
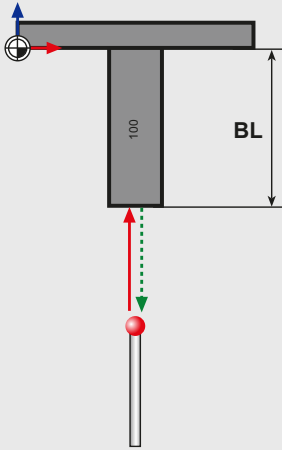
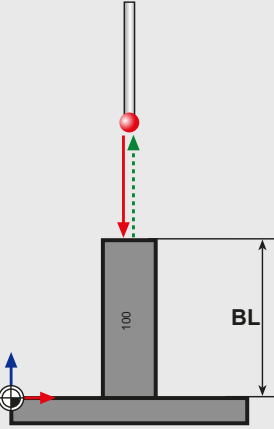
Selection	Graphic
Y-	 The diagram shows a 3D view of a probe tip (red sphere) approaching a stepped workpiece. The probe is moving along the Y-axis, indicated by a red arrow. The workpiece has a step with a height of 100. The distance from the probe tip to the workpiece surface is labeled BL. The offset from the probe tip to the workpiece surface is labeled OFA. A coordinate system with X, Y, and Z axes is shown at the bottom left.
Z+	 The diagram shows a 3D view of a probe tip (red sphere) approaching a stepped workpiece. The probe is moving along the Z-axis, indicated by a red arrow. The workpiece has a step with a height of 100. The distance from the probe tip to the workpiece surface is labeled BL. The offset from the probe tip to the workpiece surface is labeled OFA. A coordinate system with X, Y, and Z axes is shown at the top left.
Z-	 The diagram shows a 3D view of a probe tip (red sphere) approaching a stepped workpiece. The probe is moving along the Z-axis, indicated by a red arrow. The workpiece has a step with a height of 100. The distance from the probe tip to the workpiece surface is labeled BL. The offset from the probe tip to the workpiece surface is labeled OFA. A coordinate system with X, Y, and Z axes is shown at the bottom left.

Tab. 6-2: Method 1: With zero point and distance ≠ 0

Manual probing

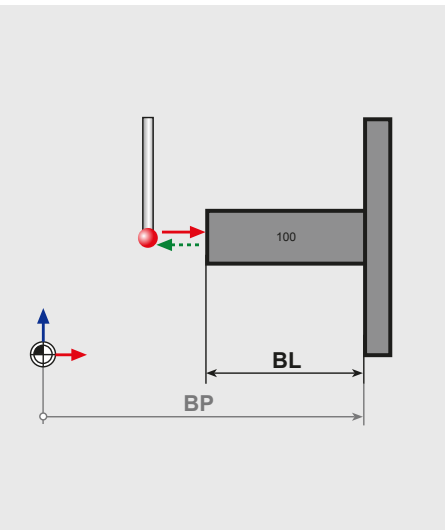
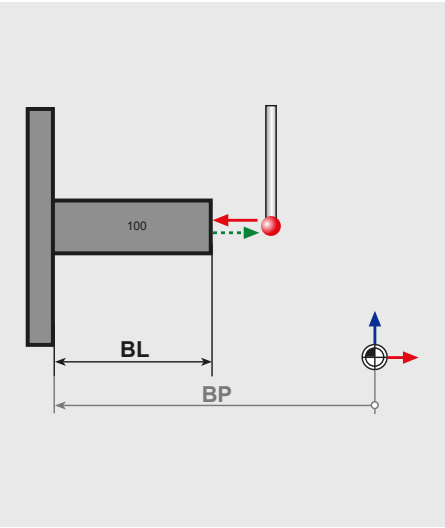
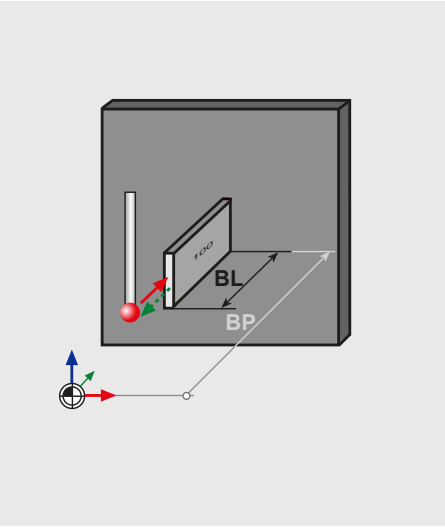
Selection	Graphic
X+	
X-	
Y+	

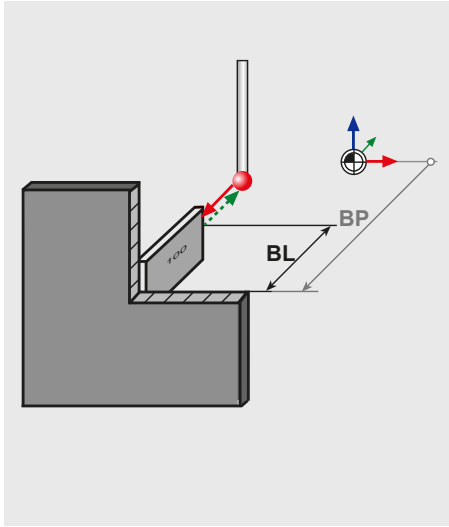
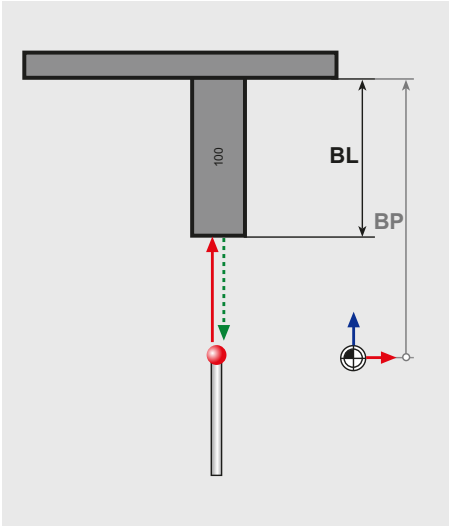
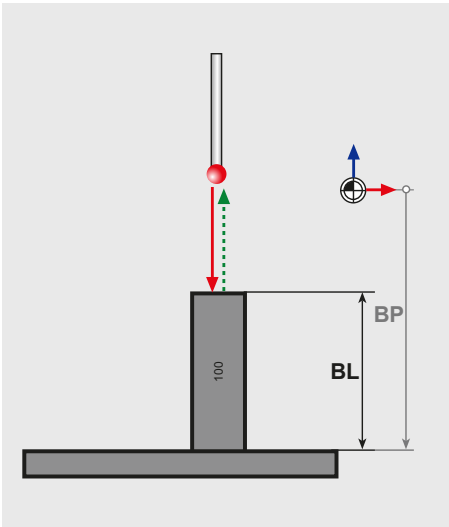
Manual probing

Selection	Graphic
Y-	
Z+	
Z-	

Tab. 6-3: Method 2: With zero point and distance = 0

Manual probing

Selection	Graphic
X+	 The diagram illustrates the X+ manual probing function. A vertical probe is positioned to the left of a horizontal workpiece. A red dot on the probe indicates the contact point. A red arrow points right towards the workpiece, and a green dashed arrow points left. The workpiece is labeled '100'. A coordinate system at the bottom left shows a blue arrow pointing up and a red arrow pointing right. Dimension lines indicate 'BL' (the distance from the probe's vertical axis to the workpiece's right edge) and 'BP' (the distance from the probe's vertical axis to the workpiece's left edge).
X-	 The diagram illustrates the X- manual probing function. A vertical probe is positioned to the right of a horizontal workpiece. A red dot on the probe indicates the contact point. A red arrow points left towards the workpiece, and a green dashed arrow points right. The workpiece is labeled '100'. A coordinate system at the bottom right shows a blue arrow pointing up and a red arrow pointing left. Dimension lines indicate 'BL' (the distance from the probe's vertical axis to the workpiece's right edge) and 'BP' (the distance from the probe's vertical axis to the workpiece's left edge).
Y+	 The diagram illustrates the Y+ manual probing function. A vertical probe is positioned to the left of a rectangular workpiece. A red dot on the probe indicates the contact point. A red arrow points right towards the workpiece, and a green dashed arrow points left. The workpiece is labeled '100'. A coordinate system at the bottom left shows a blue arrow pointing up and a red arrow pointing right. Dimension lines indicate 'BL' (the distance from the probe's vertical axis to the workpiece's right edge) and 'BP' (the distance from the probe's vertical axis to the workpiece's left edge).

Selection	Graphic
Y-	
Z+	
Z-	

Tab. 6-4: Method 3: Without zero point (and distance=0)

6.2.3 Calibrating the probe adjusting ring

Brief description The cycle "Calibrating probe, ring" records the calibration values for both axes of a plane. Measurements take place in an adjusting ring or in a calibration boring and the switching offsets per axis and measuring direction (positive/negative) are saved.

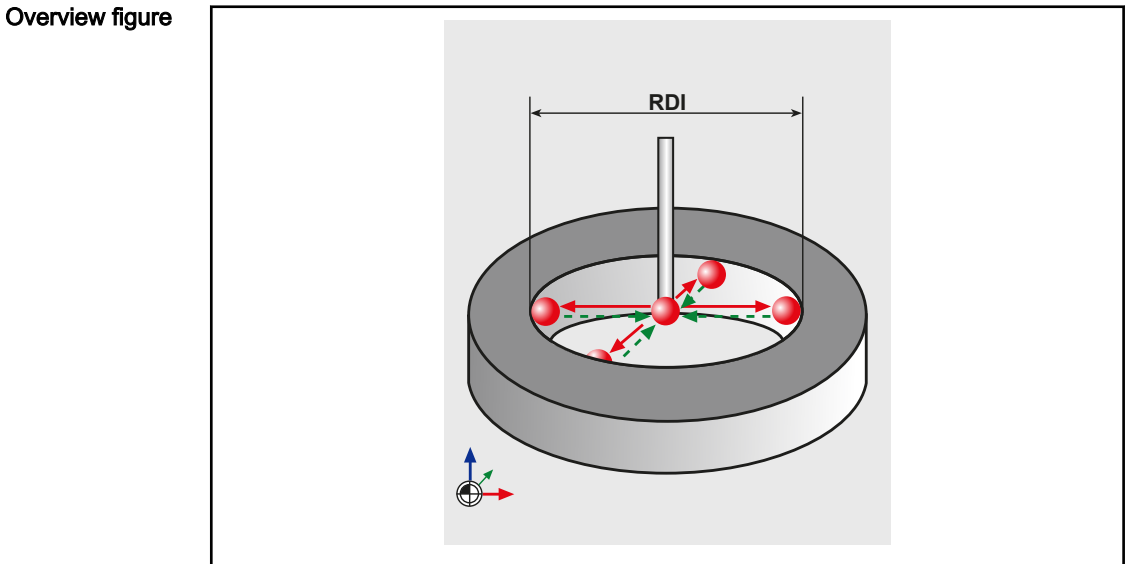


Fig. 6-3: Calibrating the probe, adjusting ring

- Sequence**
- 1. Call <M2> "Calibrate Ring"
 - 2. Select plane, enter diameter and adjust feed, if required
 - 3. Press <F2> "Start Program"
 - 4. Press NC start (program is running)
 The determined calibration values as well as the axes and the directions are displayed in the diagnostic line
 - 5. Press NC start
 The calibration values are applied

Input field

Parameters	Name	Properties	Values	Range
IPL	Interpolation level		G17 G18 G19	
RDI	Ring diameter		REAL	>0
CFE	Calibration feed		REAL	mm/min, <0

Tab. 6-5: Input field calibrating probe, adjusting ring

Graphic field One of the following graphics is displayed depending on the selected plane G17, G18, G19:

Select plane	Graphic
G17	
G18	
G19	

Tab. 6-6: Graphics depending on the input in the plane

Manual probing

6.3 Probing the zero point using the probe

6.3.1 M-key menu

Prepare <OP1>

F-key pad 1

- <F3> Probe zero point

M-Key level 1

- <M1> Point
- <M2> Rotary axis
- <M3> Corner
- <M5> Groove
- <M6> Boring
- <M7> Pocket
- <M8> M-Key level 2

M-Key level 2

- <M5> Land
- <M6> Circular spigot
- <M7> Rectangular spigot
- <M8> M-Key level 1

6.3.2 Zero point probing, point

Brief description The zero point in an axis is recording by probing a plane and is applied to the previously selected zero point table with "Probe zero point, point".

Overview figure

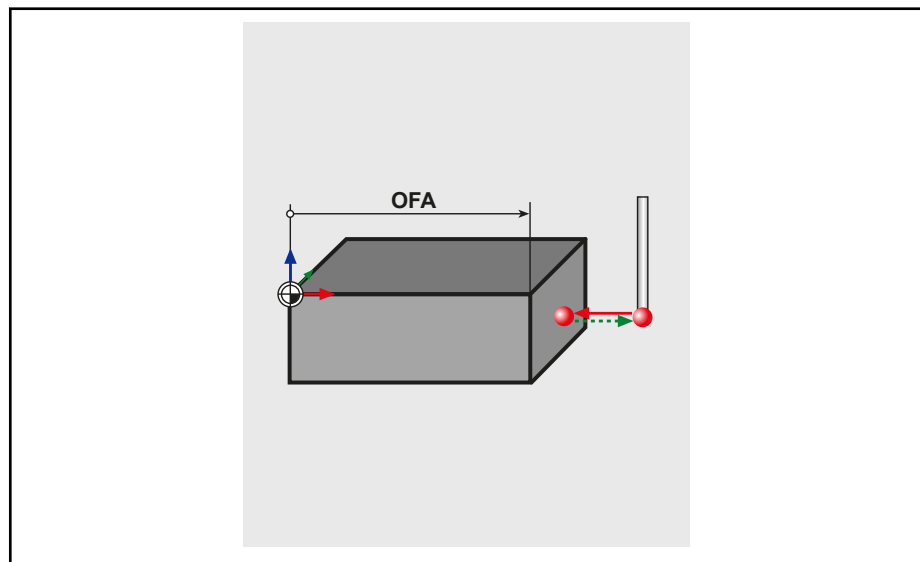


Fig. 6-4: Probe zero point, point

- Sequence**
1. Press <M1> "Zero Point, Point"
 2. Select measuring direction, enter distance and adjust feed, if required
 3. Select zero point and group
 4. Select <F6> "Apply Active Table" or <F5> "Select Table"
 5. Press <F2> "Start Program"
 6. Press NC start (program is running)

Manual probing

7. Determined measured value as well as axis are displayed in the diagnostic line
8. Press NC start
9. The measured value is applied to the selected zero point table

Input field

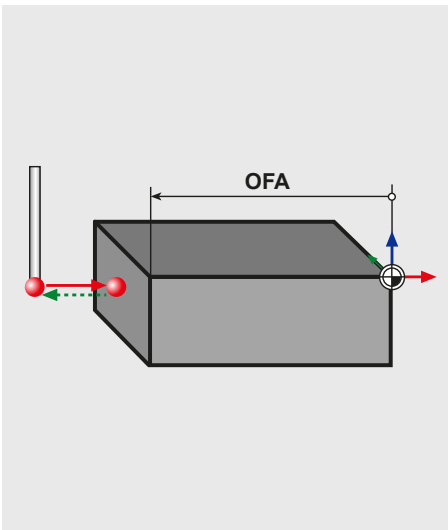
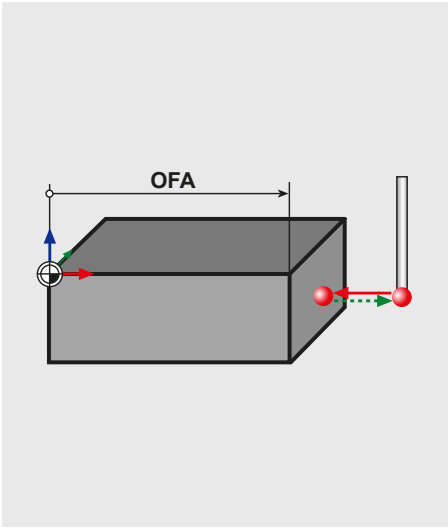
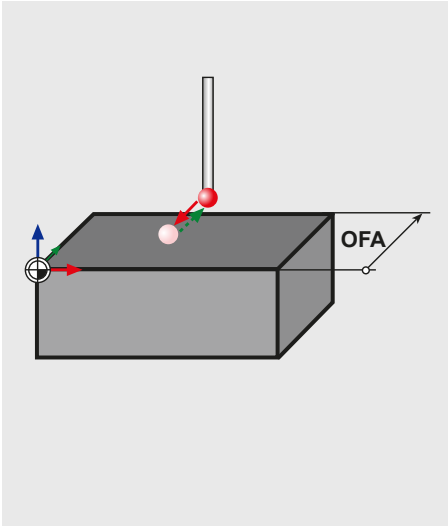
Parameters	Name	Properties	Values	Range
PAX	Measuring axis and direction		X- X+ Y- Y+ Z- Z+	X-
OFA	Offset		REAL	
PFE	Measuring feed		REAL	mm/min, >0
ZO	Zero offset (ZO)		G54 G55 G56 G57 G58 G59	
PAGE	ZO bank		INTEGER	1...5

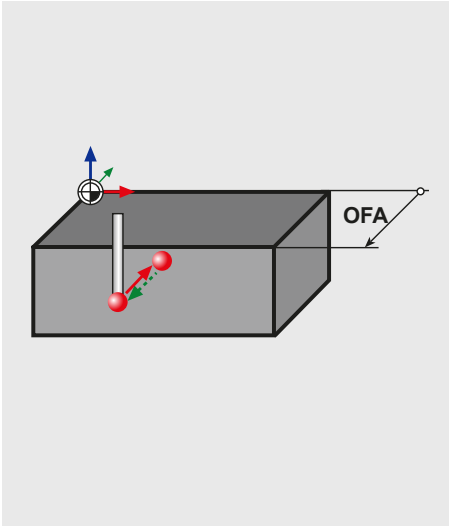
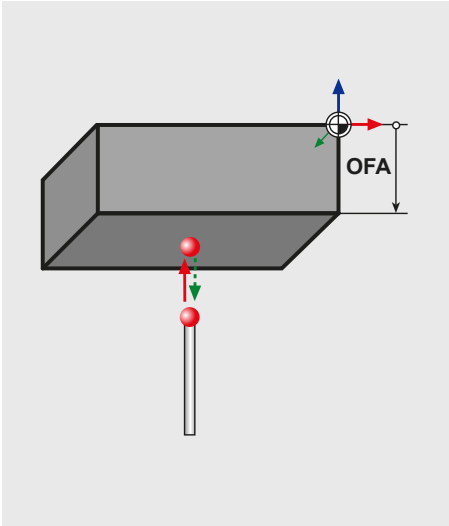
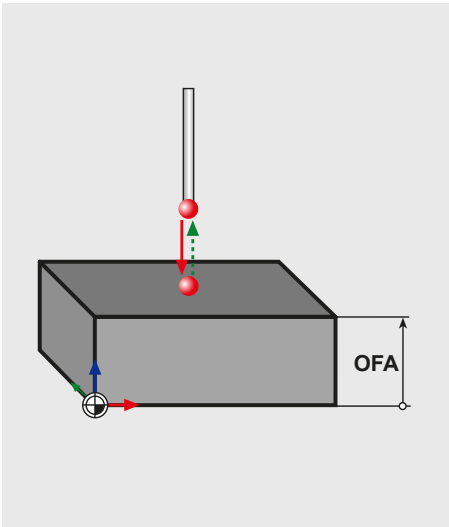
Tab. 6-7: Input field probe zero point, point

Graphic field

One of the following graphics is displayed depending on the selected axis and the selected direction:

Manual probing

Selection	Graphic
X+	 A 3D perspective view of a rectangular block. A vertical probe is positioned to the left of the block. A red sphere (the probe tip) is shown at two positions: one to the left of the block and one to the right, connected by a dashed green line. A red arrow points from the left position to the right position. A blue arrow points upwards from the right position. A white circle with a crosshair is at the right position. A dimension line labeled 'OFA' spans the distance between the two red spheres.
X-	 A 3D perspective view of a rectangular block. A vertical probe is positioned to the right of the block. A red sphere (the probe tip) is shown at two positions: one to the right of the block and one to the left, connected by a dashed green line. A red arrow points from the right position to the left position. A blue arrow points upwards from the left position. A white circle with a crosshair is at the left position. A dimension line labeled 'OFA' spans the distance between the two red spheres.
Y+	 A 3D perspective view of a rectangular block. A vertical probe is positioned above the block. A red sphere (the probe tip) is shown at two positions: one above the block and one to the right, connected by a dashed green line. A red arrow points from the top position to the right position. A blue arrow points upwards from the right position. A white circle with a crosshair is at the right position. A dimension line labeled 'OFA' spans the distance between the two red spheres.

Selection	Graphic
Y-	
Z+	
Z-	

Tab. 6-8: Graphics depending on the selected axis and direction

Manual probing

6.3.3 Zero point probing, corner

Brief description The zero point coordinates in all three coordinate system axes are determined using "Probe zero point, corner" by sampling three planes and are applied to the previously selected zero point table.

Overview figure

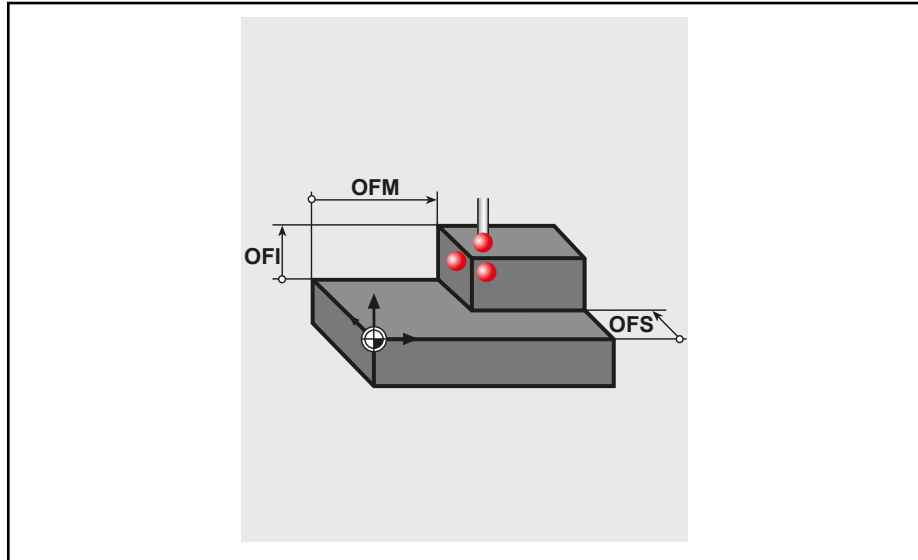


Fig. 6-5: Probe zero point, corner

- Sequence:**
1. Press <M3> "Corner"
 2. Select plane and adjust feed, if required. Select position and number for the corner. Enter the distance to the corner and if required, enter the offset
 3. Select zero point and group
 4. Select <F6> "Apply Active Table" or <F5> "Select Table"
 5. Press <F2> "Start Program"
 6. Press NC start (program is running)
The determined measured values are displayed in the diagnostic line
 7. Press NC start
The measured values are applied to the zero point table

The selected edge always has to point perpendicular to the plane. The offset value sign determines the direction of the feed motion. A positive length indicates a feed in negative direction, a negative length indicates a feed in the positive direction of the feed axis.

Example Infeed axis X, plane G19 with edge 4 (tool length positive) and edge 2 (tool length negative).

Manual probing

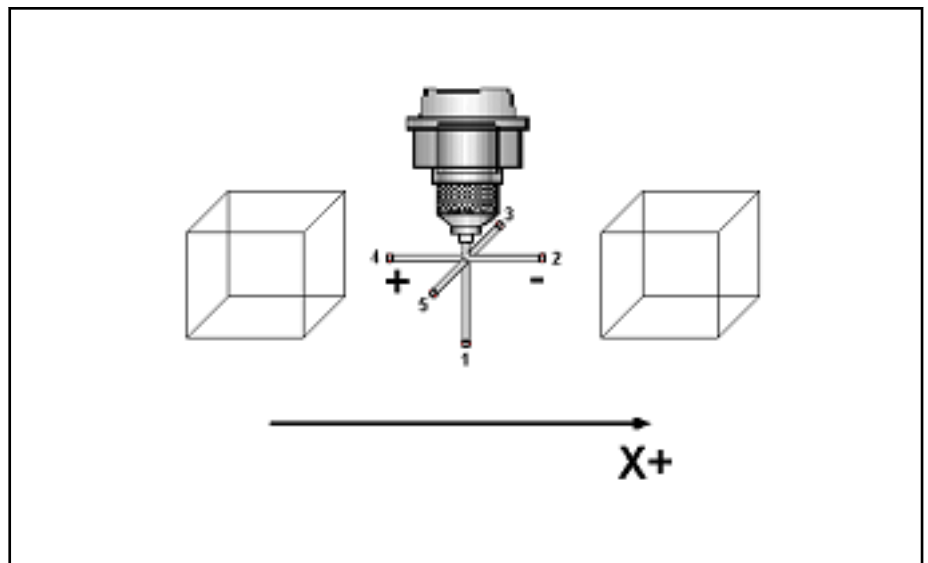


Fig. 6-6: Probe zero point corner in G19

Input field

Parameters	Name	Properties	Values	Range
IPL	Interpolation level		G17 G18 G19	
ORI	Position		External Internal	
POS	Position	If ORI = internal	Top Above	
NO	Corner number		C1 C2 C3 C4	
DI	Distance	If ORI = external	REAL	>0
OFM	Main axis offset			
OFS	Auxiliary axis offset			
OFI	Infeed axis offset			
PFE	Measuring feed		REAL	mm/min, >0
ZO	Zero offset (ZO)		G54 G55 G56 G57 G58 G59	
PAGE	ZO bank		INTEGER	1...5

Tab. 6-9: Input field probe zero point, corner

Manual probing

If "External" is selected as corner position, "Top" is selected as position of the corner. "Bottom" cannot be selected as position.

If "Internal" is selected as corner position and "Bottom" is selected as position, no distance (DI) is required (hiding the parameter).

Graphic field The following graphic is displayed when entering the offset of the main, secondary and infeed axis:

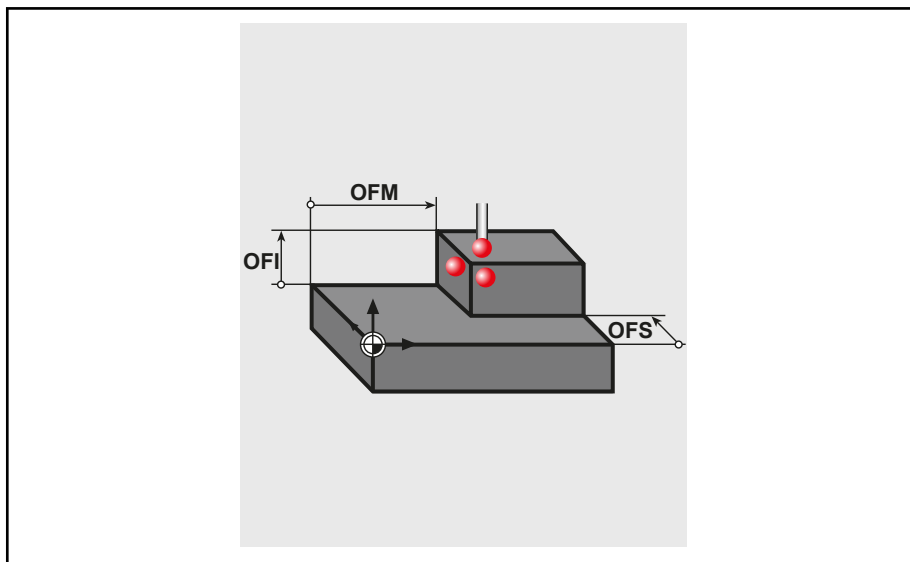
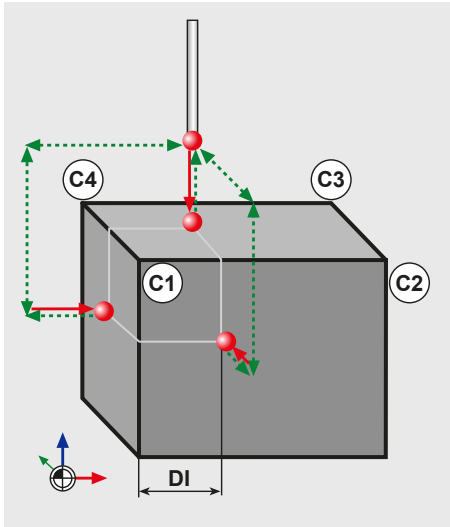
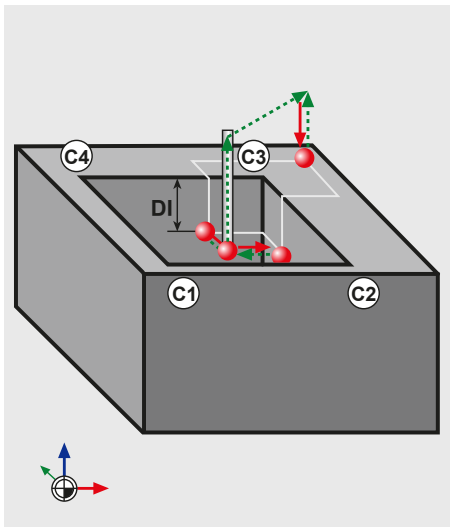
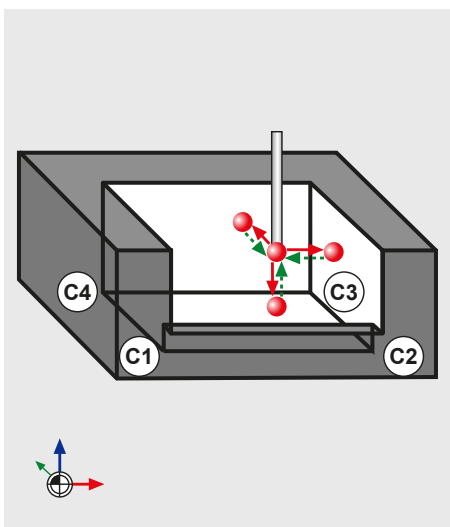
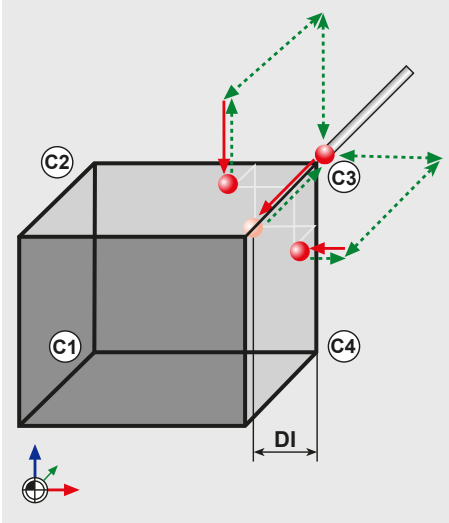
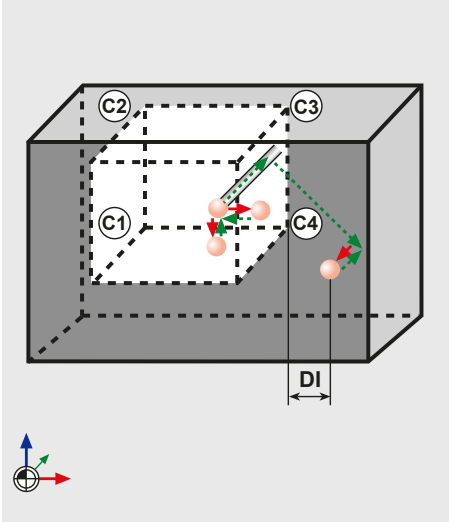
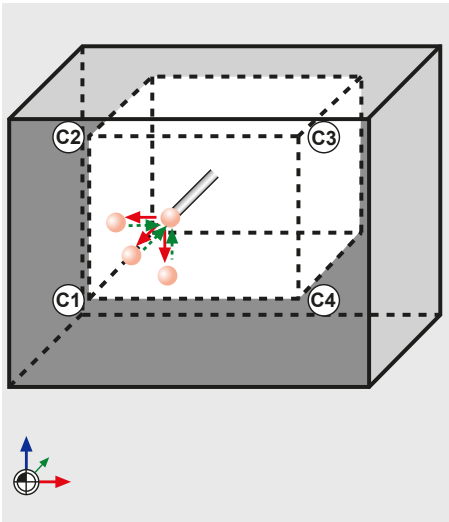


Fig. 6-7: Help image when entering the offset of the main, secondary and in-feed axis

Depending on the selected plane, number and position, the graphic is switched.

Level	Position	Position	Graphic
G17	External	Top	 The diagram shows a 3D perspective of a rectangular block. A vertical probe is positioned above the top surface. Red spheres indicate contact points at the corners of the top surface. Green dashed lines show the probe's approach and retraction paths. The corners are labeled C1, C2, C3, and C4. A dimension line labeled 'DI' indicates the distance from the probe tip to the top surface. A coordinate system with blue, green, and red axes is shown at the bottom left.
	Internal	Top	 The diagram shows a 3D perspective of a rectangular block with a central rectangular hole. The probe is positioned above the hole. Red spheres indicate contact points at the corners of the hole's top surface. Green dashed lines show the probe's approach and retraction paths. The corners of the hole are labeled C1, C2, C3, and C4. A dimension line labeled 'DI' indicates the distance from the probe tip to the top surface of the hole. A coordinate system with blue, green, and red axes is shown at the bottom left.
		Bottom	 The diagram shows a 3D perspective of a rectangular block with a central rectangular hole. The probe is positioned inside the hole, touching the bottom surface. Red spheres indicate contact points at the corners of the hole's bottom surface. Green dashed lines show the probe's approach and retraction paths. The corners of the hole are labeled C1, C2, C3, and C4. A coordinate system with blue, green, and red axes is shown at the bottom left.

Manual probing

Level	Position	Position	Graphic
G18	External	Top	
	Internal	Top	
		Bottom	

Level	Position	Position	Graphic
G19	External	Top	
	Internal	Top	
		Bottom	

Tab. 6-10: Graphics depending on the input in the plane

6.3.4 Zero point probing, boring

Brief description Using "Zero Point Probing, Boring", the zero point in the main and secondary axis of a plane is determined in relation to the boring center. The determined zero point is applied to the selected zero point table.

Overview figure

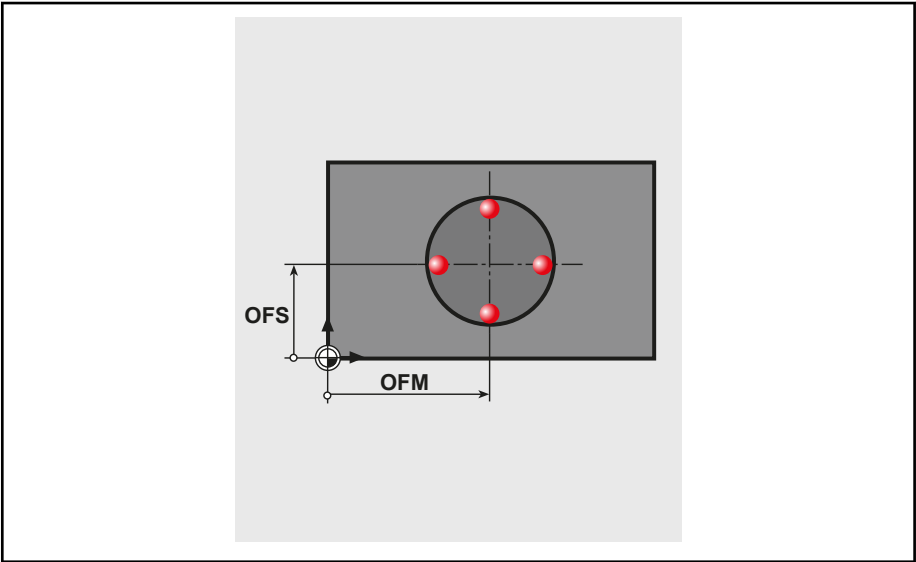


Fig. 6-8: Zero point probing, boring
There are 2 methods to record the measuring points:

- Without obstacle
- With obstacle

- Sequence**
1. Press <M6> "Boring"
 2. Select plane, adjust feed if required and enter offset
 3. Select with or without obstacle
 4. Select zero point and group
 5. Select <F6> "Apply Active Table" or <F5> "Select Table"
 6. Press <F2> "Start Program"
 7. Press NC start (program is running)
The determined measured values are displayed in the diagnostic line
 8. Press NC start
The measured values are applied to the zero point table

Input field

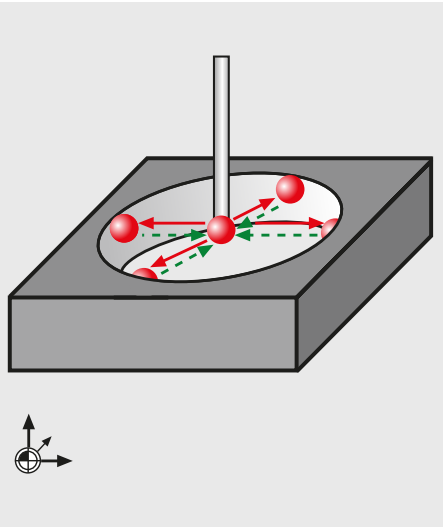
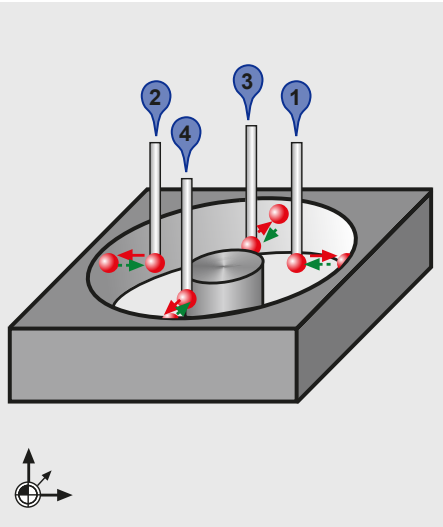
Parameters	Name	Properties	Values	Range
IPL	Interpolation level		G17 G18 G19	
OFM	Main axis offset			
OFS	Auxiliary axis offset			
LUP	Obstacle in boring		No Yes	
PFE	Measuring feed		REAL	mm/min, >0

Manual probing

Parameters	Name	Properties	Values	Range
ZO	Zero offset (ZO)		G54 G55 G56 G57 G58 G59	
PAGE	ZO bank		INTEGER	1...5

Tab. 6-11: Input field zero point probing, boring

Graphic field The following graphics are displayed when entering "Obstacle yes/no".

Obsta- cle	Graphic
No	
Yes	

Tab. 6-12: Graphics depending on "Obstacle yes/no"

The following graphic is displayed when entering the offset of the main and secondary axis:

Manual probing

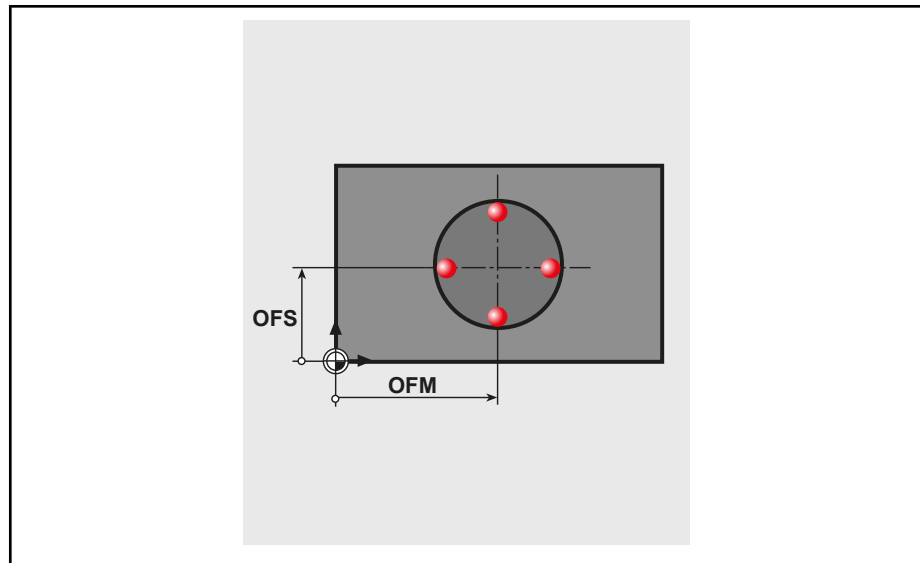


Fig. 6-9: Help image when entering the offset of the main and secondary axis

6.3.5 Zero point probing, circular spigot

Brief description Using "Zero Point Probing, Boring", the zero point in the main and secondary axis of a plane is determined in relation to the boring center. The determined zero point is applied to the selected zero point table.

Overview figure

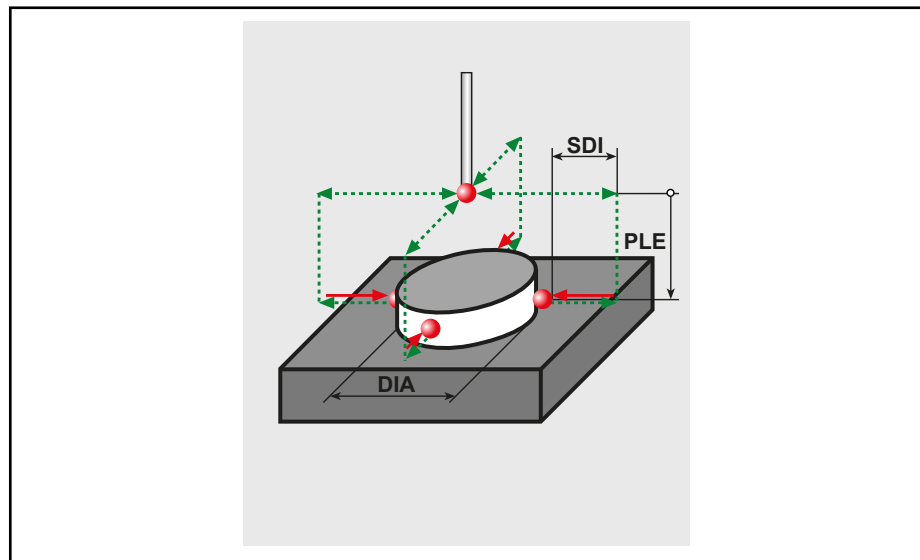


Fig. 6-10: Zero point probing, circular spigot

- Sequence**
1. Press <M6> "Zero point circular spigot" in the 2nd key level
 2. Select diameter, depths, level and safety distance, adjust feed if required and enter offset
 3. Select zero point and group
 4. Select <F6> "Apply Active Table" or <F5> "Select Table"
 5. Press <F2> "Start Program"
 6. Press NC start (program is running)
The determined measured values are displayed in the diagnostic line
 7. Press NC start
The measured values are applied to the zero point table

Manual probing

Input field

Parameters	Name	Properties	Values	Range
IPL	Interpolation level		G17 G18 G19	
DIA	Spigot diameter		REAL	>0
SDI	Safety distance		REAL	>0
PLE	Feed increment till measuring height		REAL	
OFM	Main axis offset			
OFS	Auxiliary axis offset			
PFE	Measuring feed		REAL	mm/min, >0
ZO	Zero offset (ZO)		G54 G55 G56 G57 G58 G59	
PAGE	ZO bank		INTEGER	1...5

Tab. 6-13: Zero point probing, circular spigot

Graphic field

This image is always displayed except for when entering the offset of the main and secondary axis.

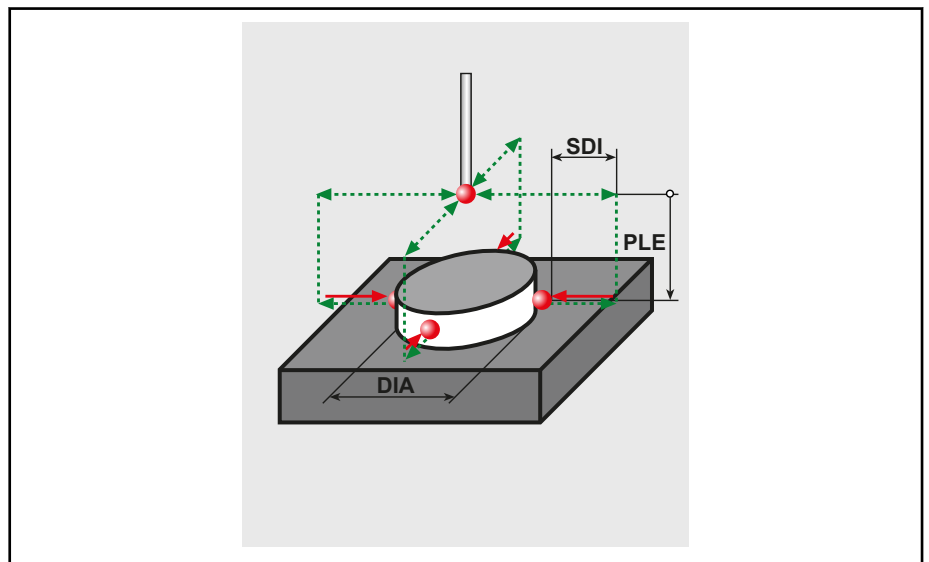


Fig. 6-11: Help image, zero point probing, circular spigot

The following graphic is displayed when entering the offset of the main and secondary axis:

Manual probing

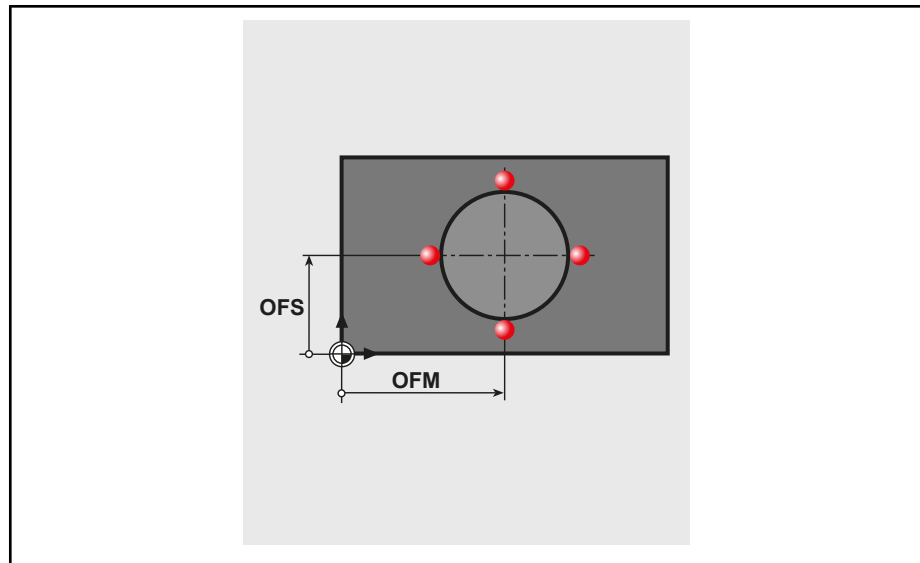


Fig. 6-12: Help image when entering the offset of the main and secondary axis

6.3.6 Zero point probing, groove

Brief description "Zero point probing, groove" determines the axis zero point which is perpendicular to an available groove. The measured value is applied to the selected zero point table.

Overview figure

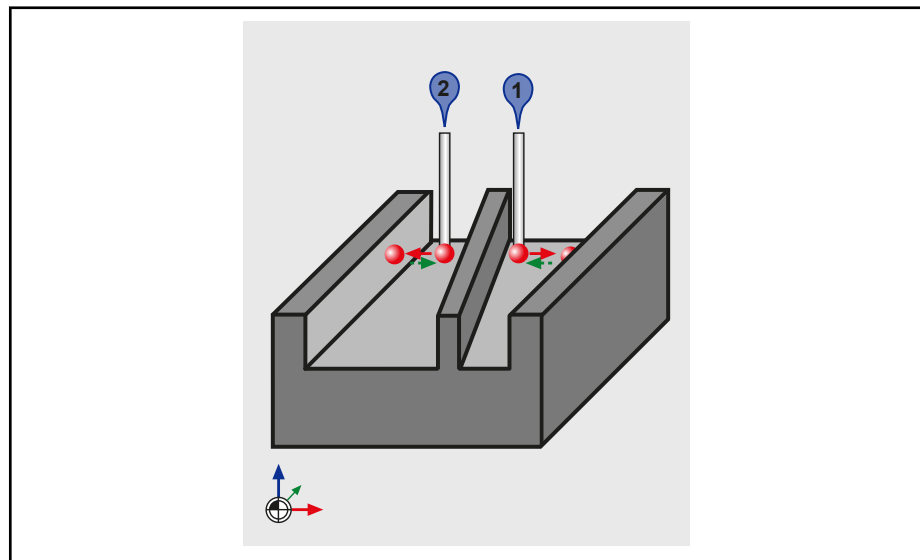


Fig. 6-13: Zero point probing, groove

There are 2 methods to record the measuring points:

- Without obstacle
- With obstacle

- Sequence**
1. Press <M5> "Groove"
 2. Select plane and measuring axis, adjust feed if required and enter offset
 3. Select with or without obstacle
 4. Select zero point and group
 5. Select <F6> "Apply Active Table" or <F5> "Select Table"
 6. Press <F2> "Start Program"

Manual probing

7. Press NC start (program is running)
The determined measured value is displayed in the diagnostic line
8. Press NC start
The measured value is applied to the zero point table

Input field

Parameters	Name	Properties	Values	Range
IPL	Interpolation level		G17 G18 G19	
PAX	Measuring axis	Depending on IPL	X Z Y Y X Z	
OFA	Offset			
LUP	Obstacle in boring		No Yes	
PFE	Measuring feed		REAL	mm/min, >0
ZO	Zero offset (ZO)		G54 G55 G56 G57 G58 G59	
PAGE	ZO bank		INTEGER	1...5

Tab. 6-14: Zero point probing, groove

Only the main and the secondary axis of the selected plane can be selected as measuring axes:

Level	Main axis	Secondary axis
G17	X	Y
G18	Z	X
G19	Y	Z

Tab. 6-15:

Graphic field The following graphic is displayed when entering the offset:

Manual probing

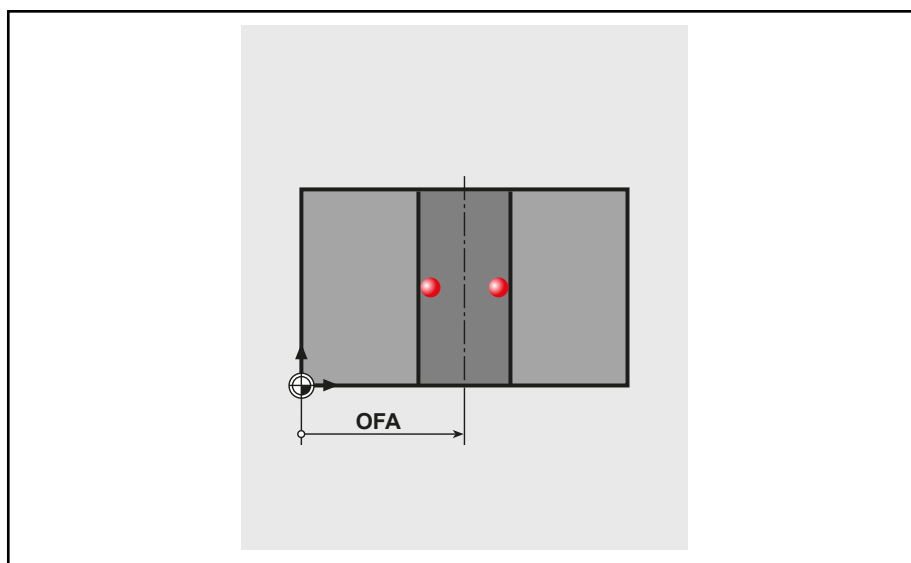
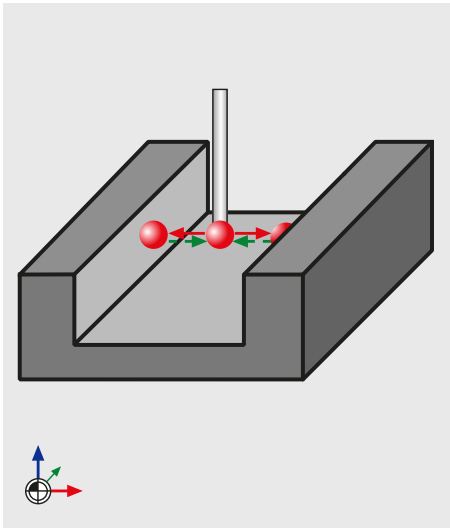
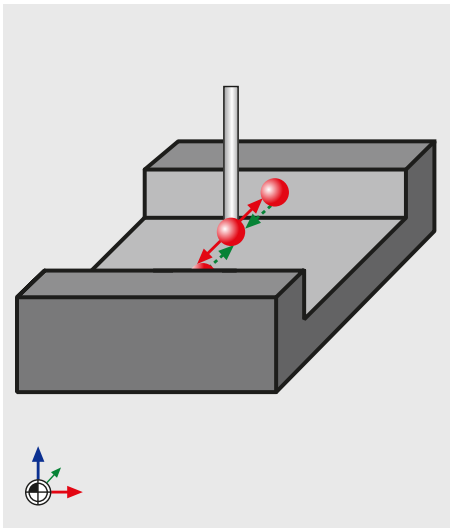
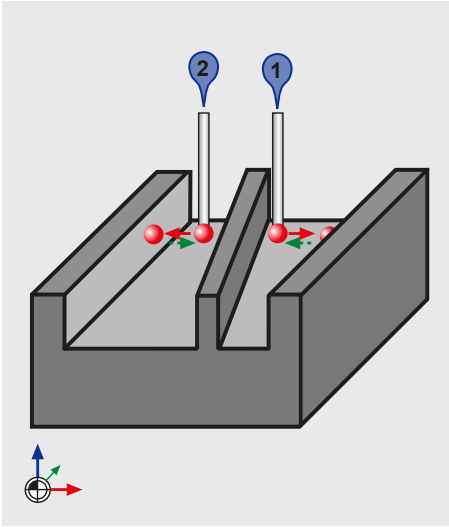
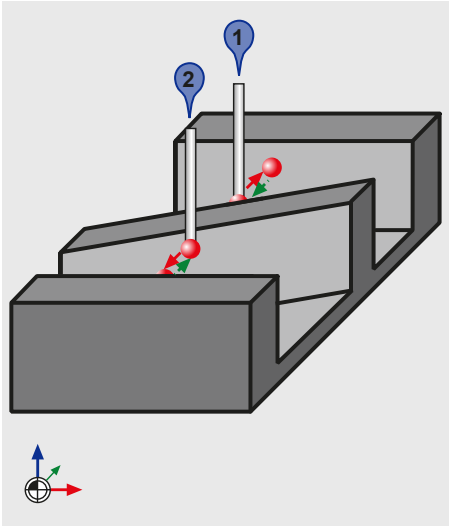


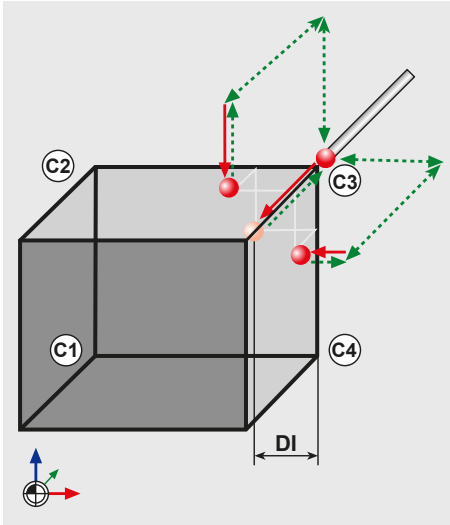
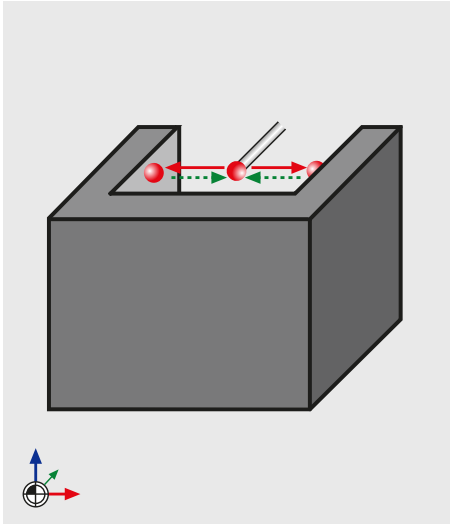
Fig. 6-14: Help image when entering the offset

The following graphics are displayed when entering "Obstacle yes/no":

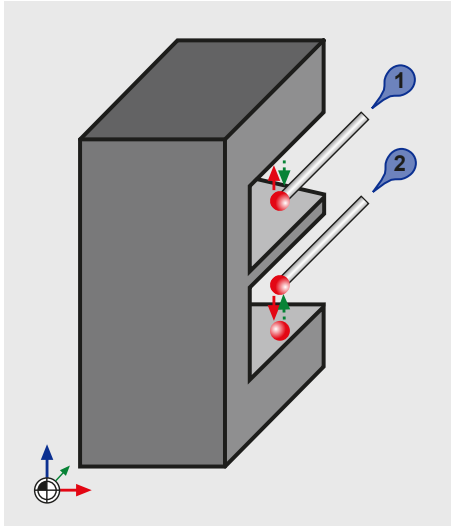
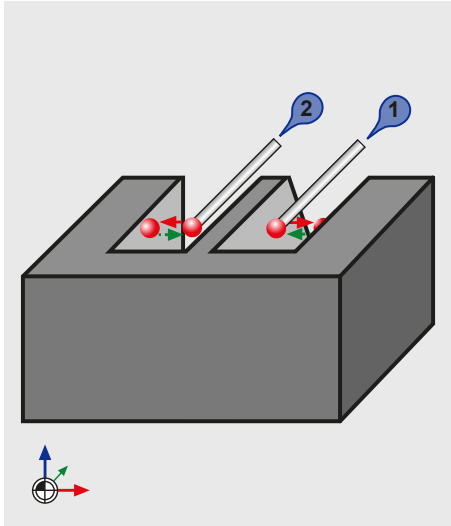
Level	Obstacle	Measuring axis	Graphic
G17	No	X	
		Y	

Manual probing

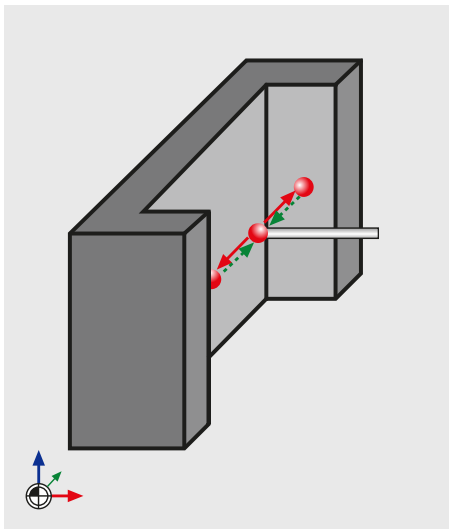
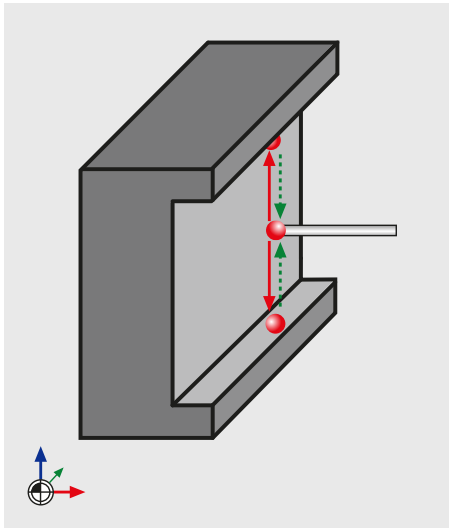
Level	Obstacle	Measuring axis	Graphic
G17	Yes	X	
		Y	

Level	Obstacle	Measuring axis	Graphic
G18	No	Z	
		X	

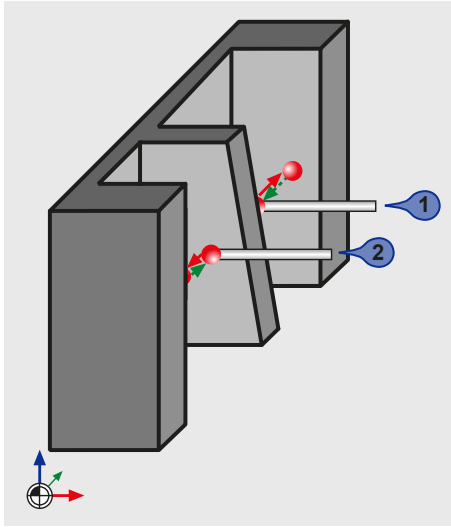
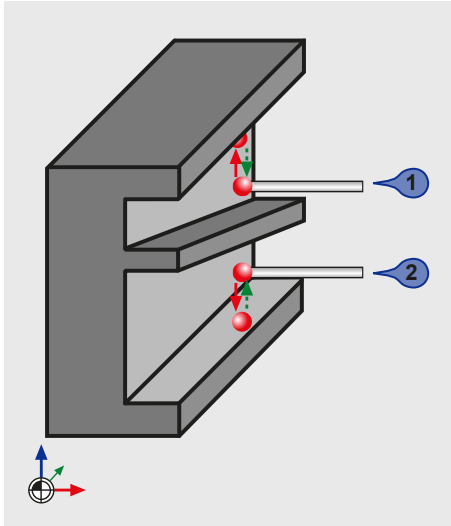
Manual probing

Level	Obstacle	Measuring axis	Graphic
G18	Yes	Z	
		X	

Manual probing

Level	Obstacle	Measuring axis	Graphic
G19	No	Y	
		Z	

Manual probing

Level	Obstacle	Measuring axis	Graphic
G19	Yes	Y	
		Z	

Tab. 6-16: Graphics depending on the input in the plane

6.3.7 Zero point probing, land

Brief description "Zero point probing, land" determines the axis zero point which is perpendicular to an available land. The measured value is applied to the selected zero point table.

Overview figure

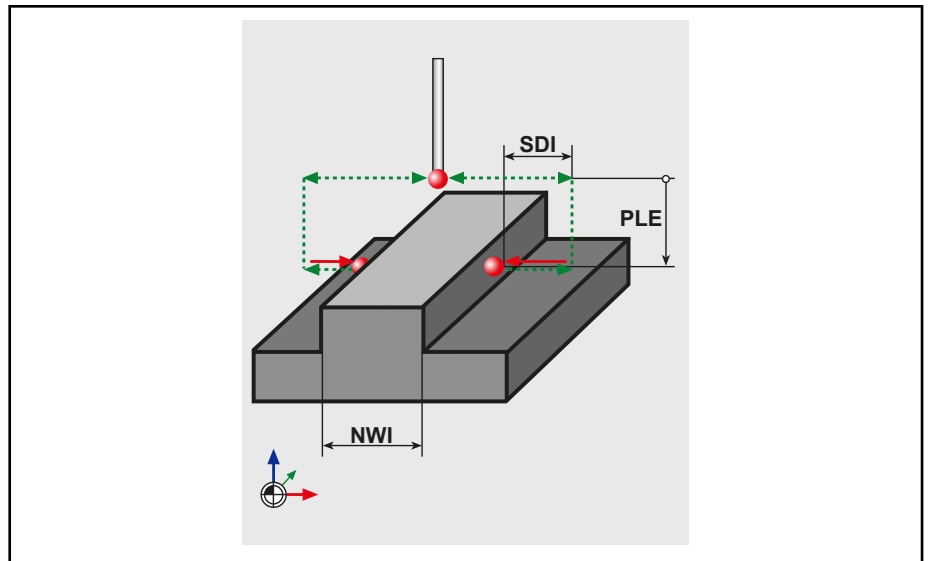


Fig. 6-15: Zero point probing, land

- Sequence**
1. Press <M6> "Zero point land" in the 2nd key level
 2. Select land width, depths, level, measuring axis and safety distance, adjust feed if required and enter offset
 3. Select zero point and group
 4. Select <F6> "Apply Active Table" or <F5> "Select Table"
 5. Press <F2> "Start Program"
 6. Press NC start (program is running)
The determined measured value is displayed in the diagnostic line
 7. The measured value is applied to the selected zero point table with NC start

Input field

Parameters	Name	Properties	Values			Range
IPL	Interpolation level		G17 G18 G19			
PAX	Measuring axis	Depending on IPL	X Y	Z X	Y Z	
NWI	Land width		REAL			>0
SDI	Safety distance		REAL			>0
PLE	Feed increment till measuring height		REAL			
OFA	Offset		REAL			
PFE	Measuring feed		REAL			mm/min, >0

Manual probing

Parameters	Name	Properties	Values	Range
ZO	Zero offset (ZO)		G54 G55 G56 G57 G58 G59	
PAGE	ZO bank		INTEGER	1...5

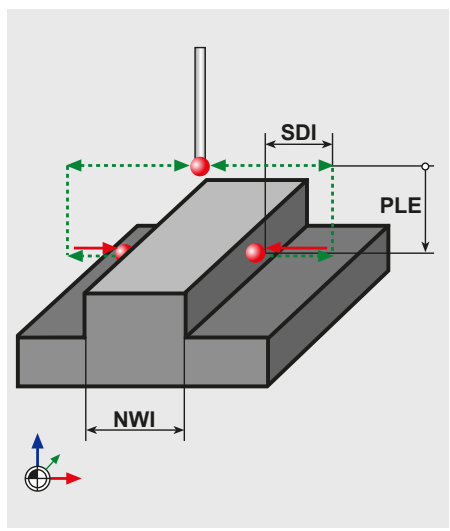
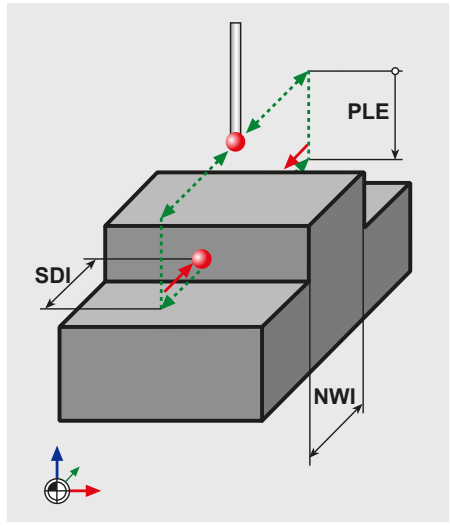
Tab. 6-17: Input field, zero point probing, land

Only the main and the secondary axis of the selected plane can be selected as measuring axes:

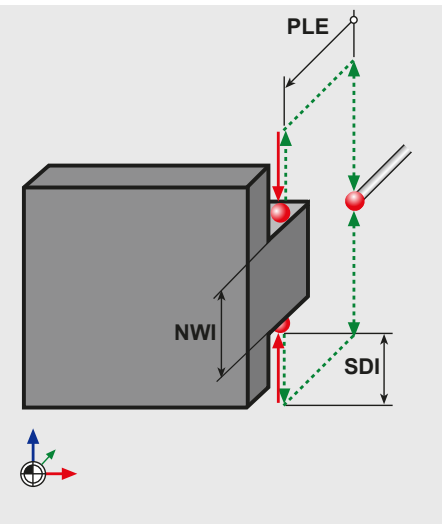
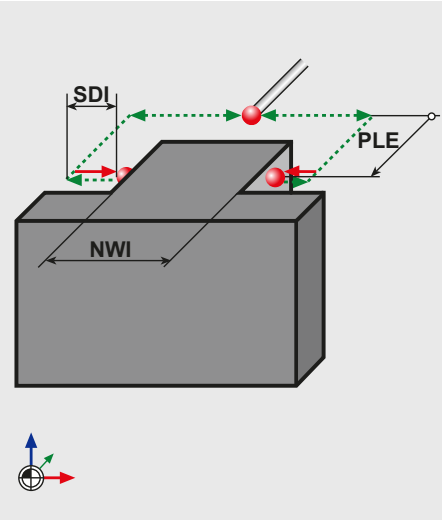
Level	Main axis	Secondary axis
G17	X	Y
G18	Z	X
G19	Y	Z

Tab. 6-18:

Graphic field

Level	Measuring axis	Graphic
G17	X	 The diagram shows a 3D perspective of a stepped cylindrical part. A vertical probe is positioned above the part. Red dots indicate the contact points on the top and side surfaces. Green dashed lines and arrows show the movement of the probe along the X-axis. Labels include SDI (Side Distance Indicator) for the horizontal distance from the probe tip to the part's edge, PLE (Probe Length Error) for the vertical distance from the probe tip to the part's top surface, and NWI (Normal Width Indicator) for the width of the part. A coordinate system icon at the bottom left shows the X-axis pointing to the right.
	Y	 The diagram shows a 3D perspective of a stepped cylindrical part. A vertical probe is positioned above the part. Red dots indicate the contact points on the top and side surfaces. Green dashed lines and arrows show the movement of the probe along the Y-axis. Labels include SDI (Side Distance Indicator) for the horizontal distance from the probe tip to the part's edge, PLE (Probe Length Error) for the vertical distance from the probe tip to the part's top surface, and NWI (Normal Width Indicator) for the width of the part. A coordinate system icon at the bottom left shows the Y-axis pointing upwards.

Manual probing

Level	Measuring axis	Graphic
G18	Z	 The diagram shows a 3D block with a vertical step. A probe is shown in two positions: one on the top surface and one on the side of the step. Red arrows indicate the vertical movement of the probe. Green dashed lines and arrows show the projection of the probe's position onto the top surface. Labels include 'PLE' (Probe Length Error) at the top, 'NWl' (Nominal Width) for the step, and 'SDl' (Side Distance) for the horizontal distance from the edge to the probe's vertical projection. A coordinate system icon with blue, green, and red axes is at the bottom left.
	X	 The diagram shows a 3D block with a horizontal step. A probe is shown in two positions: one on the top surface and one on the side of the step. Red arrows indicate the horizontal movement of the probe. Green dashed lines and arrows show the projection of the probe's position onto the top surface. Labels include 'SDl' (Side Distance) for the horizontal distance from the edge to the probe's vertical projection, 'NWl' (Nominal Width) for the step, and 'PLE' (Probe Length Error) at the top. A coordinate system icon with blue, green, and red axes is at the bottom left.

Manual probing

Level	Measuring axis	Graphic
G19	Y	
	Z	

Tab. 6-19: Graphics depending on "Obstacle yes/no"

The following graphic is displayed when entering the offset:

Manual probing

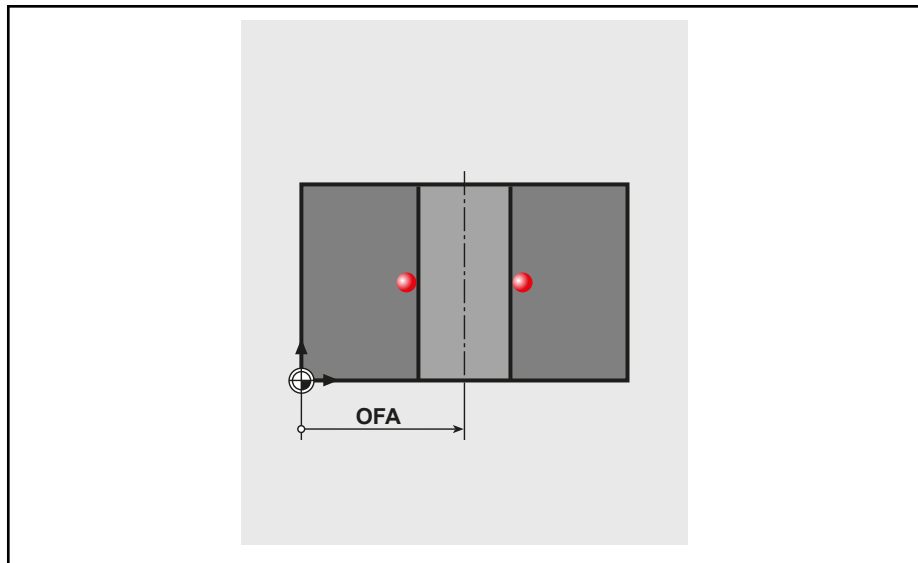


Fig. 6-16: Help image when entering the offset

6.3.8 Zero point probing, rectangular pocket

Brief description Using "Zero point probing, rectangular pocket", the zero point in the main and secondary axis of a plane is recorded on the basis of a rectangular pocket center. The measured values of both axes are applied to the selected zero point table.

There are 2 methods to record the measuring points:

- Without obstacle
- With obstacle

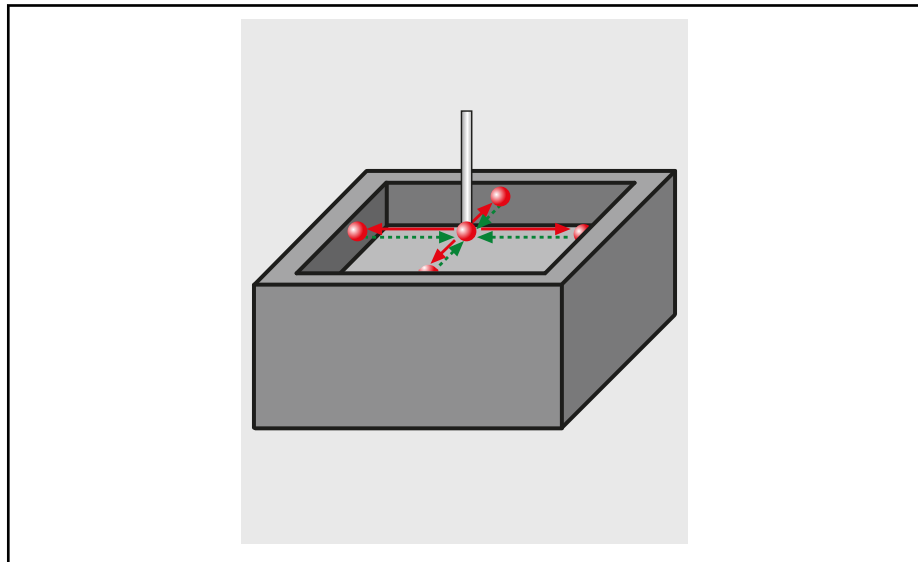


Fig. 6-17: Zero point probing, rectangular pocket

- Sequence**
1. Press <M1> "Zero point pocket"
 2. Select plane, adjust feed if required and enter offset
 3. Select with or without obstacle
 4. Select zero point and group
 5. Select <F6> "Apply Active Table" or <F5> "Select Table"
 6. Press <F2> "Start Program"

Manual probing

7. The measured values are applied to the selected zero point table with NC start

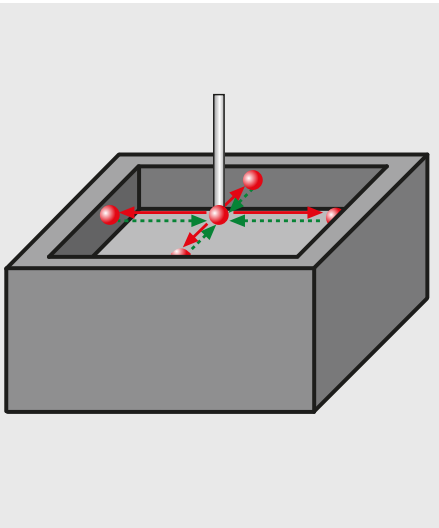
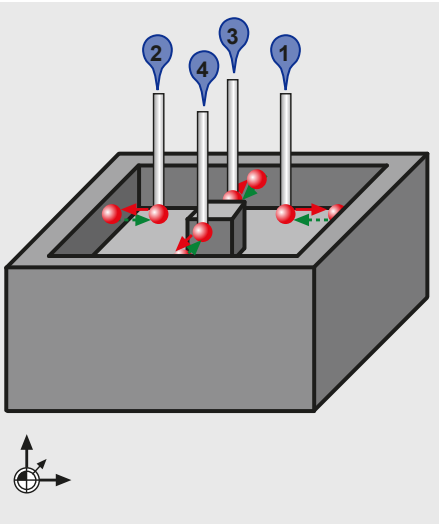
Input field

Parameters	Name	Properties	Values	Range
IPL	Interpolation level		G17 G18 G19	
OFM	Main axis offset		REAL	
OFS	Auxiliary axis offset			
LUP	Obstacle in pocket		No Yes	
PFE	Measuring feed		REAL	mm/min, >0
ZO	Zero offset (ZO)		G54 G55 G56 G57 G58 G59	
PAGE	ZO bank		INTEGER	1...5

Tab. 6-20: Input field, zero point probing, rectangular pocket

Manual probing

Graphic field The following graphics are displayed when entering "Obstacle yes/no":

Obsta- cle	Graphic
No	
Yes	

Tab. 6-21: Graphics depending on "Obstacle yes/no"

The following graphic is displayed when entering the offset of the main and secondary axis:

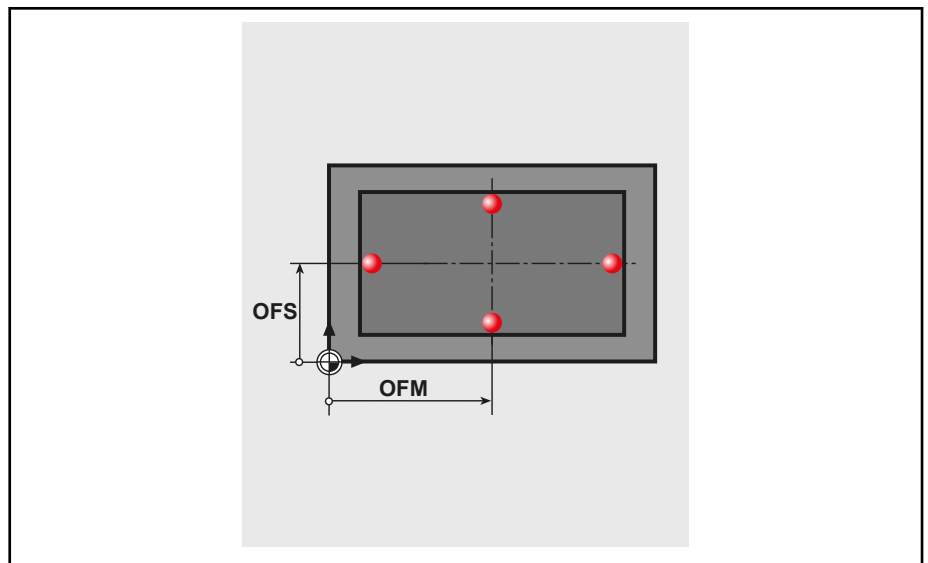


Fig. 6-18: Help image when entering the offset of the main and secondary axis

6.3.9 Zero point probing, rectangular spigot

Brief description Using "Zero point probing, rectangular spigot", the zero point in the main and secondary axis of a plane is recorded on the basis of a rectangular spigot center. The measured values of both axes are applied to the selected zero point table.

Overview figure

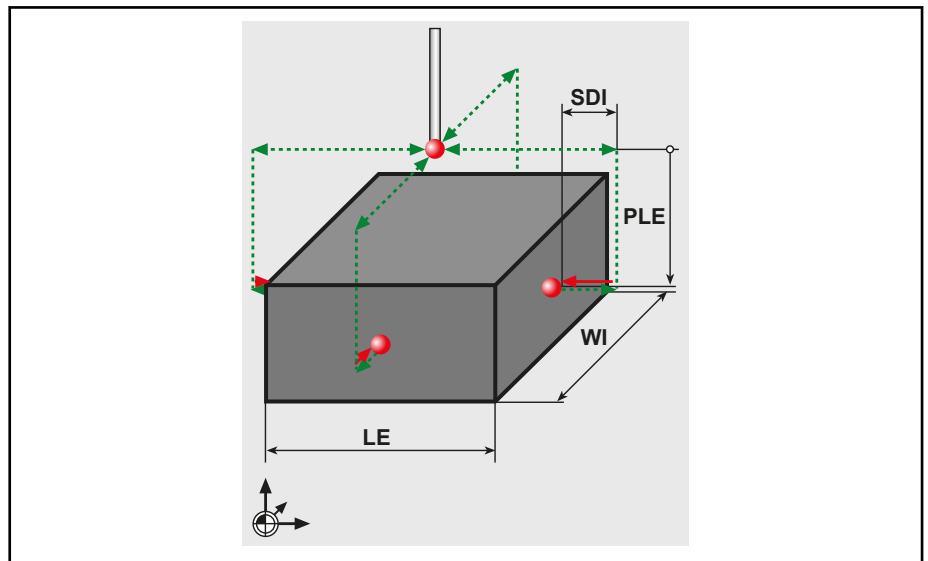


Fig. 6-19: Zero point probing, rectangular spigot

- Sequence**
1. Press M-Key with symbol "rectangular spigot"
 2. Select length, width, depth, level and safety distance, adjust feed if required and enter offset
 3. Select zero point and group
 4. Select <F6> "Apply Active Table" or <F5> "Select Table"
 5. Press <F2> "Start Program"
 6. Press NC start (program is running)
- The determined measured values are displayed in the diagnostic line

Manual probing

7. The measured values are applied to the selected zero point table with NC start

Input field

Parameters	Name	Properties	Values	Range
IPL	Interpolation level		G17 G18 G19	
LE	Length		REAL	>0
WI	Width		REAL	>0
SDI	Safety distance		REAL	>0
PLE	Feed increment till measuring height		REAL	
OFM	Main axis offset		REAL	
OFS	Auxiliary axis offset		REAL	
PFE	Measuring feed		REAL	mm/min, >0
ZO	Zero offset (ZO)		G54 G55 G56 G57 G58 G59	
PAGE	ZO bank		INTEGER	1...5

Tab. 6-22: Input field, zero point probing, rectangular spigot

Graphic field

This image is always displayed except for when entering the offset of the main and secondary axis:

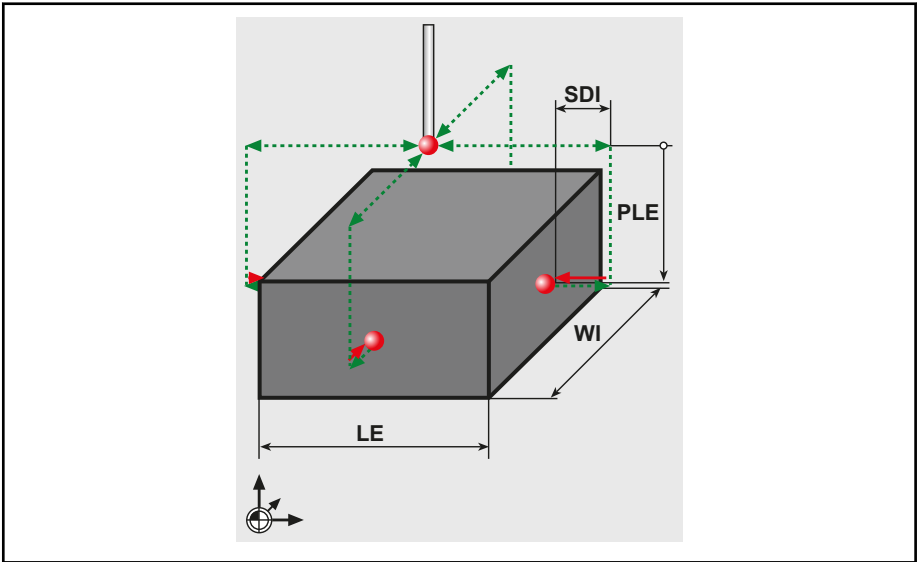


Fig. 6-20: Help image when entering the offset of the main and secondary axis

The following graphic is displayed when entering the offset of the main and secondary axis:

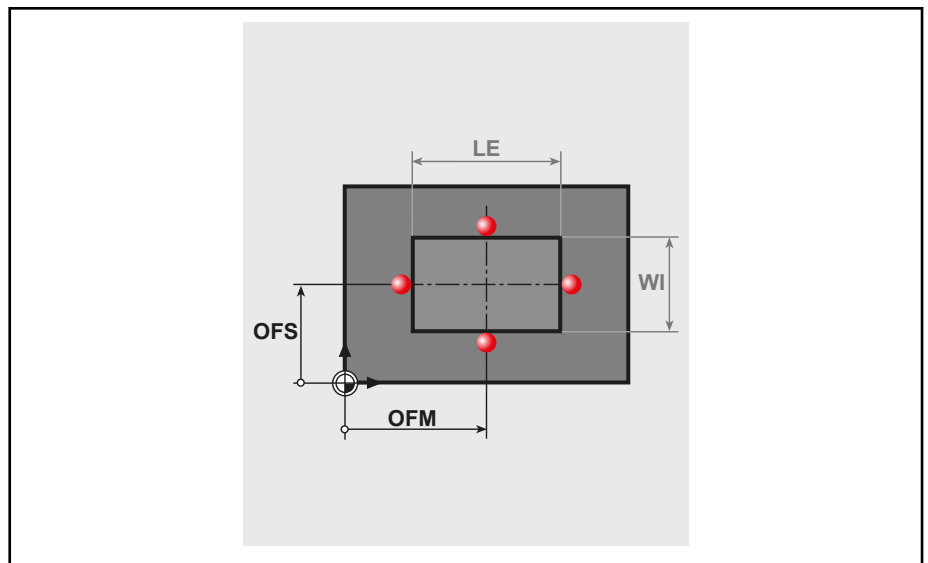


Fig. 6-21: Help image when entering the offset of the main and secondary axis

6.3.10 Zero point probing, rotary axis

Brief description Using "Probe zero point rotary axis", the angle of rotation of a plane is determined using a two-point measurement. The angle of rotation is applied to the selected zero point table as zero point of the rotary axis.

Overview figure When selecting the two measuring points, make sure that always the first measuring point is the pole for determining the angle.

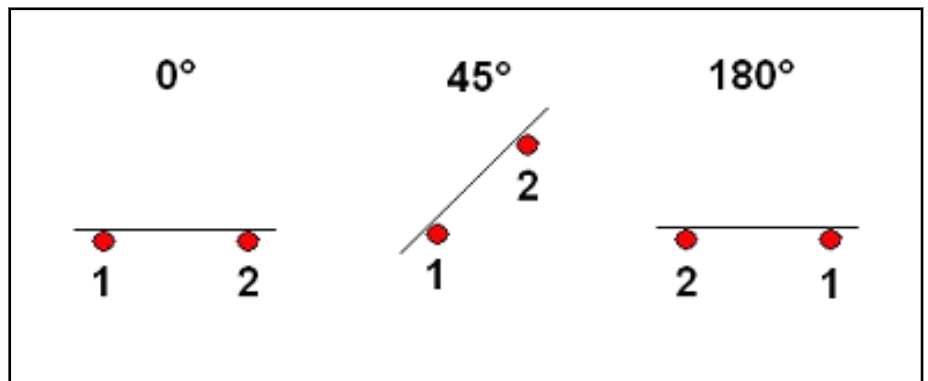


Fig. 6-22: Pole for determining the angle

The distance between the measuring points 1 and 2 has to be larger than the sphere diameter of the probe.

- Sequence**
1. Press <M2> "Zero Point, Rotary Axis"
 2. Select rotary axis and measuring direction, adjust feed if required. Enter reference axis and command angle
 3. Traverse rotary axis. Select Yes/No. If Yes is selected, select rapid traverse or optionally, the feed and the velocity
 4. Select zero point and group
 5. Press <F2> "Start Program"
 6. Press NC start (program is running)
The determined measured values are displayed in the diagnostic line
 7. Press NC start
The measured value is applied to the zero point table

Manual probing

Input field

Parameters	Name	Properties	Values	Range
RA	Rotary axis	Depending on the configuration data	A B C	
PAX	Measuring axis and direction	Depending on RA	Y- Z- X- Y+ Z+ X+ Z- X- Y- Z+ X+ Y+	
PFE	Measuring feed		REAL	mm/min, >0
BAX	Reference axis	Depending on RA	Y Z X Z X Y	
ANG	Command angle		REAL	Absolute
RM	Traverse rotary axis		Yes No	
ZO	Zero offset (ZO)		G54 G55 G56 G57 G58 G59	
PAGE	ZO bank		INTEGER	1...5

Tab. 6-23: Input field probe zero point, rotary axis

Graphic field

Only a main or a secondary axis can be selected as reference

Rotary axis	Main axis	Secondary axis
C	X	Y
B	Z	X
A	Y	Z

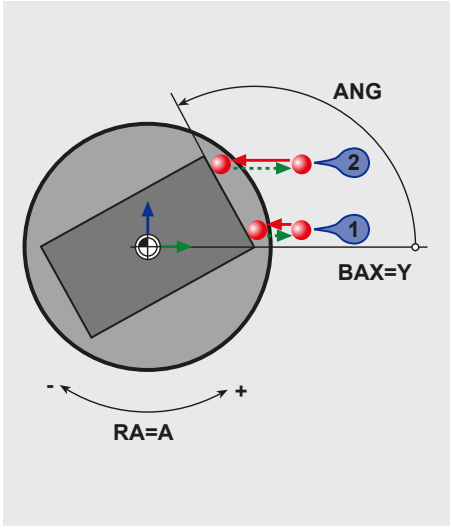
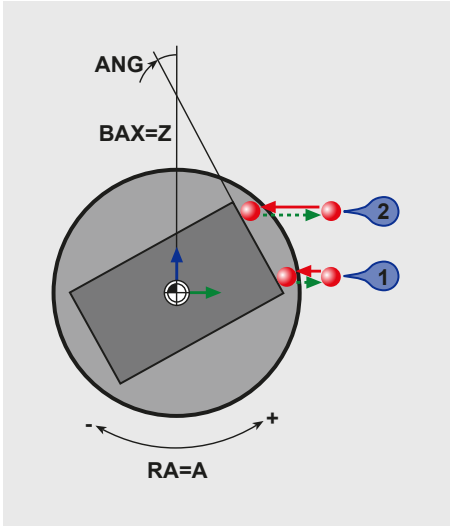
Tab. 6-24:

The following graphics are displayed depending on the selected rotary axis, the measuring direction and the reference:

Graphics displayed when selecting the A-axis:

Rotary axis	Measuring direction	Reference	Graphic
A	Y+	Y	
		Z	

Manual probing

Rotary axis	Measuring direction	Reference	Graphic
A	Y-	Y	
		Z	

Rotary axis	Measuring direction	Reference	Graphic
A	Z+	Y	
		Z	

Manual probing

Rotary axis	Measuring direction	Reference	Graphic
A	Z-	Y	
		Z	

Tab. 6-25: Graphics when selecting the A-axis

Graphics displayed when selecting the B-axis:

Rotary axis	Measuring direction	Reference	Graphic
B	Z+	Z	
		X	

Manual probing

Rotary axis	Measuring direction	Reference	Graphic
B	Z-	Z	
		X	

Rotary axis	Measuring direction	Reference	Graphic
B	X+	Z	
		X	

Manual probing

Rotary axis	Measuring direction	Reference	Graphic
B	X-	Z	
		X	

Tab. 6-26: Graphics when selecting the B-axis

Graphics displayed when selecting the C-axis:

Rotary axis	Measuring direction	Reference	Graphic
C	X+	X	
		Y	

Manual probing

Rotary axis	Measuring direction	Reference	Graphic
C	X-	X	
		Y	

Rotary axis	Measuring direction	Reference	Graphic
C	Y+	X	
		Y	

Manual probing

Rotary axis	Measuring direction	Reference	Graphic
C	Y-	X	
		Y	

Tab. 6-27: Graphics when selecting the C-axis

7 Commissioning

7.1 General information

The described measuring cycles are intended for the use at machine tools. The cycles can be used for probes to measures tools or workpieces.

Commissioning includes the following steps:

1. Setting the machine parameters
2. Adjusting Sercos files in the IndraMotion MTX NC control
3. Setting the drive parameters
4. Adjusting the PLC user program

Once these steps have been completed, the measuring functions are available.

7.2 Setting machine parameters

To use the measuring cycles, the machine parameters in IndraWorks Engineering have to be adjusted. For details on operating the configurator, also refer to:

DOK-MTX***-MA*PAR**V13-RERS-EN-P

Enabling the probe

In the first step, the probe function is enabled for the control.

The control is enabled in the data group **Setup of configuration data** via the parameter:

SUP/FuncGr[1]/EnablMeas	measure-	Value: Yes
ment (MEAS)		

Probe axis settings

Enter the axis names and the axis description to select the axes in the operating screens.

The data can be entered in the data group **Basic parameter channels** via the parameters:

ChAxName axis name (701000010)	Value: <Axis identifier>
ChAxClass axis description (701000030)	Value: Main axis X Y Z A B C

Probe drive settings

After the function has been enabled for the probe, the probe function and the edge type can be entered for each measuring axis.

The data can be entered in the data group **Optional parameters** via the parameters:

MEAS/DR[x]EnabMeas	Probe	function	Value: Yes
available (1003 000012)			
MEAS/DR[x]MeasEdge	Probe	edge	Value: positive/negative
(1003 000011)			

7.3 Setting drive parameters

Drive settings

To ensure that drives can use the integrated probe function, the "Servo function" function package has to be configured. The release of function packages can be checked in the **Function Packages** menu function at the drive node.

Commissioning

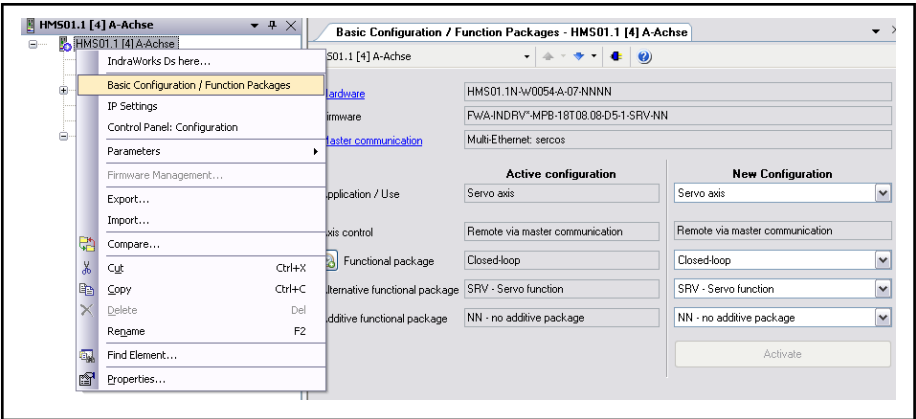


Fig. 7-1: checking the function package release in IndraWorks

Due to the properties on the control side, only 1 probe per drive axis can currently be supported. Please observe that only one probe per channel is listed in the control in parallel to the relevant drives that have been provided in the control configuration (machine parameters) for measuring.



To connect several probes, these are to be switched via relays or PLC input modules (relay contacts). This switchover has to be considered in the PLC user program.

Probe function specification

On the drive side, the following settings have to be configured in IndraWorks. Under "Local I/Os", one of the digital inputs is to be selected by left-click. Afterwards, the mask is displayed. For quick, μ s-accurate evaluation of the probe, it is recommended to assign it to the X31/3 input. For this, X31/8 has to be supplied with a voltage of 24 V against X31/9. The respective input is then assigned the "S-0-0401 probe 1" parameter in the pull-down menu.

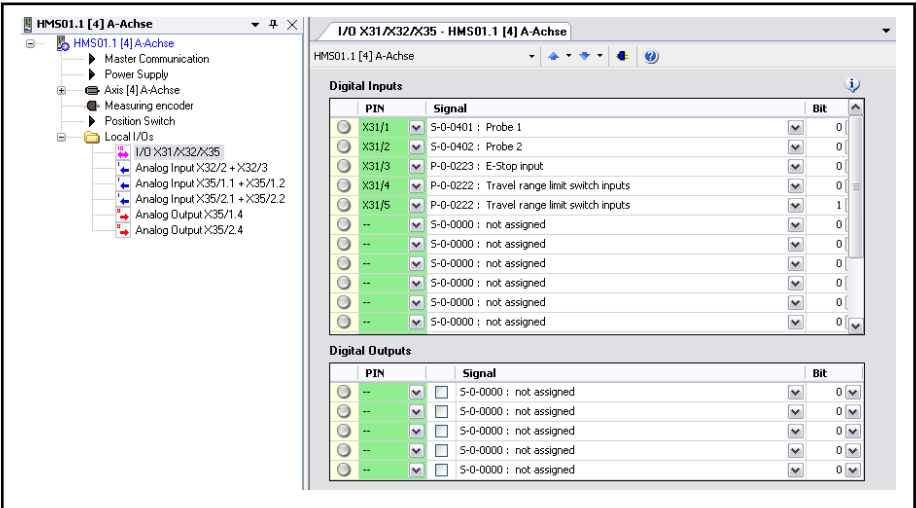


Fig. 7-2: Definition of the digital probe inputs in IndraWorks for single-axis devices

Special features of double-axis devices

Please ensure that the inputs X31/3 and X31/4 are used for double-axis devices.

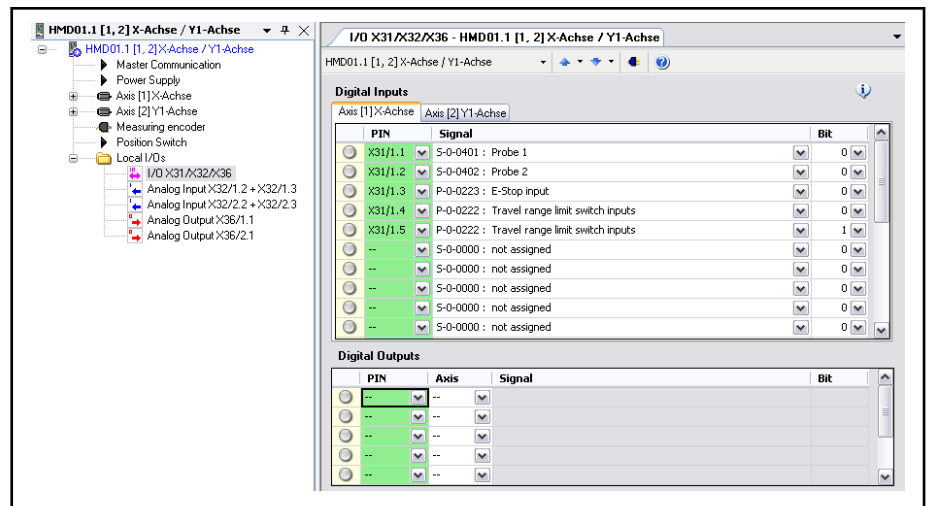


Fig. 7-3: Definition of the digital probe inputs in IndraWorks for double-axis devices

Signal selection touch probe

In S-0-0426, the signal selection for probe 1 is made:

- S-0-0051 Actual position value, encoder 1
- S-0-0053 Actual position value, encoder 2

In S-0-0427, the signals for probe 2 are selected:

- S-0-0051 Actual position value, encoder 1
- S-0-0053 Actual position value, encoder 2

7.4 PLC user program adjustment

7.4.1 General information

In the PLC user program, probe support functions are/have to be programmed:

1. *Mandatory PLC programming*
 - Activation/deactivation of probes
 - Collision monitoring for feed axes
2. *Optional PLC programming*
 - Reactivation of radio probes
 - Switching between several probes



The following description only illustrates the principle and the general tasks, partly according to a concrete example. In any case, the manufacturer documentation of the probe has to be observed for implementing PLC functions!

7.4.2 Activating/deactivating the probes

For activation/deactivation, the release of and, if necessary, switching between probes is usually realized by M-functions that have to be acknowledged.

Accordingly, a distinction is made:

- Probes that are activated once and never deactivated (e.g. fixed probes for tool and workpiece measurements)

Commissioning

- Probes that are activated via the NC program and temporarily deactivated and reactivated, if necessary (e.g. radio probes for workpiece measurements). In this case, a "Probe activated" PLC input signal is often provided.

In the SD.SysPrbase.PROBE[x].LOG.AUXON and .AUXOFF SD variables, the M-functions for activation/deactivation are stored. These are read out and applied by the measuring cycles. They have to be configured as auxiliary functions in the machine parameters that have to be acknowledged. It is recommended to display the state of the auxiliary function (on/off) in the M code display. For this purpose, these auxiliary functions have to be entered in groups and displayed.

AUXON The M-function to activate the probe is stored in the AUXON string variable (e.g. M97 for probe 1: SD.SysPrbase.PROBE[1].LOG.AUXON).

AUXOFF The M-function to deactivate the probe is stored in the AUXOFF string variable (e.g. M98 for probe 1: SD.SysPrbase.PROBE[1].LOG.AUXOFF).



These M-functions have to be accordingly programmed in the PLC. Also refer to [chapter "Specification of a probe PLC program" on page 178](#).

Manual probing



If "Manual probing" is activated, the reset information has to be written to the "SysPrMan.Reset" system date. Refer to [fig. 7-11 "Writing reset information in SD.SysPrMan.RESET system date" on page 184](#).

7.4.3 Collision monitoring for feed axes - PLC function block MT_AxProbe-Mon

General information

Principles

For the actual NC measuring task (NC command G75), the deflection signal of the probe is connected to the drive etc.

However, the PLC requires additional status information from the probe to be able to detect the following situations:

- Probe deflection without G75 (no active measurement)
- Probe deactivation during G75 (measuring distance active)
- Deactivated probe during G75 (measuring distance active)
- Prevention of motion "in the wrong direction" at the deflected probe

In all of these cases, it is recommended to set the **Axis motion lock**. Please refer to the following function block MT_AxProbeMon.

For this reason, the PLC has to know the following probe signals:

- Activation/deactivation state: "Ready for measuring" release with additional PLC input depending on the probe type
- Deflection state: same signal as drive, always with an additional PLC input
- G75 (measuring distance active): Derivations of the drive status bit in PLC via scs file (see below and documentation)

Prerequisite: Assigning G75 to the axis interface

By configuring the signal status word as described in chapter 4.2 (refer to the excerpt from the scs file regarding S-0-26 and S-0-328), the bit 0 of S-0-405

(probe 1 release) is mapped on the axis interface signal iAx_ScsState01, i.e. if G75 is active, iAx_ScsState01=TRUE applies. This signal has to be assigned to the bMeasureStatus input of the MT_AxProbeMon function block.

Brief description

Function block for probe axis monitoring

As of version 13, this function block is available in the "MT_BaseAdditional" PLC library. In order to implement the function block, this library has to be added to the PLC project.

Interface description

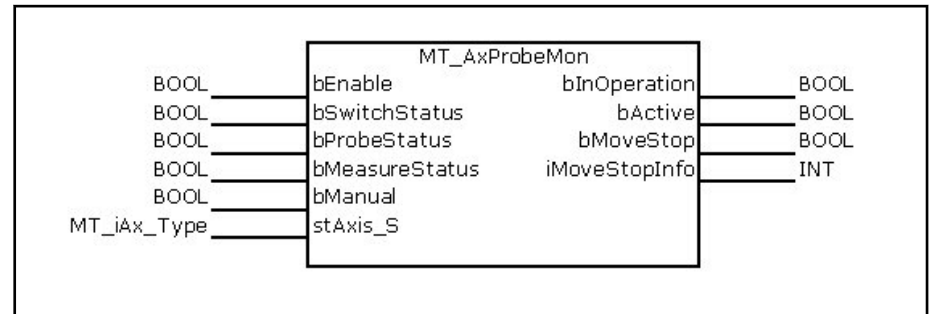


Fig. 7-4: Structure

	Name	Type	Description
VAR_INPUT	bEnable	BOOL	Activating probe monitoring
	bSwitchStatus	BOOL	Activation state of the probe (1==on, 0==off)
	bProbeStatus	BOOL	Deflection state of the probe (1==deflected, 0==not deflected)
	bMeasureStatus	BOOL	Measuring status (1==measurement active (G75), 0==measurement not active)
	bManual	BOOL	Main operating mode manual (1==manual active, 0==manual not active)
	stAxis_S	MT_iAx_Type	Axis interface status
VAR_OUTPUT	bInOperation	BOOL	Probe deflected, probe monitoring in progress
	bActive	BOOL	Probe monitoring active
	bMoveStop	BOOL	The motion lock for the axis has to be specifically programmed in the PLC program!
	iMoveStopInfo	INT	The motion lock message number has to be specifically programmed in the PLC program!

Tab. 7-1: Interface signals

Functional description

The function block MT_AxProbeMon enables monitoring an axis included in the measuring process. Axis motions after deflection of the activated probe in the same direction that leads to the destruction of the probe is prevented. This is possible during positioning of the probe by means of the NC program (G75 not active) and in jog mode if the output signal of the function block is respectively projected in the PLC user program.

Commissioning



The deflection signal of the probe is directly connected to the drive and in parallel to the PLC. When measuring with G75, the deflection signal triggers an immediate stop of the axis at the drive. The drive does not react if the probe is deflected without G75. The signal is running from the probe to the PLC. From there, DriveLock is sent to the NC and the signal is forwarded to the drive via Sercos. This long signal runtime leads to a respectively long reaction time. For this reason, stopping the axis by the PLC cannot replace the probe function in the drive!

In general, the function block output bMoveStop provides the option to prevent the axis motion via the interface signal qAx_DrvLock of the respective axis. The link has to be implemented by the PLC programmer.

If the function block is activated by setting bEnable, the states of all inputs are monitored. This is indicated by the bActive output. If a direction-related motion lock becomes active, the output bInOperation is set to TRUE. The reset of bEnable deletes all states stored in the function block as well as all outputs.



If the probe is deactivated, the function block cannot determine its actual deflection state. The deflection state (bProbeStatus) is only monitored if the probe is activated (bSwitchStatus).

In the moment of the deflection, the function block stores the active motion direction of the axis and recommends a motion lock in the following situations:

Motion lock on assumed probe abort

- iMoveStopInfo=1000
- If an activated probe aborts during driving without G75, this corresponds to a brief deflection. If this happens in automatic mode, a motion lock is recommended (bMoveStop) even if the probe is no longer deflected. This can only be canceled by deleting the travel command.

Motion lock if probe deflected and deactivated

- iMoveStopInfo=1001
- If a previously deflected probe is deactivated, the previously recommended motion lock is retained. This can either be canceled by reactivation of the probe or by canceling the travel command.

Motion lock on measuring with deactivated probe

- iMoveStopInfo=1003
- When traveling with G75, the NC programmer expects that the drive stops the axis if the probe is triggered. However, this is only the case if it is activated. For this reason, the motion lock is recommended if the probe is not activated and the travel command for measuring (G75) applies. This can only be canceled by canceling the travel command or activation of the probe.

Direction-related motion lock

- iMoveStopInfo=2001 or 2002
- If the probe is activated and deflected, a motion lock is recommended (bMoveStop) if a motion is signaled in deflection direction. For a deflection direction opposite to the motion signal, the motion lock (bMoveStop) is deleted.

Message texts

The function block provides an explanation for all recommended motion locks (bMoveStop) at the iMoveStopInfo output.

The following messages are recommended to the operator and have to be integrated in the message text file:

iMoveStopInfo	Message type	Message text	Cause text	Remedy text
1000	Errors	Axis stopped, probe potentially broken off, delete travel command	The probe is currently not deflected, however, was previously deflected during travel without G75. For this reason, a probe breakage is assumed	The motion lock can be canceled by deleting the travel command
1001	Warning	Axis stopped, probe deflected and deactivated, reactivate probe	The probe was deflected and deactivated. The motion lock is still active	Reactivate probe
1003	Warning	Axis stopped, G75 travel command on deactivated probe, activate probe	The measurement was started with G75 and the travel command for this axis was detected. However, the probe required for measurement was not activated	The motion lock can be canceled by activating the probe or by aborting the measurement
2002	Note	Axis stopped, probe deflected, move axis only in positive direction	Motion signal of the axis in negative direction although the probe is deflected in this direction	Move the axis in positive direction
2001	Note	Axis stopped, probe deflected, move axis only in negative direction	Motion signal of the axis in positive direction although the probe is deflected in this direction	Move the axis in negative direction

Tab. 7-2: Operator message recommendations

Implementation example

The function block has to be programmed separately for each feed axis in the PLC.

For a complete example, refer to the end of this chapter.

7.4.4 Reactivation of Radio Probes

Radio probes remain only active for a limited time after activation (e.g. 2 minutes) and are automatically deactivated after this time if no switching process has taken place during this time (otherwise, the deactivation time is re-triggered by the internal logics of the radio probe on switching).



For the exact conditions, refer to the manufacturer documentation of the probe.

Commissioning

For proper function, "reactivation after automatic deactivation" is required. The PLC has to detect automatic deactivation and reactivate the probe. Depending on the probe, it may be necessary to wait a specific time (e.g. 9 sec).

PLC tasks during this time:

- Activation of the motion lock for the axes
- Setting the stipulated "Custom bit x" in the channel interface to the NC

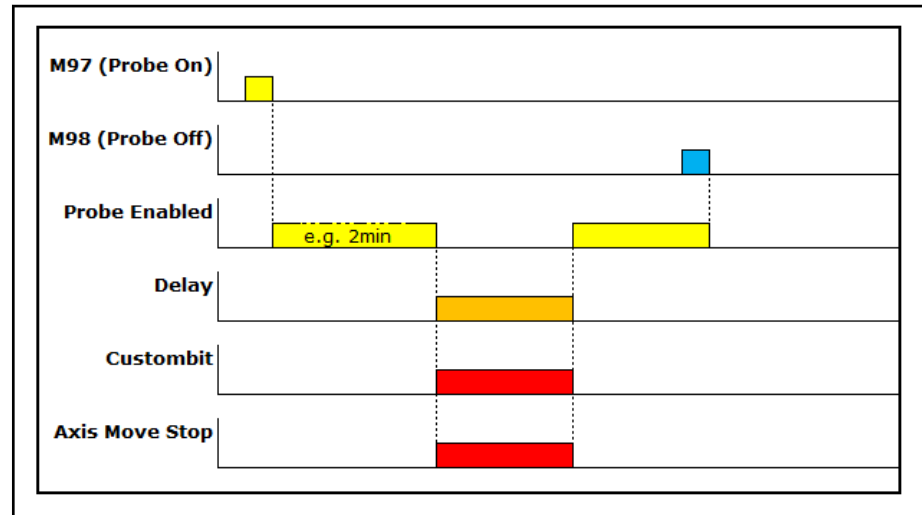


Fig. 7-5: Signal curve on reactivation of radio probes



If required, this function has to be accordingly programmed in the PLC. Also refer to the example at the end of this chapter.

Whether and with which behavior radio probes are applied has to be defined in the SD.SysPrbase.PROBE[x].LOG.RETRIG and .CUSBIT SD variables. These are read out and processed by the NC measuring cycles.

RETRIG The Boolean variable RETRIG has to be set to "TRUE" if a probe with time-related self-deactivation is applied (e.g. TRUE for probe 1: SD.SysPrbase.PROBE[1].LOG.RETRIG).

CUSBIT In the single-digit string variable CUSBIT, the number of the channel custom bit for the PLC for reporting the "Reactivation after automatic deactivation" information is stored (e.g. "8" for probe 1: SD.SysPrbase.PROBE[1].LOG.CUSBIT for probe 1 etc.)



The property "Reactivation" and the stipulated "Custom bit" also have to be specified in the PLC. In the example at the end of this chapter, the data are programmed in the PLC, however not read out from the SD variable.

7.4.5 PLC implementation example

General information

The following example illustrates mandatory and optional programming for PLC integration of probes.

Requirements

The example is subject to the following requirements:

- Two probes with a switchover in between

- *M-functions to be acknowledged for activation and deactivation of the probes or for release:*
 - Probe 1: On: M97; Off: M98
 - Probe 2: On: M99; Off: M100
- *Probe 1 is a radio probe (for "workpiece measurement"):*
 - Consideration of reactivation on automatic deactivation
 - Provides signal for "activated" to the PLC
 - Application of the inverted switching signal for deflection
- Probe 2 is permanently activated and provides a switching signal, however no signal for "activated" to the PLC (for "tool measurement")
- The switchover between probe 1 and 2 is implemented by a PLC output signal to a relay

The SD variables for probe 1 and 2 have to be assigned the following values (entered in the HMI setup mask or in the NC variable editor):

- *Probe 1 SD.SysPrbase.PROBE[1].LOG.*
 - AUXON M97
 - AUXOFF M98
 - RETRIG true
 - CUSBIT 8
- *Probe 2: SD.SysPrbase.PROBE[2].LOG.*
 - AUXON M99
 - AUXOFF M100
 - RETRIG false or <do not enter any value>
 - CUSBIT <do not enter a value>

Probe example data



The following description only illustrates the principle and the general tasks using an example. In any case, the manufacturer documentation of the probe has to be observed for implementing PLC functions!

Global Variables

Some general signals and I/O variables are functionally specified, e.g. in a global variable list.

Global variable list for the probe example

```
VAR_GLOBAL
(*
conditions at Mahomat shopfloor Lohr:
1.) probe 2 is always on and therefore needn't to switch on/off again (no M99, M100)
   It doesn't exist an PLC-input for the switched on status for probe 2.

2.) probe 2 supports a single signal for deflection
   probe 1 supports a double signal for deflection (normal and inverted signal)

3.) The selection of the right probe must be done with an external electrical switch.
   Only this signal is transferred to the drive and the PLC as the "deflection signal".
   The input-signal in the PLC is always on "%IX23.3".
   The inverted signal "%IX23.0" from probe 1 is not wired to the drives!
   That's why this signal is also not wired into the PLC neither.
   (*iPROBEpos          AT %IX23.0 : BOOL; (* probe status positiv*)*)
*)

(*signal: probe is deflected for probe 1 and 2*)
(*signal is only valid for the selected probe 1 or 2*)
iPROBEneg          AT %IX23.3      : BOOL; (* input: probe status negativ *)
```

Commissioning

```

iPROBE_LOWBAT      AT %IX23.1      : BOOL; (* input: probe 1 battery low status*)
iPROBE_OK          AT %IX23.2      : BOOL; (* input: probe 1 OK and active*)
qPROBE_ON          AT %QX7.6       : BOOL;  (* output: probe 1 switch on*)

(*bProbeSwitchRelay AT %QX13.0: BOOL :=TRUE; (*not used*)*)

(*to switch the deflection signal between probe 1 and 2*)
(*1 == probe 2 is selected *)
(*0 == probe 1 is selected*)
bProbeChange       AT %QX14.0      : BOOL;  (*output: switch between probe 1 (FALSE) and 2 (TRUE)*)
END_VAR

```

Specification of a probe PLC program

An independent PLC program with all mandatory and optional program parts is functionally programmed.

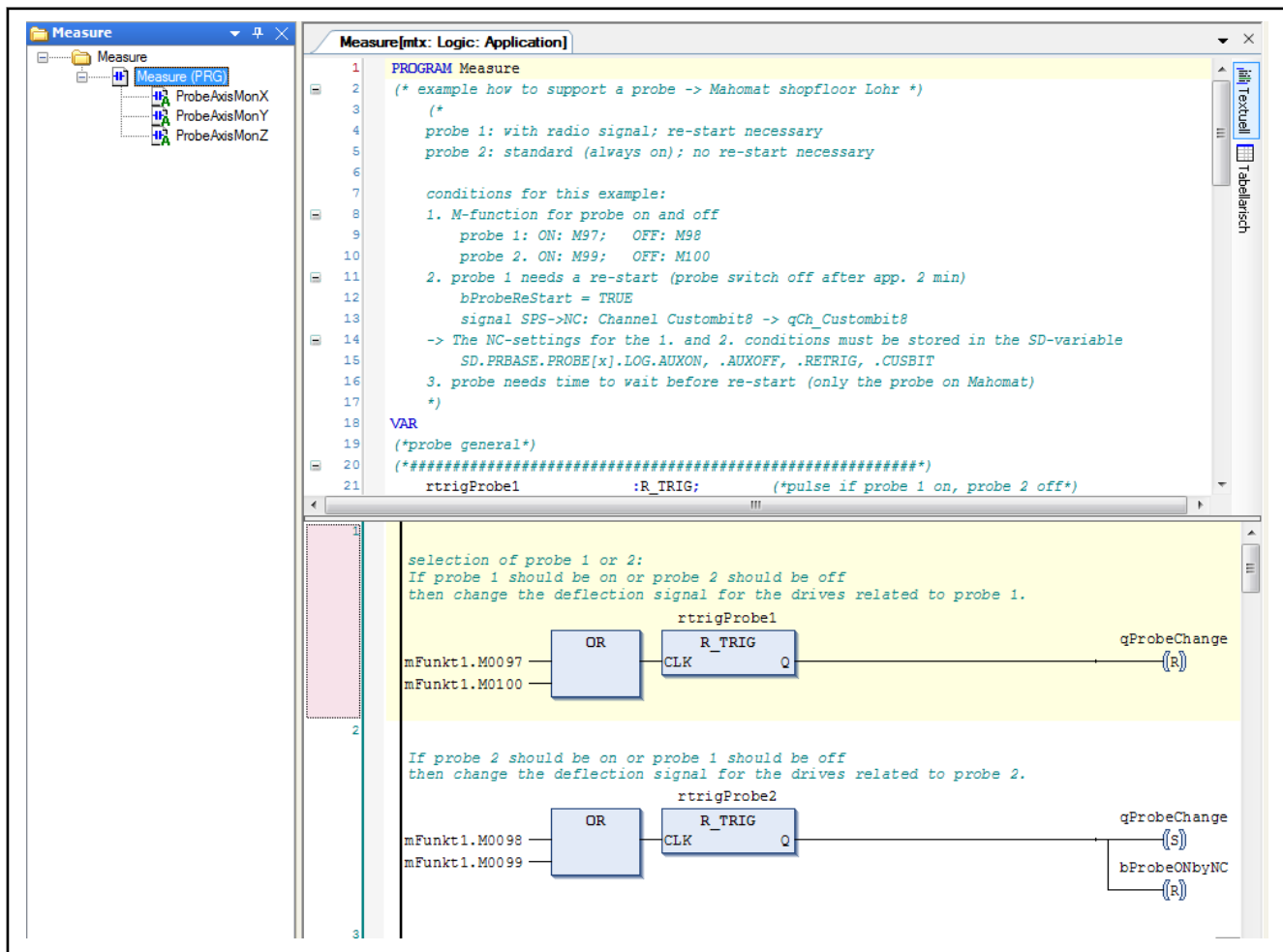


Fig. 7-6: Program measure for probe example

Declaration example program measure

Declaration program measure for probe example

```

PROGRAM Measure
(* example how to support a probe -> Mahomat shopfloor Lohr *)
(*
probe 1: with radio signal; re-start necessary
probe 2: standard (always on); no re-start necessary

conditions for this example:
1. M-function for probe on and off
   probe 1: ON: M97;   OFF: M98
   probe 2: ON: M99;   OFF: M100

```

Commissioning

```

2. probe 1 needs a re-start (probe switch off after app. 2 min)
   bProbeReStart = TRUE
   signal SPS->NC: Channel Custombit8 -> qCh Custombit8
-> The NC-settings for the 1. and 2. conditions must be stored in the SD variable
   SD.SysPrbase.PROBE[x].LOG.AUXON, .AUXOFF, .RETRIG, .CUSBIT
3. probe needs time to wait before re-start (only the probe on Mahomat)
*)
VAR
(*probe general*)
(*****)
rtrigProbe1      :R_TRIG;      (*pulse if probe 1 on, probe 2 off*)
rtrigProbe2      :R_TRIG;      (*pulse if probe 2 on, probe 1 off*)

(*probe 1*)
(*-----*)
bProbeReStart    :BOOL:= TRUE;  (*! must be TRUE if probe has to be re-started !*)
bProbeONbyNC     :BOOL;         (*probe was activated by NC (M-function)*)

rtrigProbeOK     :R_TRIG;      (*pulse if probe switched on *)
ftrigProbeOK     :F_TRIG;      (*pulse if probe switched off*)
bSwitchStatus    :BOOL;        (*probe status on / off*)

tWaitBeforeProbeReStart :TIME:=T#9s;  (*time to wait before next re-start of probe*)
tpWaitBeforeProbeReStart :TP;        (*timer to wait before next re-start of probe*)
bProbeReStartReq  :BOOL;        (*automatically probe re-start requested*)

fbProbeSwitch    :IL Toggle;    (*toggle to switch on the probe*)
tProbeSwitch     :TIME:=T#2s;    (*time to wait for change output-signal (Renishaw)*)
tonProbeSwitch   :TON;          (*timer because of Renishaw behaviour*)

(*axes monitoring*)
(*****)
(*monitoring axis X*)
(*-----*)
fbProbeAxisMonX  :MT_AxProbeMon; (*FB for probe monitoring of an axis*)
bInOperationX    :BOOL;          (*The probe is on and the correct traveldirection monitored *)
bActiveX         :BOOL;          (*process active*)
bMoveStopX       :BOOL;          (*signal for drive lock*)
iMoveStopInfoX   :INT;           (* for all axes:
    1000 probe potentially broken, reset axis travel command (Measuring active)
    1001 Collision through travelling without G75 (Measuring active)
    1002 Collision through travelling with G75 (Measuring active)
    2001 positive direction is not possible, probe was pushed in this direction
    2002 negative direction is not possible, probe was pushed in this direction*)

(*monitoring axis Y*)
(*-----*)
fbProbeAxisMonY  :MT_AxProbeMon; (*FB for probe monitoring of an axis*)
bInOperationY    :BOOL;          (*The probe is on and the correct traveldirection monitored *)
bActiveY         :BOOL;          (*process active*)
bMoveStopY       :BOOL;          (*signal for drive lock*)
iMoveStopInfoY   :INT;           (*see X-axis*)

(*monitoring axis Z*)
(*-----*)
fbProbeAxisMonZ  :MT_AxProbeMon; (*FB for probe monitoring of an axis*)
bInOperationZ    :BOOL;          (*The probe is on and the correct traveldirection monitored *)
bActiveZ         :BOOL;          (*process active*)
bMoveStopZ       :BOOL;          (*signal for drive lock*)
iMoveStopInfoZ   :INT;           (*see X-axis*)
END_VAR

```

Commissioning

Implementation example program Measure

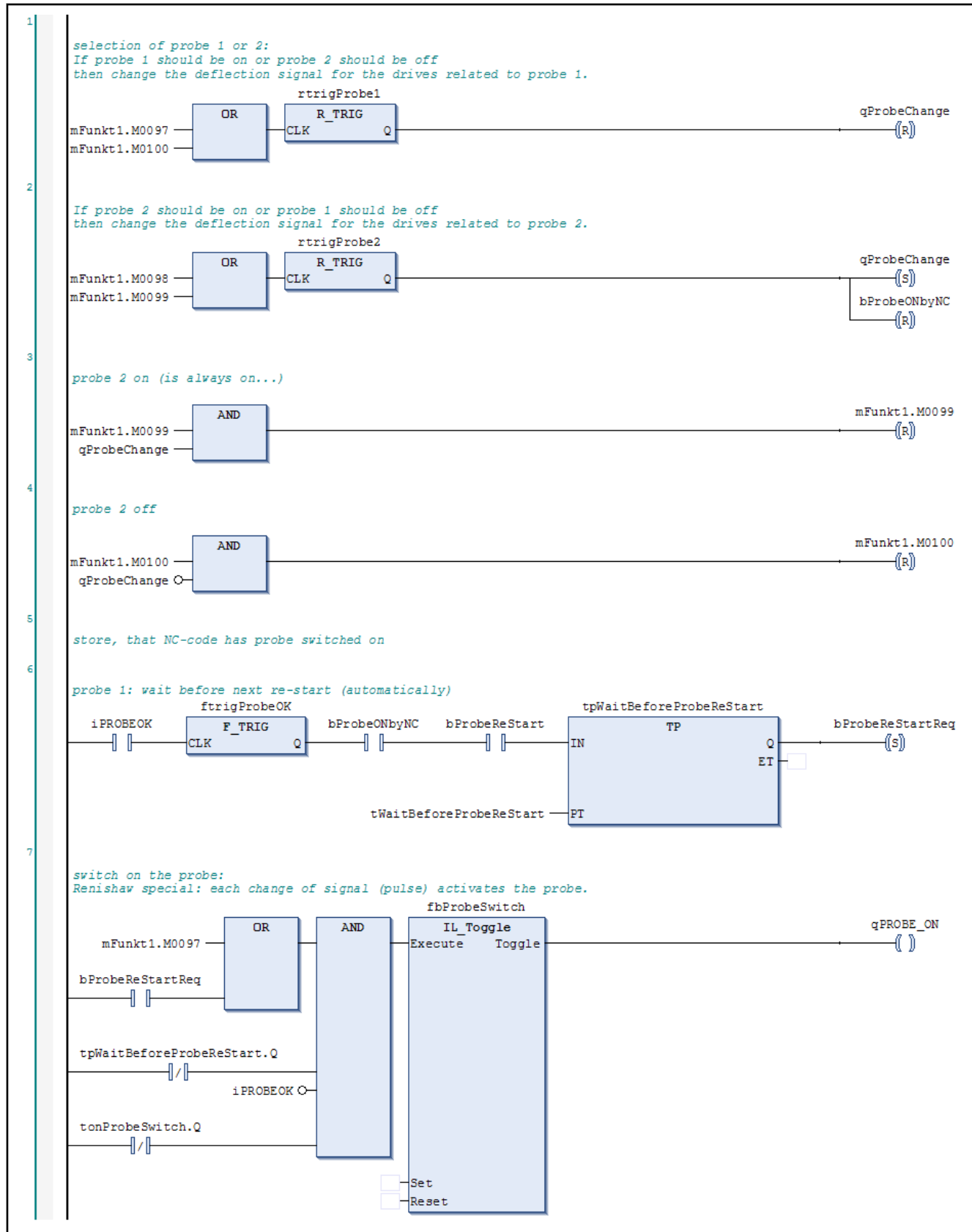


Fig. 7-7: Implementation program measure for probe example 1

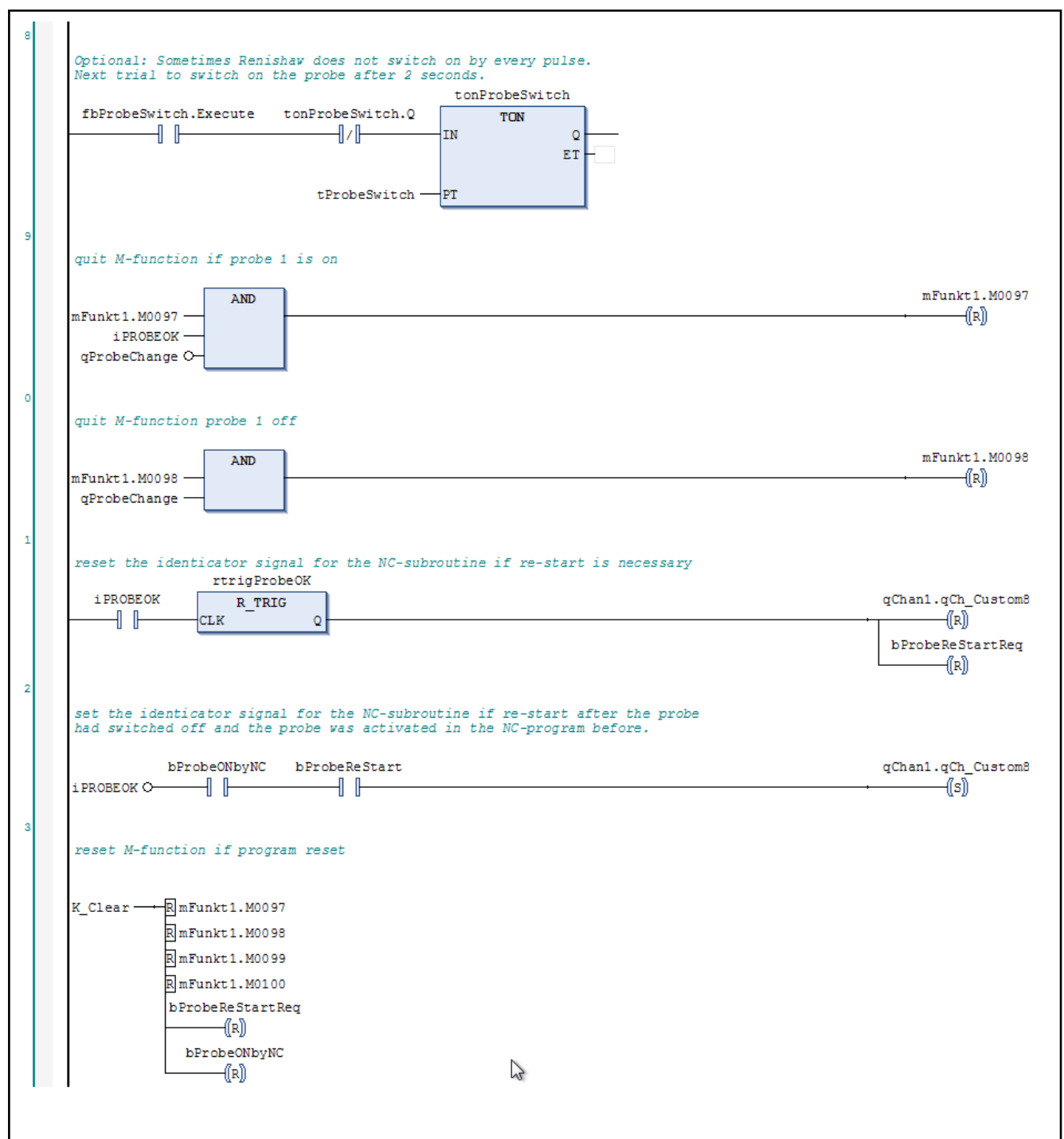


Fig. 7-8: Implementation program measure for probe example 2

Measure.ProbeAxisMonX action with MT_AxProbeMon function block (Y, Z respectively equal):

Commissioning

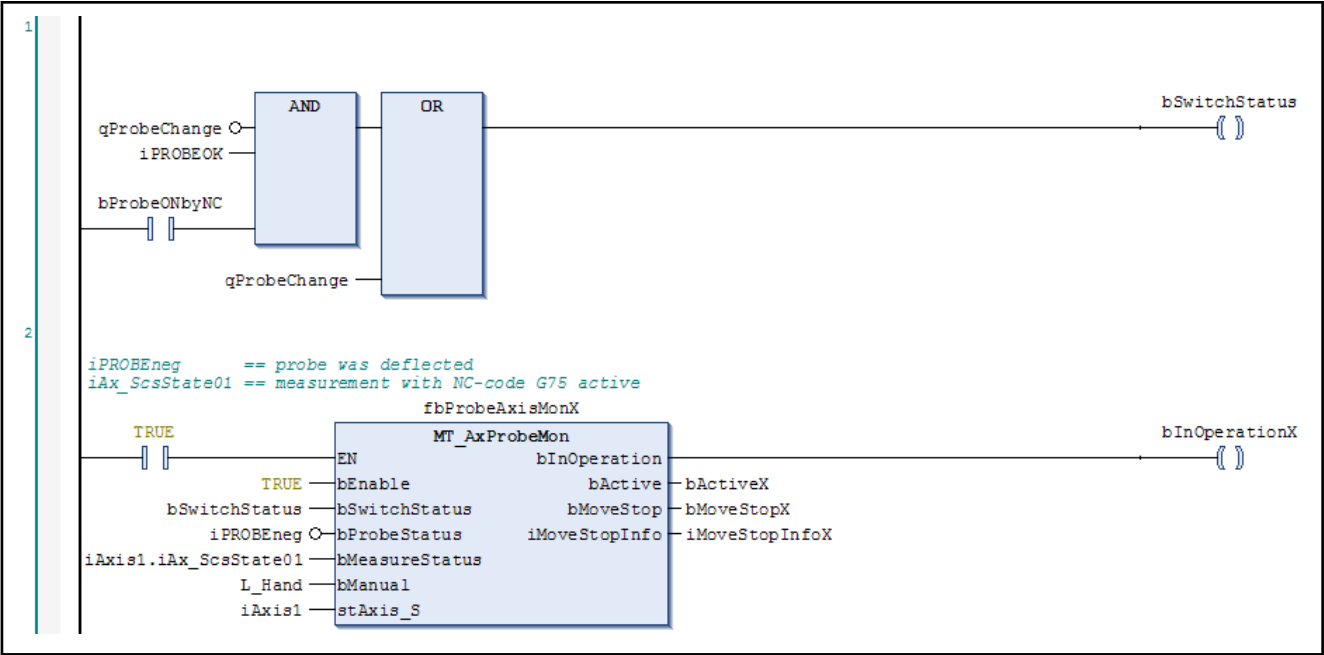


Fig. 7-9: Implementation action for X axis monitoring for probe example 1

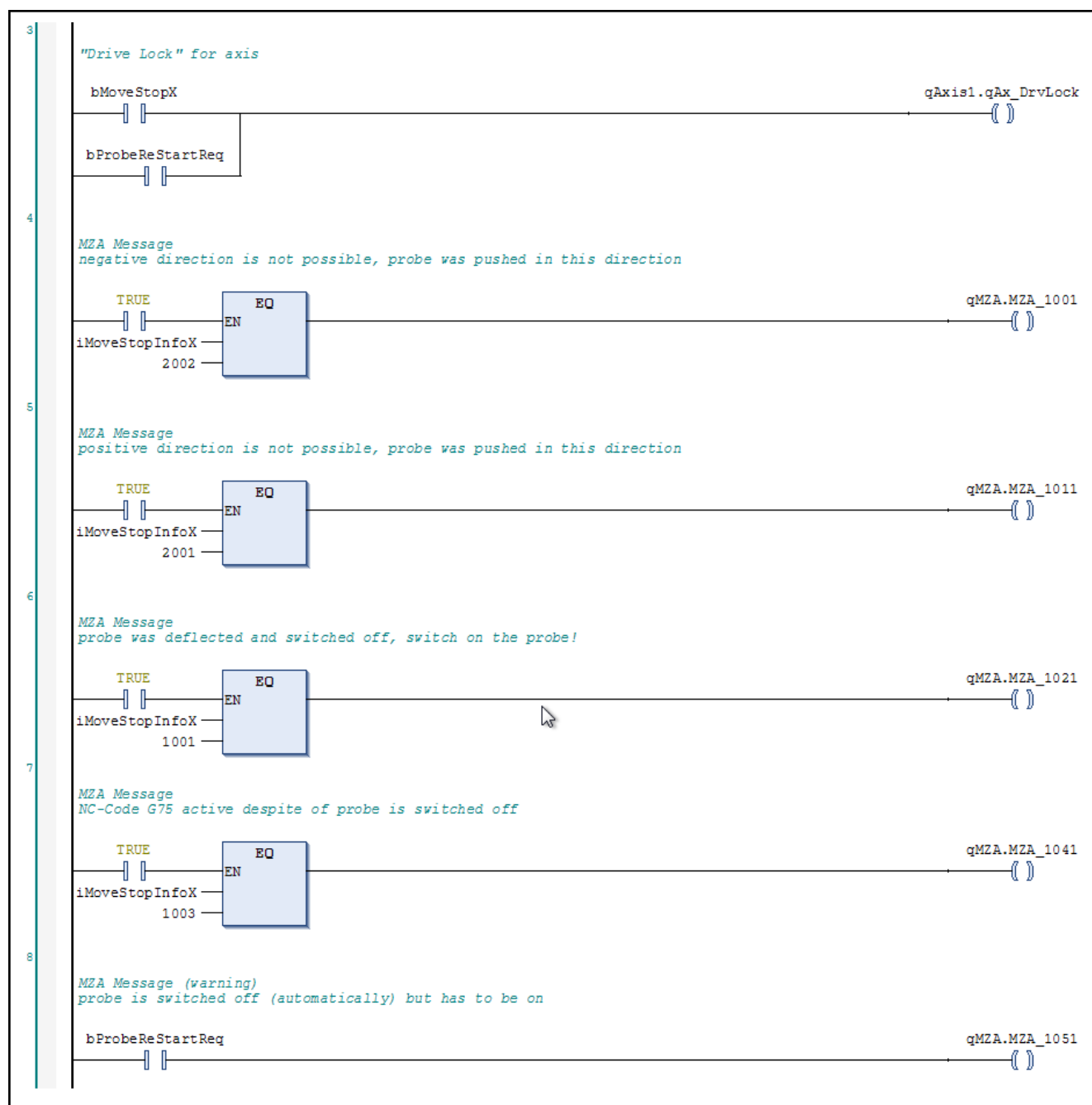


Fig. 7-10: Implementation action for X axis monitoring for probe example 2

As message text for motion lock of the axis during the time period of expected reactivation of the probe by the PLC, the following message text file entry is recommended.

Event	Message type	Message text	Cause text	Remedy text
PLC variable bProbeReStartReq according to example	Warning	Axis stopped, the probe was deactivated automatically, automatic reactivation not active	After expiry of the activation time, the probe was automatically deactivated, axis motion lock active	The probe is activated by the PLC or has to be reactivated by the "probe on function", the motion lock is then canceled again

Tab. 7-3: Operator message recommendation

Commissioning



Before an ASUP is processed in "manual" operation mode for "Manual probing", it has to be ensured that a NC start can also be executed in this operation mode.

Example to write the reset information to "SysPrMan.Reset" on "Manual probing":

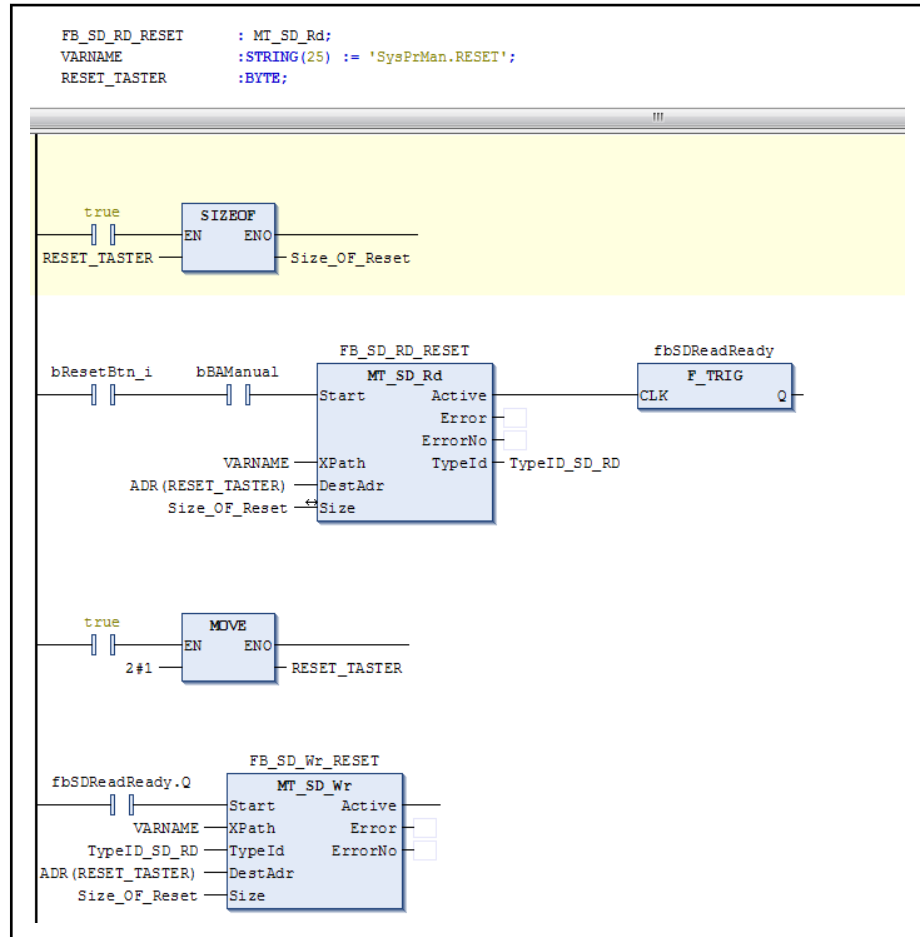


Fig. 7-11: Writing reset information in "SD.SysPrMan.RESET" system data

7.5 SD variables

7.5.1 Standard structure

In order to be able to define the SD variables, the relevant scheme types as well as the definition files have to be provided by copying and renaming the template files available in the root/feprm or root/feprm/schemes directory to the root/usrfep or root/usrfep/schemes directory.

The standard SD variables contain the geometry data of a tool probe, the positioning velocity, the auxiliary functions, the calibration values as well as the variables for storing the measuring results. The variable names are SD.SysPrBase, SD.SysPrResult and SD.SysPrMan and are available in the standard.

Scheme definitions:

Type	Definition file in the root/feprom/ schemes directory	Structure of SD variables
SysPrBase_t	sdprbase.xsd	chapter 5.4 "SD variables for probe data" on page 96
SysPrMan_t	sdprman.xsd	chapter 5.4 "SD variables for probe data" on page 96
SysPrResult_t	sdprresult.xsd	chapter 5.4 "SD variables for probe data" on page 96

Tab. 7-4: Scheme definitions

SD definition files:

	Definition file in the root/feprom directory
Variable definition:	SDDefPrb.xml
Variable initialization:	SDDatPrb.xml

Tab. 7-5: SD definition files

7.5.2 Structure expansion

Files in *.xsd format can be opened with the provided scheme editor. The editor can be found in the start menu under **Programs ▶ Rexroth ▶ IndraWorks ▶ MTXTools ▶ SchemeEditor**. In order to expand the structure for multiple probes, axes or channels, the respective scheme file (e.g. sdprbase.xsd) has to be copied to the root/schemes directory and opened to make changes. After successfully checking the changes, the changed files are to be moved to the usr/feprom/schemes directory.



In order to apply the changes of the files sdprbase.xsd or SDDefPrb.xml, an NC restart has to be carried out.

Expanding the structure for multiple probes

In the provided file sdprbase.xsd, two probes are already available. For example, if three probes are to be operated, line 7 of sdprbase.xsd is to be changed as follows:

Original: Line 8: <xs:elementname="PROBE"maxOccurs="2">

Changed: Line 8: <xs:elementname="PROBE"maxOccurs="3">

Expanding the structure for multiple axes

In the provided file sdprresult.xsd, three axes are available. For example, if the structure is to be extended to eight axes, the lines 11 and 34 of sdprresult.xsd are to be changed as follows:

Original: Line 11: <xs:elementname="AXIS"maxOccurs="3">

Line 11: <xs:elementname="AXISRES"type="xs:float"maxOccurs="3"/>

Changed: Line 11: <xs:elementname="AXIS"maxOccurs="8">

Line 11: <xs:elementname="AXISRES"type="xs:float"maxOccurs="8"/>

Expanding the structure for multiple channels

The file SDDefPrb.xml can be opened with the SD configurator.

In the **Dimension** column, "Channel" is to be selected.

Commissioning

7.6 Initialization screen

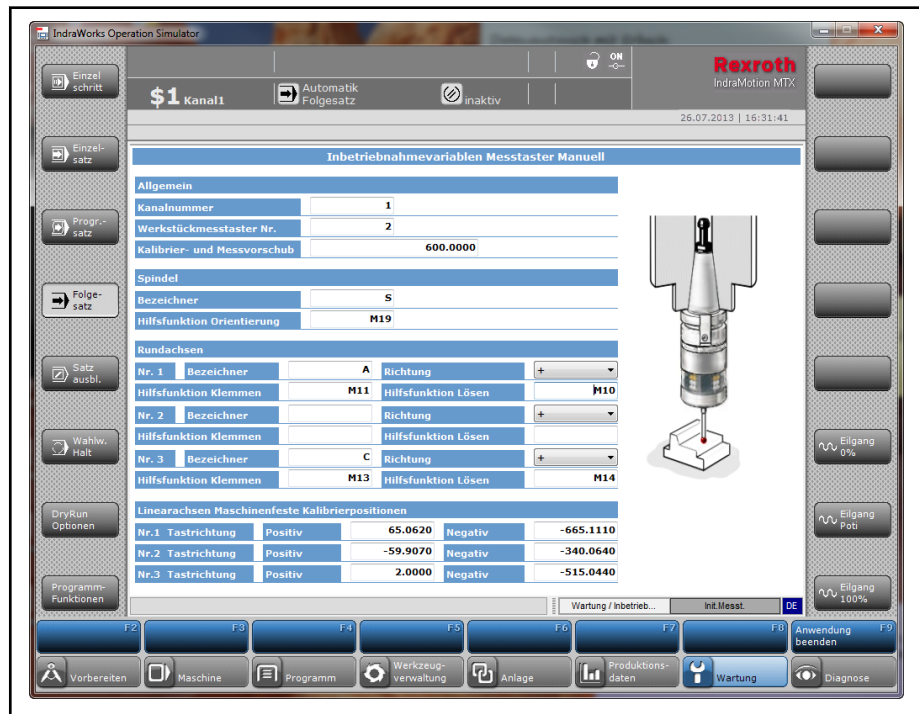


Fig. 7-12: Probe initialization of manual functions

The initialization screen serves for easy adjustment of individual functions to the machine.

The following variables are to be entered:

Channel number for the functions

Probe number

Measuring and calibration feed

Spindle identifier

Auxiliary function for spindle orientation

Rotary axes:

Axis no. 1

Identifier (A)

Direction (+/-)

Auxiliary function for clamping

Auxiliary function for unclamping

Axis no. 2

Identifier (B)

Direction (+/-)

Auxiliary function for clamping

Auxiliary function for unclamping

Axis no. 3

Identifier (C)

Commissioning

- Direction (+/-)
- Auxiliary function for clamping
- Auxiliary function for unclamping
- Machine-fixed positions of the linear axes:
 - Axis no. 1
 - Probing direction X+
 - Probing direction X-
 - Axis no. 2
 - Probing direction Y+
 - Probing direction Y-
 - Axis no. 3
 - Probing direction Z+
 - Probing direction Z-

Tab. 7-6: Probe initialization of manual functions

Commissioning

Probe images

Probe 1 (tool probe):

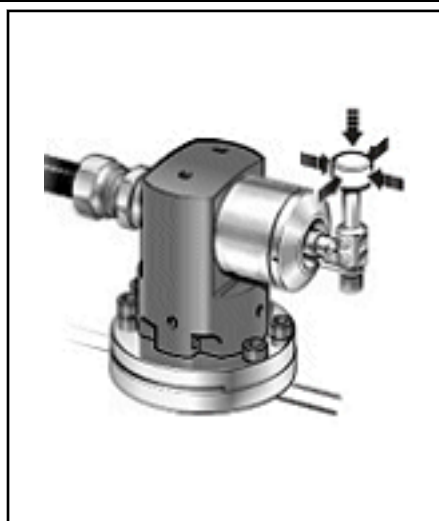


Fig. 7-13:

Probe 2 (workpiece probe):

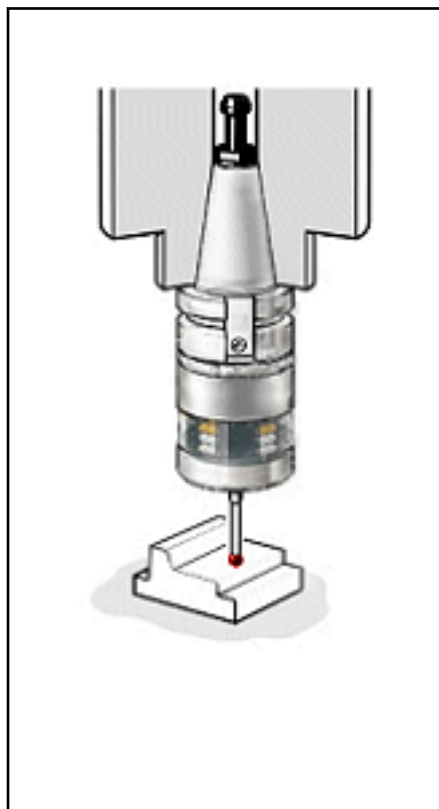


Fig. 7-14:

Tab. 7-7: Probe images

Commissioning

Workpiece probe commissioning and service screen

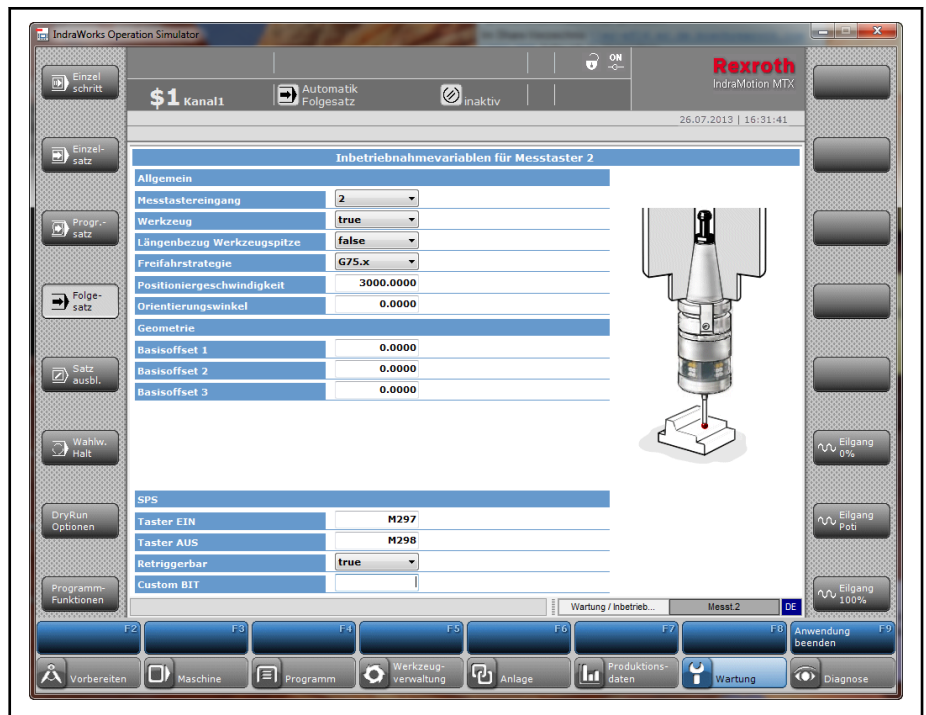


Fig. 7-15: Commissioning screen 1

Tool probe commissioning and service screen

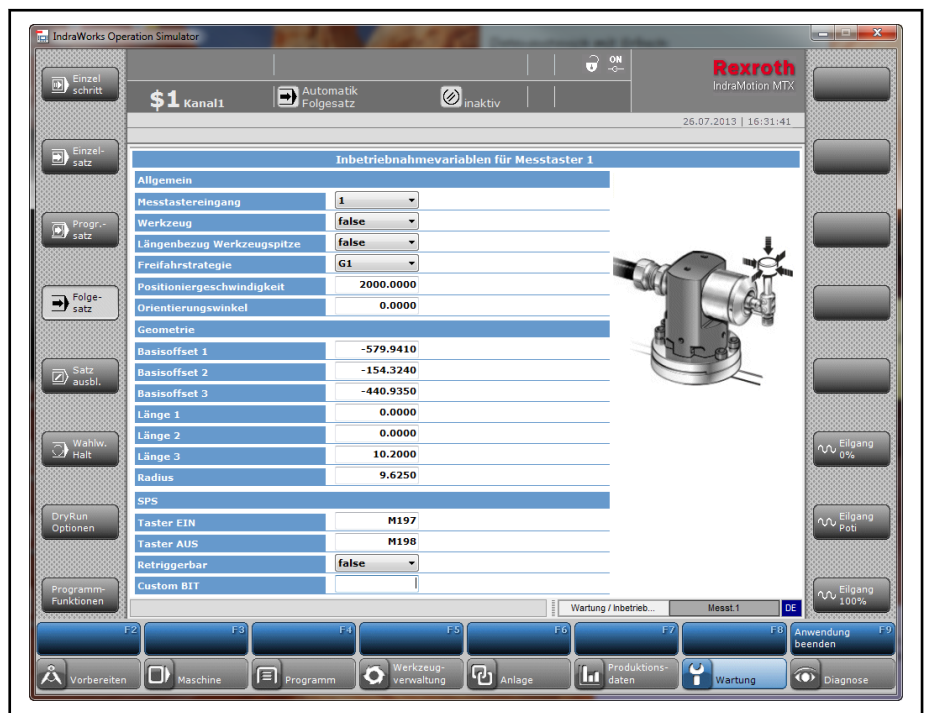


Fig. 7-16: Commissioning screen 2



The screens for "manual and automatic" probe commissioning can be used for a maximum of 2 probes.

If the number of probes was extended to more than 2 as described under [chapter 7.5 "SD variables"](#) on page 184, the values can be entered only by means of a variable list.

Commissioning

7.7 Mechanical installation examples

7.7.1 Probe installation examples

Lathe - Workpiece probing

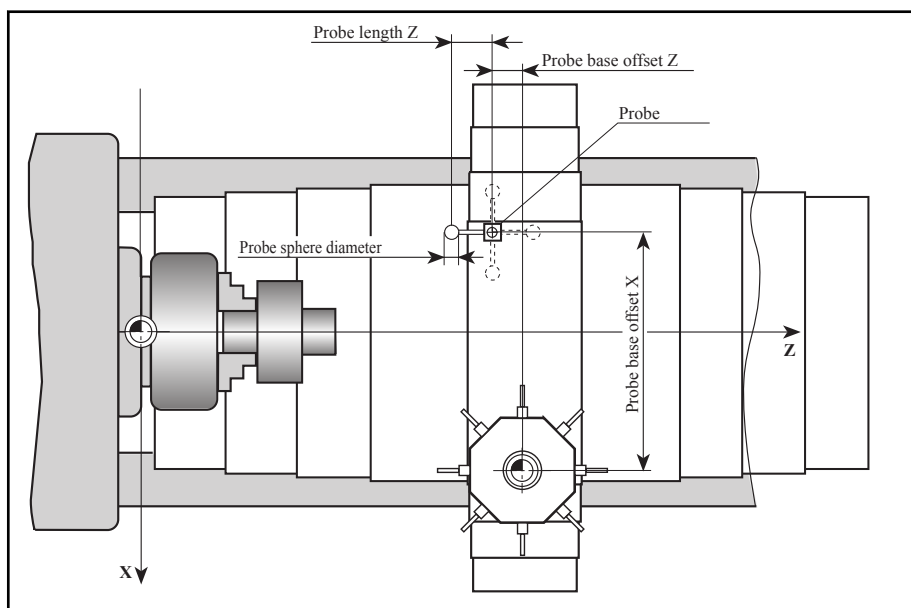


Fig. 7-17: Lathe - Workpiece probing

Lathe - Tool probing

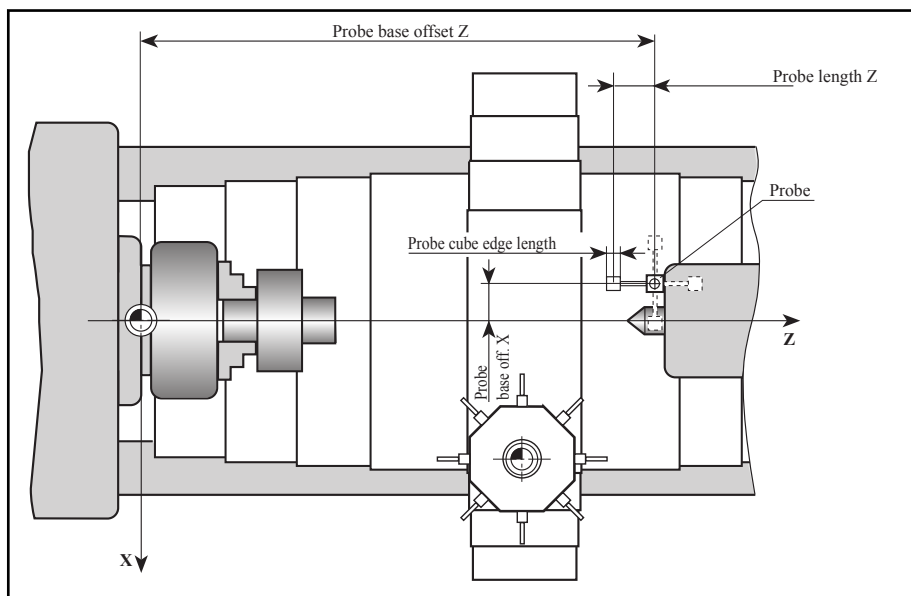


Fig. 7-18: Lathe - Tool probing

Milling machine - Workpiece probing

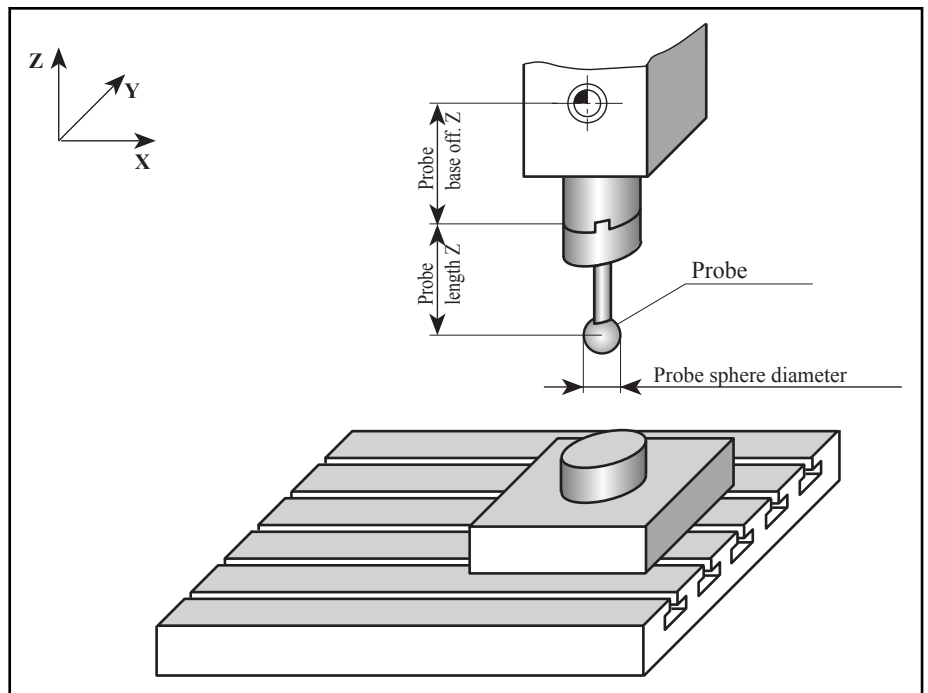


Fig. 7-19: Milling machine - Workpiece probing

Milling machine - Tool probing

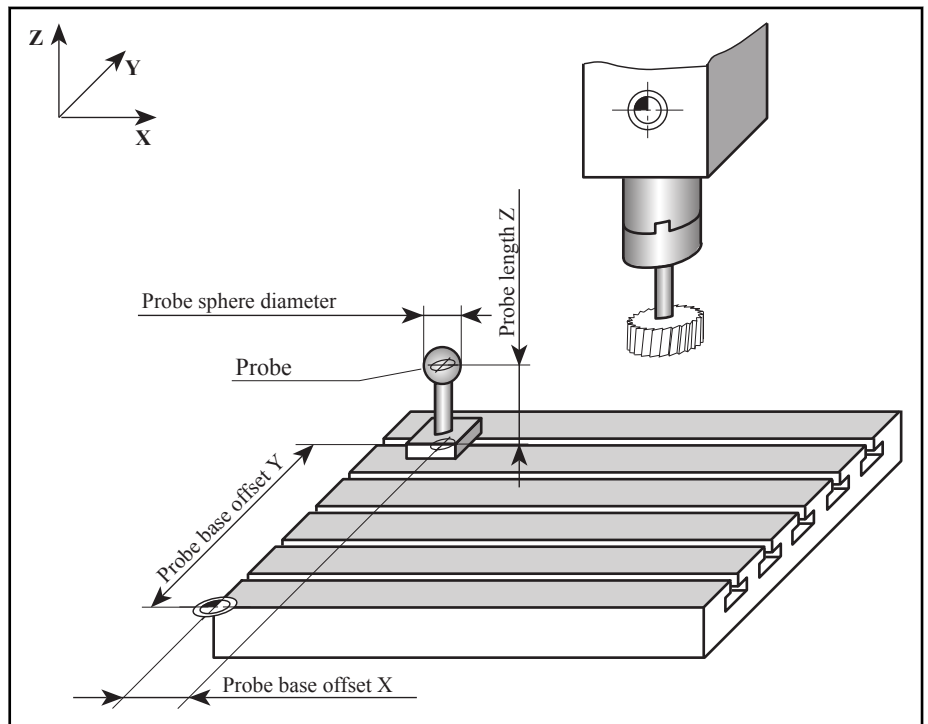


Fig. 7-20: Milling machine - Tool probing

Commissioning

7.8 Electrical connection diagram example

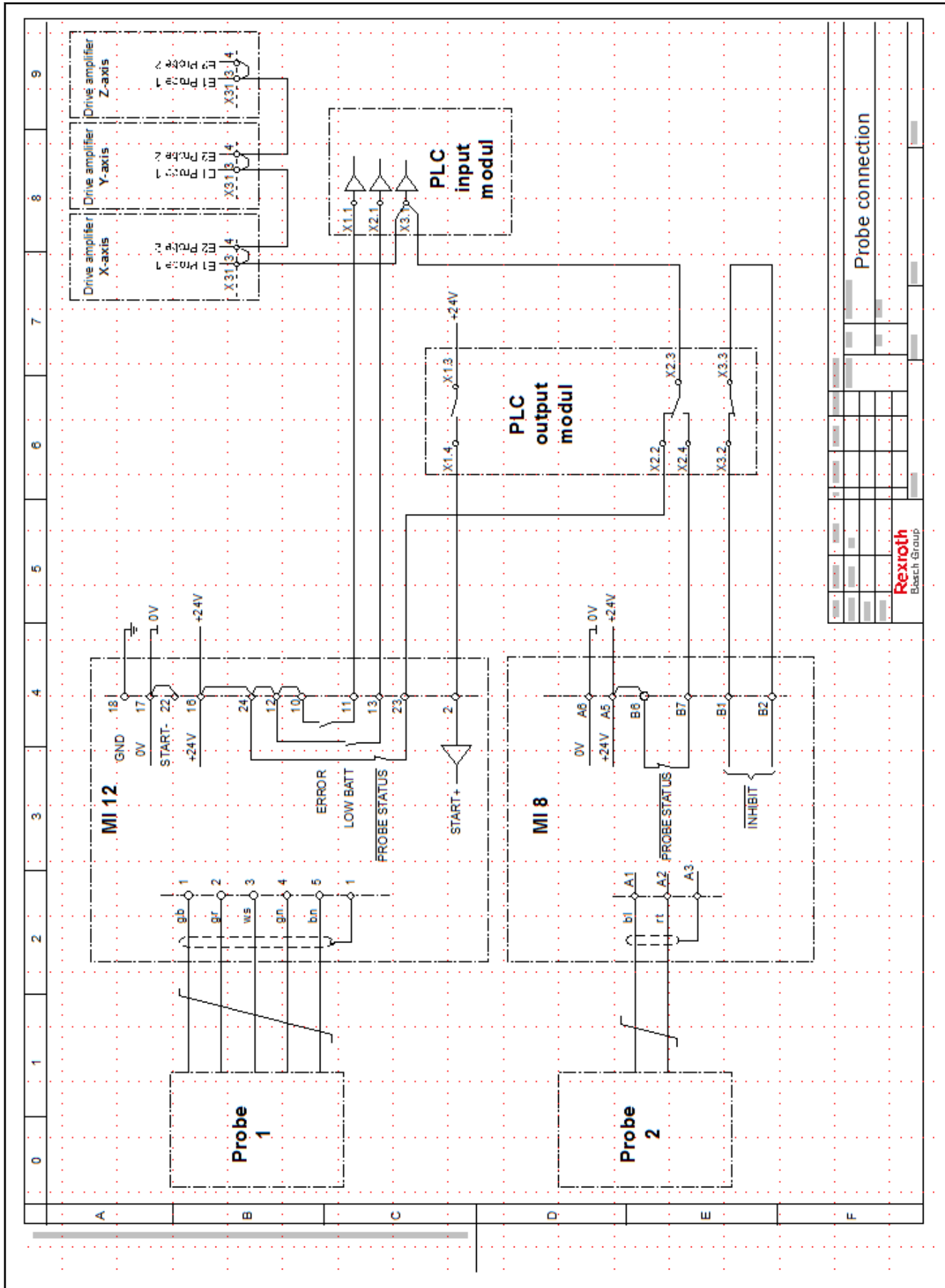


Fig. 7-21: Probe connection

8 Service and support

Our worldwide service network provides an optimized and efficient support. Our experts offer you advice and assistance should you have any queries. You can contact us **24/7**.

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Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

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Phone: **+49 9352 40 5060**
Fax: **+49 9352 18 4941**
E-mail: service.svc@boschrexroth.de
Internet: <http://www.boschrexroth.com/>

Additional information on service, repair (e.g. delivery addresses) and training can be found on our internet sites.

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Outside Germany, please contact your local service office first. For hotline numbers, refer to the sales office addresses on the internet.

Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances
- Type plate specifications of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your e-mail address)

Index

A

Abbreviations.....	12
About this documentation.....	5
Validity of the documentation.....	5
Actual dimension.....	75
ANSI Z535.6-2006.....	11

C

Calibrating probe	
Adjusting ring.....	120
Point.....	111
Calibrating the probe	
M-Key menu.....	111
Collision monitoring for feed axes	
Brief description.....	173
Functional description.....	173
General information.....	172
Implementation example.....	175
Interface description.....	173
Message texts.....	175
Prerequisite: Assign G75 to axis interface...	172
Commissioning	
Electrical connection diagram example.....	192
General information.....	169
Initialization screen.....	186
Mechanical installation examples.....	190
PLC user program adjustment.....	171
SD variables.....	184
Set drive parameters.....	169
Setting machine parameters.....	169
Complaints.....	12
Criticism.....	12
Customer feedback.....	12

D

Developing a user-defined measuring cycle automatic	
Example: Creating a user-defined cycle for automatic.....	89
Developing a user-defined measuring cycles automatic	
The basic cycle STP_PRBASE.....	93
Developing an individual measuring cycle automatic	
General information.....	89
Developing user-defined measuring cycle automatic	
SD variables for probe data.....	96
Differential dimension.....	75

E

Empirical value.....	75
Example: Creating a user-defined cycle for automatic	
Task.....	89

Task steps.....	89
-----------------	----

F

Feedback.....	12
---------------	----

G

General notes	
General information.....	19
Meaning of abbreviations.....	22

H

Hazard warning.....	10
Helpdesk.....	193
Hotline.....	193

I

Information representation	
Names and abbreviations.....	12
Intended use	
Areas of Application.....	13
Introduction.....	13
Use cases.....	13

L

Lower deviation.....	75
----------------------	----

M

Manual probing	
Calibrating the probe.....	111
General information.....	109
Probing the zero point using the probe.....	122
Measurement	
Probe workpiece.....	45
Tool measurement.....	41
Measuring cycle automatic	
General information.....	19
General notes.....	19
Measurement.....	41
Measuring value evaluation.....	73
Probe calibration.....	23
Processing compensations.....	86
Measuring cycles	
Commissioning.....	169
Developing an individual measuring cycle automatic.....	89
Introduction.....	15
Manual probing.....	109
Measuring cycle automatic.....	19
Measuring value evaluation	
General information.....	73
Terms.....	74

N

Nominal dimension.....	74
------------------------	----

Index

P

PLC implementation example

Declaration example program measure.....	178
General information.....	176
Global variables.....	177
Implementation example program Measure	180
Probe example data.....	177
Requirements.....	176
Specification of a probe PLC program.....	178

PLC user program adjustment

Activation/deactivation of probes.....	171
Collision monitoring for feed axes.....	172
General information.....	171
Reactivation of radio probes.....	175

Probe calibration

for workpiece measuring.....	24, 36
General information.....	23

Probe zero point using the probe

Boring.....	132
Circular Spigot.....	134
Corner.....	126
Groove.....	136
Land.....	144
Point.....	122
Rectangular pocket.....	150
Rectangular spigot.....	153
Rotary axis.....	155

Probing the zero point using the probe

M-Key menu.....	122
-----------------	-----

Processing compensation

Tool compensation.....	86
Workpiece compensation.....	86

S

Safety alert symbol.....	11
--------------------------	----

Safety instructions.....	10
--------------------------	----

SD variable provision

Structure Expansion.....	185
--------------------------	-----

SD variables for probe data

Data input.....	106
General information.....	96
SD variable structure SysPrBase.....	97
SD variable structure SysPrMan.....	100
SD variable structure SysPrResult.....	98

SD variables standard structure

Standard structure.....	184
-------------------------	-----

Service hotline.....	193
----------------------	-----

Signal words.....	11
-------------------	----

Suggestions.....	12
------------------	----

Support.....	193
--------------	-----

Symbols used.....	12
-------------------	----

T

Target groups.....	5
--------------------	---

The basic cycle STP_PRBASE

Basic cycle.....	93
General information.....	93

Tolerance center.....	75
-----------------------	----

U

Unintended use.....	14
---------------------	----

Unintended Use

Consequences, non-liability.....	13
----------------------------------	----

Upper deviation.....	75
----------------------	----

User program adjustment

PLC implementation example.....	176
---------------------------------	-----

W

Warnings.....	10
---------------	----

Notes

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