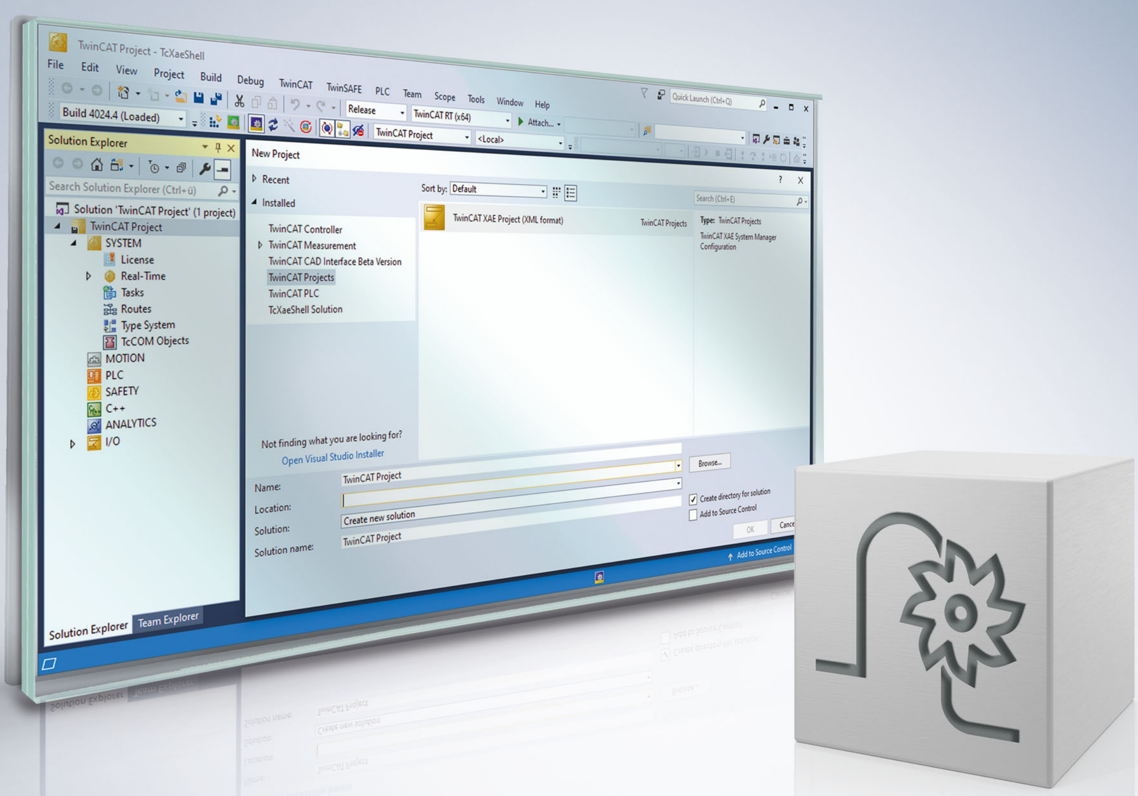
BECKHOFF New Automation Technology

Manual | EN

TF5225 | TwinCAT 3 CNC

Measurement



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Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning the components.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.
We reserve the right to revise and change the documentation at any time and without prior announcement.
No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

Trademarks

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General and safety instructions

Icons used and their meanings

This documentation uses the following icons next to the safety instruction and the associated text. Please read the (safety) instructions carefully and comply with them at all times.

Icons in explanatory text

1. Indicates an action.

⇨ Indicates an action statement.

⚠ DANGER

Acute danger to life!

If you fail to comply with the safety instruction next to this icon, there is immediate danger to human life and health.

⚠ CAUTION

Personal injury and damage to machines!

If you fail to comply with the safety instruction next to this icon, it may result in personal injury or damage to machines.

NOTICE

Restriction or error

This icon describes restrictions or warns of errors.

Tips and other notes

This icon indicates information to assist in general understanding or to provide additional information.

General example

Example that clarifies the text.

NC programming example

Programming example (complete NC program or program sequence) of the described function or NC command.

Specific version information

Optional or restricted function. The availability of this function depends on the configuration and the scope of the version.

Contents

List of figures

1 Cycles - Introduction

Cycles are additional options and subject to the purchase of a license.

General information

Cycle call

ISG cycles are called using a cycle call:

```
L CYCLE[ NAME="..." @P1 = .. @P2 = .. ...]
```

A cycle is called by specifying the cycle name. It is also possible to parameterise the cycle input parameters to modify cycle behaviour to a special application.

This documentation contains a separate subsection for each cycle where cycle behaviour is described in greater detail. It also contains a list of the input parameters used for the cycle. Finally, a simple programming example describes how to call the cycle.

Selecting the cycle plane

A cycle is programmed independently of the currently valid plane (G17, G18, G19) and independently of the axis names configured in the NC channel.

In the cycle documentation, the axes are described by the following names for the sake of better legibility:

- The X axis describes the 1st main axis
- The Y axis describes the 2nd main axis
- The Z axis describes the 3rd main axis
- A axis is the designation for the rotary axis about the 1st main axis
- B axis is the designation for the rotary axis about the 2nd main axis
- C axis is the designation for the rotary axis about the 3rd main axis

Cycles can also be used in offset and rotated coordinate systems. These coordinate systems should only be defined using the #CS command. The #ROTATION command is not suitable for use in combination with cycles.

1.1 Note on installing the cycles

Content of the cycle packet

The cycle packet contains the following files and directories:

- Set-up file to execute the cycle set-up.
- Dependency graph: Describes the dependencies (subroutine calls) for each of the cycles.
- Release notes: Description of relevant changes which the release contains.
- Documentation index: Contains the cycle documentation.
- Index of error messages: Contains the cycle error messages.
- Condensed index of cycles: This contains the CNC cycle and example call programs. When the set-up is executed, the files are unpacked and saved on the specified path.

Executing the set-up

To install the cycles, execute the file *isg-cnc-cycles-setup.exe* contained in the cycle packet.

When the cycle set-up is executed, the CNC cycles and the example call programs are unpacked and saved on the specified path.

To execute the cycles, the specified path must be saved in the controller as the subroutine path.

NOTICE

When the cycle set-up is executed the contents of the previously installed cycle packet are overwritten.

Integrating error messages

The error files must be saved in the TwinCAT set-up to ensure that the correct error messages are output if CNC cycles are incorrectly executed.

The file *TcCncCycleErrors.xml* in the error directory (*error_files*) in the TwinCAT set-up directory (here *C:\TwinCat*) is saved on the following path in order to output error message in the HMI: *C:\TwinCAT\3.1\Target\Resource*.

The file *err_text_cycles_eng.txt* (or *err_text_cycles.txt*) in the error directory (*error_files*) in the TwinCAT set-up directory (here *C:\TwinCat*) is saved on the following path in order to output error messages correctly in the log file: *C:\TwinCAT\3.1\Components\Mc\CNC\Diagnostics*.

Alternatively, the name of the error message file can also be modified by the channel parameter P-STUP-00200.

2 Note on installing the cycles

Content of the cycle packet

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- Set-up file to execute the cycle set-up.
- Dependency graph: Describes the dependencies (subroutine calls) for each of the cycles.
- Release notes: Description of relevant changes which the release contains.
- Documentation index: Contains the cycle documentation.
- Index of error messages: Contains the cycle error messages.
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Alternatively, the name of the error message file can also be modified by the channel parameter P-STUP-00200.

3 Calibrating and measuring

3.1 Overview

Cycles are additional options and subject to the purchase of a license.

Task

In order to increase the machining precision of workpieces in CNC-controlled production, geometric errors must be reliably detected and corrected.

The purpose of “Measurement cycles - Calibration includes

- the automatic calibration of measuring equipment
- the measurement of coordinate systems, and
- the measurement of workpieces and tools.

See “Cycles - Kinematic optimisation” for how to determine and correct geometric errors in machine kinematics.

Please note that cycles are additional options and subject to the purchase of a license.

Programming and parameterisation

The programming and parameterisation of cycles is described in each of the overviews in the main chapter.

3.2 Handling output variables

The measurement and calibration cycles contain output variables that can be used to request the result. There are two options to read out the output variables. They are described in more detail below.

Option 1: Read out the output variables per cycle variables

The first option is to create the V.CYC. output variable in the program calling the cycle. The cycle checks whether this variable already exists. If this is the case, the corresponding result value is written in the existing V.CYC. variable.

Read out the output variables per cycle variables

The example describes how to read out the output variables for the cycle "SysCalibTouchprobe1.ecy". Analogously, the procedure can be transferred to all measurement and calibration cycles. In the program calling the cycle, the result values must be written to the file "result.txt". For this purpose, the output variables in which the result value is written on cycle execution are created locally.

```
%main.nc
#VAR
  V.CYC.SysRetOffsetX
  V.CYC.SysRetOffsetY
  V.CYC.SysRetToolRadius
#ENDVAR
T1 D1

G00 G90 Z0
L CYCLE [NAME=SysCalibTouchprobe1.ecy @P2 = 100]
G00 G90 Z50

#FILENAME[MSG="result.txt"]
#MSG SAVE["Tool Radius = %f", V.CYC.SysRetOffsetX]
#MSG SAVE["Offset in X = %f", V.CYC.SysRetOffsetY]
```

```
#MSG SAVE["Offset in Y = %f", V.CYC.SysRetToolRadius]

M30
```

Option 2: Read out the output variables per subroutine

The post files of the cycles created by the user can also be used to read out the result values. These post files are automatically called at the end of the cycle. The output variables are visible in them.

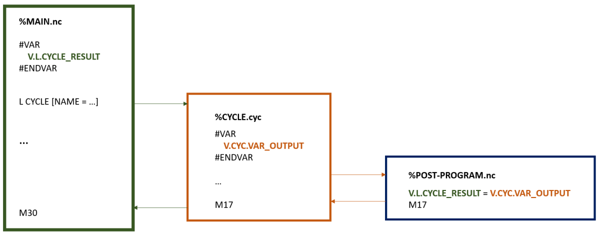

Fig. 1: SysCalibMeasOutput

Read out the output variables per subroutine

The example describes how to read out the output variables for the cycle `SysCalibTouchprobe1.ecy`. Analogously, the procedure can be transferred to all measurement and calibration cycles. In the program calling the cycle, the result values must be written to the file "`result.txt`". For this purpose, result variables must be created locally to receive the values of the output variables.

```
%main.nc
#VAR
  V.L.ResOffX
  V.L.ResOffY
  V.L.ResRadius
#ENDVAR
T1 D1

G00 G90 Z0
L CYCLE [NAME=SysCalibTouchprobe1.ecy @P2 = 100]
G00 G90 Z50

#FILENAME[MSG="result.txt"]
#MSG SAVE["Tool Radius = %f", V.L.ResRadius]
#MSG SAVE["Offset in X = %f", V.L.ResOffX]
#MSG SAVE["Offset in Y = %f", V.L.ResOffY]

M30
```

In order for the result values to be transferred to the variables created by the user within the cycle, the post subroutine "SysCalibTouchprobe1Post.nc" must be created by the user. It is then called automatically within the cycle.

```
%SysCalibTouchprobe1Post.nc
V.L.ResOffX = V.CYC.SysRetOffsetX
V.L.ResOffY = V.CYC.SysRetOffsetY
V.L.ResRadius = V.CYC.SysRetToolRadius
M17
```

3.3 Calibrating a touch probe

3.3.1 Overview

Task

This instruction describes:

- the automatic calibration of the touch probe.

Possible applications

The characteristic touch probe parameters are determined by measuring geometric objects with known properties.

The determining parameters include:

- the length of the touch probe,
- the radius of the touch probe sphere
- and the shift of the touch probe along the X and Y axes.

These are electronic variables that integrate the speed-dependent trigger offsets during measurement and may therefore deviate from the geometric values.

The various output variables are defined in greater detail in the subsections for each of the cycles.

Programming

The cycles are called with the L CYCLE[..] function and the required parameters are taken directly from the NC program.
A more detailed description of the call is provided in the subsections for each of the cycles.

3.3.2 Description

3.3.2.1 General

The length of the touch probe is defined up to the bottom of the touch probe sphere. The velocity-dependent delay between the fixed stop point of the touch probe sphere and the trigger point of the measurement is calculated in the diameter of the touch probe sphere. Calibration is also useful when the exact physical diameter of the touch probe sphere is known.

The SysCalibConfigTouchprobe.nc calibration file [▶ 18] must be present and the corresponding parameters must be configured before the cycles are used (except for the calibration parameters to be identified), otherwise the cycles cannot run.

If no measuring signal is triggered during the measurement, the machine stops with the error message: "No workpiece detected, please check your measuring section“ P-ERR-13413.

If a measurement is detected during positioning, the machine stops with the error message: “Collision on positioning, please check your motion range”P-ERR-13414.

The measurement results are saved in V.CYC variables (output variables) and can be processed in the post-files. An overview of existing output variables is contained in each of the cycle sections.

NOTICE

Cycles which output the touch probe shift contain a spindle rotation and require a measurement with the rear of the touch probe. If this is not possible, the cycle may not be executed.

3.3.2.2 Configuration file

The following items are required to successfully configure the touch probe:

- the radius of the touch probe sphere, the offsets in X and Y and the length of the touch probe must be defined using the tool data.
- The configuration file SysCalibConfigTouchprobe.nc was created, containing at least the measuring and positioning feedrates.

Detailed description

The SysCalibConfigTouchprobe.nc file is executed before each cycle to identify the touch probe parameters. The following variables must then be defined.

Variables	Description
V.CYC.SysConf_Probes_feed	Measuring feedrate.
V.CYC.SysConf_Probes_feed_max	Positioning feedrate between measuring points.
V.CYC.SysConf_Spindle_orientation	Definition whether the touch probe is to be positioned in the measurement direction before every measurement run. 0 = touch probe is not positioned (default value). Touch probe must be in initial position before the start of the cycle. 1 = touch probe is positioned
V.CYC.SysConf_Probes_feed_repeat	Measuring feedrate for a second probing at a slow speed. If defined with a value > 0, the probe is retracted slightly after the first probing and the measurement is repeated. Default value = 0.
V.CYC.SysConf_Probes_dist_repeat	Retraction distance in the measuring direction for the second probing at a slow speed. Only used if V.CYC.SysConf_Probes_feed_repeat is greater than zero. Default value = 2.
V.CYC.SysConf_Spindle_angle	Definition of the basic angle specified to position the touch probe. Only used if V.CYC.SysConf_Spindle_orientation = 1. Corresponds to the spindle position (M19) required for measuring in the positive X direction. Default value = 0.
V.CYC.SysConf_Spindle_Pos_Dir	Position of the spindle final position when positioned with M19. Only used if V.CYC.SysConf_Spindle_orientation = 1. 0 = The spindle positions the touch probe clockwise when the touch probe tip is viewed from below (default value). 1 = The spindle positions the touch probe counter clockwise when the touch probe tip is viewed from below.
V.CYC.SysConf_Probes_spdl_feed	Spindle feedrate for spindle positioning of the touch probe. Default value = 200
V.CYC.SysConf_Probes_spdl_wait	Time in seconds to wait for the spindle to reposition before a corresponding measurement run. Default value = 1

Additional configuration data for the touch probe is read from the current tool data. The touch probe must therefore be defined as a current tool and its tool data must be saved (except for calibration).

The tool data to be considered includes:

- The radius of the touch probe sphere (V.G.WZ_AKT.R)
- The length of the touch probe (V.G.WZ_AKT.L)

- Horizontal offsets of the touch probe tip relative to the spindle flange (V.G.WZ_AKT.V.X and W.G.WZ_AKT.V.Y)

The measurement results are calculated to include the offsets between the touch probe tip and the spindle flange and the radius of the touch probe sphere.

For example, the configuration file SysCalibConfigTouchprobe.nc may look like this:

Configuration file

```
V.CYC.SysConf_Probes_feed         =  500      (measuring feed rate)
V.CYC.SysConf_Probes_feed_max     = 1000      (positioning feed rate)
V.CYC.SysConf_Spindle_orientation =    0      (positioning of probe)
V.CYC.SysConf_Spindle_angle       =    0      (probe basic angle)
M17
```

3.3.2.3 Pre- and post-files

For this cycle there are 2 pre-files which must be called before this cycle and 2 post-files which are called after each cycle.

- These files are optional. If they do not exist, this step is skipped.
- As required, these files must therefore be created as a subroutine. In general, a post-file is required to process the output variables stored in the local V.CYC. variables.
- Machine-specific adaptations, e.g. activation of the touch probe, can be carried out in the pre-file.
- The post-file can be used to process output variables, for example.

In addition, separate pre and post-files can be written for each cycle, with each file being valid for each cycle. The syntax is obtained from the cycle name+pre.nc or cycle name+post.nc.

There is a general pre-file and a general post-file which are used for all SysCalibTouchprobe cycles:

- SysCalibTouchprobePre.nc
- SysCalibTouchprobePost.nc

These files are only valid for this cycle and consist of the following:

Cyclename +1Pre or 1Post +.nc

- SysCalibTouchprobe1Pre.nc
- SysCalibTouchprobe1Post.nc

3.3.2.4 General cycle process

The cycles call internally different subroutines in this sequence.

Example based on SysCalibTouchprobe1.ecy:

1. SysCalibTouchprobePre.nc (optional)
2. SysCalibTouchprobe1Pre.nc (optional)
3. SysCalibConfigTouchprobe.nc
4. SysCalibTouchprobe1Post.nc (optional)
5. SysCalibTouchprobePost.nc (optional)

3.3.3 Calibrating the touch probe on a ring

The touch probe head is calibrated by approaching a ring of known diameter several times. The shifts in the X and Y directions and the radius of the touch probe sphere are included in the identified calibration parameters. The spindle is turned through 180° during the cycle.

3.3.3.1 Process (internal cycle)

Starting position before the cycle is called: The touch probe must be positioned as centrally as possible in the ring either manually or in automatic mode. It stands vertically, i.e. the touch probe rotation stands at 0.

The internal cycle process can be described as follows:

1. If there is a deviation, the spindle position is turned automatically to its initial position.
2. The touch probe travels a total of four measurements along the inner side of the ring and returns to the starting position.
3. The spindle position is turned through 180° automatically.
4. The touch probe again travels four measurements along the inner side of the ring and returns to the starting position.
5. The spindle position is turned automatically back to its initial position.

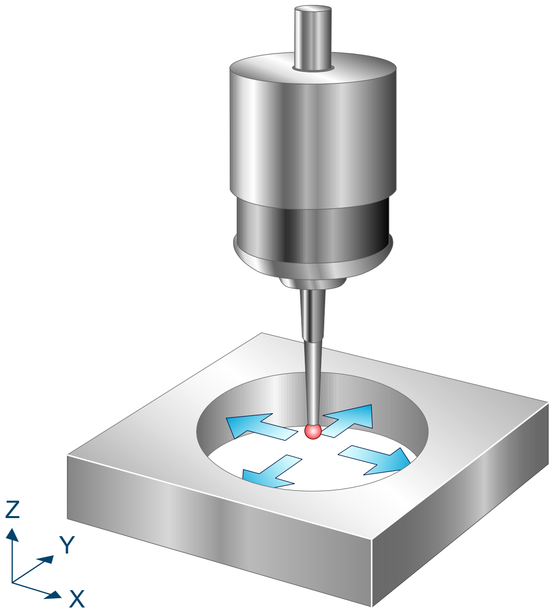

Fig. 2: Calibrating the touch probe on a ring

3.3.3.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P2	Inner diameter of the ring
@P14 (optional)	Probe angle of the first lateral measurement in relation to the positive X axis Presetting = 0°
@P15 (optional)	Difference between the probe angle and the lateral measurements Presetting = 90°
@P33 (optional)	Crossover range during measurement process Presetting = @P2/2

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.3.3.3 Syntax

L CYCLE [NAME = SysCalibTouchprobe1.ecy @P.. = ..]

3.3.3.4 Programming example

Calibrating the touch probe on a ring

```
T1 D1
G53
G00 G90 X100 Y100 Z100
G00 G91 Z-50
L CYCLE [NAME=SysCalibTouchprobe1.ecy   \
        @P2  = 50                       \
        @P14 = 20                       \
        @P15 = 70                       \
        @P33 = 30                       \
        ]
G00 G91 Z50
M30
```

3.3.3.5 Output variables

Variable	Value
V.CYC.SysRetOffsetX	Calculated shift of the touch probe head along the X axis
V.CYC.SysRetOffsetY	Calculated shift of the touch probe head along the Y axis
V.CYC.SysRetToolRadius	Calculated radius of the touch probe sphere

See information on use of the output variables [▶ 14].

3.3.4 Calibrating the length of the touch probe

Calibrating the length of the touch probe by comparison with a known reference surface.

3.3.4.1 Process (internal cycle)

The touch probe stands vertically, i.e. the rotation is at 0.

Starting from the starting position, a vertical measurement is executed along the Z axis. After the measurement value is recorded, the touch probe returns to the starting position.

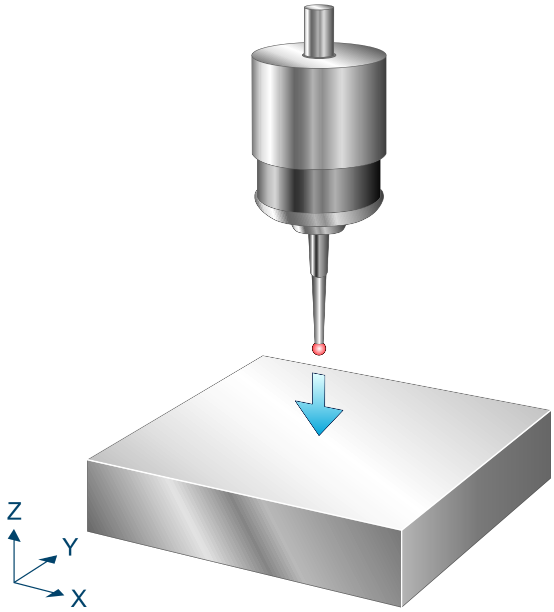

Fig. 3: Calibrating the length of the touch probe

3.3.4.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P6	Measurement path in the direction of the negative Z axis, only positive values permitted
@P86	Z reference value of known surface

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.3.4.3 Syntax

L CYCLE [NAME = SysCalibTouchprobe2.ecy @P.. = ..]

3.3.4.4 Programming example

Calibrating the length of the touch probe

```
T1 D1
G53
G00 G90 X140 Y-65 Z400
L CYCLE [NAME=SysCalibTouchprobe2.ecy \
        @P6  = 200                    \
        @P86 = 300                    \
        ]
M30
```

3.3.4.5 Output variables

Variable	Value
V.CYC.SysRetTouchprobeLength	Calculated length of the touch probe head
V.CYC.SysRetOffsetZ	Resulting offset (negative length)

See information on use of the output variables [▶ 14].

3.3.5 Calibrating the touch probe at an edge along the X axis

The touch probe head is calibrated by approaching a known reference point along the X axis several times. The shifts of the touch probe head in the X and Y directions and the radius of the touch probe sphere are included in the identified calibration parameters.

3.3.5.1 Process (internal cycle)

Starting position before the cycle is called: The touch probe must be positioned at a start point manually or in automatic mode so that the probe can reach the reference edge in the measurement direction without collision. It stands vertically, i.e. the touch probe rotation stands at 0.

The internal cycle process can be described as follows:

1. If there is a deviation, the spindle position is turned to its initial position
2. The touch probe runs a measurement along the X axis and back to the starting position. This measurement is repeated with the spindle turned through another 90 degrees until a total of four measurements are executed.
3. The spindle is turned automatically back to its initial position

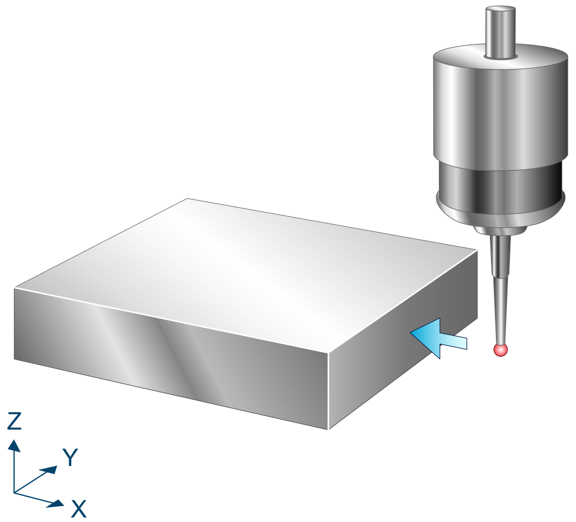

Fig. 4: Calibrating the touch probe at an edge along the X axis

3.3.5.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P4	Length and sign of the measurement path along the X axis
@P84	Reference value of the edge in X

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.3.5.3 Syntax

```
L CYCLE [ NAME = SysCalibTouchprobe3.ecy @P.. = .. ]
```

3.3.5.4 Programming example

Calibrating the touch probe at an edge along the X axis

```
T1 D1
G53
G00 G90 X200 Y200 Z400
L CYCLE [NAME=SysCalibTouchprobe3.ecy   \
        @P4  = 200                      \
        @P84 = 300                      \
        ]
M30
```

3.3.5.5 Output variables

Variable	Value
V.CYC.SysRetOffsetX	Calculated shift of the touch probe head along the X axis
V.CYC.SysRetOffsetY	Calculated shift of the touch probe head along the Y axis
V.CYC.SysRetToolRadius	Radius of the touch probe sphere

See information on use of the output variables [▶ 14].

3.3.6 Calibrating the touch probe at an edge along the Y axis

The touch probe head is calibrated by approaching a known reference edge along the Y axis several times. The shifts of the touch probe head in the X and Y directions and the radius of the touch probe sphere are included in the identified calibration parameters.

3.3.6.1 Process (internal cycle)

Starting position before the cycle is called: The touch probe must be positioned at a start point manually or in automatic mode so that the probe can reach the reference edge in the measurement direction without collision. It stands vertically, i.e. the touch probe rotation stands at 0.

The internal cycle process can be described as follows:

1. If there is a deviation, the spindle position is turned to its initial position
2. The touch probe runs a measurement along the Y axis and back to the starting position. This measurement is repeated with the spindle turned through another 90 degrees until a total of four measurements are executed.
3. The spindle is turned automatically back to its initial position

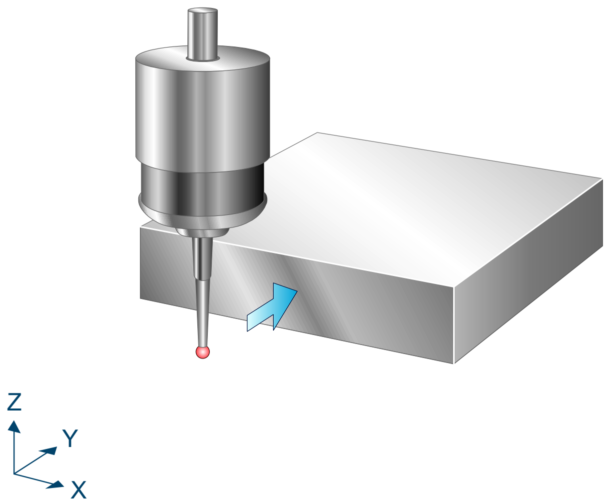

Fig. 5: Calibrating the touch probe at an edge along the Y axis

3.3.6.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P5	Length and sign of the measurement path along the Y axis
@P85	Reference value of the edge in Y

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.3.6.3 Syntax

L CYCLE [NAME = SysCalibTouchprobe4.ecy @P.. = ..]

3.3.6.4 Programming example

Calibrating the touch probe at an edge along the Y axis

```
T1 D1
G53
G00 G90 X1400 Y1400 Z1000
L CYCLE [NAME=SysCalibTouchprobe4.ecy   \
        @P5  = 200                      \
        @P85 = 1500                     \
        ]
M30
```

3.3.6.5 Output variables

Variable	Value
V.CYC.SysRetOffsetX	Calculated shift of the touch probe head along the X axis
V.CYC.SysRetOffsetY	Calculated shift of the touch probe head along the Y axis
V.CYC.SysRetToolRadius	Radius of the touch probe sphere

See information on use of the output variables [▶ 14].

3.3.7 Calibrating the touch probe at two edges along the X axis

The touch probe head is calibrated by approaching two reference points at a known distance along the X axis several times. The shifts of the touch probe head in the X and Y directions and the radius of the touch probe sphere are included in the identified calibration parameters.

3.3.7.1 Process (internal cycle)

Starting position before the cycle is called: The touch probe must be positioned at the start point manually or in automatic mode so that the probe can reach the two reference edges without collision. It stands vertically, i.e. the touch probe rotation stands at 0.

The internal cycle process can be described as follows:

1. If there is a deviation, the spindle position is turned to its initial position
2. The touch probe runs a measurement along the X axis on the specified measurement path in the direction of the first edge and back to the starting position. This measurement is repeated with the spindle turned through another 90 degrees until a total of four measurements are executed.
3. The spindle is turned automatically back to its initial position
4. A measurement is executed with a negative measurement path in the direction of the second edge
5. Return to starting position

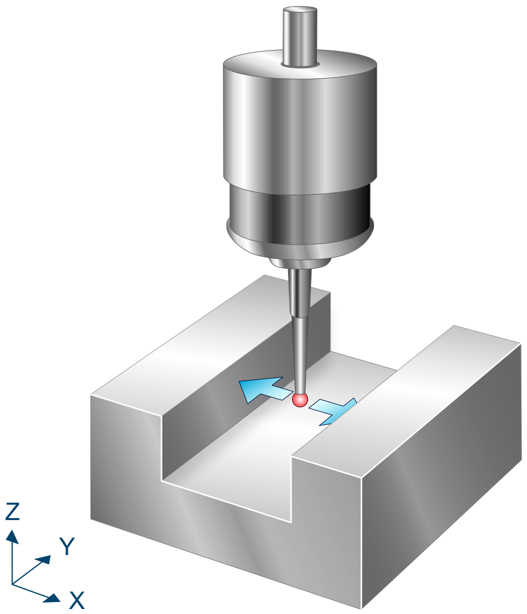

Fig. 6: Calibrating the touch probe at two edges along the X axis

3.3.7.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P3	Clearance of the two edges along the X axis
@P4	Length and sign of the 1st measurement path along the X axis

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.3.7.3 Syntax

L CYCLE [NAME = SysCalibTouchprobe5.ecy @P.. = ..]

3.3.7.4 Programming example

Calibrating the touch probe at two edges along the X axis

```
T1 D1
G53
G00 G90 X1400 Y1410 Z1000
L CYCLE [NAME=SysCalibTouchprobe5.ecy   \
        @P3 = 200                       \
        @P4 = 300                       \
        ]
M30
```

3.3.7.5 Output variables

Variable	Value
V.CYC.SysRetOffsetX	Calculated shift of the touch probe head along the X axis
V.CYC.SysRetOffsetY	Calculated shift of the touch probe head along the Y axis
V.CYC.SysRetToolRadius	Radius of the touch probe sphere

See information on use of the output variables [▶ 14].

3.3.8 Calibrating the touch probe at two edges along the Y axis

The touch probe head is calibrated by approaching two reference points at a known distance along the Y axis several times. The shifts of the touch probe head in the X and Y directions and the radius of the touch probe sphere are included in the identified calibration parameters.

3.3.8.1 Process (internal cycle)

Starting position before the cycle is called: The touch probe must be positioned at the start point manually or in automatic mode so that the probe can reach the two reference edges without collision. It stands vertically, i.e. the touch probe rotation stands at 0.

The internal cycle process can be described as follows:

1. If there is a deviation, the spindle position is turned to its initial position
2. The touch probe runs a measurement along the Y axis on the specified measurement path in the direction of the first edge and back to the starting position. This measurement is repeated with the spindle turned through another 90 degrees until a total of four measurements are executed.
3. The spindle is turned automatically back to its initial position
4. A measurement is executed with a negative measurement path in the direction of the second edge
5. Return to starting position

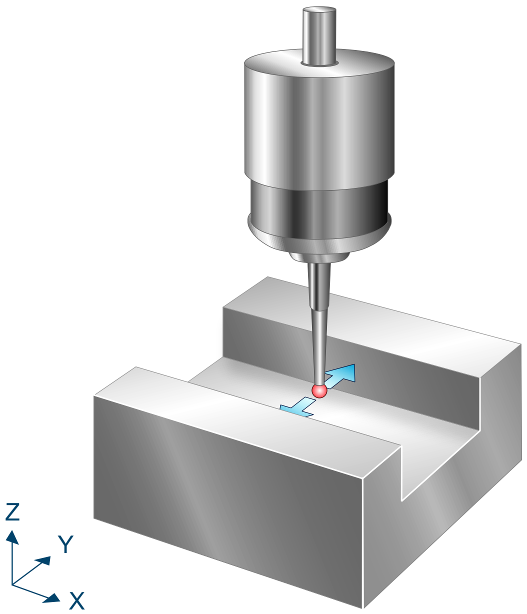

Fig. 7: Calibrating the touch probe at two edges along the Y axis

3.3.8.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P3	Distance of the two edges along the Y axis
@P5	Length and sign of the 1st measurement path along the Y axis

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.3.8.3 Syntax

L CYCLE [NAME = SysCalibTouchprobe6.ecy @P.. = ..]

3.3.8.4 Programming example

Calibrating the touch probe at two edges along the Y axis

```
T1 D1
G53
G00 G90 X1400 Y1410 Z1000 A0 B90 C0
L CYCLE [NAME=SysCalibTouchprobe6.ecy   \
        @P3 = 200                       \
        @P5 = 300                       \
        ]
M30
```

3.3.8.5 Output variables

Variable	Value
V.CYC.SysRetOffsetX	Calculated shift of the touch probe head along the X axis
V.CYC.SysRetOffsetY	Calculated shift of the touch probe head along the Y axis
V.CYC.SysRetToolRadius	Radius of the touch probe sphere

See information on use of the output variables [▶ 14].

3.3.9 Calibrating the touch probe on a sphere

The touch probe head is calibrated by approaching a sphere of known diameter several times. The shifts of the touch probe head in the X and Y directions and the radius of the touch probe sphere are included in the identified calibration parameters. In addition, the length of the touch probe is determined by specifying a reference parameter for the Z axis. Optionally, the calibration of the known sphere centre point is repeated to improve the calibration accuracy.

This cycle is only suitable for calibrating a touch probe providing there is a negligible difference between the trigger offset in Z and the trigger offset in X and Y.

The sphere diameter must be significantly greater than the sphere diameter of the touch probe for the calibration.

3.3.9.1 Process (internal cycle)

Starting position before the cycle is called: The touch probe must be positioned either manually or in automatic mode as centrally as possible and at a short clearance above the first sphere. It stands vertically, i.e. the touch probe rotation stands at 0.

The internal cycle process can be described as follows:

1. If there is a deviation, the spindle position is turned automatically to its initial position.
2. The touch probe first runs a measurement in the Z direction and a total of four lateral measurements, after which it returns to the starting position.
3. The spindle position is turned through 180°.
4. The touch probe again runs a measurement in the Z direction and a total of four lateral measurements, after which it returns to the starting position.
5. The spindle is turned back to its initial position and the touch probe approaches the calculated centre point on the XY plane.
6. If a measurement repetition was specified in @P88 to enhance accuracy, points 2 to 6 are repeated, whereby the lateral measurements take place at the calculated height of the equator.
7. If @P86 was defined, an additional measurement is executed in the Z direction before the touch probe returns again to the starting position.

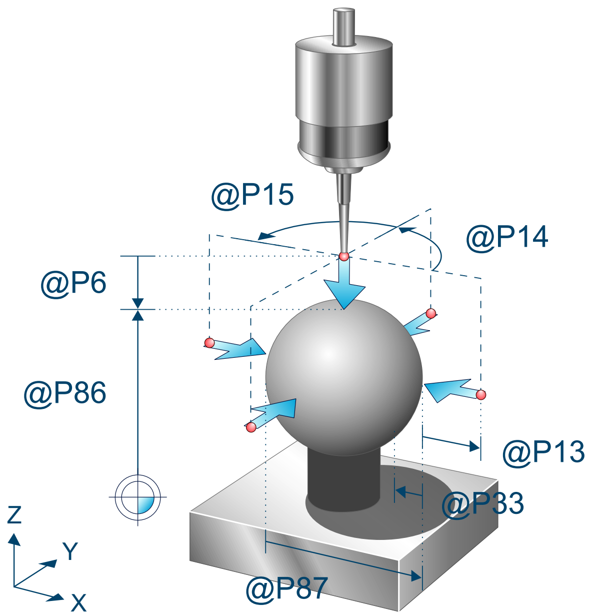

Fig. 8: Calibrating the touch probe on a sphere

3.3.9.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P6	Measurement path in the direction of the negative Z axis, only positive values permitted
@P13 (optional)	Security distance for pre-positioning Default value = @P87/4 (calibration at sphere)
@P14 (optional)	Probe angle of the first lateral measurement in relation to the positive X axis [degrees] Default value = 0
@P15 (optional)	Difference of the probe angle between the lateral measurements [degrees] Default value = 90
@P33 (optional)	Crossover range during measurement process Default value = @P87/4 (calibration at sphere)
@P64 (optional)	Definition of the path to approach to pre-position 0 = linear (default value) 1 = circular
@P86 (optional)	Z reference of top sphere edge. If parameters are specified, the length of the touch probe is modified.
@P87	Diameter of sphere
@P88 (optional)	Measurement repetition with calculated parameters at height of equator for enhanced accuracy 1 = yes 2 = no (default value)

NOTICE

If circular approach of the pre-position was selected in @P64, collision detection is disabled. This option may only be enabled if safe approach to the pre-position is ensured.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.3.9.3 Syntax

L CYCLE [NAME = SysCalibTouchprobe7.ecy @P.. = ..]

3.3.9.4 Programming example

Calibrating the touch probe on a sphere

```
T1 D1
G53
G00 G90 X100 Y100 Z95
L CYCLE [NAME=SysCalibTouchprobe7.ecy    \
        @P6  = 10                        \
        @P64 = 1                         \
        @P14 = 20                        \
        @P13 = 10                        \
        @P33 = 15                        \
        @P87 = 90                        \
        ]
M30
```

3.3.9.5 Output variables

Variable	Value
V.CYC.SysRetOffsetX	Calculated shift of the touch probe along the X axis.
V.CYC.SysRetOffsetY	Calculated shift of the touch probe along the Y axis.
V.CYC.SysRetOffsetRadius	Calculated radius of the touch probe sphere.
V.CYC.SysRetTouchprobeLength	Calculated length of the touch probe head

See information on use of the output variables [▶ 14].

3.4 Calibrating the tool touch probe

3.4.1 Overview

These instructions describe the automatic calibration of a tool touch probe with a reference tool.

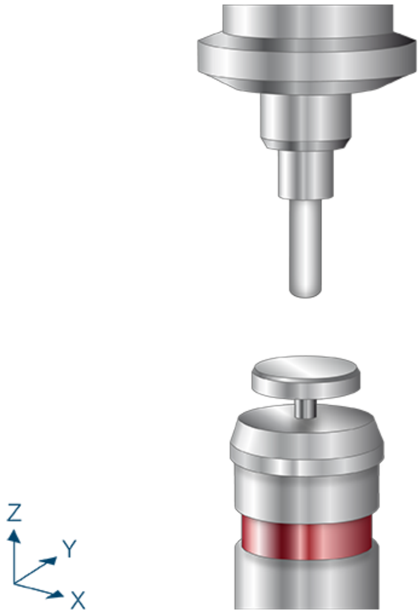

Fig. 9: Calibrating the tool touch probe

Possible applications

During the calibration, the surface position of the touch probe is determined in Z, the centre point in X and Y and the diameter of the measuring plate.

The velocity-dependent shift of the measurement trigger points are also scanned in the tool touch probe parameters measured. It is therefore practical to repeat a calibration if only the measurement velocity changes.

Prerequisites

To ensure that the calibration of the tool touch probe is executed successfully, the following requirements must be fulfilled:

1. Tool touch probe is fitted and active
2. A reference tool of known length and know radius is changed and the tool data is activated.
3. The required measurement and pre-positioning velocities and the approximate plate diameter were entered in the configuration file [▶ 36].

3.4.2 Description

3.4.2.1 Configuration file

The SysCalibConfigToolSettingProbe.nc file is executed within the cycle and helps to parameterise the tool touch probe.

For calibration, it is sufficient to specify the measuring and positioning feed and the approximate measuring plate diameter. This is required for pre-positioning.

After completing calibration, the measurement results must also be entered in the configuration file.

For the value MESS_POS, the number transferred to the cycle by @P20 must be entered.

The following values must be entered before the cycle is started:

Variables	Description
V.CYC.SysConf_Meas_feed[MESS_POS]	Measuring feed
V.CYC.SysConf_Meas_feed_max[MESS_POS]	Positioning feed
V.CYC.SysConf_Plate_Diam[MESS_POS]	Approximate touch measuring plate diameter.

For example, the configuration file SysCalibConfigToolSettingProbe.nc may look like this:

Configuration file

```
V.CYC.SysConf_Meas_feed[1]     =  500  (measuring feed rate)
V.CYC.SysConf_Meas_feed_max[1] = 1000  (positioning feed rate)
V.CYC.SysConf_Plate_Diam[1]    =   30  (estimated plate diameter)
M17
```

The following values must be entered after the cycle has been executed.

Variables	Description
V.CYC.SysConf_Pos_Ax1[MESS_POS]	Centre of touch probe in the X axis
V.CYC.SysConf_Pos_Ax2[MESS_POS]	Centre of touch probe in the Y axis
V.CYC.SysConf_Pos_Ax3[MESS_POS]	Surface position of touch probe in the Z axis
V.CYC.SysConf_Plate_Diam[MESS_POS]	Measured diameter of measuring plate.

3.4.2.2 Pre- and post-files

For this cycle there is a pre-file which must be called before this cycle and a post-file which is called after this cycle. These files are optional. If they do not exist, this step is skipped. As required, these files must therefore be created as a subroutine. Machine-specific adaptations, e.g. activation of the touch probe, can be carried out in the pre-file. The post-file can be used to process output variables, for example.

Pre- and post-files must have the following names:

- SysCalibToolSettingProbePre
- SysCalibToolSettingProbePost

3.4.2.3 Process (internal cycle)

Before cycle start, the reference tool must be positioned centrally above the tool touch probe.

After cycle start, the following process then results when default parameters are used:

1. Measurement takes place from the starting point in the Z direction and is then lifted to the starting position.
2. The reference tools is positioned next to the measuring plate at the positioning feed in the X+ direction.
3. Measure from this position in the direction of the plate centre.
4. This procedure is repeated for all four directions (X+,X-,Y+,Y-).
5. The tool retracts to the starting position in Z.
6. Measurement is repeated in the Z direction
7. The tool retracts to the starting position in Z.

3.4.2.4 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P6	Measurement distance in the direction of the negative Z axis, only positive values permitted [mm, inch]
@P22	Measurement offset in Z for lateral measurements [mm, inch]

The following parameters can be modified as an option:

Cycle parameters	Description
@P13 (optional)	Safety clearance for lateral measurements [mm, inch] Default value = 1/4 of measuring plate diameter.
@P14 (optional)	Probe angle for first lateral measurement [degrees] Default value = 0
@P15 (optional)	Incremental angle for lateral measurements [degrees] Default value = 90
@P16 (optional)	Measuring feedrate for a slow measurement If defined, the measurements are repeated at the specified feedrate.
@P17 (optional)	Radial return clearance for the slow measurement [mm, inch] Default value = 1
@P18 (optional)	Axial return clearance for the slow measurement [mm, inch] Default value = 1
@P20 (optional)	Numbering of tool touch probe (Required to read out the configuration from SysCalibToolSettingProbe.nc) Default value = 1

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.4.2.5 Syntax

L CYCLE [NAME = SysCalibToolSettingProbe.ecy @P.. = ..]

3.4.2.6 Programming example

Calibration of tool touch probe

To execute the programming example, save the configuration file SysCalibConfigToolSettingProbe.nc with the following contents:

```
V.CYC.SysConf_Meas_feed[1]     = 500
V.CYC.SysConf_Meas_feed_max[1] = 1000
V.CYC.SysConf_Plate_Diam[1]    = 40
M17
```

Call the cycle using the following program after changing the reference tool and positioning it above the centre of the touch probe:

```
L CYCLE [NAME=SysCalibToolSettingProbe.ecy  \
        @P6  = 30                           \
        @P22 = 10                           \
        ]
M30
```

3.4.2.7 Output variables

Cycle parameters	Description
V.CYC.SysRetPosAx1	The centre point of the tool touch probe in X.
V.CYC.SysRetPosAx2	The centre point of the tool touch probe in Y.
V.CYC.SysRetPosAx3	Surface position of the touch probe in Z.
V.CYC.SysRetDiameter	The measuring plate diameter measured.

See information on use of the output variables [▶ 14].

After completing calibration, the measurement results must also be entered in the configuration file SysCalibConfigToolSettingProbe.nc.

3.5 Calibrating laser

3.5.1 Overview

Task

Automatic determination of parameters of a laser measuring station for measuring tools.

Possible applications

Precise measurement of laser switching behaviour.

3.5.2 Description

3.5.2.1 Configuration files

The SysCalibConfigLaser.nc file must be present in the form of a subroutine. It contains the laser parameters. Approximate values are sufficient for the position of the laser focal point for calibration. They are used to pre-position the tool. The exact position values are determined during calibration-

Variables	Description
V.CYC.LASER_POS_X	Position of the laser focal point in the X axis
V.CYC.LASER_POS_Y	Position of the laser focal point in the Y axis
V.CYC.LASER_POS_Z	Position of the laser focal point in the Z axis
V.CYC.DIRECTION	Definition of measuring and positioning direction: 0- Measurement takes place in X- direction 1- Measurement takes place in Y- direction 2- Measurement takes place in X+ direction 3- Measurement takes place in Y+ direction
V.CYC.LASER_Z_START_POS	Start point of first measurement in Z.
V.CYC.LASER_Z_END_POS	End point of first measurement in Z.
V.CYC.MEAS_FEED_SLOW	Measuring feedrate for precision measurement.
V.CYC.MEAS_FEED_FAST	Measuring feedrate for fast measurement
V.CYC.LASER_BRAKEOFFSET	Return clearance for precision measurement

For example, the configuration file SysCalibConfigLaser.nc may look like this:

Configuration file

```
%SysCalibConfigLaser.nc

; Position of the focal point of the laser
V.CYC.LASER_POS_X = 10

; Position of the focal point of the laser
V.CYC.LASER_POS_Y = 20

; Position of the focal point of the laser
V.CYC.LASER_POS_Z = 35

; Position/measurement direction
V.CYC.DIRECTION   = 1

; Retraction distance for precision measurement
V.CYC.LASER_BRAKEOFFSET = 0.5

; Measurement feedrate for fast measurement
V.CYC.MEAS_FEED_FAST = 500

; Measurement feedrate for precision measurement
V.CYC.MEAS_FEED_SLOW = 100

; Start point of first meas in Z
V.CYC.LASER_Z_START_POS = V.CYC.LASER_POS_Z + 20

; End point of first meas in Z
V.CYC.LASER_Z_END_POS   = V.CYC.LASER_POS_Z - 10

M17
```

Optionally, the two subroutines below can be saved. They control the activation and deactivation of the lasers:

1. SysCalibConfigLaserOn.nc
2. SysCalibConfigLaserOff.nc

A distinction is made between push and pull measurements.

3.5.2.2 Pre- and post-files

There is a general pre file and a general post file which are used for the SysCalibLaser cycle:

- SysCalibLaserPre.nc
- SysCalibLaserPost.nc

3.5.3 Calibrating touch probe

3.5.3.1 Process

1. The reference tool moves to the configured starting point of the measurement in Z.
2. The reference tool is positioned simultaneously in the X and Y directions above the configured focal point of the laser.
3. The focal point of the laser is determined in the Z direction at a higher measuring speed. (when length measurement is active)
4. A precision measurement is executed in the Z direction at a slow measuring speed. (when length measurement is active)
5. The reference tool is positioned next to the laser and lowered. (when radius measurement is active)
6. A lateral measurement in XY is executed. (when radius measurement is active)
7. The reference tool is returned to the starting point position.

3.5.3.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P65	Type 0 = length measurement 1 = radius measurement 2 = length and radius measurement
@P66	Measurement offset in Z for lateral measurements [mm, inch] Only positive values are permissible.

The following parameters can be modified as an option:

Cycle parameters	Description
@P13 (optional)	Clearance for lateral measurements [mm, inch] Default value = 1/2 * current tool diameter (V.G.WZ_AKT.R)
@P23 (optional)	Precision measurement repetitions Default value = 1
@P33 (optional)	Crossover range during measurement process [mm, inch] Default value = 1/2 * current tool diameter (V.G.WZ_AKT.R)
@P37 (optional)	Permissible tolerance of measuring point scatter. Default value = 1/100 * current tool diameter (V.G.WZ_AKT.R) If the difference of the measured values exceeds this tolerance, an error is output.
@P64 (optional)	Mode 0 = push (default value) 1 = pull
@P67 (optional)	Lateral offset for length measurements [mm, inch] Only positive values are permissible. The value should stand at 0 for pointed tools, small tools and spherical tools. Default value = 0

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.5.3.3 Syntax

L CYCLE [NAME = SysCalibLaserSystem.ecy @P.. = ..]

3.5.3.4 Programming example

Calibrating laser

```
T1 D1
G53
G0 Z500
G0 X500 Y500
L CYCLE [NAME=SysCalibLaserSystem.ecy \
        @P23 = 2                      \
        @P37 = 0.05                   \
        @P64 = 0                      \
        @P65 = 2                      \
        @P66 = 5                      \
        @P67 = 5                      \
        ]

M30
```

3.5.3.5 Output variables

Cycle parameters	Description
V.CYC.SysRetLaserPosX	Determined position of the laser focal point in the X axis
V.CYC.SysRetLaserPosY	Determined position of the laser focal point in the Y axis
V.CYC.SysRetLaserPosZ	Determined position of the laser focal point in the Z axis
V.CYC.SysRetOffsetLength	Determined length offset
V.CYC.SysRetOffsetRadius	Determined radius offset

See information on use of the output variables [▶ 14].

3.6 Measure laser tool

3.6.1 Overview

Task

Automatic measurement of tool parameters.

3.6.2 Description

NOTICE

Possible damage to laser measuring station: The tool diameter may not be greater than the distance between the laser transmitter and receiver.

3.6.2.1 Configuration files

The SysCalibConfigLaser.nc file must be present in the form of a subroutine. It contains the laser parameters. Laser position data can be determined using the calibration cycle [▶ 42].

Variables	Description
V.CYC.LASER_POS_X	Position of the laser focal point in the X axis
V.CYC.LASER_POS_Y	Position of the laser focal point in the Y axis
V.CYC.LASER_POS_Z	Position of the laser focal point in the Z axis
V.CYC.DIRECTION	Definition of measuring and positioning direction: 0- Measurement takes place in X- direction 1- Measurement takes place in Y- direction 2- Measurement takes place in X+ direction 3- Measurement takes place in Y+ direction
V.CYC.LASER_Z_START_POS	Start point of first measurement in Z.
V.CYC.LASER_Z_END_POS	End point of first measurement in Z.
V.CYC.MEAS_FEED_SLOW	Measuring feedrate for precision measurement.
V.CYC.MEAS_FEED_FAST	Measuring feedrate for fast measurement
V.CYC.LASER_BRAKEOFFSET	Return clearance for precision measurement

For example, the configuration file SysCalibConfigLaser.nc may look like this:

Configuration file

```
%SysCalibConfigLaser.nc

; Position of the focal point of the laser
V.CYC.LASER_POS_X = 10

; Position of the focal point of the laser
V.CYC.LASER_POS_Y = 20

; Position of the focal point of the laser
V.CYC.LASER_POS_Z = 35

; Position/measurement direction
V.CYC.DIRECTION   = 1

; Retraction distance for precision measurement
V.CYC.LASER_BRAKEOFFSET = 0.5

; Measurement feedrate for fast measurement
V.CYC.MEAS_FEED_FAST = 500

; Measurement feedrate for precision measurement
V.CYC.MEAS_FEED_SLOW = 100

; Start point of first meas in Z
V.CYC.LASER_Z_START_POS = V.CYC.LASER_POS_Z + 20

; End point of first meas in Z
V.CYC.LASER_Z_END_POS   = V.CYC.LASER_POS_Z - 10

M17
```

Optionally, the two subroutine files below can be saved. They control the activation and deactivation of the lasers:

1. SysCalibConfigLaserOn.nc
2. SysCalibConfigLaserOff.nc

A distinction is made between push and pull measurements.

3.6.2.2 Pre- and post-files

For this cycle there are 2 pre-files which must be called before this cycle and 2 post-files which are called after each cycle.

These files are optional.

As required, these files can be created as a subroutine.

You can make machine-.specific modifications in this file, such as:

- Extend laser
- Retract laser

There is a general pre file and a general post file which are used for all laser cycles.

- SysMeasLaserPre.nc
- SysMeasLaserPost.nc

These files are only **valid for this cycle** and consist of the following:

Cyclename +Pre or Post +.nc

- SysMeasLaserToolPre.nc
- SysMeasLaserToolPost.nc

3.6.2.3 General cycle process

The cycles call internally different subroutines.

Example based on SysMeasLaserTool.ecy

```
1. SysMeasLaserPre.nc       (optional)
2. SysMeasLaserToolPre.nc   (optional)
3. SysCalibConfigLaser.nc
4. SysMeasLaserToolPost.nc  (optional)
5. SysMeasLaserPost.nc      (optional)
```

3.6.2.4 V.E. variables as transfer parameters

It is possible to create V.E. variables to process the measured values.

Variable	Description
V.E. ToolMeasResult.LengthValid	A length measurement was executed. This value is set to False at the end of the cycle.
V.E. ToolMeasResult.Length	Length value measured.
V.E. ToolMeasResult.RadiusValid	A radius measurement was executed. This value is set to False at the end of the cycle.
V.E. ToolMeasResult.Radius	Radius value measured.

V.E variables must be saved in the machine configuration.

```
var[n].name ToolMeasResult
var[n].type structToolMeasResult
var[n].scope CHANNEL
var[n].synchronisation FALSE
var[n].access_rights READ_WRITE
var[n].array_size 0
var[n].create_hmi_interface 0


struct[n].name structToolMeasResult
struct[n].element[0].name Length
struct[n].element[0].type REAL64
struct[n].element[1].name LengthValid
struct[n].element[1].type BOOLEAN
struct[n].element[2].name Radius
struct[n].element[2].type REAL64
struct[n].element[3].name RadiusValid
struct[n].element[3].type BOOLEAN
```

3.6.3 Measure length and radius

This cycle determines the parameters of a tool (length and radius) using a laser.

3.6.3.1 Internal cycle process

1. The reference tool moves to the configured starting point of the measurement in Z.
2. The reference tool is positioned simultaneously in the X and Y directions above the configured focal point of the laser.
3. The focal point of the laser is determined in the Z direction at a higher measuring speed. (when length measurement is active)
4. A precision measurement is executed in the Z direction at a slow measuring speed. (when length measurement is active)
5. The reference tool is positioned next to the laser and lowered. (when radius measurement is active)
6. A lateral measurement in XY is executed. (when radius measurement is active)
7. The reference tool is returned to the starting point position.

3.6.3.2 Parameters

Required input parameters

Input parameters	Description
@P65	Type 0 = length measurement 1 = radius measurement 2 = length and radius measurement
@P66	Measurement offset in Z for lateral measurements [mm, inch] Only positive values are permissible.

Optional input parameters

Input parameters	Description
@P13	Clearance for lateral measurements [mm, inch] Default value = 1/2 * current tool diameter (V.G.WZ_AKT.R)
@P23	Precision measurement repetitions Default value = 1
@P33	Crossover range during measurement process [mm, inch] Default value = 1/2 * current tool diameter (V.G.WZ_AKT.R)
@P37	Permissible tolerance of measuring point scatter. Default value = 1/100 * current tool diameter (V.G.WZ_AKT.R) If the difference of the measured values exceeds this tolerance, an error is output.
@P64	Mode 0 = push (default value) 1 = pull
@P67	Lateral offset for length measurements [mm, inch] Only positive values are permissible. The value should stand at 0 for pointed tools, small tools and spherical tools. Default value = 0

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.6.3.3 Syntax

L CYCLE [NAME = SysMeasLaserTool.ecy @P.. = ..]

3.6.3.4 Programming example

Measure length and radius

```
T1 D1
M6
G53
G0 Z500
G0 X500 Y500
L CYCLE [NAME=SysMeasLaserTool.ecy  \
        @P64 = 0                    \
        @P65 = 2                    \
        @P66 = 10                   \
        ]
M30
```

3.6.3.5 Output variables

Variable	Value
V.CYC.SysRetToolLength	Tool length measured
V.CYC.SysRetToolRadius	Determined tool radius

For information on the use of output variables, see Handling output variables See information on use of the output variables [▸ 14].

3.7 Laser tool breakage check

3.7.1 Overview

Task

Automatic breakage check of a tool.

Possible applications

This cycle can be used to check tools for breakage or wear during production to prevent damage to follow-on tools, for example.

Programming

The cycles are called with the L CYCLE[..] function and the required parameters are taken directly from the NC program. A more detailed description of the call is provided in the subsections for each of the cycles.

Parameters

The section Parameters describes the total overview of all parameters. Each cycle also has a modified parameter list which includes only the relevant parameters for the cycle.

3.7.2 General

NOTICE

The tool diameter may not be greater than the distance between the laser transmitter and receiver.

The 3 files must be present and configured before use, otherwise the cycles cannot run.

1. SysCalibConfigLaser.nc
2. SysCalibConfigLaserOn.nc
3. SysCalibConfigLaserOff.nc

In the event of a tool breakage, the machine stops with the error message P-ERR-13461.

If wear exceed the specified tolerance, the machine stops with the error message P-ERR-13450.

3.7.2.1 Configuration files

The SysCalibConfigLaser.nc file is executed before each cycle to calibrate the laser.

Variables	Description
V.CYC.LASER_POS_X	Position of the laser focal point in the X axis
V.CYC.LASER_POS_Y	Position of the laser focal point in the Y axis
V.CYC.LASER_POS_Z	Position of the laser focal point in the Z axis
V.CYC.DIRECTION	Definition of measuring and positioning direction 0- Positioning takes place in X+ and measurement in X- direction 1- Positioning takes place in Y+ and measurement in Y- direction 2- Positioning takes place in X- and measurement in X+ direction 3- Positioning takes place in Y- and measurement in Y+ direction
V.CYC.LASER_Z_START_POS	This position is approached before the first measurement in Z. It should be a couple of mm above the laser focal point.
V.CYC.LASER_Z_END_POS	This position is approached for the first measurement It should be a couple of mm under the laser focal point.

These 2 files control the activation and deactivation of the lasers:

- SysCalibConfigLaserOn.nc
- SysCalibConfigLaserOff.nc

3.7.2.2 Pre- and post-files

For this cycle there are 2 pre-files which must be called before this cycle and 2 post-files which are called after each cycle.

These files are optional.

As required, these files can be created as a subroutine.

You can make machine-.specific modifications in this file, such as:

- Extend laser
- Retract laser

There is a general pre file and a general post file which are used for all SysMeasLaser cycles.

- SysMeasLaserPre.nc
- SysMeasLaserPost.nc

These files are only **valid for this cycle** and consist of the following:

Cyclename +Pre or Post +.nc

- SysMeasLaserToolBreakPre.nc
- SysMeasLaserToolBreakPost.nc

3.7.2.3 General cycle process

The cycles call internally different subroutines in this sequence.

Measuring

Example based on SysMeasLaserToolBreak.ecy

1. SysMeasLaserPre.nc (optional)
2. SysMeasLaserToolBreakPre.nc (optional)
3. SysCalibConfigLaser.nc
4. SysMeasLaserToolBreakPost.nc (optional)
5. SysMeasLaserPost.nc (optional)

3.7.3 Breakage check

Position the tool above the measuring station as centrally as possible either manually or in automatic mode.

3.7.3.1 Internal cycle process

1. The tool moves in Z direction until just before the software limit switches.
2. The tool is positioned simultaneously in X and Y directions above the laser focal point including the radius offset. (These values were defined in the file SysCalibConfigLaser.nc).
3. The device moves in Z direction across the focal point.
4. This is followed by 2 measurement to determine the tool length.
5. The device moves back in Z to the starting position.

3.7.4 Parameters

Input parameters	Description
@P33	Permissible tolerance of the measuring points to determine tool breakage. If this value is exceed, it is evaluated as a tool breakage. (default = 0.5)
@P37	Permissible tolerance of the measuring points to determine tool wear. (default = 0.1) It the tolerance is too small, it may result in unnecessary machine stops.
@P67	Radius offset (lateral offset when probing) Only positive values are permissible. Set the offset according to the tool measurement. (default = 0)
@P70	0 (default) = warning when tool is worn, 1 = stop when tool is worn
@P71	0 (default) = warning when tool breaks, 1 = stop when tool breaks

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.7.5 Syntax

L CYCLE [NAME = SysMeasLaserToolBreak.ecy @P.. = ..]

3.7.6 Programming example

Laser tool breakage check

```
T1 D1  (D10 shaft end cutter)
M6
G53
G0 Z500
G0 X500 Y500
L CYCLE [NAME=SysMeasLaserToolBreak.ecy \
        @P33 = 0.2                      \
        @P37 = 0.1                      \
        @P67 = 5                        \
        ]
M30
```

3.7.7 Output variables

Variable	Value
V.CYC.SysRetToolIsWorn	Tool is worn (0=No, 1=Yes)
V.CYC.SysRetToolIsBroken	Tool is broken (0=No, 1=Yes)

For information on the use of output variables, see Handling output variables See information on use of the output variables [▶ 14].

3.8 Teach-in (sequence numbering)

3.8.1 Overview

Task

Measure the position and orientation of workpieces.

Possible applications

- Precise measuring of the position and orientation of a workpiece
- Generate a machining coordinate system to compensate for the inclined position of the workpiece

Programming

The cycles are called with the L CYCLE[..] function and the required parameters are taken directly from the NC program. A more detailed description of the call is provided in the subsections for each of the cycles.

The example below explains the typical programming of a teach-in based on the example of the SysMeasCs4.ecy cycle which determines the inclined position of a workpiece by 3 measurements. After the cycle is called, activate the machining coordinate system generated in the cycle to compensate for the inclined position of the workpiece. In addition, the example writes the calculated values of the machining coordinate system to a text file. This can be implemented in the NC program as follows:

Teach-in

```
#VAR
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetZ
  V.CYC.SysRetA
  V.CYC.SysRetB
  V.CYC.SysRetC
#ENDVAR

T1 D1
M6
G00 G90 X140 Y-65 Z100
L CYCLE [NAME=SysMeasCs4.ecy  \
        @P6  = 50             \
        @P17 = 30             \
        @P18 = 30             \
        @P39 = 2              \
        @P41 = 40             \
        @P42 = 60             \
        @P44 = 50             \
        ]

G00 G91 Z100
#FILE NAME [MSG="SysMeaCsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetZ =%f", V.CYC.SysRetZ]
#MSG SAVE ["V.CYC.SysRetA =%f", V.CYC.SysRetA]
#MSG SAVE ["V.CYC.SysRetB =%f", V.CYC.SysRetB]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

L CS_BASE_2.bcs

G0 G90 X0 Y0 Z100
... machining ...

#CS OFF

M30
```

To enable program execution, a configuration file [▶ 58] must also be saved as NC program.

3.8.2 Description

These cycles are used to determine the precise position, orientation and zero position using a touch probe or a reference tool.

The values determined are written to a subroutine.

The measurement results are on V.CYC variables (output variables) and can be processed in the post files.

3.8.2.1 General

A axis is the designation for the rotary axis about X.

B axis is the designation for the rotary axis about Y.

C axis is the designation for the rotary axis about Z.

> **i** The SysCalibConfigTouchprobe.nc file is not used for manual teach-in.

If no measuring signal is triggered during the measurement, the machine stops with the error message: “No workpiece detected, please check your measuring section.“

P-ERR-13413

If a measurement is detected during positioning, the machine stops with the error message: “Collision on positioning, please check your motion range.“

P-ERR-13414

The SysCalibConfigTouchprobe.nc file must be present and configured before the cycles are used, otherwise the cycles cannot run.

At the end of the cycles, a file is written CS_BASE_[CS ID @P39].bcs.

NOTICE

If the file already exists, it is deleted and a new file is written. No back-up is made!

From then on, the file can be called from any program.

The generated program defines the required coordinate system (CS) and enables it immediately.

3.8.2.2 Parameters

The input parameters are listed in the corresponding cycle subsection.

3.8.2.3 Configuration file

The following items are required to successfully configure the touch probe:

- the radius of the touch probe sphere, the offsets in X and Y and the length of the touch probe must be defined using the tool data.
- The configuration file SysCalibConfigTouchprobe.nc was created, containing at least the measuring and positioning feedrates.

Detailed description

The SysCalibConfigTouchprobe.nc file is executed before each cycle to identify the touch probe parameters. The following variables must then be defined.

Variables	Description
V.CYC.SysConf_Probes_feed	Measuring feedrate.
V.CYC.SysConf_Probes_feed_max	Positioning feedrate between measuring points.
V.CYC.SysConf_Spindle_orientation	Definition whether the touch probe is to be positioned in the measurement direction before every measurement run. 0 = touch probe is not positioned (default value). Touch probe must be in initial position before the start of the cycle. 1 = touch probe is positioned
V.CYC.SysConf_Probes_feed_repeat	Measuring feedrate for a second probing at a slow speed. If defined with a value > 0, the probe is retracted slightly after the first probing and the measurement is repeated. Default value = 0.
V.CYC.SysConf_Probes_dist_repeat	Retraction distance in the measuring direction for the second probing at a slow speed. Only used if V.CYC.SysConf_Probes_feed_repeat is greater than zero. Default value = 2.
V.CYC.SysConf_Spindle_angle	Definition of the basic angle specified to position the touch probe. Only used if V.CYC.SysConf_Spindle_orientation = 1. Corresponds to the spindle position (M19) required for measuring in the positive X direction. Default value = 0.
V.CYC.SysConf_Spindle_Pos_Dir	Position of the spindle final position when positioned with M19. Only used if V.CYC.SysConf_Spindle_orientation = 1. 0 = The spindle positions the touch probe clockwise when the touch probe tip is viewed from below (default value). 1 = The spindle positions the touch probe counter clockwise when the touch probe tip is viewed from below.
V.CYC.SysConf_Probes_spdl_feed	Spindle feedrate for spindle positioning of the touch probe. Default value = 200
V.CYC.SysConf_Probes_spdl_wait	Time in seconds to wait for the spindle to reposition before a corresponding measurement run. Default value = 1

Additional configuration data for the touch probe is read from the current tool data. The touch probe must therefore be defined as a current tool and its tool data must be saved (except for calibration).

The tool data to be considered includes:

- The radius of the touch probe sphere (V.G.WZ_AKT.R)
- The length of the touch probe (V.G.WZ_AKT.L)

- Horizontal offsets of the touch probe tip relative to the spindle flange (V.G.WZ_AKT.V.X and W.G.WZ_AKT.V.Y)

The measurement results are calculated to include the offsets between the touch probe tip and the spindle flange and the radius of the touch probe sphere.

For example, the configuration file SysCalibConfigTouchprobe.nc may look like this:

Configuration file

```
V.CYC.SysConf_Probes_feed         =  500      (measuring feed rate)
V.CYC.SysConf_Probes_feed_max     = 1000      (positioning feed rate)
V.CYC.SysConf_Spindle_orientation =    0      (positioning of probe)
V.CYC.SysConf_Spindle_angle       =    0      (probe basic angle)
M17
```

3.8.2.4 Pre- and post-files

For this cycle there are 2 pre-files which must be called before this cycle and 2 post-files which are called after each cycle.

These files are optional.

As required, these files can be created as a subroutine.

You can make machine-.specific modifications in this file, such as:

- Extend laser
- Retract laser
- Activate the touch probe etc.

There is a general pre file and a general post file which are used for all SysMeasCs cycles.

- SysMeasCsPre.nc
- SysMeasCsPost.nc

In addition there is normally a separate file for each cycle and this is only valid for this particular cycle.

Cyclename +Pre or Post +.nc

- SysMeasCs1Pre.nc
- SysMeasCs1Post.nc

3.8.2.5 General cycle process

The cycles call internally different subroutines.

Example based on SysMeasCs1.ecy

SysMeasCsPre.nc (optional)

SysMeasCs1Pre.nc (optional)

SysCalibConfigTouchprobe.nc

SysMeasCs1Post.nc (optional)

SysMeasCsPost.nc (optional)

3.8.3 Teach-in

A CS is determined and saved to record several points.

3.8.3.1 SysMeasCs1 - Manual teach-in

- 3 points must be approached manually.
- A pointed tool is suitable for this method.
- No touch probe is required.

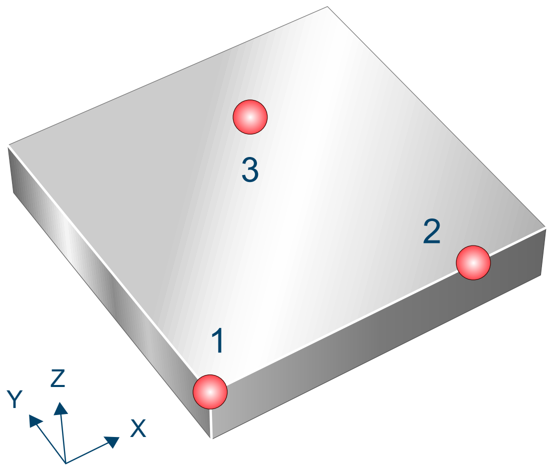

Fig. 10: Manual teach-in

3.8.3.1.1 Process (internal cycle)

1. After the start of the cycle you are requested to approach the first point. Bottom left corner.
2. Required: X0Y0Z0
3. Press Start again.
4. You are requested to approach the second point.
5. One point along the positive X axis.
6. Press Start again.
7. You are requested to approach the third point.
8. Positive on the X and Y surface viewed from the first point.
9. Press Start a final time to end the cycle.
10. A new file is written CS_BASE_[CS ID @P39].bcs

3.8.3.1.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P39	Select the required CS to be written. Value range: 1-10

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.8.3.1.3 Syntax

L CYCLE [NAME = SysMeasCs1.ecy @P.. = ..]

3.8.3.1.4 Programming example

Manual teach-in

```
T9 D9
M6
L CYCLE [NAME= SysMeasCs1.ecy @P39=1]
M30
```

Another example for handling SysMeasCs cycles is contained in the Overview section [▶ 56] in the subsection Programming.

3.8.3.1.5 Example of a program generated

```
CS_BASE_1.bcs
#COMMENT BEGIN
CS X = 1421.5527
CS Y = -46.6678
CS Z = 719.0895
CS A = -0.005
CS B = 0.0387
CS C = -0.0222
#COMMENT END
#CS DEF [1][1421.5527,-46.6678,719.0895,-0.005,0.0387,-0.0222]
#CS ON [1]
M17
```

3.8.3.1.6 Output variables

Variable	Value
V.CYC.SysRetX	The calculated X value
V.CYC.SysRetY	The calculated Y value
V.CYC.SysRetZ	The calculated Z value
V.CYC.SysRetA	The calculated A value
V.CYC.SysRetB	The calculated B value
V.CYC.SysRetC	The calculated C value

For information on the use of output variables, see Handling output variables [▶ 14]

3.8.3.2 SysMeasCs2 - Semi-automatic teach-in

7 points must be pre-positioned manually.

The measurements are executed automatically in conjunction with a touch probe.

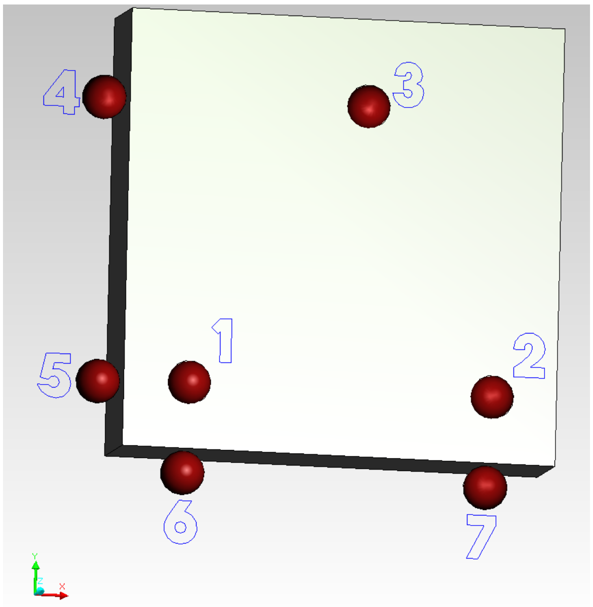

Fig. 11: Semi-automatic teach-in

3.8.3.2.1 Process (internal cycle)

1. Measurements in Z direction
2. After the start of the cycle, the touch probe must be positioned manually above the 1st measuring point.
3. Press Start again to start the measurement run.
4. Repeat this process with point 2 and point 3.
5. Then lift to the security distance @P13.
6. The orientation of the top surface is calculated and axes A, B and C are swivelled in.
7. Measurements in X direction
8. Then approach starting point 4 and press Start again.
9. Afterwards, approach starting point 5 and press Start again.
10. The measurement direction is determined from these points and positions 4 and 5 are measured automatically.
11. Measurements in Y direction
12. Approach point 6 manually and press Start.
13. Finally, approach point 7 manually and press Start.
14. The measurement direction is determined from these points and positions 6 and 7 are measured automatically.
15. A new file is written CS_BASE_[CS ID @P39].bcs

NOTICE

If the file already exists, it is deleted and a new file is written. No back-up is made!

3.8.3.2.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description

@P4	Measurement path in X axis - Only positive value permitted
@P5	Measurement path in Y axis - Only positive value permitted
@P6	Measurement path in Z axis - Only positive value permitted
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P11	Shift the measuring point along the Z axis
@P13	Safety clearance [mm, inch] Default value = 10
@P14	Angle 1 - Basic setting of the A axis
@P15	Angle 2 - Basic setting of the B axis
@P16	Angle 3 - Basic setting of the C axis
@P39	Select the required CS to be written. Value range: 1-10

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.8.3.2.3 Syntax

```
L CYCLE [ NAME = SysMeasCs2.ecy @P.. = .. ]
```

3.8.3.2.4 Programming example

Semi-automatic teach-in

```
T9 D9
M6
L CYCLE [NAME= SysMeasCs2.ecy   \
        @P4  = 30               \
        @P5  = 30               \
        @P6  = -40              \
        @P9  = 0                \
        @P10 = 0                \
        @P11 = 0                \
        @P13 = 150              \
        @P14 = 0                \
        @P15 = 90               \
        @P16 = 0                \
        @P39 = 3                \
        ]
M30
```

Another example for handling SysMeasCs cycles is contained in the Overview section [▶ 56] in the subsection Programming.

3.8.3.2.5 Example of a program generated

```
CS_BASE_1.bcs
#COMMENT BEGIN
CS X = 1421.5527
CS Y = -46.6678
CS Z = 719.0895
CS A = -0.005
CS B = 0.0387
CS C = -0.0222
#COMMENT END
#CS DEF [1][1421.5527,-46.6678,719.0895,-0.005,0.0387,-0.0222]
#CS ON [1]
M17
```

3.8.3.2.6 Output variables

Variable	Value
V.CYC.SysRetX	The calculated X value
V.CYC.SysRetY	The calculated Y value
V.CYC.SysRetZ	The calculated Z value
V.CYC.SysRetA	The calculated A value
V.CYC.SysRetB	The calculated B value
V.CYC.SysRetC	The calculated C value

For information on the use of output variables, see Handling output variables [▶ 14]

3.8.3.3 SysMeasCs3 - Automatic teach-in

7 measurements are executed automatically depending on the defined parameters.

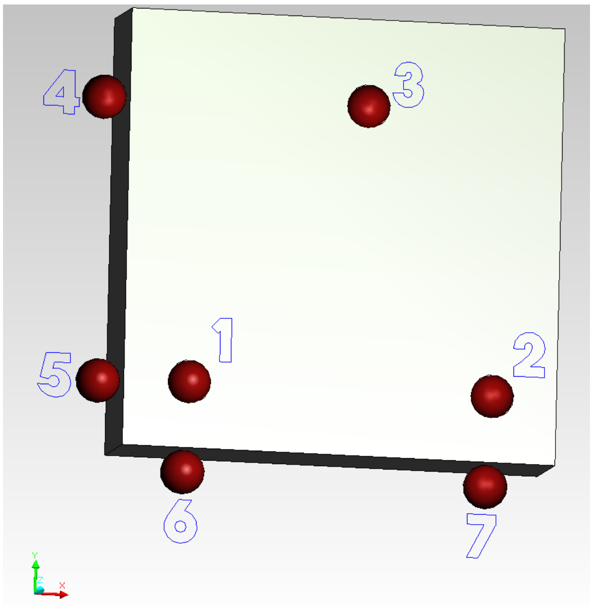

Fig. 12: Automatic teach-in

3.8.3.3.1 Process (internal cycle)

1. The touch probe must be positioned manually or in automatic mode in the proximity of the front left corner so that the probe can reach all points without collision.
2. First execute 3 measurements on the top surface.
3. Then execute the two measurements on the X surface.
4. Finally, execute the two measurements on the Y surface.
5. If a retraction height was transferred, the touch probe is retracted to this height.
6. A new file is written CS_BASE_[CS ID @P39].bcs

NOTICE
If the file already exists, it is deleted and a new file is written. No back-up is made!

3.8.3.3.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P4	Measurement path in X axis - Only positive value permitted
@P5	Measurement path in Y axis - Only positive value permitted
@P6	Measurement path in Z axis - Only positive value permitted

@P17	Pre-position in X
@P18	Pre-position in Y
@P19	Pre-position in Z
@P39	Select the required CS to be written. Value range: 1-10
@P41	Pre-position in X2
@P42	Pre-position in X3
@P43	Pre-position in Y2
@P44	Pre-position in Y3

Optional input parameters

Input parameters	Description
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P11	Shift the measuring point along the Z axis
@P49	Retraction height after measurement Default value = position after last measurement

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.8.3.3.3 Syntax

L CYCLE [NAME = SysMeasCs3.ecy @P.. = ..]

Another example for handling SysMeasCs cycles is contained in the Overview section [▶ 56] in the subsection Programming.

3.8.3.3.4 Programming example

Automatic teach-in

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 G90 X1400 Y-65 Z735

#VAR
  ; input parameters:
  V.L.MeasDistX  =  30
  V.L.MeasDistY  =  30
  V.L.MeasDistZ  =  40
  V.L.NumberCS   =   2
  V.L.PrePosX1   =  30
  V.L.PrePosY1   =  30
  V.L.PrePosZ1   = -25
  V.L.PrePosX2   =  40
  V.L.PrePosY2   =  40
  V.L.PrePosX3   =  60
  V.L.PrePosY3   =  50

  ; output variables:
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetZ
  V.CYC.SysRetA
  V.CYC.SysRetB
```

```
  V.CYC.SysRetC
#ENDVAR

L CYCLE [NAME=SysMeasCs3.ecy  @P4=V.L.MeasDistX @P5=V.L.MeasDistX \
                              @P6=V.L.MeasDistZ @P17=V.L.PrePosX1 \
                              @P18=V.L.PrePosY1 @P19=V.L.PrePosZ1 \
                              @P39=V.L.NumberCS @P41=V.L.PrePosX2 \
                              @P42=V.L.PrePosX3 @P43=V.L.PrePosY2 \
                              @P44=V.L.PrePosY3]

; print result
#FILE NAME [MSG="SysMeaCsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetZ =%f", V.CYC.SysRetZ]
#MSG SAVE ["V.CYC.SysRetA =%f", V.CYC.SysRetA]
#MSG SAVE ["V.CYC.SysRetB =%f", V.CYC.SysRetB]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

; calling the #CS by the subroutine written in the cycle
L CS_BASE_2.bcs
; ... machining workpiece with measured coordinate system ....
#CS OFF

M30
```

3.8.3.3.5 Example of a program generated

```
CS_BASE_3.bcs
#COMMENT BEGIN
CS X = 1421.5527
CS Y = -46.6678
CS Z = 719.0895
CS A = -0.005
CS B = 0.0387
CS C = -0.0222
#COMMENT END
#CS DEF [1][1421.5527,-46.6678,719.0895,-0.005,0.0387,-0.0222]
#CS ON [1]
M17
```

3.8.3.3.6 Output variables

Variable	Value
V.CYC.SysRetX	The calculated X value
V.CYC.SysRetY	The calculated Y value
V.CYC.SysRetZ	The calculated Z value
V.CYC.SysRetA	The calculated A value
V.CYC.SysRetB	The calculated B value
V.CYC.SysRetC	The calculated C value

For information on the use of output variables, see Handling output variables [▸ 14]

3.8.3.4 SysMeasCs4 - Align plane cycle

Automated alignment of a plane by measuring three points on the workpiece surface.

The cycle calculates a machining coordinate system (CS) to modify the angle position to a plane. The translatory shift of the calculated coordinate system causes a shift to the first measuring point on the plane. The calculated rotary shift causes an angle compensation related to the measured plane.

Forming a new coordinate system

The first point measured on the plane determines the relative shift of the coordinate system. The system can also be further shifted by the cycle input parameters @P9@P11.

The rotation of the new coordinate system is calculated so that its X axis runs through the vector from the first to the second measured point (irrespective of the shift by the input parameters). The Y axis is obtained by the vertical projection of the line to the third measured point on the new X axis. The Z axis is defined in order to retain the original rectangular system representation.

The graphic below describes the measurement of a horizontal XY plane. The measured points therefore have the same height in the original coordinate system.. This clearly shows that the selection of the pre-positions has an influence on the resulting coordinate system.

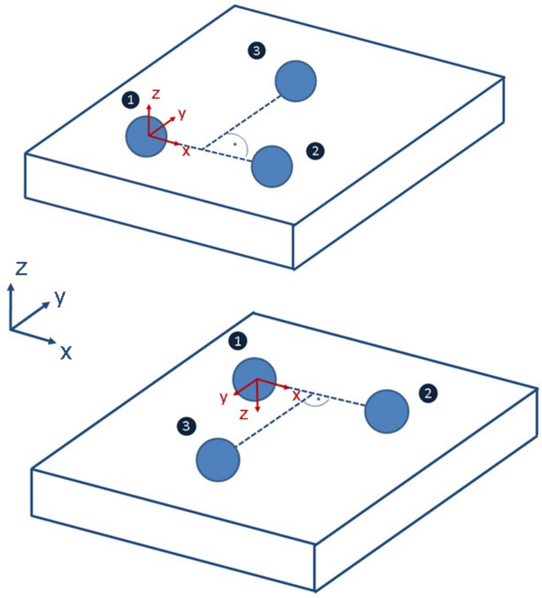

Fig. 13: Resulting coordinate system

3.8.3.4.1 Process (internal cycle)

Starting position before the cycle is called: The touch probe must be positioned at the start point manually or in automatic mode so that the probe can reach all points without collision.

The internal cycle process can be described as follows:

1. The touch probe approaches the first pre-position specified in @P17 and @P18 relative to the start point.
2. Measurement in Z direction
3. The touch probe approaches the second pre-position in X direction specified in @P41 relative to the first measuring point.
4. Measurement in Z direction
5. The touch probe approaches the third pre-position specified in @P42 and @P44 relative to the start point.
6. Measurement in Z direction
7. If a retraction height was transferred, the touch probe is retracted to this height

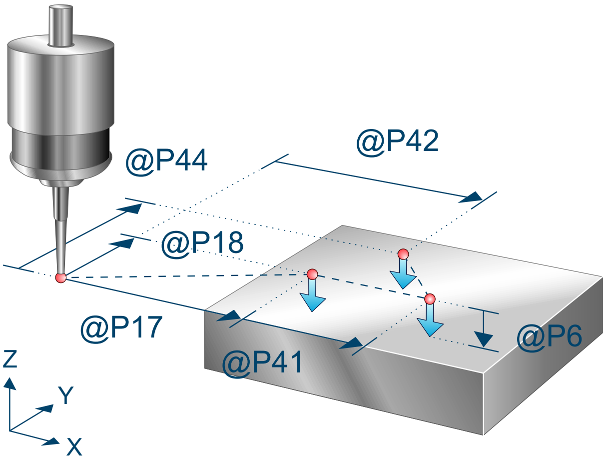

Fig. 14: Align plane

3.8.3.4.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P6	Measurement path in the direction of the negative Z axis, only positive values permitted
@P17	Pre-position in X of the first measuring point relative to the start point
@P18	Pre-position in Y of the first measuring point relative to the start point
@P39	Select the required CS to be written. Value range: 1-10
@P41	Pre-position in X of the second measuring point relative to the first measuring point
@P42	Pre-position in X of the third measuring point relative to the start point
@P44	Pre-position in Y of the third measuring point relative to the start point

Optional input parameters

Input parameters	Description
@P9	Shift the measurement result along the 1st axis (shifts origin of the calculated coordinate system) Default value = 0
@P10	Shift the measurement result along the 2nd axis (shifts origin of the calculated coordinate system) Default value = 0
@P11	Shift the measurement result along the 3rd axis (shifts origin of the calculated coordinate system) Default value = 0

@P49	Retraction height after measurement Default value = position after last measurement

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.8.3.4.3 Syntax

L CYCLE [NAME = SysMeasCs4.ecy @P.. = ..]

3.8.3.4.4 Programming example

Align plane

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G00 G90 X1400 Y-65 Z735

#VAR
  ; input parameters:
  V.L.MeasDistZ  =  40
  V.L.NumberCS   =   2
  V.L.PrePosX1   =  30
  V.L.PrePosY1   =  30
  V.L.PrePosX2   =  40
  V.L.PrePosX3   =  60
  V.L.PrePosY3   =  50

  ; output variables:
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetZ
  V.CYC.SysRetA
  V.CYC.SysRetB
  V.CYC.SysRetC
#ENDVAR

L CYCLE [NAME=SysMeasCs4.ecy  @P6=V.L.MeasDistZ @P17=V.L.PrePosX1 \
                              @P18=V.L.PrePosY1 @P39=V.L.NumberCS \
                              @P41=V.L.PrePosX2 @P42=V.L.PrePosX3 \
                              @P44=V.L.PrePosY3]

; print result
#FILE NAME [MSG="SysMeaCsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetZ =%f", V.CYC.SysRetZ]
#MSG SAVE ["V.CYC.SysRetA =%f", V.CYC.SysRetA]
#MSG SAVE ["V.CYC.SysRetB =%f", V.CYC.SysRetB]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

; calling the #CS by the subroutine written in the cycle
L CS_BASE_2.bcs
; ... machining workpiece with measured coordinate system ....
#CS OFF

M30
```

Example of a program generated:

```
%CS_BASE_2.bcs
#COMMENT BEGIN
CS X = 1430
CS Y = -35
CS Z = 734,992
```

```
CS A = 0
CS B = 0
CS C = -0.0222
#COMMENT END
#CS DEF [2][1430,-35,734.992,0,0,0]
#CS ON [2]
M17
```

Another example for handling SysMeasCs cycles is contained in the Overview section [▸ 56] in the subsection Programming.

3.8.3.4.5 Output variables

Variable	Value
V.CYC.SysRetX	X value for the translatory shift of the calculated coordinate system. Corresponds to the X value of the first measuring point.
V.CYC.SysRetY	Y value for the translatory shift of the calculated coordinate system. Corresponds to the X value of the first measuring point.
V.CYC.SysRetZ	Z value for the translatory shift of the calculated coordinate system. Corresponds to the X value of the first measuring point.
V.CYC.SysRetA	A value for the rotary shift of the calculated coordinate system.
V.CYC.SysRetB	A value for the rotary shift of the calculated coordinate system.
V.CYC.SysRetC	A value for the rotary shift of the calculated coordinate system.

For information on the use of output variables, see Handling output variables [▸ 14]

3.8.3.5 SysMeasCs5 - Teach-in with 3 spheres

This cycle determines a coordinate system which is defined by the centre points of three spheres. The automatic measurement of the three spheres determines their centre points in order to calculate the necessary coordinate system parameters.

The sphere diameter must be significantly greater than the sphere diameter of the touch probe for a successful calibration.

A pre-positioning for the second and third spheres must be specified for the measurement. Here, an approximate parameter is sufficient. However, the deviation from the actual position of the spheres should be small.

Forming a new coordinate system

The centre point of the first sphere measured specifies the relative shift of the coordinate system. The system can also be further shifted by the cycle input parameters @P9@P11.

The rotation of the new coordinate system is calculated so that its X axis runs through the vector from the centre point of the first sphere to the centre point of the second sphere (irrespective of the shift by the input parameters). The Y axis is obtained by the vertical projection of the centre point to the third sphere on the new X axis. The Z axis is defined in order to retain the original rectangular system representation.

The graphic below describes the measurement of three spheres in the XY plane. The spheres therefore have the same height in the original coordinate system.

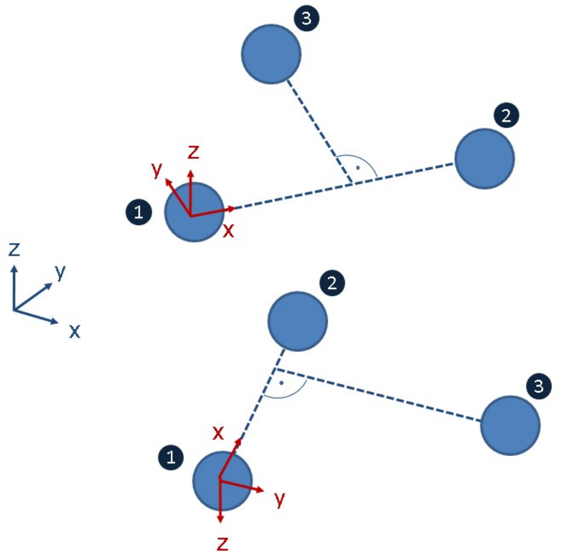

Fig. 15: Measurement of three spheres in a plane

It becomes obvious that the measurement order influences the resulting coordinate system.

3.8.3.5.1 Process (internal cycle)

Starting position before the cycle is called: The touch probe must be positioned either manually or in automatic mode as centrally as possible and at a short clearance above the first sphere. It stands vertically, i.e. the touch probe rotation stands at 0. In addition, the touch probe must be in initial position.

The position of the touch probe in the Z axis is retained for all pre-positions.

The internal cycle process can be described as follows:

1. The touch probe first runs a measurement in the Z direction and a total of four lateral measurements, after which it returns to the starting position. If a measurement repetition was specified in @P88 to enhance accuracy, the measurement is repeated, whereby the lateral measurements take place at the calculated height of the equator.

2. The touch probe approaches the second pre-position specified in @P41 and @P43 with constant Z position.
3. The second sphere is measured in the same way as in step 1.
4. The touch probe approaches the third pre-position specified in @P42 and @P44 with constant Z position.
5. The third sphere is measured in the same way as in step 1.
6. The touch probe returns to the starting position.

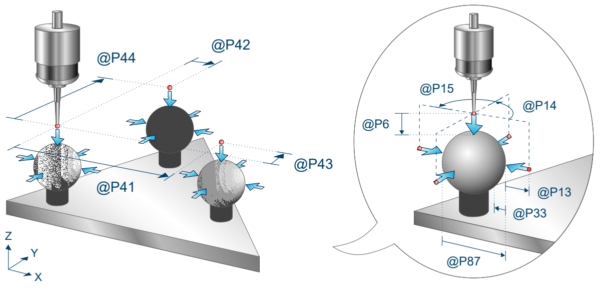

Fig. 16: Teach-in with 3 spheres

3.8.3.5.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P6	Measurement path in the direction of the negative Z axis (only positive values permitted)
@P39	Select the required CS to be written. Value range: 1-10
@P41	Pre-position in X of the second measuring point relative to the start point
@P42	Pre-position in X of the third measuring point relative to the start point
@P43	Pre-position in Y of the second measuring point relative to the start point
@P44	Pre-position in Y of the third measuring point relative to the start point
@P87	Estimated diameter of the spheres. Here, an approximate parameter is sufficient. It is used to calculate the pre-positions.

Optional input parameters

Input parameters	Description
@P9	Shift the measurement result along the 1st axis (shifts origin of the calculated coordinate system) Default value = 0
@P10	Shift the measurement result along the 2nd axis (shifts origin of the calculated coordinate system) Default value = 0
@P11	Shift the measurement result along the Z axis (shifts origin of the calculated coordinate system) Default value = 0
@P13	Security distance for pre-positioning (Default value = @P87/4)

@P14	Probe angle of the first lateral measurement in relation to the positive 1st Axis [degrees] Default value = 0
@P15	Difference of the probe angle between the lateral measurements [degrees] Default value = 90
@P33	Crossover range during measurement process Default value = @P87/4
@P64	Definition of the path to approach to pre-position 0 = linear (default value) 1 = circular (Caution: collision detection disabled)
@P88	Measurement repetition at the height of the equator using calculated parameters from the first pass for enhanced accuracy 1 = yes 2 = no (default value)

NOTICE

Disabled collision detection when @P64 is active.

If circular approach of the pre-position was selected in @P64, collision detection is disabled. This option may only be enabled if safe approach to the pre-position is ensured.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.8.3.5.3 Syntax

L CYCLE [NAME = SysMeasCs5.ecy @P.. = ..]

3.8.3.5.4 Programming example

Teach-in with 3 spheres

```
; touch probe activation
T1 D1
G53

; deactivation of the zero offset
G53

#VAR
  ; input parameters:
  V.L.MeasDistZ      =  40
  V.L.NumberCS       =   2
  V.L.PrePosX2       =  40
  V.L.PrePosY3       =  50
  V.L.PrePosY2       =  40
  V.L.PrePosX3       =  60
  V.L.SphereDiameter =  20

  ; output variables:
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetZ
  V.CYC.SysRetA
  V.CYC.SysRetB
  V.CYC.SysRetC
#ENDVAR

L CYCLE [NAME=SysMeasCs5.ecy  @P6 = V.L.MeasDistZ @P39 = V.L.NumberCS \
                              @P41=V.L.PrePosX2   @P42=V.L.PrePosX3   \
                              @P43 = V.L.PrePosY2 @P44=V.L.PrePosY3   \
                              @P87 = V.L.SphereDiameter ]
```

```
; print result
#FILE NAME [MSG="SysMeaCsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetZ =%f", V.CYC.SysRetZ]
#MSG SAVE ["V.CYC.SysRetA =%f", V.CYC.SysRetA]
#MSG SAVE ["V.CYC.SysRetB =%f", V.CYC.SysRetB]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

; calling the #CS by the subroutine written in the cycle
L CS_BASE_2.bcs
; ... machining workpiece with measured coordinate system ....
#CS OFF

M30
```

Example of a program generated:

```
%CS_BASE_2.bcs
#COMMENT BEGIN
CS X = 1430
CS Y = -35
CS Z = 734,992
CS A = 0
CS B = 0
CS C = -0.0222
#COMMENT END
#CS DEF [2][1430,-35,734.992,0,0,0]
#CS ON [2]
M17
```

Another example for handling SysMeasCs cycles is contained in the Overview section [▶ 56] in the subsection Programming.

3.8.3.5.5 Output variables

Variable	Value
V.CYC.SysRetX	Relative shift of the calculated coordinate system in the first axis
V.CYC.SysRetY	Relative shift of the calculated coordinate system in the second axis
V.CYC.SysRetZ	Relative shift of the calculated coordinate system in the third axis
V.CYC.SysRetA	Rotation of the calculated coordinate system about the first axis (rotation sequence ZYX)
V.CYC.SysRetB	Rotation of the calculated coordinate system about the second axis (rotation sequence ZYX)
V.CYC.SysRetC	Rotation of the calculated coordinate system about the third axis (rotation sequence ZYX)
V.CYC.SysRetDiameter1	Determined sphere diameter of the first sphere
V.CYC.SysRetCenterX1	Determined sphere centre point of the first sphere - first axis
V.CYC.SysRetCenterY1	Determined sphere centre point of the first sphere - second axis
V.CYC.SysRetCenterZ1	Determined sphere centre point of the first sphere - third axis
V.CYC.SysRetDiameter2	Determined sphere diameter of the second sphere
V.CYC.SysRetCenterX2	Determined sphere centre point of the second sphere - first axis
V.CYC.SysRetCenterY2	Determined sphere centre point of the second sphere - second axis
V.CYC.SysRetCenterZ2	Determined sphere centre point of the second sphere - third axis
V.CYC.SysRetDiameter3	Determined sphere centre point of the second sphere - first axis
V.CYC.SysRetCenterX3	Calculate sphere centre point of the third sphere - first axis
V.CYC.SysRetCenterY3	Determined sphere centre point of the third sphere - second axis
V.CYC.SysRetCenterZ3	Determined sphere centre point of the third sphere - third axis

For information on the use of output variables, see Handling output variables [▶ 14]

3.9 Workpiece Coordinate System (WCS)

3.9.1 Overview

Task

This instruction describes the automatic measurement of workpieces. In addition, a zero offset is written to offset the origin of the machining coordinate system to match the workpiece,

Possible applications

The following applications are conceivable:

- Precise measurement of workpieces before or after machining
- Generating a zero offset to match the workpiece to simplify the programming for machining
- Measuring machining operations with active zero offset

Programming

The cycles are called with the L CYCLE[..] function and the required parameters are taken directly from the NC program. A more detailed description of the call is provided in the subsections for each of the cycles.

The section below explains the typical programming of a teach-in based on the example of the SysMeasWcs7.ecy cycle which determines the corner point of a rectangular workpiece by 3 measurements. After calling the cycle, the zero offset generated in the cycle is activated and traverses over the corner point of the workpiece. In addition, the example writes the coordinates of the corner point to a text file. This can be implemented in the NC program as follows:

TCS measurement: Set zero offset (G54) followed by machining to zero offset (G54)

```
#VAR
V.CYC.SysRetX
V.CYC.SysRetY
V.CYC.SysRetZ
#ENDVAR

T1 D1
M6
G53
G00 G90 X-50 Y-50
G00 G91 Z-100

L CYCLE [NAME=SysMeasWcs7.ecy   \
        @P4  = 10               \
        @P5  = 10               \
        @P6  = -10              \
        @P7  = 54               \
        @P9  = 0                \
        @P10 = 0                \
        @P11 = -2               \
        @P17 = 20               \
        @P18 = 30               \
        @P19 = -15              \
        ]

G00 G91 Z100
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetZ =%f", V.CYC.SysRetZ]

G54
G0 G90 X0 Y0 Z200
... Workpiece machining ....
G53

M30
```

TCS measurement: Measure with active zero offset (G54)

```
#VAR
V.CYC.SysRetX
V.CYC.SysRetY
V.CYC.SysRetZ
#ENDVAR

T1 D1
M6
G54
G00 G90 X-5 Y-5
G00 G90 Z5

L CYCLE [NAME=SysMeasWcs7.ecy   \
        @P4  = 10               \
        @P5  = 10               \
        @P6  = -10              \
        @P9  = 0                \
        @P10 = 0                \
        @P11 = -2               \
        @P17 = 20               \
        @P18 = 30               \
        @P19 = -15              \
        ]

G00 G90 Z100
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetZ =%f", V.CYC.SysRetZ]

G53

M30
```

To enable program execution, a configuration file [▶ 81] must also be saved as NC program.

3.9.2 Description

3.9.2.1 General

P-ERR-13413.

If a measurement is detected during positioning, the machine stops with the error message: “Collision on positioning, please check your motion range.“

P-ERR-13414.

The measurement results are on V.CYC variables (output variables) and can be processed in the post files.

3.9.2.2 Pre- and post-files

For this cycle there are 2 pre-files which must be called before this cycle and 2 post-files which are called after each cycle.

These files are optional.

As required, these files can be created as a subroutine.

You can make machine-.specific modifications in this file, such as:

- Extend laser
- Retract laser
- Activate the touch probe etc.

There is a general pre file and a general post file which are used for all SysMeasWcs cycles.

- SysMeasWcsPre.nc
- SysMeasWcsPost.nc

In addition there is normally a separate file for each cycle and this is only valid for this particular cycle.

Cyclename +Pre or Post +.nc

- SysMeasWcs1Pre.nc
- SysMeasWcs1Post.nc

3.9.2.3 Configuration file

The following items are required to successfully configure the touch probe:

- the radius of the touch probe sphere, the offsets in X and Y and the length of the touch probe must be defined using the tool data.
- The configuration file SysCalibConfigTouchprobe.nc was created, containing at least the measuring and positioning feedrates.

Detailed description

The SysCalibConfigTouchprobe.nc file is executed before each cycle to identify the touch probe parameters. The following variables must then be defined.

Variables	Description
V.CYC.SysConf_Probes_feed	Measuring feedrate.
V.CYC.SysConf_Probes_feed_max	Positioning feedrate between measuring points.
V.CYC.SysConf_Spindle_orientation	Definition whether the touch probe is to be positioned in the measurement direction before every measurement run. 0 = touch probe is not positioned (default value). Touch probe must be in initial position before the start of the cycle. 1 = touch probe is positioned
V.CYC.SysConf_Probes_feed_repeat	Measuring feedrate for a second probing at a slow speed. If defined with a value > 0, the probe is retracted slightly after the first probing and the measurement is repeated. Default value = 0.
V.CYC.SysConf_Probes_dist_repeat	Retraction distance in the measuring direction for the second probing at a slow speed. Only used if V.CYC.SysConf_Probes_feed_repeat is greater than zero. Default value = 2.

V.CYC.SysConf_Spindle_angle	Definition of the basic angle specified to position the touch probe. Only used if V.CYC.SysConf_Spindle_orientation = 1. Corresponds to the spindle position (M19) required for measuring in the positive X direction. Default value = 0.
V.CYC.SysConf_Spindle_Pos_Dir	Position of the spindle final position when positioned with M19. Only used if V.CYC.SysConf_Spindle_orientation = 1. 0 = The spindle positions the touch probe clockwise when the touch probe tip is viewed from below (default value). 1 = The spindle positions the touch probe counter clockwise when the touch probe tip is viewed from below.
V.CYC.SysConf_Probes_spdl_feed	Spindle feedrate for spindle positioning of the touch probe. Default value = 200
V.CYC.SysConf_Probes_spdl_wait	Time in seconds to wait for the spindle to reposition before a corresponding measurement run. Default value = 1

Additional configuration data for the touch probe is read from the current tool data. The touch probe must therefore be defined as a current tool and its tool data must be saved (except for calibration).

The tool data to be considered includes:

- The radius of the touch probe sphere (V.G.WZ_AKT.R)
- The length of the touch probe (V.G.WZ_AKT.L)
- Horizontal offsets of the touch probe tip relative to the spindle flange (V.G.WZ_AKT.V.X and W.G.WZ_AKT.V.Y)

The measurement results are calculated to include the offsets between the touch probe tip and the spindle flange and the radius of the touch probe sphere.

For example, the configuration file SysCalibConfigTouchprobe.nc may look like this:

Configuration file

```
V.CYC.SysConf_Probes_feed          =  500      (measuring feed rate)
V.CYC.SysConf_Probes_feed_max      = 1000      (positioning feed rate)
V.CYC.SysConf_Spindle_orientation =    0      (positioning of probe)
V.CYC.SysConf_Spindle_angle        =    0      (probe basic angle)
M17
```

3.9.2.4 General cycle process

The cycles call internally different subroutines.

Example based on SysMeasCs1.ecy

```
SysMeasWcsPre.nc           (optional)
SysMeasWcs1Pre.nc          (optional)
SysCalibConfigTouchprobe.nc
SysMeasWcs1Post.nc         (optional)
SysMeasWcsPost.nc          (optional)
```

3.9.3 Single point measurement

Only one point is approached in these cycles.

The calculated value is transferred to the selected zero offset.

3.9.3.1 Measure in X axis

After positioning, the touch probe measures along the X axis until it contacts a workpiece. The touch probe must be positioned at measuring depth in front of the required surface, either manually or in automatic mode, before the cycle is started.

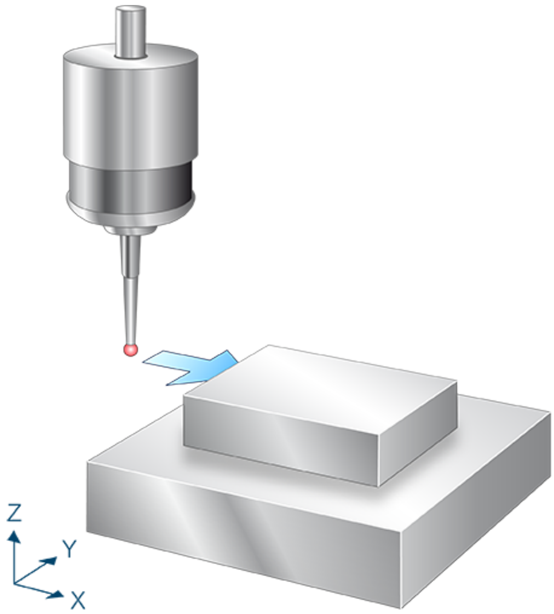

Fig. 17: Measure in X axis

3.9.3.1.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Measurement takes place from the starting point viewed in the X- direction.
2. When the measurement is completed, the device moves back to the starting point.
3. Description of selected zero offset.

3.9.3.1.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P4	Measurement path in the X axis (incremental) Positive value: the touch probe moves in positive X direction Negative value: the touch probe moves in negative X direction

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.3.1.3 Syntax

L CYCLE [NAME = SysMeasWcs1.ecy @P.. = ..]

3.9.3.1.4 Programming example

Measure in X axis

```
; touch probe activation
T1 D1
M6
; deactivation of the zero offset
G53

; positioning to the starting point
G0 X-50 Y0
G0 Z-10

#VAR
  ; input parameters:
  V.L.MeasDistX        = 10
  V.L.ZeroOffsetNumber = 54

  ; output variables:
  V.CYC.SysRetX
#ENDVAR

; cycle call
L CYCLE [NAME="SysMeasWcs1.ecy"      \
        @P4 = V.L.MeasDistX          \
        @P7 = V.L.ZeroOffsetNumber   \
        ]
```

```
; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]

G54
; ... machining workpiece with measured zero offset ....
G53

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.3.1.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value of workpiece

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.3.2 Measure in Y axis

After positioning, the touch probe measures along the Y axis until it contacts a workpiece. The touch probe must be positioned at measuring depth in front of the required surface, either manually or in automatic mode, before the cycle is started.

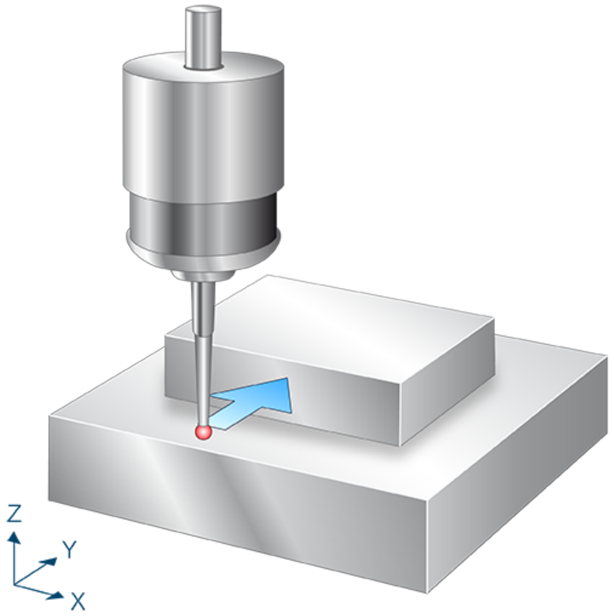

Fig. 18: Measure in Y axis

3.9.3.2.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Measurement takes place from the starting point in the Y direction.
2. When the measurement is completed, the device moves back to the starting point.
3. Description of selected zero offset.

3.9.3.2.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P5	Measurement path in the Y axis (incremental) Positive value: the touch probe moves in positive Y direction Negative value: the touch probe moves in negative Y direction

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P10	Shift the measuring point along the Y axis

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.3.2.3 Syntax

L CYCLE [NAME = SysMeasWcs2.ecy @P.. = ..]

3.9.3.2.4 Programming example

Measure in Y axis

```
; touch probe activation
T1 D1
M6
; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y-50
Z-10

#VAR
  ;input parameters
  V.L.MeasDistY        = 10
  V.L.ZeroOffsetNumber = 54

  ;output parameters
  V.CYC.SysRetY
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs2.ecy"    \
        @P5=V.L.MeasDistY        \
        @P7=V.L.ZeroOffsetNumber ]

; print result
```

```
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]

G0 Z10
M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.3.2.5 Output variables

Variables	Value
V.CYC.SysRetY	Calculated Y value of workpiece

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.3.3 Measure in Z axis

After positioning, the touch probe measures along the Z axis until it contacts a workpiece. The touch probe must be positioned at measuring depth in front of the required surface, either manually or in automatic mode, before the cycle is started.

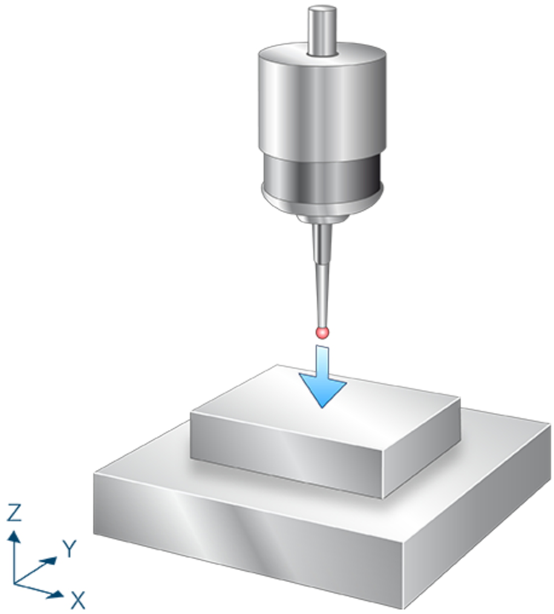

Fig. 19: Measure in Z axis

3.9.3.3.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Measurement takes place from the starting point in the Z direction.
2. When the measurement is completed, the device moves back to the starting point.
3. Description of selected zero offset.

3.9.3.3.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P6	Measurement path in the Z axis (incremental) Positive value, the touch probe moves in positive Z direction Negative value, the touch probe moves in negative Z direction

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P11	Shift the measuring point along the Z axis

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.3.3.3 Syntax

L CYCLE [NAME = SysMeasWcs3.ecy @P.. = ..]

3.9.3.3.4 Programming example

Measure in Z axis

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ; input parameters:
  V.L.MeasDistZ        = -10
  V.L.ZeroOffsetNumber = 54

  ; output variables:
  V.CYC.SysRetZ
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs3.ecy"    \
        @P6=V.L.MeasDistZ        \
        @P7=V.L.ZeroOffsetNumber ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
```

```
#MSG SAVE ["V.CYC.SysRetZ =%f", V.CYC.SysRetZ]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.3.3.5 Output variables

Variables	Value
V.CYC.SysRetZ	Calculated Z value of workpiece

For information on the use of output variables, see Handling output variables [▸ 14]

3.9.4 Two point measurement

2 points are approached in these cycles.

The determined values are transferred to the selected zero offset.

3.9.4.1 Measure in X and Y axes

After positioning, the touch probe first measures along the X axis until it contacts a workpiece. After repositioning measurement takes place in Y direction. The touch probe must be positioned either manually or in automatic mode so that it can be positioned in front of the measuring surface in X and Y axes.

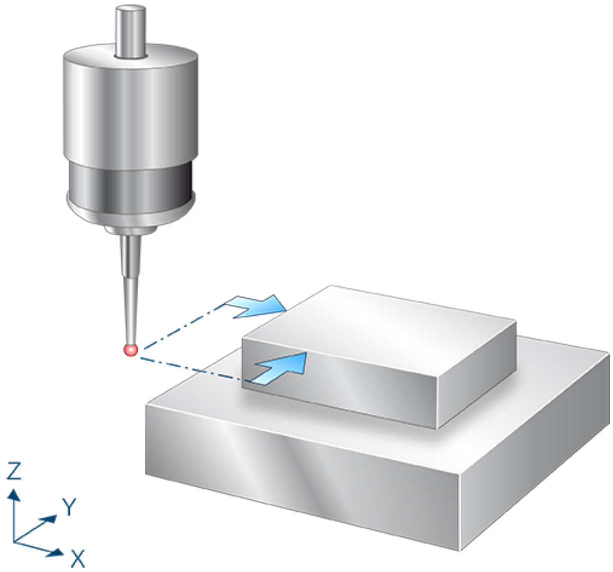

Fig. 20: Measure in X and Y axes

3.9.4.1.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in front of the measuring surface in Y and then measure in X direction.
2. After clearance, the device moves back to the starting point.
3. Pre-position in front of the measuring surface in X and then measure in Y direction.
4. After clearance, the device moves back to the starting point.
5. Description of selected zero offset.

3.9.4.1.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P4	Measurement path in the X axis (incremental) Positive value, the touch probe moves in positive X direction Negative value, the touch probe moves in negative X direction
@P5	Measurement path in the Y axis (incremental) Positive value, the touch probe moves in positive Y direction Negative value, the touch probe moves in negative Y direction

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P17	Pre-position along the X axis Default value = @P4
@P18	Pre-position along the Y axis Default value = @P5

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.4.1.3 Syntax

L CYCLE [NAME = SysMeasWcs4.ecy @P.. = ..]

3.9.4.1.4 Programming example

Measure in X and Y axes

```
; touch probe activation
T1 D1
M6
; deactivation of the zero offset
G53

; positioning to the starting point
G0 X-50 Y-50
Z-10

#VAR
  ; input parameters:
```

```
  V.L.MeasDistX        = 10
  V.L.MeasDistY        = 10
  V.L.ZeroOffsetNumber = 54
  V.L.PositioningX     = 15
  V.L.PositioningY     = 20

  ; output variables:
  V.CYC.SysRetX
  V.CYC.SysRetY
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs4.ecy"     \
        @P4  = V.L.MeasDistX        \
        @P5  = V.L.MeasDistY        \
        @P7  = V.L.ZeroOffsetNumber \
        @P17 = V.L.PositioningX     \
        @P18 = V.L.PositioningY     \
        ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]

G0 Z10
M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.4.1.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value of workpiece
V.CYC.SysRetY	Calculated Y value of workpiece

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.4.2 Measure in X and Z axes

After positioning, the touch probe first measures along the Z axis until it contacts a workpiece. After repositioning measurement takes place in X direction. The touch probe must be positioned either manually or in automatic mode so that it can be positioned in front of the measuring surface in X and Z axes.

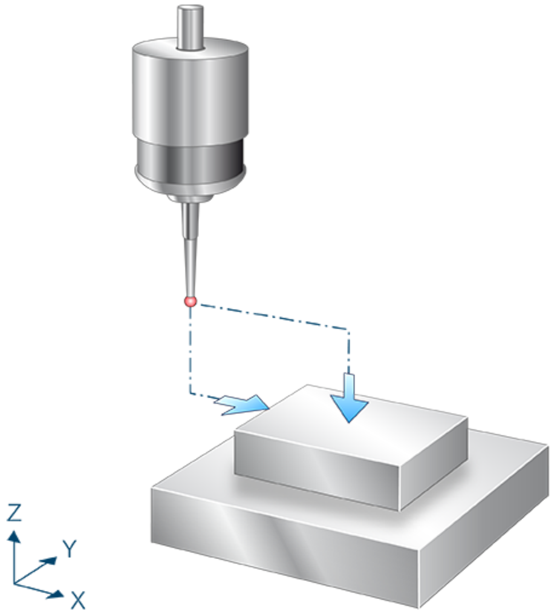

Fig. 21: Measure in X and Z axes

3.9.4.2.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position above the measuring surface in X and then measure in Z direction.
2. After clearance, the device moves back to the starting point.
3. Pre-position in front of the measuring surface in Z and then measure in X direction.
4. After clearance, the device moves back to the starting point.
5. Description of selected zero offset.

3.9.4.2.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P4	Measurement path in the X axis (incremental) Positive value, the touch probe moves in positive X direction Negative value, the touch probe moves in negative X direction
@P6	Measurement path in the Z axis (incremental) Positive value, the touch probe moves in positive Z direction Negative value, the touch probe moves in negative Z direction

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P11	Shift the measuring point along the Z axis
@P17	Pre-position along the X axis Default value = @P4
@P19	Pre-position along the Z axis Default value = @P6

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.4.2.3 Syntax

L CYCLE [NAME = SysMeasWcs5.ecy @P.. = ..]

3.9.4.2.4 Programming example

Measure in X and Z axes

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X-50 Y0 Z5

#VAR
  ; input parameters:
  V.L.MeasDistX        = 10
```

```
  V.L.MeasDistZ        = -10
  V.L.ZeroOffsetNumber = 54
  V.L.PositioningX     = 20
  V.L.PositioningZ     = -15

  ; output variables:
  V.CYC.SysRetX
  V.CYC.SysRetZ
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs5.ecy"\
        @P4=V.L.MeasDistX\
        @P6=V.L.MeasDistZ\
        @P7=V.L.ZeroOffsetNumber\
        @P17=V.L.PositioningX\
        @P19=V.L.PositioningZ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetZ =%f", V.CYC.SysRetZ]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.4.2.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value of workpiece
V.CYC.SysRetZ	Calculated Z value of workpiece

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.4.3 Measure in Y and Z axes

After positioning, the touch probe first measures along the Z axis until it contacts a workpiece. After repositioning measurement takes place in Y direction. The touch probe must be positioned either manually or in automatic mode so that it can be positioned in front of the measuring surface in Y and Z axes.

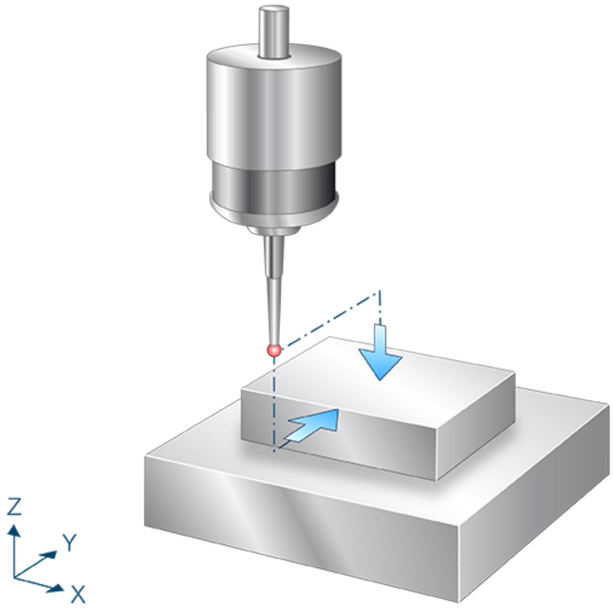

Fig. 22: Measure in Y and Z axes

3.9.4.3.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position above the measuring surface in Y and then measure in Z direction.
2. After clearance, the device moves back to the starting point.
3. Pre-position in front of the measuring surface in Z and then measure in Y direction.
4. After clearance, the device moves back to the starting point.
5. Description of selected zero offset.

3.9.4.3.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P5	Measurement path in the Y axis (incremental) Positive value, the touch probe moves in positive Y direction Negative value, the touch probe moves in negative Y direction
@P6	Measurement path in the Z axis (incremental) Positive value, the touch probe moves in positive Z direction Negative value, the touch probe moves in negative Z direction

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P10	Shift the measuring point along the Y axis
@P11	Shift the measuring point along the Z axis
@P18	Pre-position along the Y axis Default value = @P5
@P19	Pre-position along the Z axis Default value = @P6

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.4.3.3 Syntax

L CYCLE [NAME = SysMeasWcs6.ecy @P.. = ..]

3.9.4.3.4 Programming example

Measure in Y and Z axes

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y-50 Z5

#VAR
  ; input parameters:
  V.L.MeasDistY        = 10
```

```
  V.L.MeasDistZ         = -10
  V.L.ZeroOffsetNumber  = 54
  V.L.PositioningY      = 20
  V.L.PositioningZ      = -15

  ; output variables:
  V.CYC.SysRetY
  V.CYC.SysRetZ
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs6.ecy"\
        @P5=V.L.MeasDistY\
        @P6=V.L.MeasDistZ\
        @P7=V.L.ZeroOffsetNumber\
        @P18=V.L.PositioningY\
        @P19=V.L.PositioningZ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetZ =%f", V.CYC.SysRetZ]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.4.3.5 Output variables

Variables	Value
V.CYC.SysRetY	Calculated Y value of workpiece
V.CYC.SysRetZ	Calculated Z value of workpiece

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.5 Three point measurement

3 points are approached in these cycles.

The determined values are transferred to the selected zero offset.

3.9.5.1 Measure in X, Y and Z axes

After positioning, the touch probe first measures along the Z axis until it contacts a workpiece. After repositioning measurement takes place in X direction and after further repositioning measurement takes place in Y direction. The touch probe must be positioned either manually or in automatic mode so that it can be positioned in front of the measuring surface in X, Y and Z axes.

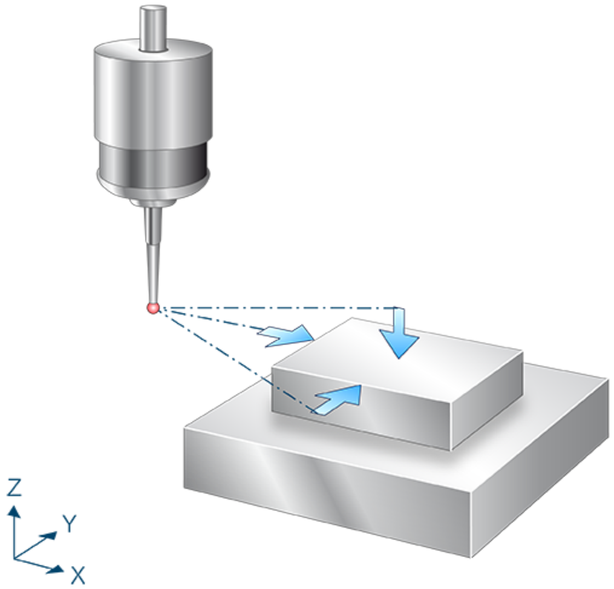

Fig. 23: Measure in X, Y and Z axes

3.9.5.1.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position above the measuring surface in X and Y and then measure in Z direction.
2. After clearance, the device moves back to the starting point.
3. Pre-position in front of the measuring surface in Y and Z and then measure in X direction.
4. After clearance, the device moves back to the starting point.
5. Pre-position in front of the measuring surface in X and Z and then measure in Y direction.
6. After clearance, the device moves back to the starting point.
7. Description of selected zero offset.

3.9.5.1.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P4	Measurement path in the X axis (incremental) Positive value, the touch probe moves in positive X direction Negative value, the touch probe moves in negative X direction
@P5	Measurement path in the Y axis (incremental) Positive value, the touch probe moves in positive Y direction Negative value, the touch probe moves in negative Y direction
@P6	Measurement path in the Z axis (incremental) Positive value, the touch probe moves in positive Z direction Negative value, the touch probe moves in negative Z direction

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P11	Shift the measuring point along the Z axis
@P17	Pre-position along the X axis (Default value = @P4)
@P18	Pre-position along the Y axis (Default value = @P5)
@P19	Pre-position along the Z axis (Default value = @P6)

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.5.1.3 Syntax

L CYCLE [NAME = SysMeasWcs7.ecy @P.. = ..]

3.9.5.1.4 Programming example

Measure in X, Y and Z axes

```
; touch probe activation
T1 D1
```

```
; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ; input parameters:
  V.L.MeasDistX        = 10
  V.L.MeasDistY        = 10
  V.L.MeasDistZ        = -10
  V.L.ZeroOffsetNumber = 54
  V.L.PositioningX     = 20
  V.L.PositioningY     = 15
  V.L.PositioningZ     = -13

  ; output variables:
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetZ
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs7.ecy"   \
        @P4=V.L.MeasDistX       \
        @P5=V.L.MeasDistY       \
        @P6=V.L.MeasDistZ       \
        @P7=V.L.ZeroOffsetNumber\
        @P17=V.L.PositioningX   \
        @P18=V.L.PositioningY   \
        @P19=V.L.PositioningZ   ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetZ =%f", V.CYC.SysRetZ]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.5.1.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value of workpiece
V.CYC.SysRetY	Calculated Y value of workpiece
V.CYC.SysRetZ	Calculated Z value of workpiece

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.6 Measure the diameter

The cycle sets the zero offset by means of drilled holes or pins. The determined values are transferred to the selected zero offset.

3.9.6.1 Inner diameter with four points

After positioning within the drilled hole, the touch probe measures along the C and Y axes both in the positive and negative directions. The touch probe must be positioned in the drilled hole as centrally as possible at measuring depth either manually or in automatic mode.

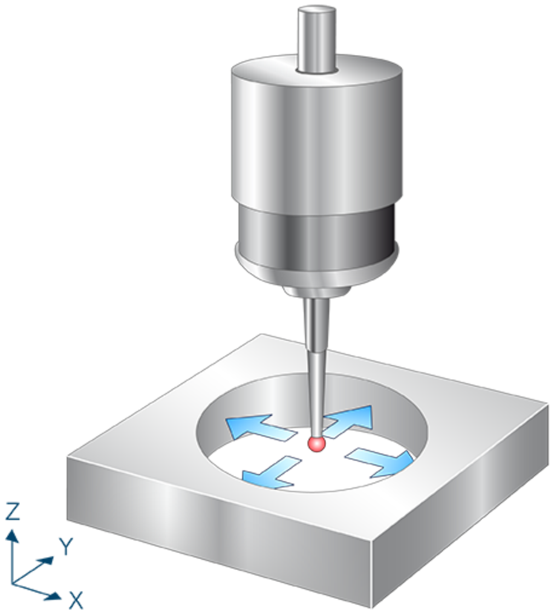

Fig. 24: Inner diameter with four points

3.9.6.1.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in X direction.
2. Measure in X- direction.
3. Move back to starting point.
4. Then follow measurements in X+, Y- and Y+.
5. Description of selected zero offset.

3.9.6.1.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Drilled hole diameter

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P13	Security distance for pre-positioning
@P33	Crossover range [mm, inch] Default value = 5

If @P13 is not specified, the entire measuring section is traversed at the measuring feed rate.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.6.1.3 Syntax

L CYCLE [NAME = SysMeasWcs8.ecy @P.. = ..]

3.9.6.1.4 Programming example

Inner diameter with 4 points

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0
G0 Z-10

#VAR
  ;input parameters
  V.L.HoleDiameter     = 40
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 5
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
```

```
  V.CYC.SysRetDiameter
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs8.ecy"    \
        @P2=V.L.HoleDiameter     \
        @P7=V.L.ZeroOffsetNumber \
        @P13=V.L.SafetyDistance  \
        @P33=V.L.CrossOver       ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX        =%f", V.CYC.SysRetX       ]
#MSG SAVE ["V.CYC.SysRetY        =%f", V.CYC.SysRetY       ]
#MSG SAVE ["V.CYC.SysRetDiameter =%f", V.CYC.SysRetDiameter]

G0 Z10
M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.6.1.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (circle centre point)
V.CYC.SysRetY	Calculated Y value (circle centre point)
V.CYC.SysRetDiameter	Calculated circle diameter

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.6.2 Inner diameter with three points

After positioning within the drilled hole the touch probe measured along the specified angled straight lines. The touch probe must be positioned in the drilled hole as centrally as possible at measuring depth either manually or in automatic mode.

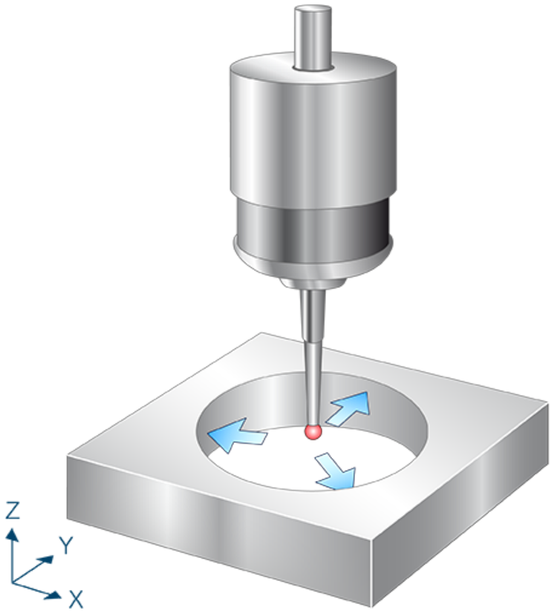

Fig. 25: Inner diameter with three points

3.9.6.2.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in X and Y directions
2. Measure along a straight line in the X-Y plane using the 1st angle.
3. Move back to starting point.
4. This is followed by the measurements at angle 2 and angle 3.
5. Description of selected zero offset.

3.9.6.2.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Drilled hole diameter
@P14	Angle 1 to measuring point 1 in relation to X+ axis [degrees] Default value = 0
@P15	Angle 2 to measuring point 2 in relation to X+ axis [degrees] Default value = 120
@P16	Angle 3 to measuring point 3 in relation to X+ axis [degrees] Default value = 240
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P13	Security distance for pre-positioning

Angles 1-3 must be different.

If @P13 is not specified, the entire measuring section is traversed at the measuring feed rate.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.6.2.3 Syntax

L CYCLE [NAME = SysMeasWcs9.ecy @P.. = ..]

3.9.6.2.4 Programming example

Inner diameter with 3 points

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0
```

```
G0 Z-10

#VAR
  ;input parameters
  V.L.HoleDiameter     = 40
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 5
  V.L.FirstAngle       = 30
  V.L.SecondAngle      = 150
  V.L.ThirdAngle       = 270
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetDiameter
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs9.ecy"\
        @P2=V.L.HoleDiameter\
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance\
        @P14=V.L.FirstAngle\
        @P15=V.L.SecondAngle\
        @P16=V.L.ThirdAngle\
        @P33=V.L.CrossOver]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX        =%f", V.CYC.SysRetX       ]
#MSG SAVE ["V.CYC.SysRetY        =%f", V.CYC.SysRetY       ]
#MSG SAVE ["V.CYC.SysRetDiameter =%f", V.CYC.SysRetDiameter]

G0 Z10
M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.6.2.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (circle centre point)
V.CYC.SysRetY	Determined Y value (circle centre point)
V.CYC.SysRetDiameter	Determined circle diameter

For information on the use of output variables, see Handling output variables [▸ 14]

3.9.6.3 Outer diameter with four points

The touch probe is positioned above the workpiece. Then, measurements take place in the positive and negative directions of the X and Y axes. This requires repeated pre-positioning in each case. The touch probe must be positioned as centrally as possible above the spigot either manually or in automatic mode.

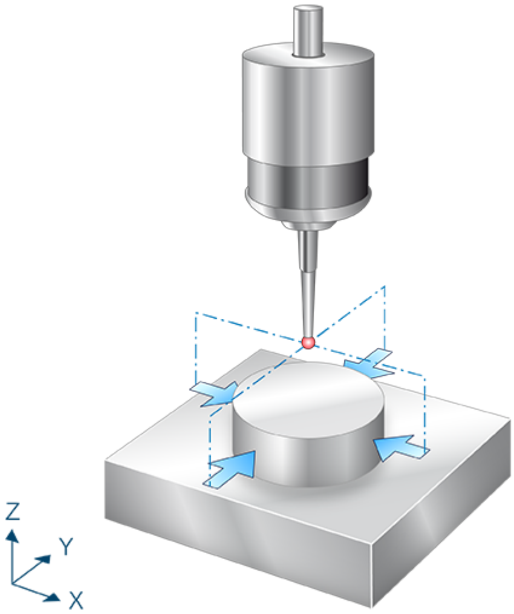

Fig. 26: Outer diameter with four points

3.9.6.3.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in X direction.
2. Pre-position in Z- direction.
3. Measure in X+ direction.
4. Clearance in X- direction.
5. Move back to Z start.
6. Move back to X start.
7. Then follow measurements in X+, Y- and Y+.
8. Description of selected zero offset.

3.9.6.3.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Pin diameter
@P19	Pre-position along the Z axis
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P13	Safety clearance for pre-positioning [mm, inch] Default value = 10

If @P13 is not specified, the safety clearance is set to 10mm.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.6.3.3 Syntax

L CYCLE [NAME = SysMeasWcs10.ecy @P.. = ..]

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.6.3.4 Programming example

Outer diameter with 4 points

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.SpigotDiameter   = 20
  V.L.ZeroOffsetNumber = 54
```

```
  V.L.SafetyDistance   = 10
  V.L.PositioningZ     = -10
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetDiameter
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs10.ecy"\
        @P2=V.L.SpigotDiameter\
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance\
        @P19=V.L.PositioningZ\
        @P33=V.L.CrossOver]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX        =%f", V.CYC.SysRetX       ]
#MSG SAVE ["V.CYC.SysRetY        =%f", V.CYC.SysRetY       ]
#MSG SAVE ["V.CYC.SysRetDiameter =%f", V.CYC.SysRetDiameter]

M30
```

3.9.6.3.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (circle centre point)
V.CYC.SysRetY	Calculated Y value (circle centre point)
V.CYC.SysRetDiameter	Calculated circle diameter

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.6.4 Outer diameter with three points

The touch probe is positioned above the workpiece. Then, measurements takes place along the specified angled straight lines. This requires pre-positioning in each case. The touch probe must be positioned as centrally as possible above the spigot either manually or in automatic mode.

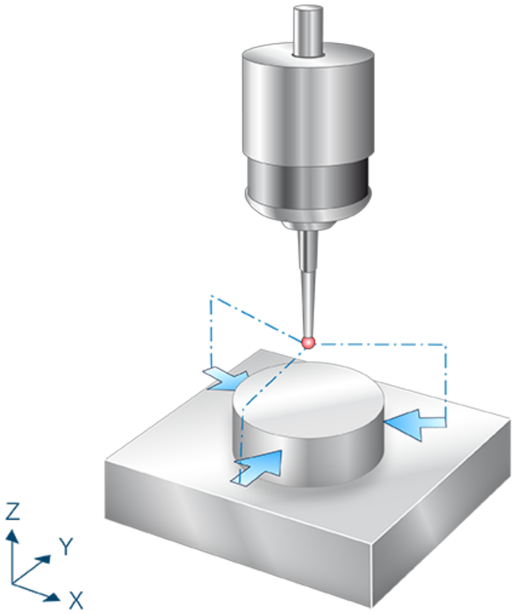

Fig. 27: Outer diameter with three points

3.9.6.4.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in X and Y directions using 1st angle.
2. Pre-position in Z.
3. Measure along an angled straight line in the X-Y plane using the 1st angle.
4. Clearance in X and Y directions for pre-positioning using 1st angle
5. Move back to Z start.
6. Move back to starting point.
7. This is followed by the measurements at angle 2 and angle 3.
8. Description of selected zero offset.

3.9.6.4.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Pin diameter
@P14	Angle 1 to measuring point 1 relation to X+ axis [degrees] Default value = 0
@P15	Angle 2 to measuring point 2 relation to X+ axis [degrees] Default value = 120
@P16	Angle 3 to measuring point 3 relation to X+ axis [degrees] Default value = 240
@P19	Pre-position along the Z axis
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P13	Safety clearance for pre-positioning [mm, inch] Default value = 10

If @P13 is not specified, the security distance is set to 10 mm.

Angles 1-3 must be different.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.6.4.3 Syntax

L CYCLE [NAME = SysMeasWcs11.ecy @P.. = ..]

3.9.6.4.4 Programming example

Outer diameter with 3 points

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53
```

```
; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.SpigotDiameter   = 20
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 10
  V.L.FirstAngle       = 30
  V.L.SecondAngle      = 150
  V.L.ThirdAngle       = 270
  V.L.PositioningZ     = -10
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetDiameter
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs11.ecy"\
        @P2=V.L.SpigotDiameter\
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance\
        @P14=V.L.FirstAngle\
        @P15=V.L.SecondAngle\
        @P16=V.L.ThirdAngle\
        @P19=V.L.PositioningZ\
        @P33=V.L.CrossOver]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX        =%f", V.CYC.SysRetX       ]
#MSG SAVE ["V.CYC.SysRetY        =%f", V.CYC.SysRetY       ]
#MSG SAVE ["V.CYC.SysRetDiameter =%f", V.CYC.SysRetDiameter]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.6.4.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (circle centre point)
V.CYC.SysRetY	Calculated Y value (circle centre point)
V.CYC.SysRetDiameter	Calculated circle diameter

For information on the use of output variables, see Handling output variables [▸ 14]

3.9.6.5 Inner diameter with four points and obstacle

After positioning above the spigot, the touch probe measures along the X and Y axes both in the positive and negative directions after it was again pre-positioned. The touch probe must be positioned as centrally as possible above the spigot either manually or in automatic mode.

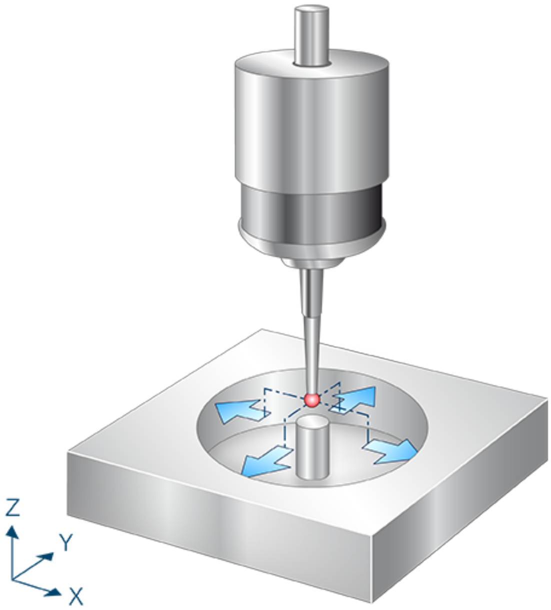

Fig. 28: Inner diameter with four points and obstacle

3.9.6.5.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in X direction.
2. Pre-position in Z direction.
3. Measure in X- direction.
4. Clearance in X+ direction.
5. Move back to Z start.
6. Move back to X start.
7. Then follow measurements in X+, Y- and Y+.
8. Description of selected zero offset.

3.9.6.5.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Drilled hole diameter
@P19	Pre-position along the Z axis
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P13	Safety clearance for pre-positioning [mm, inch] Default value = 10

If @P13 is not specified, the security distance is set to 10 mm.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.6.5.3 Syntax

L CYCLE [NAME = SysMeasWcs18.ecy @P.. = ..]

3.9.6.5.4 Programming example

Inner diameter with 4 points and obstacle

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.HoleDiameter     = 40
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 5
  V.L.PositioningZ     = -15
  V.L.CrossOver        = 20
```

```
  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetDiameter
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs18.ecy"\
        @P2=V.L.HoleDiameter\
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance\
        @P19=V.L.PositioningZ\
        @P33=V.L.CrossOver]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX        =%f", V.CYC.SysRetX       ]
#MSG SAVE ["V.CYC.SysRetY        =%f", V.CYC.SysRetY       ]
#MSG SAVE ["V.CYC.SysRetDiameter =%f", V.CYC.SysRetDiameter]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.6.5.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (circle centre point)
V.CYC.SysRetY	Calculated Y value (circle centre point)
V.CYC.SysRetDiameter	Calculated circle diameter

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.7 Measure slot and web

These cycles determine the centre point of the slot/web by specifying the slot/web width.

The calculated value is transferred to the selected zero offset.

3.9.7.1 Measure slot in X axis

After positioning within the slot, the touch probe measures both in the positive and negative X directions. The touch probe must be positioned at measuring depth as centrally as possible in the slot either manually or in automatic mode.

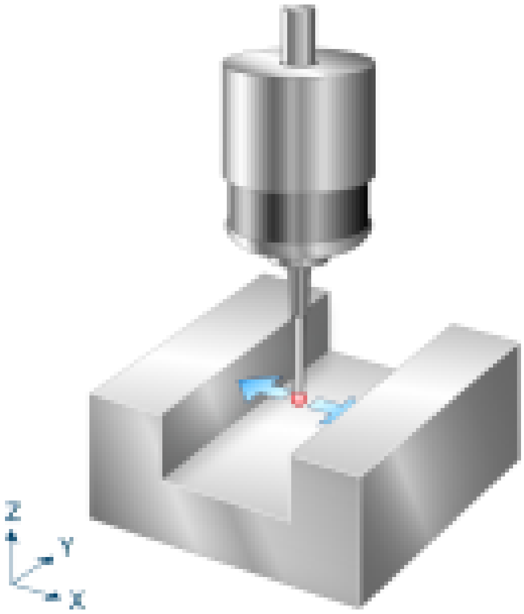

Fig. 29: Measure slot in X axis

3.9.7.1.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. (Pre-position in X direction.)
2. Measure in X- direction.
3. Move back to starting point.
4. Then follows measurement in X+.
5. Description of selected zero offset.

3.9.7.1.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▸ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P3	Slot width
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P13	Security distance for pre-positioning

If @P13 is not specified, the entire measuring section is traversed at the measuring feed rate.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.7.1.3 Syntax

L CYCLE [NAME = SysMeasWcs12.ecy @P.. = ..]

3.9.7.1.4 Programming example

Measure slot in X axis

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0
G0 Z-10

#VAR
  ;input parameters
  V.L.SlotWidth        = 40
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 5
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetLengthX
#ENDVAR
```

```
;cycle call
L CYCLE [NAME="SysMeasWcs12.ecy"\
        @P3=V.L.SlotWidth\
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance\
        @P33=V.L.CrossOver]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetLengthX =%f", V.CYC.SysRetLengthX]

G0 Z10

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.7.1.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (centre of slot)
V.CYC.SysRetLengthX	Calculated X length (width of slot)

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.7.2 Measure slot in Y axis

After positioning within the slot, the touch probe measures both in the positive and negative X directions. The touch probe must be positioned at measuring depth as centrally as possible in the slot either manually or in automatic mode. Measure slot in Y axis.

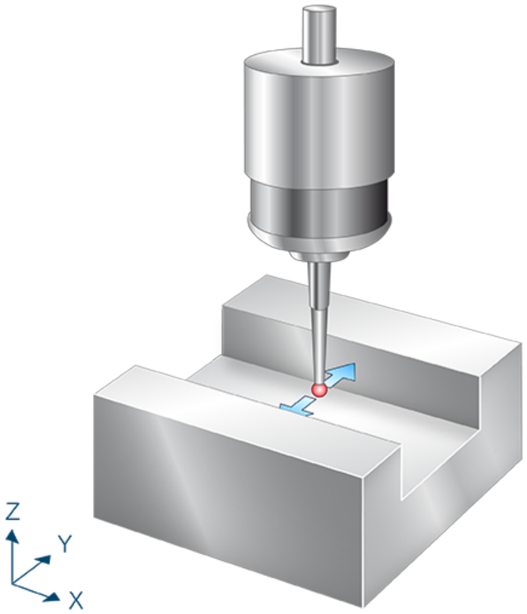

Fig. 30: Measure slot in Y axis

3.9.7.2.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. (Pre-position in Y direction.)
2. Measure in Y- direction.
3. Move back to starting point.
4. Then follows measurement in Y+
5. Description of selected zero offset.

3.9.7.2.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P3	Slot width
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P10	Shift the measuring point along the Y axis
@P13	Security distance for pre-positioning

If @P13 is not specified, the entire measuring section is traversed at the measuring feed rate.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.7.2.3 Syntax

L CYCLE [NAME = SysMeasWcs13.ecy @P.. = ..]

3.9.7.2.4 Programming example

Measure slot in Y axis

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0
G0 Z-10

#VAR
  ;input parameters
  V.L.SlotWidth         = 40
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance    = 5
  V.L.CrossOver         = 10

  ;output variables
  V.CYC.SysRetY
  V.CYC.SysRetLengthY
#ENDVAR
```

```
;cycle call
L CYCLE [NAME="SysMeasWcs13.ecy"\
        @P3=V.L.SlotWidth\
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance\
        @P33=V.L.CrossOver]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetLengthY =%f", V.CYC.SysRetLengthY]

G0 Z10

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.7.2.5 Output variables

Variables	Value
V.CYC.SysRetY	Calculated Y value (centre of slot)
V.CYC.SysRetLengthY	Calculated Y length (width of slot)

For information on the use of output variables, see Handling output variables [▸ 14]

3.9.7.3 Measure web in X axis

After positioning above the web, the touch probe measures both in the positive and negative X directions after repeated pre-positioning. The touch probe must be positioned as centrally as possible above the web either manually or in automatic mode.

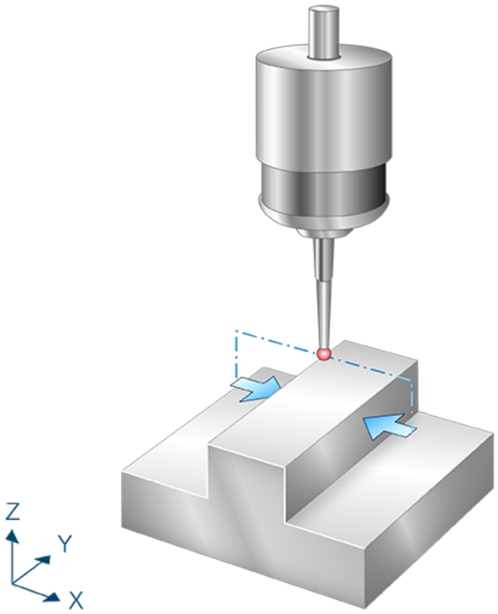

Fig. 31: Measure web in X axis

3.9.7.3.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in X direction.
2. Pre-position in Z direction.
3. Measure in X+ direction.
4. Clearance in X- direction.
5. Move back to Z start.
6. Move back to X start.
7. Then follows measurement in X- direction.
8. Description of selected zero offset.

3.9.7.3.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file.

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P3	Web width
@P19	Pre-position along the Z axis
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P13	Safety clearance for pre-positioning [mm, inch] Default value = 10

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.7.3.3 Syntax

L CYCLE [NAME = SysMeasWcs14.ecy @P.. = ..]

3.9.7.3.4 Programming example

Measure web in X axis

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.WebWidth          = 20
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 5
  V.L.PositioningZ     = -10
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetLengthX
#ENDVAR
```

```
;cycle call
L CYCLE [NAME="SysMeasWcs14.ecy"\
        @P3=V.L.WebWidth\
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance\
        @P19=V.L.PositioningZ\
        @P33=V.L.CrossOver]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetLengthX =%f", V.CYC.SysRetLengthX]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.7.3.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (centre of web)
V.CYC.SysRetLengthX	Calculated X length (width of web)

For information on the use of output variables, see Handling output variables [▸ 14]

3.9.7.4 Measure web in Y axis

After positioning above the web, the touch probe measures both in the positive and negative Y directions after repeated pre-positioning. The touch probe must be positioned as centrally as possible above the web either manually or in automatic mode.

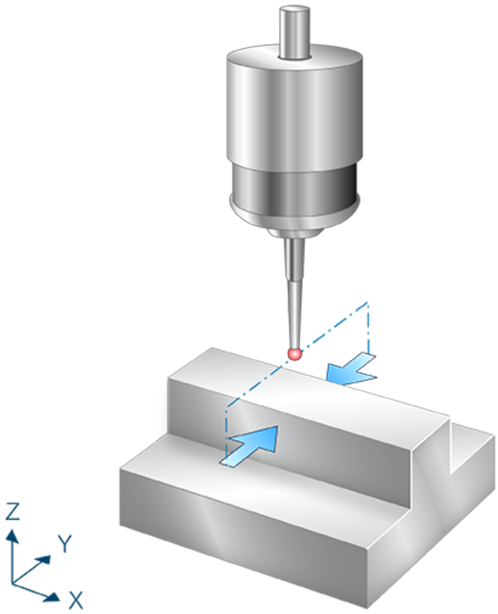

Fig. 32: Measure web in Y axis

3.9.7.4.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in Y direction.
2. Pre-position in Z direction.
3. Measure in Y+ direction.
4. Clearance in Y- direction.
5. Move back to Z start.
6. Move back to Y start
7. Then follows measurement in Y+.
8. Description of selected zero offset.

3.9.7.4.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▸ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P3	Web width
@P19	Pre-position along the Z axis
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P10	Shift the measuring point along the Y axis
@P13	Safety clearance for pre-positioning [mm, inch] Default value = 10

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.7.4.3 Syntax

L CYCLE [NAME = SysMeasWcs15.ecy @P.. = ..]

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.7.4.4 Programming example

Measure slot and web

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.WebWidth         = 20
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 5
  V.L.PositioningZ     = -10
  V.L.CrossOver        = 10
```

```
  ;output variables
  V.CYC.SysRetY
  V.CYC.SysRetLengthY
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs15.ecy"\
        @P3=V.L.WebWidth\
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance\
        @P19=V.L.PositioningZ\
        @P33=V.L.CrossOver]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]

M30
```

3.9.7.4.5 Output variables

Variables	Value
V.CYC.SysRetY	Calculated Y value (centre of web)
V.CYC.SysRetLengthY	Calculated Y length (width of web)

3.9.7.5 Measure slot in X axis with obstacle

After positioning above the obstacle, the touch probe measures both in the positive and negative X directions. The touch probe must be positioned as centrally as possible above the obstacle either manually or in automatic mode. The obstacle is located in the middle of the slot.

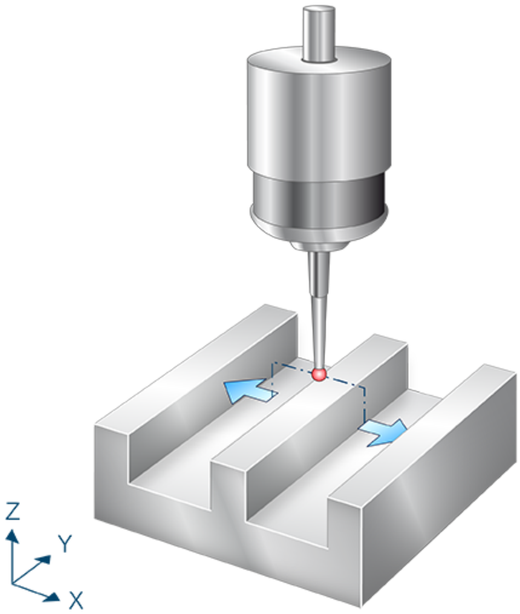

Fig. 33: Measure slot in X axis with obstacle

3.9.7.5.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in X direction.
2. Pre-position in Z direction.
3. Measure in X- direction.
4. Clearance in X+ direction.
5. Move back to Z start.
6. Move back to X start.
7. Then follows measurement in X+.
8. Description of selected zero offset.

3.9.7.5.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P3	Slot width
@P19	Pre-position along the Z axis
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P13	Safety clearance for pre-positioning [mm, inch] Default value = 10

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.7.5.3 Syntax

L CYCLE [NAME = SysMeasWcs16.ecy @P.. = ..]

3.9.7.5.4 Programming example

Measure slot in X axis with obstacle

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.SlotWidth         = 40
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance    = 10
  V.L.PositioningZ      = -15
  V.L.CrossOver         = 10

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetLengthX
#ENDVAR
```

```
;cycle call
L CYCLE [NAME="SysMeasWcs16.ecy"\
        @P3=V.L.SlotWidth\
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance\
        @P19=V.L.PositioningZ\
        @P33=V.L.CrossOver]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetLengthX =%f", V.CYC.SysRetLengthX]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.7.5.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (centre of slot)
V.CYC.SysRetLengthX	Calculated X length (width of slot)

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.7.6 Measure slot in Y axis with obstacle

After positioning above the obstacle, the touch probe measures both in the positive and negative Y direction after repeated pre-positioning in the slot. The touch probe must be positioned as centrally as possible above the obstacle either manually or in automatic mode. The obstacle is located in the middle of the slot.

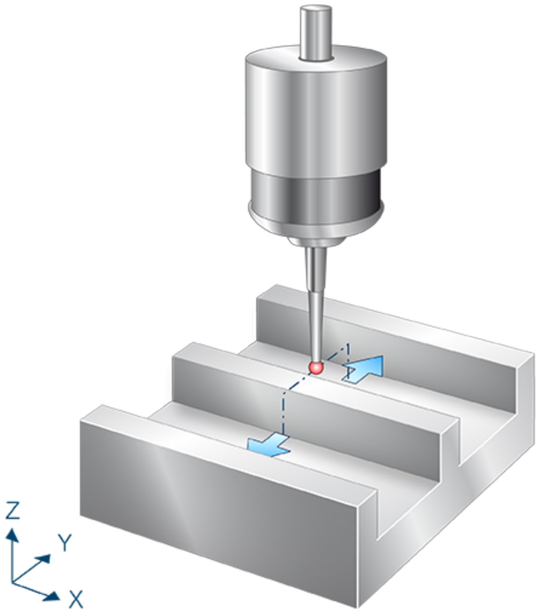

Fig. 34: Measure slot in Y axis with obstacle

3.9.7.6.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in Y direction.
2. Pre-position in Z direction.
3. Measure in Y- direction.
4. Clearance in Y+ direction.
5. Move back to Z start.
6. Move back to Y start.
7. Then follows measurement in Y+.
8. Description of selected zero offset.

3.9.7.6.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P3	Slot width
@P19	Pre-position along the Z axis
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P10	Shift the measuring point along the Y axis
@P13	Safety clearance for pre-positioning [mm, inch] Default value = 10

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.7.6.3 Syntax

L CYCLE [NAME = SysMeasWcs17.ecy @P.. = ..]

3.9.7.6.4 Programming example

Measure slot in Y axis with obstacle

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.SlotWidth        = 40
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 5
  V.L.PositioningZ     = -15
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetY
  V.CYC.SysRetLengthY
#ENDVAR
```

```
;cycle call
L CYCLE [NAME="SysMeasWcs17.ecy"\
        @P3=V.L.SlotWidth\
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance\
        @P19=V.L.PositioningZ\
        @P33=V.L.CrossOver]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetLengthY =%f", V.CYC.SysRetLengthY]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.7.6.5 Output variables

Variables	Value
V.CYC.SysRetY	Calculated Y value (centre of slot)
V.CYC.SysRetLengthY	Calculated Y length (width of slot)

For information on the use of output variables, see Handling output variables [▸ 14]

3.9.8 Angle measurement

These cycles determine workpiece twist and the compensation value. The calculated value is transferred to the selected zero offset.

3.9.8.1 Measure angle in X axis (C axis)

After positioning, the touch probe measures in the direction of the X axis. The touch probe must be positioned as centrally as possible at measuring depth at the first measuring point either manually or in automatic mode.

The calculated angle corresponds to the twist of the workpiece about the Z axis in relation to the Y axis.

If no C axis is configured, call the cycle without transferring @P7. The twist in C can be manually transferred to the related zero offset by evaluating the output variables in the post-program.

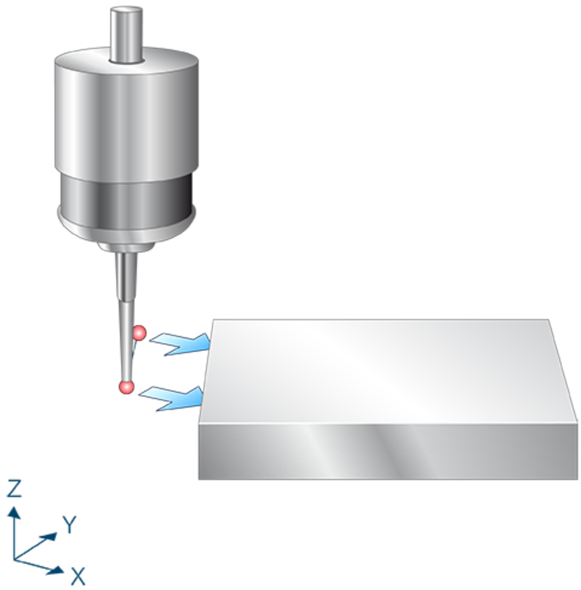

Fig. 35: Measure angle in X axis (C axis)

3.9.8.1.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Measure in X axis.
2. Clearance in X to starting point.
3. Position in X and Y axes.
4. Measure in X axis.
5. Clearance in X at second starting point.
6. Calculate twist in C.
7. Description of selected zero offset.

3.9.8.1.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P4	Measurement path in the X axis (incremental) Positive value, the touch probe moves in positive X direction Negative value, the touch probe moves in negative X direction
@P18	Pre-position along the Y axis before the 2nd measurement @P18 may not be 0.

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P12	Reference angle [degrees] Default value = 0
@P17	Pre-position along the X axis before the 2nd measurement [mm, inch] Default value = 0

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.8.1.3 Syntax

L CYCLE [NAME = SysMeasWcs19.ecy @P.. = ..]

3.9.8.1.4 Programming example

Measure angle in X axis (C axis)

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0
G0 Z-10

#VAR
  ;input parameters
  V.L.MeasDistX        = 10
  V.L.ZeroOffsetNumber = 54
  V.L.PositioningY     = 10

  ;output variables
```

```
  V.CYC.SysRetC
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs19.ecy"\
        @P4=V.L.MeasDistX\
        @P7=V.L.ZeroOffsetNumber\
        @P18=V.L.PositioningY]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

G0 Z10

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.8.1.5 Output variables

Variables	Value
V.CYC.SysRetC	Calculated C value (twist in relation to X axis)

If the workpiece is parallel to the Y axis, V.CYC.SysRetC = 0.

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.8.2 Measure angle in Y axis (C axis)

After positioning, the touch probe measures in the direction of the Y axis. The touch probe must be positioned as centrally as possible at measuring depth at the first measuring point either manually or in automatic mode.

The calculated angle corresponds to the twist of the workpiece about the Z axis in relation to the X axis.

If no C axis is configured, call the cycle without transferring @P7. The twist in C can be manually transferred to the related zero offset by evaluating the output variables in the post-program.

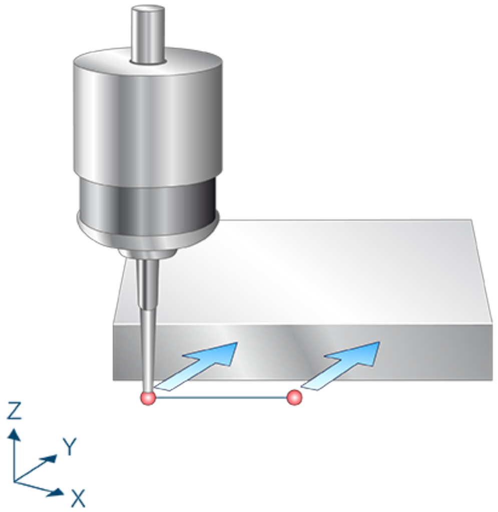

Fig. 36: Measure angle in Y axis (C axis)

3.9.8.2.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Measure in Y axis.
2. Clearance in Y at starting point.
3. Position in X and Y axes.
4. Measure in Y axis.
5. Clearance in Y at second starting point.
6. Calculate twist in C.
7. Description of selected zero offset.

3.9.8.2.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P5	Measurement path in the Y axis (incremental) Positive value, the touch probe moves in positive Y direction Negative value, the touch probe moves in negative Y direction
@P17	Pre-position along the X axis before the 2nd measurement @P17 may not be 0.

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P12	Reference angle [degrees] Default value = 0
@P18	Pre-position along the Y axis before the 2nd measurement Default value = 0

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.8.2.3 Syntax

L CYCLE [NAME = SysMeasWcs20.ecy @P.. = ..]

3.9.8.2.4 Programming example

Measure angle in Y axis (C axis)

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0
G0 Z-10

#VAR
  ;input parameters
  V.L.MeasDistY        = 10
  V.L.ZeroOffsetNumber = 54
  V.L.PositioningX     = 10

  ;output variables
```

```
  V.CYC.SysRetC
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs20.ecy"\
        @P5=V.L.MeasDistY\
        @P7=V.L.ZeroOffsetNumber\
        @P17=V.L.PositioningX]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

G0 Z10

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.8.2.5 Output variables

Variables	Value
V.CYC.SysRetC	Calculated C value (twist in relation to X axis)

If the workpiece is parallel to X axis, V.CYC.SysRetC = 0.

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.8.3 Measure angle between 2 drilled holes (C axis)

The centre point of the drilled holes is calculated by 4 measured points (see SysMeasWcs8) and by the angle between the drilled holes in relation to the X axis.

The touch probe must be positioned as centrally as possible above the first drilled hole either manually or in automatic mode.

If no C axis is configured, call the cycle without transferring @P7. The twist in C can be manually transferred to the related zero offset by evaluating the output variables in the post-program.

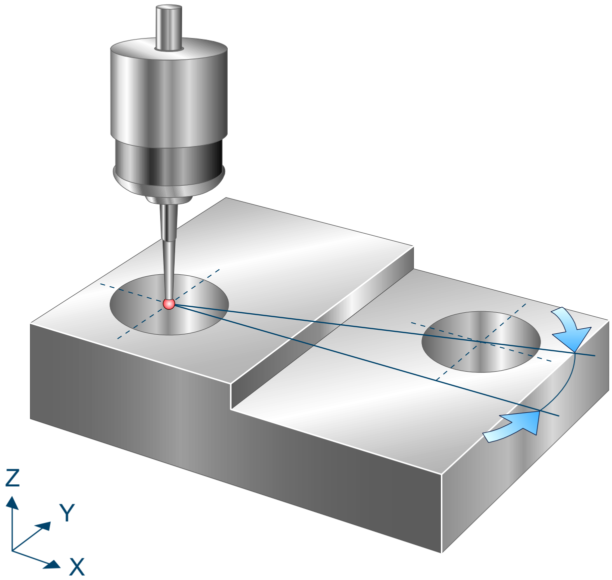

Fig. 37: Measure angle between 2 drilled holes (C axis)

3.9.8.3.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in Z.
2. Measure in X- direction.
3. Move back to starting point.
4. Then follow measurements in X+, Y- and Y+
5. Move back in Z to starting position.
6. Position in X, Y and Z above the 2nd drilled hole.
7. Measure the 2nd drilled hole with the same sequence as drilled hole 1.
8. Description of selected zero offset.

3.9.8.3.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Drilled hole diameter
@P22	Measuring depth
@P29	Diameter of the 2nd drilled hole
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P12	Reference angle [degrees] Default value = 0
@P17	Pre-position along the X axis above the 2nd drilled hole
@P18	Pre-position along the Y axis above the 2nd drilled hole
@P19	Pre-position along the Z axis Default value is the starting position above the 1st drilled hole

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.8.3.3 Syntax

L CYCLE [NAME = SysMeasWcs21.ecy @P.. = ..]

3.9.8.3.4 Programming example

Measure angle between 2 drilled holes (C axis)

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.HoleDiameter     = 20
  V.L.ZeroOffsetNumber = 54
  V.L.PositioningX     = 50
```

```
  V.L.PositioningY     = 20
  V.L.PositioningZ     = 10
  V.L.MeasDepth        = -15
  V.L.HoleDiameter2    = 30
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetC
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs21.ecy"\
        @P2=V.L.HoleDiameter\
        @P7=V.L.ZeroOffsetNumber\
        @P17=V.L.PositioningX\
        @P18=V.L.PositioningY\
        @P19=V.L.PositioningZ\
        @P22=V.L.MeasDepth\
        @P29=V.L.HoleDiameter2\
        @P33=V.L.CrossOver]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.8.3.5 Output variables

Variables	Value
V.CYC.SysRetC	Calculated C value (twist of straight lines through the circle centre points in relation to the X axis)

If the straight line through the two centre points is parallel to the X axis, V.CYC.SysRetC = 0.

For information on the use of output variables, see Handling output variables [▸ 14]

3.9.8.4 Measure angle between pins (C axis)

The centre point of the spigot is calculated by 4 measured points (see SysMeasWcs10) and by the angle between the drilled holes in relation to the X axis.

The touch probe must be positioned as centrally as possible above the first spigot either manually or in automatic mode.

If no C axis is configured, call the cycle without transferring @P7. The twist in C can be manually transferred to the related zero offset by evaluating the output variables in the post-program.

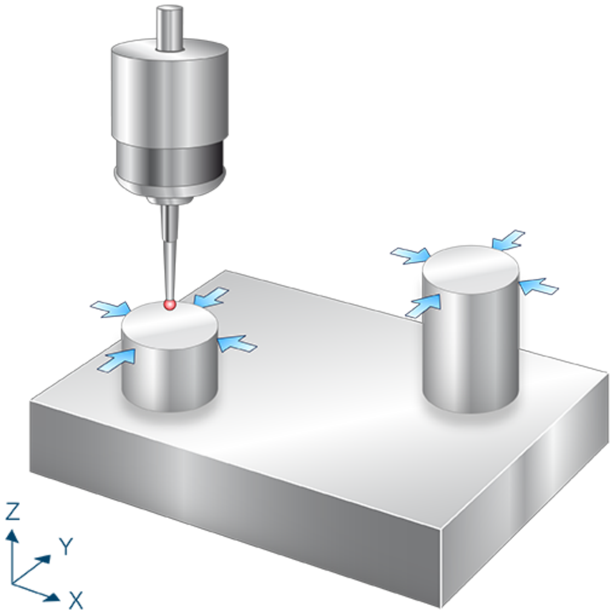

Fig. 38: Measure angle between pins (C axis)

3.9.8.4.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in X direction.
2. Pre-position in Z direction.
3. Measure in X+ direction.
4. Clearance in X- direction.
5. Move back to Z start.
6. Move back to X start.
7. Then follow measurements in X+, Y- and Y+
8. Move back in Z to starting position.
9. Position in X, Y and Z above the 2nd pin.
10. Measure the second pin with the same sequence as drilled hole 1.
11. Description of selected zero offset.

3.9.8.4.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▸ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Pin diameter
@P22	Measuring depth
@P29	Diameter of the 2nd pin
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P12	Reference angle [degrees] Default value = 0
@P13	Safety clearance for pre-positioning [mm, inch] Default value = 10
@P17	Pre-position along the X axis above the 2nd spigot
@P18	Pre-position along the Y axis above the 2nd spigot
@P19	Pre-position along the Z axis above the 2nd spigot Default value is the starting position above the 1st spigot

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.8.4.3 Syntax

L CYCLE [NAME = SysMeasWcs22.ecy @P.. = ..]

3.9.8.4.4 Programming example

Measure angle between pins (C axis)

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
```

```
  V.L.SpigotDiameter   = 20
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 5
  V.L.PositioningX     = 50
  V.L.PositioningY     = 20
  V.L.PositioningZ     = 10
  V.L.MeasDepth        = -15
  V.L.SpigotDiameter2  = 30
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetC
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs22.ecy"   \
        @P2=V.L.SpigotDiameter    \
        @P7=V.L.ZeroOffsetNumber \
        @P17=V.L.PositioningX    \
        @P18=V.L.PositioningY    \
        @P19=V.L.PositioningZ    \
        @P22=V.L.MeasDepth       \
        @P29=V.L.SpigotDiameter2 \
        @P33=V.L.CrossOver       ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.8.4.5 Output variables

Variables	Value
V.CYC.SysRetC	Calculated C value (twist of straight lines through the circle centre points in relation to the X axis)

If the straight line through the two centre points is parallel to the X axis, V.CYC.SysRetC = 0.

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.8.5 Measure angle between drilled hole and spigot (C axis)

The centre point of the drilled hole is calculated by 4 measured points (see SysMeasWcs8, SysMeasWcs10) and by the angle between the drilled holes in relation to the X axis.

The touch probe must be positioned as centrally as possible above the first drilled hole either manually or in automatic mode.

If no C axis is configured, call the cycle without transferring @P7. The twist in C can be manually transferred to the related zero offset by evaluating the output variables in the post-program.

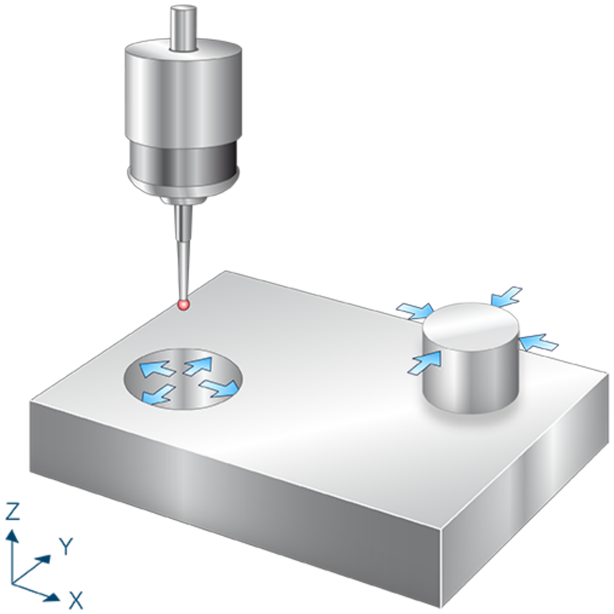

Fig. 39: Measure angle between drilled hole and spigot (C axis)

3.9.8.5.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in Z.
2. Measure in X- direction.
3. Move back to starting point.
4. Then follow measurements in X+, Y- and Y+
5. Move back in Z to starting position.
6. Position in X, Y and Z above the pin.
7. Measure the pin in the same sequence as the drilled hole.
8. Description of selected zero offset.

3.9.8.5.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Drilled hole diameter (pin diameter
@P22	Measuring depth
@P29	Pin diameter
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P12	Reference angle [degrees] Default value = 0
@P13	Safety clearance for pre-positioning [mm, inch] Default value = 10 @P13 only relates to the spigot.
@P17	Pre-position along the X axis above the pin
@P18	Pre-position along the Y axis above the pin
@P19	Pre-position along the Z axis above the pin Default value is the starting position above the drilled hole

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.8.5.3 Syntax

L CYCLE [NAME = SysMeasWcs23.ecy @P.. = ..]

3.9.8.5.4 Programming example

Measure angle between drilled hole and spigot (C axis)

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5
```

```
#VAR
  ;input parameters
  V.L.HoleDiameter     = 20
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 10
  V.L.PositioningX     = 50
  V.L.PositioningY     = 20
  V.L.PositioningZ     = 10
  V.L.MeasDepth        = -15
  V.L.SpigotDiameter   = 30
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetC
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs23.ecy"  \
        @P2=V.L.HoleDiameter    \
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance \
        @P17=V.L.PositioningX   \
        @P18=V.L.PositioningY   \
        @P19=V.L.PositioningZ   \
        @P22=V.L.MeasDepth      \
        @P29=V.L.SpigotDiameter \
        @P33=V.L.CrossOver      ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.8.5.5 Output variables

Variables	Value
V.CYC.SysRetC	Calculated C value (twist of straight lines through the circle centre points in relation to the X axis)

If the straight line through the two centre points is parallel to the X axis, V.CYC.SysRetC = 0.

For information on the use of output variables, see Handling output variables [▸ 14]

3.9.8.6 Measure angle between point in Y and drilled hole (C axis)

The centre point of the drilled hole is calculated by 4 measured points (see SysMeasWcs8) and by the angle between the drilled hole and the measured point in Y (see SysMeasWcs2) in relation to the X axis.

The touch probe must be positioned in front of the required surface above the workpiece, either manually or in automatic mode, before the cycle is started.

If no C axis is configured, call the cycle without transferring @P7. The twist in C can be manually transferred to the related zero offset by evaluating the output variables in the post-program.

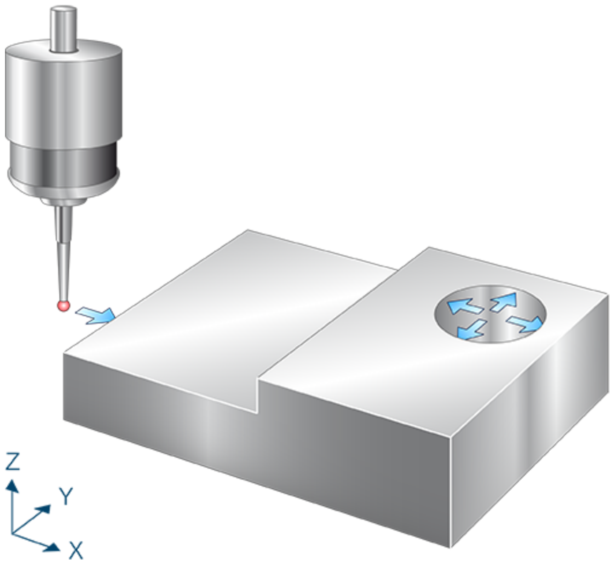

Fig. 40: Measure angle between point in Y and drilled hole (C axis)

3.9.8.6.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in Z.
2. Measure in X axis.
3. Clearance in X to starting point.
4. Move back in Z to starting position.
5. Position in X, Y and Z above the 2nd
6. Pre-position in X direction.
7. Pre-position in Z direction.
8. Measure in X+ direction.
9. Clearance in X- direction.
10. Move back to Z start.
11. Move back to X start.
12. Then follow measurements in X+, Y- and Y+
13. Description of selected zero offset.

3.9.8.6.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Drilled hole diameter
@P4	Measurement path in the X axis (incremental) Positive value, the touch probe moves in positive X direction Negative value, the touch probe moves in negative X direction
@P22	Measuring depth
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P12	Reference angle [degrees] Default value = 0
@P17	Pre-position along the X axis above the pin
@P18	Pre-position along the Y axis above the pin

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.8.6.3 Syntax

L CYCLE [NAME = SysMeasWcs24.ecy @P.. = ..]

3.9.8.6.4 Programming example

Measure angle between point in Y and drilled hole (C axis)

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.HoleDiameter     = 20
  V.L.MeasDistX        = 10
  V.L.ZeroOffsetNumber = 54
```

```
  V.L.PositioningX     = 50
  V.L.PositioningY     = 20
  V.L.PositioningZ     = 10
  V.L.MeasDepth        = -10
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetC
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs24.ecy"     \
          @P2=V.L.HoleDiameter     \
          @P4=V.L.MeasDistX        \
          @P7=V.L.ZeroOffsetNumber \
          @P17=V.L.PositioningX    \
          @P18=V.L.PositioningY    \
          @P19=V.L.PositioningZ    \
          @P22=V.L.MeasDepth       \
          @P33=V.L.CrossOver       ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.8.6.5 Output variables

Variables	Value
V.CYC.SysRetC	Calculated C value (twist of straight lines through the measuring point and circle centre points in relation to the X axis)

If the straight line through the two points is parallel to the X axis, V.CYC.SysRetC = 0.

For information on the use of output variables, see Handling output variables [▸ 14]

3.9.8.7 Measure angle between point in Y and spigot (C axis)

The centre point of the spigot is calculated by 4 measured points (see SysMeasWcs10) and by the angle between the drilled hole and the measured point in Y (see SysMeasWcs2) in relation to the X axis.

The touch probe must be positioned in front of the required surface above the workpiece, either manually or in automatic mode, before the cycle is started.

If no C axis is configured, call the cycle without transferring @P7. The twist in C can be manually transferred to the related zero offset by evaluating the output variables in the post-program.

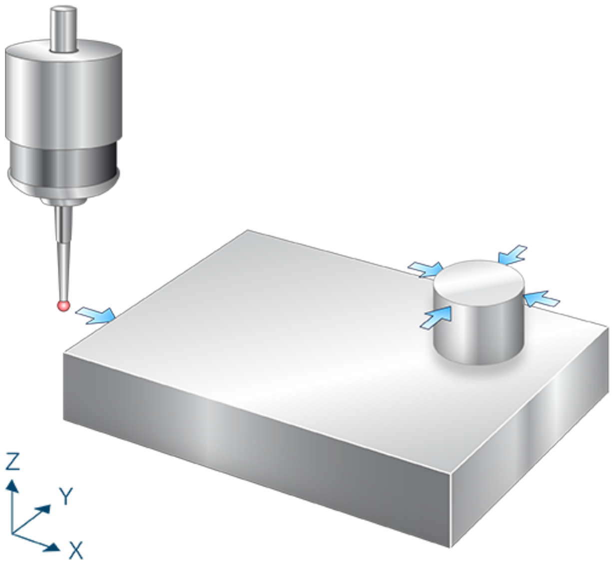

Fig. 41: Measure angle between point in Y and spigot (C axis)

3.9.8.7.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in Z.
2. Measure in X axis.
3. Clearance in X to starting point.
4. Move back in Z to starting position.
5. Position in X, Y and Z above the pin.
6. Pre-position in X direction.
7. Pre-position in Z direction.
8. Measure in X+ direction.
9. Clearance in X- direction.
10. Move back to Z start.
11. Move back to X start.
12. Then follow measurements in X+, Y- and Y+
13. Description of selected zero offset.

3.9.8.7.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Pin diameter
@P4	Measurement path in the X axis (incremental) Positive value, the touch probe moves in positive X direction Negative value, the touch probe moves in negative X direction
@P22	Measuring depth
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P12	Reference angle [degrees] Default value = 0
@P13	Safety clearance for pre-positioning [mm, inch] Default value = 10
@P17	Pre-position along the X axis above the pin
@P18	Pre-position along the Y axis above the pin
@P19	Pre-position along the Z axis above the pin

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.8.7.3 Syntax

L CYCLE [NAME = SysMeasWcs25.ecy @P.. = ..]

3.9.8.7.4 Programming example

Measure angle between point in Y and spigot (C axis)

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5
```

```
#VAR
  ;input parameters
  V.L.SpigotDiameter    = 20
  V.L.MeasDistX         = 10
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance    = 10
  V.L.PositioningX      = 50
  V.L.PositioningY      = 20
  V.L.PositioningZ      = -15
  V.L.MeasDepth         = -10
  V.L.CrossOver         = 10

  ;output variables
  V.CYC.SysRetC
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs25.ecy"    \
        @P2=V.L.SpigotDiameter    \
        @P4=V.L.MeasDistX         \
        @P7=V.L.ZeroOffsetNumber \
        @P13=V.L.SafetyDistance   \
        @P17=V.L.PositioningX     \
        @P18=V.L.PositioningY     \
        @P19=V.L.PositioningZ     \
        @P22=V.L.MeasDepth        \
        @P33=V.L.CrossOver        ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.8.7.5 Output variables

Variables	Value
V.CYC.SysRetC	Calculated C value (twist of straight lines through the measuring point and circle centre points in relation to the X axis)

If the straight line through the two points is parallel to the X axis, V.CYC.SysRetC = 0.

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.8.8 Measure angle between point in X and drilled hole (C axis)

The centre point of the drilled hole is calculated by 4 measured points (see SysMeasWcs8) and by the angle between the drilled hole and the measured point in X (see SysMeasWcs1) in relation to the X axis.

The touch probe must be positioned in front of the required surface above the workpiece, either manually or in automatic mode, before the cycle is started.

If no C axis is configured, call the cycle without transferring @P7. The twist in C can be manually transferred to the related zero offset by evaluating the output variables in the post-program.

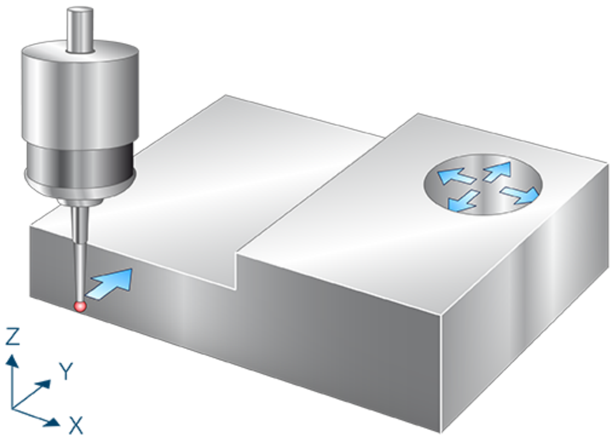

Fig. 42: Measure angle between point in X and drilled hole (C axis)

3.9.8.8.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in Z.
2. Measure in Y axis.
3. Clearance in Y at starting point.
4. Move back in Z to starting position.
5. Position in X, Y and Z above the 2nd
6. Pre-position in X direction.
7. Pre-position in Z direction.
8. Measure in X+ direction.
9. Clearance in X- direction.
10. Move back to Z start.
11. Move back to X start.
12. Then follow measurements in X+, Y- and Y+
13. Description of selected zero offset.

3.9.8.8.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▸ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Drilled hole diameter
@P5	Measurement path in the Y axis (incremental) Positive value, the touch probe moves in positive Y direction Negative value, the touch probe moves in negative Y direction
@P22	Measuring depth
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P12	Reference angle [degrees] Default value = 0
@P17	Pre-position along the X axis above the drilled hole
@P18	Pre-position along the Y axis above the drilled hole
@P19	Pre-position along the Z axis above the drilled hole

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.8.8.3 Syntax

L CYCLE [NAME = SysMeasWcs26.ecy @P.. = ..]

3.9.8.8.4 Programming example

Measure angle between point in X and drilled hole (C axis)

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.HoleDiameter      = 20
```

```
  V.L.MeasDistY        = 10
  V.L.ZeroOffsetNumber = 54
  V.L.PositioningX     = 50
  V.L.PositioningY     = 20
  V.L.PositioningZ     = -15
  V.L.MeasDepth        = -10
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetC
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs26.ecy"  \
        @P2=V.L.HoleDiameter    \
        @P5=V.L.MeasDistY       \
        @P7=V.L.ZeroOffsetNumber\
        @P17=V.L.PositioningX   \
        @P18=V.L.PositioningY   \
        @P19=V.L.PositioningZ   \
        @P22=V.L.MeasDepth      \
        @P33=V.L.CrossOver      ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.8.8.5 Output variables

Variables	Value
V.CYC.SysRetC	Calculated C value (twist of straight lines through the measuring point and circle centre points in relation to the X axis)

If the straight line through the two points is parallel to the X axis, V.CYC.SysRetC = 0.

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.8.9 Measure angle between point in X and spigot (C axis)

The centre point of the drilled hole is calculated by 4 measured points (see SysMeasWcs10) and by the angle between the drilled hole and the measured point in X (see SysMeasWcs1) in relation to the X axis.

The touch probe must be positioned in front of the required surface above the workpiece, either manually or in automatic mode, before the cycle is started.

If no C axis is configured, call the cycle without transferring @P7. The twist in C can be manually transferred to the related zero offset by evaluating the output variables in the post-program.

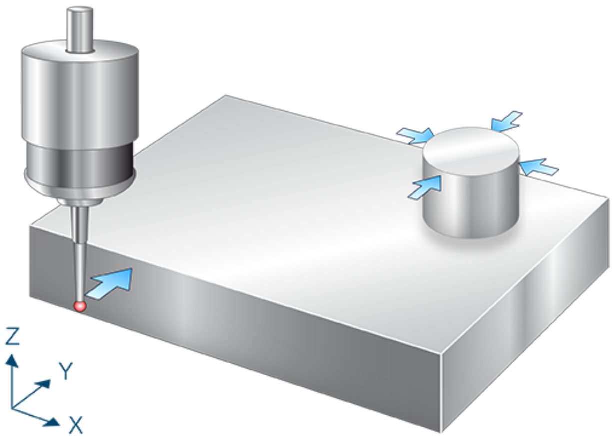

Fig. 43: Measure angle between point in X and spigot (C axis)

3.9.8.9.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in Z.
2. Measure in Y axis.
3. Clearance in Y at starting point.
4. Move back in Z to starting position.
5. Position in X, Y and Z above the pin.
6. Pre-position in X direction.
7. Pre-position in Z direction.
8. Measure in X+ direction.
9. Clearance in X- direction.
10. Move back to Z start.
11. Move back to X start.
12. Then follow measurements in X+, Y- and Y+
13. Description of selected zero offset.

3.9.8.9.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Pin diameter
@P5	Measurement path in the Y axis (incremental) Positive value, the touch probe moves in positive Y direction Negative value, the touch probe moves in negative Y direction
@P22	Measuring depth
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P12	Reference angle [degrees] Default value = 0
@P13	Safety clearance for pre-positioning [mm, inch] Default value = 10
@P17	Pre-position along the X axis above the pin
@P18	Pre-position along the Y axis above the pin
@P19	Pre-position along the Z axis above the pin

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.8.9.3 Syntax

L CYCLE [NAME = SysMeasWcs27.ecy @P.. = ..]

3.9.8.9.4 Programming example

Measure angle between point in X and spigot (C axis)

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5
```

```
#VAR
  ;input parameters
  V.L.SpigotDiameter    = 20
  V.L.MeasDistY         = 10
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance    = 10
  V.L.PositioningX      = 50
  V.L.PositioningY      = 20
  V.L.PositioningZ      = 10
  V.L.MeasDepth         = -15
  V.L.CrossOver         = 10

  ;output variables
  V.CYC.SysRetC
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs27.ecy"  \
        @P2=V.L.SpigotDiameter  \
        @P5=V.L.MeasDistY       \
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance \
        @P17=V.L.PositioningX   \
        @P18=V.L.PositioningY   \
        @P19=V.L.PositioningZ   \
        @P22=V.L.MeasDepth      \
        @P33=V.L.CrossOver      ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.8.9.5 Output variables

Variables	Value
V.CYC.SysRetC	Calculated C value (twist of straight lines through the measuring point and circle centre points in relation to the X axis)

If the straight line through the two points is parallel to the X axis, V.CYC.SysRetC = 0.

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.8.10 Measure angle in Z axis (A axis)

After positioning, the touch probe measures in the direction of the Y axis. The touch probe must be positioned as centrally as possible at measuring depth at the first measuring point either manually or in automatic mode.

The calculated angle corresponds to the twist of the workpiece about the X axis in relation to the Z axis.

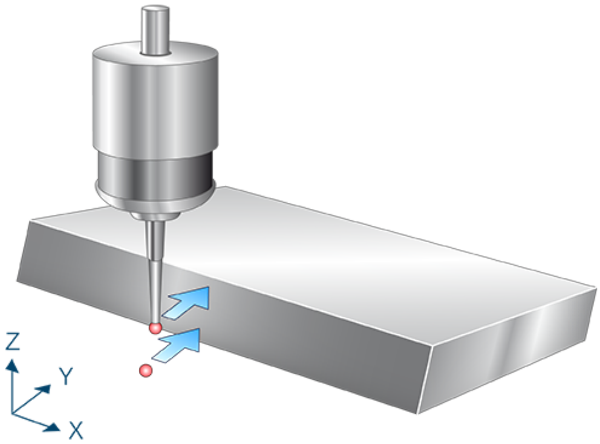

Fig. 44: Measure angle in Z axis (A axis)

3.9.8.10.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Measure in Y axis.
2. Clearance in Y at starting point.
3. Position in Z and Y axes.
4. Measure in Y axis.
5. Clearance in Y at second starting point.
6. Calculate twist in A.
7. Description of selected zero offset.

3.9.8.10.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P5	Measurement path in the Y axis (incremental) Positive value, the touch probe moves in positive Y direction Negative value, the touch probe moves in negative Y direction
@P19	Pre-position along the Z axis

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P12	Reference angle [degrees] Default value = 0
@P17	Pre-position along the Y axis

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.8.10.3 Syntax

L CYCLE [NAME = SysMeasWcs32.ecy @P.. = ..]

3.9.8.10.4 Programming example

Measure angle in Z axis (A axis)

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0
G0 Z-15

#VAR
  ;input parameters
  V.L.MeasDistY          = 10
  V.L.ZeroOffsetNumber   = 54
  V.L.PositioningZ       = -10

  ;output variables
  V.CYC.SysRetA
#ENDVAR

;cycle call
```

```
L CYCLE [NAME="SysMeasWcs32.ecy"\
        @P5=V.L.MeasDistY\
        @P7=V.L.ZeroOffsetNumber\
        @P19=V.L.PositioningZ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetA =%f", V.CYC.SysRetA]

G0 Z10

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.8.10.5 Output variables

Variables	**Value**
V.CYC.SysRetA	Calculated A value (twist in relation to Z axis)

If the workpiece is parallel to Z axis, V.CYC.SysRetA = 0.

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.8.11 Measure angle in Z axis (B axis)

After positioning, the touch probe measures in the direction of the X axis. The touch probe must be positioned as centrally as possible at measuring depth at the first measuring point either manually or in automatic mode.

The calculated angle corresponds to the twist of the workpiece about the Y axis in relation to the Z axis.

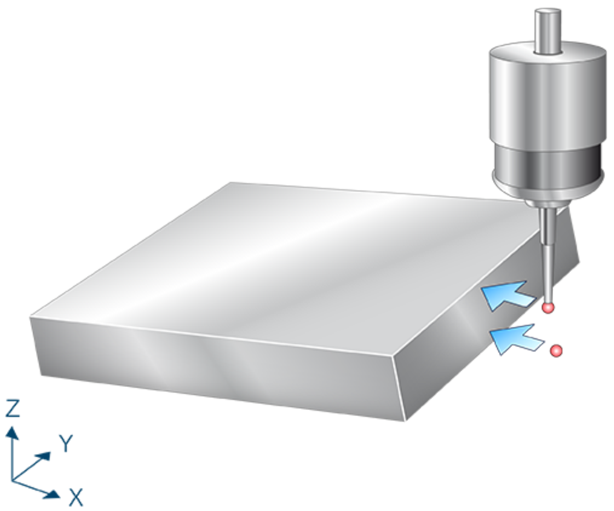

Fig. 45: Measure angle in Z axis (B axis)

3.9.8.11.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Measure in X axis.
2. Clearance in X to starting point.
3. Position in X and Z axes.
4. Measure in X axis.
5. Clearance in X at second starting point.
6. Calculate twist in B.
7. Description of selected zero offset.

3.9.8.11.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P4	Measurement path in the X axis (incremental) Positive value, the touch probe moves in positive X direction Negative value, the touch probe moves in negative X direction
@P19	Pre-position along the Z axis

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P12	Reference angle [degrees] Default value = 0
@P17	Pre-position along the X axis

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.8.11.3 Syntax

L CYCLE [NAME = SysMeasWcs33.ecy @P.. = ..]

3.9.8.11.4 Programming example

Measure angle in Z axis (B axis)

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0
G0 Z-15

#VAR
  ;input parameters
  V.L.MeasDistX          = 10
  V.L.ZeroOffsetNumber   = 54
  V.L.PositioningZ       = -10

  ;output variables
  V.CYC.SysRetB
#ENDVAR

;cycle call
```

```
L CYCLE [NAME="SysMeasWcs33.ecy"   \
        @P4=V.L.MeasDistX         \
        @P7=V.L.ZeroOffsetNumber \
        @P19=V.L.PositioningZ     ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetB =%f", V.CYC.SysRetB]

G0 Z10

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.8.11.5 Output variables

Variables	Value
V.CYC.SysRetB	Calculated B value (twist in relation to Z axis)

If the workpiece is parallel to Z axis, V.CYC.SysRetB = 0.

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.9 Rectangle

These cycles determined the centre point of a rectangle.

The calculated value is transferred to the selected zero offset.

3.9.9.1 Inner rectangle

After positioning in the pocket, the tough probe measures in the position and negative X and Y directions and uses the measured values to calculate the centre point.

The touch probe must be positioned at measuring depth as centrally as possible in the pocket either manually or in automatic mode.

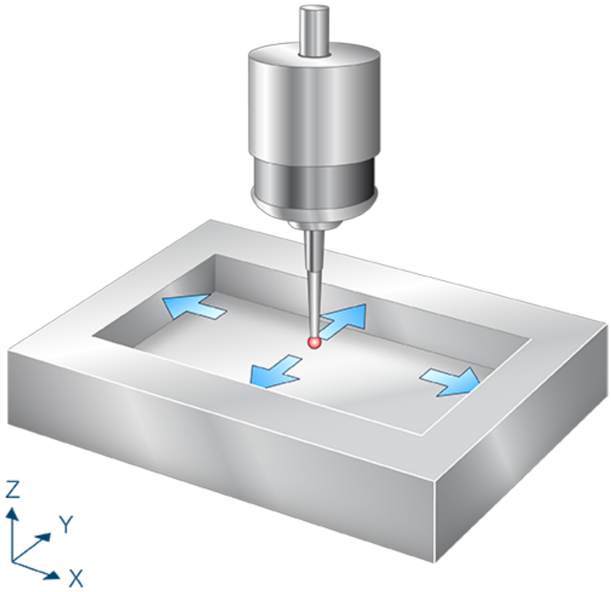

Fig. 46: Inner rectangle

3.9.9.1.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. (Pre-position in X direction.)
2. Measure in X- direction.
3. Move back to starting point.
4. Then follow measurements in X+, Y- and Y+
5. Description of selected zero offset.

3.9.9.1.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P31	Length of the pocket in X
@P32	Length of the pocket in Y
@P33	Crossover range [mm, inch] Default value = 5

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P13	Security distance for pre-positioning If @P13 is not specified, the entire measuring section is traversed at the measuring feed rate.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.9.1.3 Syntax

L CYCLE [NAME = SysMeasWcs28.ecy @P.. = ..]

3.9.9.1.4 Programming example

Inner rectangle

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0
G0 Z-15

#VAR
  ;input parameters
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 5
  V.L.PocketLengthX    = 40
  V.L.PocketLengthY    = 60
  V.L.CrossOver        = 5
```

```
  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetLengthX
  V.CYC.SysRetLengthY
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs28.ecy"  \
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance \
        @P31=V.L.PocketLengthX  \
        @P32=V.L.PocketLengthY  \
        @P33=V.L.CrossOver      ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetLengthX =%f", V.CYC.SysRetLengthX]
#MSG SAVE ["V.CYC.SysRetLengthY =%f", V.CYC.SysRetLengthY]

G0 Z10
M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.9.1.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (rectangle centre point)
V.CYC.SysRetY	Calculated Y value (rectangle centre point)
V.CYC.SysRetLengthX	Calculated X length (length of rectangle)
V.CYC.SysRetLengthY	Calculated Y length (width of rectangle)

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.9.2 Outer rectangle

The touch probe is positioned above the spigot and then measures in the positive and negative X and Y directions after pre-positioning in each case. It then calculates the centre point from these measured values.

The touch probe must be positioned as centrally as possible above the rectangular pocket either manually or in automatic mode.

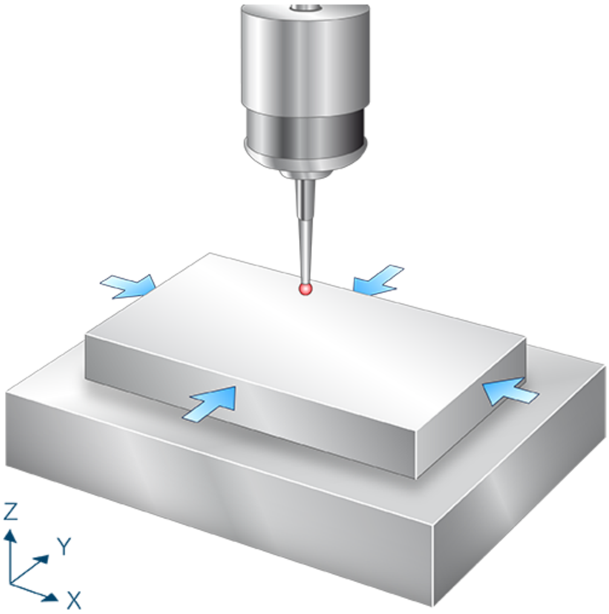

Fig. 47: Outer rectangle

3.9.9.2.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in X direction.
2. Pre-position in Z direction.
3. Measure in X+ direction.
4. Clearance in X- direction.
5. Move back to Z start.
6. Move back to X start.
7. Then follow measurements in X+, Y- and Y+
8. Description of selected zero offset.

3.9.9.2.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▸ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P19	Pre-position along the Z axis above the pin
@P31	Length in X of rectangle
@P32	Length in Y of rectangle

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P13	Safety clearance for pre-positioning [mm, inch] Default value = 10
@P33	Crossover range [mm, inch] Default value = 5

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.9.2.3 Syntax

L CYCLE [NAME = SysMeasWcs29.ecy @P.. = ..]

3.9.9.2.4 Programming example

Outer rectangle

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 10
  V.L.PositioningZ     = -15
  V.L.PocketLengthX    = 40
  V.L.PocketLengthY    = 60
  V.L.CrossOver        = 10
```

```
  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetLengthX
  V.CYC.SysRetLengthY
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs29.ecy"  \
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance \
        @P19=V.L.PositioningZ   \
        @P31=V.L.PocketLengthX  \
        @P32=V.L.PocketLengthY  \
        @P33=V.L.CrossOver      ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetLengthX =%f", V.CYC.SysRetLengthX]
#MSG SAVE ["V.CYC.SysRetLengthY =%f", V.CYC.SysRetLengthY]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.9.2.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (rectangle centre point)
V.CYC.SysRetY	Calculated Y value (rectangle centre point)
V.CYC.SysRetLengthX	Calculated X length (length of rectangle)
V.CYC.SysRetLengthY	Calculated Y length (width of rectangle)

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.10 Extra measurement cycles

The calculated value is transferred to the selected zero offset.

3.9.10.1 Centre point across 4 drilled holes

The centre points of each of the drilled holes are calculated by 4 points (see SysMeasWcs8) and the total centre point is calculated from the 4 centre points.

The touch probe must be positioned in the drilled hole as centrally as possible at measuring depth either manually or in automatic mode.

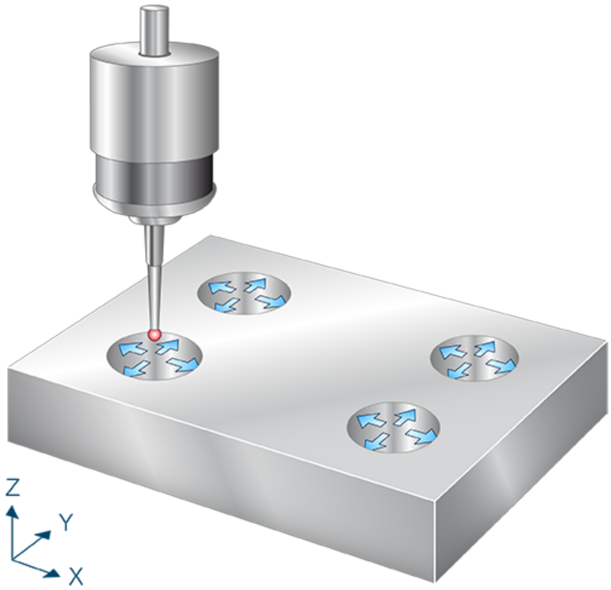

Fig. 48: Centre point across 4 drilled holes

3.9.10.1.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in Z.
2. (Pre-position in X direction.)
3. Measure in X- direction.
4. Move back to starting point.
5. Then follow measurements in X+, Y- and Y
6. Move back to starting point in Z.
7. Position in Y on the 2nd drilled hole and repeat the measurement process.
8. Position in X on the 3rd drilled hole and repeat the measurement process.
9. Position in Y on the 4th drilled hole and repeat the measurement process.
10. Determine the central points of the 4 drilled holes
11. Description of selected zero offset.

3.9.10.1.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Drilled hole diameter
@P17	Pre-position along the X axis above the drilled holes
@P18	Pre-position along the Y axis above the drilled holes
@P19	Pre-position along the Z axis above the drilled holes

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P13	Security distance for pre-positioning If @P13 is not specified, the entire measuring section is traversed at the measuring feed rate.
@P33	Crossover range [mm, inch] Default value = 5

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.10.1.3 Syntax

L CYCLE [NAME = SysMeasWcs30.ecy @P.. = ..]

3.9.10.1.4 Programming example

Centre point across 4 drilled holes

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.HoleDiameter     = 30
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 5
  V.L.PositioningX     = 40
```

```
  V.L.PositioningY     = 30
  V.L.PositioningZ     = -15
  V.L.CrossOver        = 10

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs30.ecy"  \
        @P2=V.L.HoleDiameter    \
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance \
        @P17=V.L.PositioningX   \
        @P18=V.L.PositioningY   \
        @P19=V.L.PositioningZ   \
        @P33=V.L.CrossOver      ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.10.1.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (centre point)
V.CYC.SysRetY	Calculated Y value (centre point)

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.10.2 Centre point of a hole circle

The touch probe calculated the centre points of each of the drilled holes by 4 points (see SysMeasWcs8) and calculated the total centre point of the hole circle from the centre points.

The touch probe must be positioned as centrally as possible above the central point of the hole circle either manually or in automatic mode.

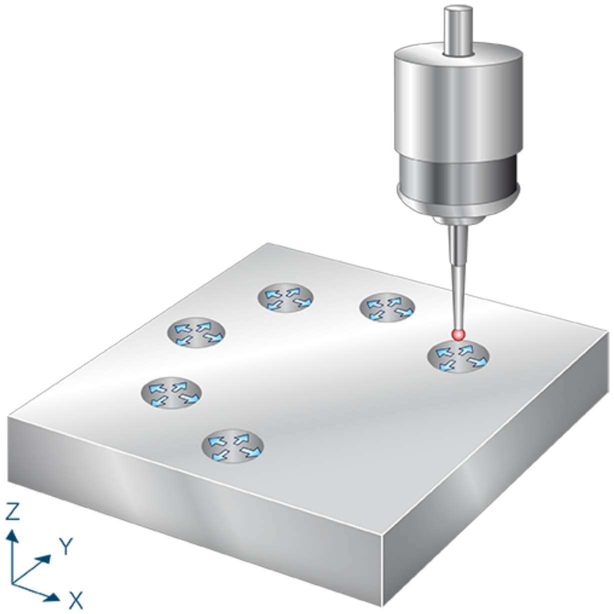

Fig. 49: Centre point of a hole circle

3.9.10.2.1 Process (internal cycle)

The internal cycle process can be described as follows:

1. Pre-position in Z
2. (Pre-position in X direction.)
3. Measure in X- direction.
4. Move back to starting point.
5. Then follow measurements in X+, Y- and Y+.
6. Move back to starting point in Z.
7. The next drilled hole positions are calculated and the first drilled hole is measured.
8. When the last drilled hole is measured, the centre point of all measurements is calculated
9. Description of selected zero offset.

3.9.10.2.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Drilled hole diameter
@P22	Pre-position along the Z axis above the drilled holes
@P29	Hole circle diameter

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measuring point along the X axis
@P10	Shift the measuring point along the Y axis
@P13	Security distance for pre-positioning If @P13 is not specified, the entire measuring section is traversed at the measuring feed rate.
@P14	Angle of hole circle [degrees] Default value = 360
@P15	Angle between the drilled holes - Alternatively, this parameter can be made using @P30
@P16	Starting angle [degrees] Default value = 0
@P30	Number of drilled holes If not specified, the number of drilled holes is calculated from the angle values.
@P33	Crossover range [mm, inch]default value = 5

The number of drilled holes can be defined by the angle between the drilled holes or the number of drilled holes. It is **not** permissible to specify @P15 **and** @P30 in the same cycle.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.10.2.3 Syntax

L CYCLE [NAME = SysMeasWcs31.ecy @P.. = ..]

3.9.10.2.4 Programming example

Centre point of a hole circle

```
; touch probe activation
```

```
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0 Z5

#VAR
  ;input parameters
  V.L.HoleDiameter       = 30
  V.L.ZeroOffsetNumber   = 54
  V.L.PositioningZ       = -15
  V.L.HoleCircleDiameter = 50
  V.L.NumberOfHoles      = 3
  V.L.CrossOver          = 10

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs31.ecy"      \
        @P2=V.L.HoleDiameter        \
        @P7=V.L.ZeroOffsetNumber    \
        @P22=V.L.PositioningZ       \
        @P29=V.L.HoleCircleDiameter \
        @P30=V.L.NumberOfHoles      \
        @P33=V.L.CrossOver          ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.10.2.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (hole circle centre point)
V.CYC.SysRetY	Calculated Y value (hole circle centre point)

For information on the use of output variables, see Handling output variables [▸ 14]

3.9.11 Measuring a circle segment

The following cycles determine the X and Y values of the centre point of a circle segment. The determined values are transferred to the selected zero offset.

3.9.11.1 Measuring circle segment from the inside (3 points)

After positioning within the drilled hole, the touch probe measures along the 3 angled straight lines defined by an incremental angle. The touch probe must be positioned in the drilled hole as centrally as possible at measuring depth either manually or in automatic mode.

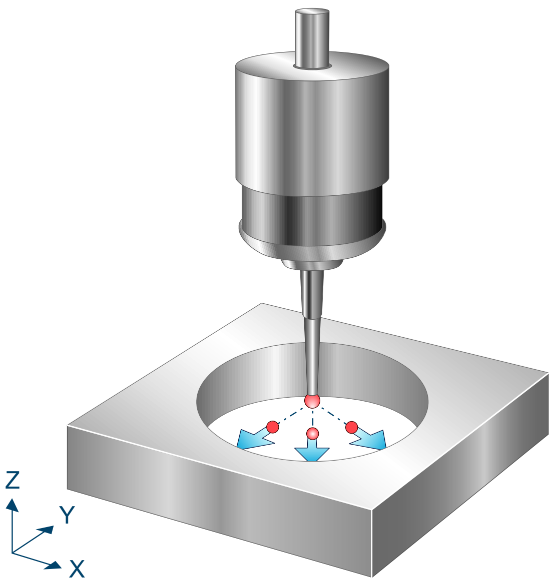

Fig. 50: Measure circle segment from the inside with 3 points

3.9.11.1.1 Process (internal cycle)

The internal cycle process can be described as follows

1. (Pre-position in X and Y directions using 1st angle.)
2. Measure in X and Y directions using 1st angle.
3. Move back to starting point.
4. This is followed by the measurements at angle 2 and angle 3.
5. Description of selected zero offset.

3.9.11.1.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Estimated drilled hole diameter. Here, an approximate parameter is sufficient. For calculating pre-positioning.

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measurement result along the X axis
@P10	Shift the measurement result along the Y axis
@P13	Security distance for pre-positioning
@P14	Angle to measuring point 1 in relation to X+ axis [degrees] (default: 0)
@P15	Incremental angle [degrees] (default: 120)
@P33	Crossover range [mm, inch] (default: 5)

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.11.1.3 Syntax

L CYCLE [NAME = SysMeasWcs36.ecy @P.. = ..]

3.9.11.1.4 Programming example

Measuring a workpiece

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G00 X50 Y20
G00 Z-10

#VAR
  ;input parameters
  V.L.HoleDiameter     = 20
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 1
  V.L.StartAngle       = 20
  V.L.IncrementalAngle = 70
  V.L.CrossOver        = 0

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetDiameter
#ENDVAR

;cycle call
L CYCLE[NAME="SysMeasWcs36.ecy"\
        @P2=V.L.HoleDiameter\
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance\
        @P14=V.L.StartAngle\
        @P15=V.L.IncrementalAngle\
        @P33=V.L.CrossOver]
```

```
; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX        =%f", V.CYC.SysRetX       ]
#MSG SAVE ["V.CYC.SysRetY        =%f", V.CYC.SysRetY       ]
#MSG SAVE ["V.CYC.SysRetDiameter =%f", V.CYC.SysRetDiameter]

G00 Z10

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.11.1.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (circle centre point)
V.CYC.SysRetY	Calculated Y value (circle centre point)
V.CYC.SysRetDiameter	Calculated circle diameter

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.11.2 Measuring circle segment from the inside (4 points)

After positioning within the drilled hole, the touch probe measures along the 3 angled straight lines defined by an incremental angle. The touch probe must be positioned in the drilled hole as centrally as possible at measuring depth either manually or in automatic mode.

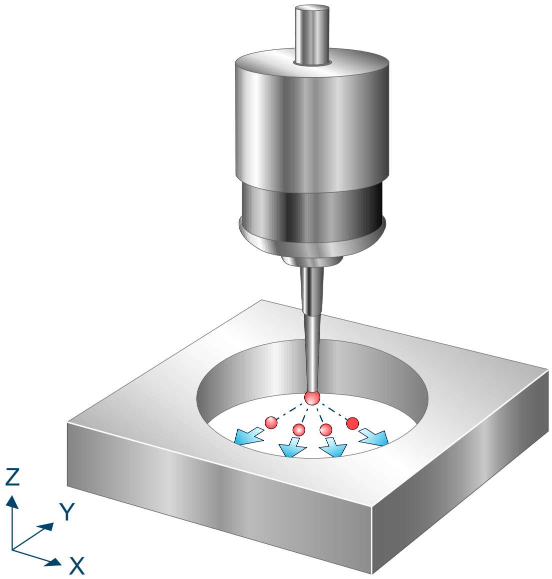

Fig. 51: Measure circle segment from the inside with 4 points

3.9.11.2.1 Process (internal cycle)

The internal cycle process can be described as follows

1. Pre-position in X and Y directions using 1st angle.
2. Measure in X and Y directions using 1st angle.
3. Move back to starting point.
4. This is followed by the measurements at angle 2, angle 3 and angle 4.
5. Description of selected zero offset.

3.9.11.2.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Estimated drilled hole diameter. Here, an approximate parameter is sufficient. For calculating pre-positioning.

Optional input parameters

Input parameters	Description

@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measurement result along the X axis
@P10	Shift the measurement result along the Y axis
@P13	Security distance for pre-positioning
@P14	Angle to measuring point 1 in relation to X+ axis [degrees] (default: 0)
@P15	Incremental angle [degrees] (default: 90)
@P33	Crossover range [mm, inch] (default: 5)

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.11.2.3 Syntax

L CYCLE [NAME = SysMeasWcs37.ecy @P.. = ..]

3.9.11.2.4 Programming example

Measuring a workpiece

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G00 X50 Y20
G00 Z-10

#VAR
  ;input parameters
  V.L.HoleDiameter     = 20
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance   = 1
  V.L.StartAngle       = 20
  V.L.IncrementalAngle = 44
  V.L.CrossOver        = 0

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetDiameter
#ENDVAR

;cycle call
L CYCLE[NAME="SysMeasWcs37.ecy"\
        @P2=V.L.HoleDiameter\
        @P7=V.L.ZeroOffsetNumber\
        @P13=V.L.SafetyDistance\
        @P14=V.L.StartAngle\
        @P15=V.L.IncrementalAngle\
        @P33=V.L.CrossOver]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX        =%f", V.CYC.SysRetX       ]
```

```
#MSG SAVE ["V.CYC.SysRetY        =%f", V.CYC.SysRetY       ]
#MSG SAVE ["V.CYC.SysRetDiameter =%f", V.CYC.SysRetDiameter]

G00 Z10

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.11.2.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (circle centre point)
V.CYC.SysRetY	Calculated Y value (circle centre point)
V.CYC.SysRetDiameter	Calculated circle diameter

For information on the use of output variables, see Handling output variables [▸ 14]

3.9.11.3 Measuring circle segment from the outside (3 points)

After positioning above the spigot, the touch probe measures along the 3 angled straight lines defined by an incremental angle. The touch probe must be positioned in the drilled hole as centrally as possible at measuring depth either manually or in automatic mode.

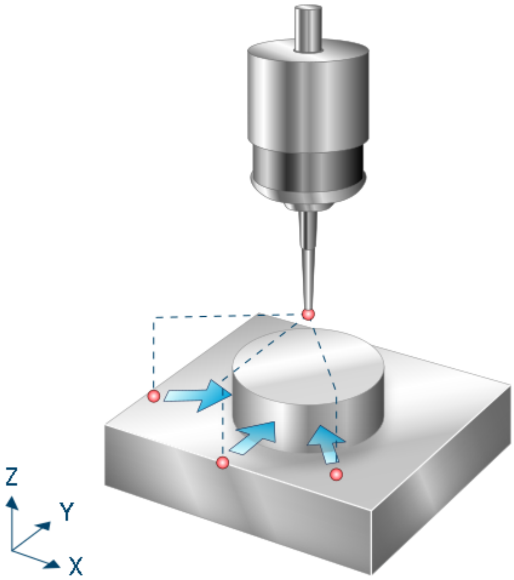

Fig. 52: Measure circle segment from the outside with 3 points

3.9.11.3.1 Process (internal cycle)

The internal cycle process can be described as follows

1. Pre-position in X and Y directions using 1st angle.
2. Pre-position in Z direction.
3. Measure in X and Y directions using 1st angle.
4. Lift in Z and return to start point.
5. This is followed by the measurements at angle 2 and angle 3.
6. Description of selected zero offset.

3.9.11.3.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Estimated spigot diameter. Here, an approximate parameter is sufficient. For calculating pre-positioning.

Optional input parameters

Input parameters	Description

@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measurement result along the X axis
@P10	Shift the measurement result along the Y axis
@P13	Security distance for pre-positioning
@P14	Angle to measuring point 1 in relation to X+ axis [degrees] (default: 0)
@P15	Incremental angle [degrees] (default: 120)
@P19	Pre-positioning in the Z axis, relative
@P33	Crossover range [mm, inch] (default: 5)

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.11.3.3 Syntax

L CYCLE [NAME = SysMeasWcs38.ecy @P.. = ..]

3.9.11.3.4 Programming example

Measuring a workpiece

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G00 X50 Y20
G00 Z10

#VAR
  ;input parameters
  V.L.SpigotDiameter    = 20
  V.L.ZeroOffsetNumber = 54
  V.L.SafetyDistance    = 3
  V.L.StartAngle        = 20
  V.L.IncrementalAngle = 70
  V.L.CrossOver         = 5

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetDiameter
#ENDVAR

;cycle call
L CYCLE[NAME="SysMeasWcs38.ecy"      \
          @P2=V.L.SpigotDiameter     \
          @P7=V.L.ZeroOffsetNumber   \
          @P13=V.L.SafetyDistance    \
          @P14=V.L.StartAngle        \
          @P15=V.L.IncrementalAngle \
          @P33=V.L.CrossOver         ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
```

```
#MSG SAVE ["V.CYC.SysRetX        =%f", V.CYC.SysRetX       ]
#MSG SAVE ["V.CYC.SysRetY        =%f", V.CYC.SysRetY       ]
#MSG SAVE ["V.CYC.SysRetDiameter =%f", V.CYC.SysRetDiameter]

G00 Z0

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.11.3.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (circle centre point)
V.CYC.SysRetY	Calculated Y value (circle centre point)
V.CYC.SysRetDiameter	Calculated circle diameter

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.11.4 Measuring circle segment from the outside (4 points)

After positioning above the spigot, the touch probe measures along the 4 angled straight lines defined by an incremental angle. The touch probe must be positioned outside the spigot as centrally as possible at measuring depth either manually or in automatic mode.

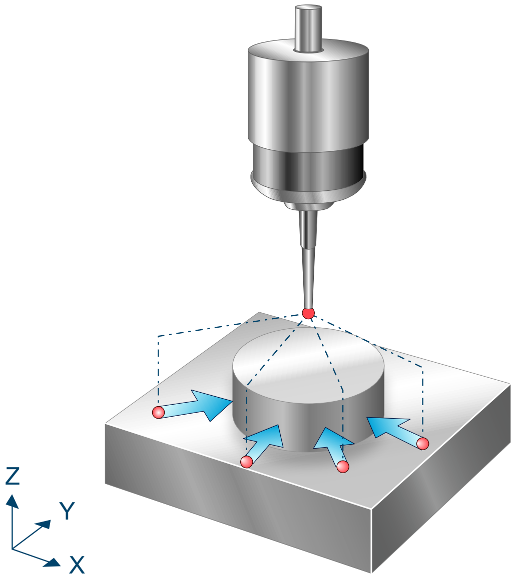

Fig. 53: Measure circle segment from the outside with 4 points

3.9.11.4.1 Process (internal cycle)

The internal cycle process can be described as follows

1. Pre-position in X and Y directions using 1st angle.
2. Pre-position in Z direction.
3. Measure in X and Y directions using 1st angle.
4. Lift in Z and return to start point.
5. This is followed by the measurements at angle 2, angle 3 and angle 4.
6. Description of selected zero offset.

3.9.11.4.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P2	Estimated spigot diameter. Here, an approximate parameter is sufficient. For calculating pre-positioning.

Optional input parameters

Input parameters	Description

@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measurement result along the X axis
@P10	Shift the measurement result along the Y axis
@P13	Security distance for pre-positioning
@P14	Angle to measuring point 1 in relation to X+ axis [degrees] (default: 0)
@P15	Incremental angle [degrees] (default: 90)
@P19	Pre-positioning in the Z axis, relative
@P33	Crossover range [mm, inch] (default: 5)

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.11.4.3 Syntax

L CYCLE [NAME = SysMeasWcs39.ecy @P.. = ..]

3.9.11.4.4 Programming example

Measuring a workpiece

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G00 X50 Y20
G00 Z10

#VAR
  ;input parameters
  V.L.SpigotDiameter    = 20
  V.L.ZeroOffsetNumber  = 54
  V.L.SafetyDistance    = 3
  V.L.StartAngle        = 20
  V.L.IncrementalAngle  = 70
  V.L.CrossOver         = 5

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetDiameter
#ENDVAR

;cycle call
L CYCLE[NAME="SysMeasWcs39.ecy" @P2  = V.L.SpigotDiameter   \
                                @P7  = V.L.ZeroOffsetNumber \
                                @P13 = V.L.SafetyDistance   \
                                @P14 = V.L.StartAngle       \
                                @P15 = V.L.IncrementalAngle \
                                @P33 = V.L.CrossOver        ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX        =%f", V.CYC.SysRetX       ]
```

```
#MSG SAVE ["V.CYC.SysRetY        =%f", V.CYC.SysRetY       ]
#MSG SAVE ["V.CYC.SysRetDiameter =%f", V.CYC.SysRetDiameter]

G00 Z0

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.11.4.5 Output variables

Variables	Value
V.CYC.SysRetX	Calculated X value (circle centre point)
V.CYC.SysRetY	Calculated Y value (circle centre point)
V.CYC.SysRetDiameter	Calculated circle diameter

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.12 Measuring a corner

The following cycles determine the X and Y values of the corner and the rotation of the workpiece. The determined values are transferred to the selected zero offset.

3.9.12.1 Rectangular corner

This cycle measures a rectangular outside or inside corner. This requires three measuring points. Outside and inside corners are distinguished by an appropriate enquiry of the input parameters, as described in the related subsection.

If @P7 is specified, only the corner coordinates in X and Y are written to the zero offset, but not the twist in C. If required, the twist in C can be manually transferred to the related zero offset by evaluating the output variables in the post-program.

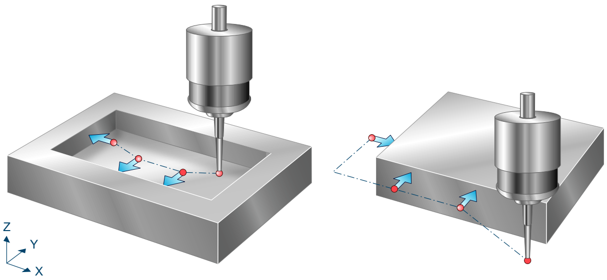

Fig. 54: Rectangular inside and outside corners

3.9.12.1.1 Process (internal cycle)

The internal cycle process can be described as follows

1. Approach the pre-position.
2. Measure in Y axis.
3. Clearance in Y at starting point.
4. Position in X axis.
5. Measure in Y axis.
6. Clearance in Y at second starting point.
7. Position in X axis.
8. Position in Y axis.
9. Measure in X axis.
10. Description of selected zero offset.

3.9.12.1.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P4	Measurement path in the X axis (incremental) Positive value, the touch probe moves in positive X direction Negative value, the touch probe moves in negative X direction

@P5	Measurement path in the Y axis (incremental) Positive value, the touch probe moves in positive Y direction Negative value, the touch probe moves in negative Y direction
@P17	Pre-position in the X axis (absolute), position of measuring point 1
@P18	Pre-position in the Y axis (absolute), position of measuring point 1
@P41	Relative path distance along X axis from measuring point 1 to measuring point 2
@P42	Relative path distance along X axis from measuring point 2 to measuring point 3
@P43	Relative path distance along Y axis from measuring point 2 to measuring point 3

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measurement result along the X axis
@P10	Shift the measurement result along the Y axis
@P12	Reference angle [degrees] (default 0)

Difference between outside and inside corners

An outside corner is traversed when

- @P5 > 0 and @P43 > 0, or
- @P5 < 0 and @P43 < 0.

An inside corner is traversed when

- @P5 > 0 and @P43 < 0, or
- @P5 < 0 and @P43 > 0.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.12.1.3 Syntax

L CYCLE [NAME = SysMeasWcs34.ecy @P.. = ..]

3.9.12.1.4 Programming example

Measuring a rectangular outside corner

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0
G0 Z-10

#VAR
  ;input parameters
```

```
  V.L.MeasDistX          = 5
  V.L.MeasDistY          = 5
  V.L.ZeroOffsetNumber   = 54
  V.L.PositioningX       = 10
  V.L.PositioningY       = 10
  V.L.RelativeX1         = -30
  V.L.RelativeX2         = -30
  V.L.RelativeY          = 30

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetC
#ENDVAR

;cycle call
L CYCLE[NAME="SysMeasWcs34.ecy"\
        @P4=V.L.MeasDistX\
        @P5=V.L.MeasDistY\
        @P7=V.L.ZeroOffsetNumber\
        @P17=V.L.PositioningX\
        @P18=V.L.PositioningY\
        @P41=V.L.RelativeX1\
        @P42=V.L.RelativeX2\
        @P43=V.L.RelativeY]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

G00 Z10

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.12.1.5 Output variables

Variable	Value
V.CYC.SysRetX	Calculated X value of corner
V.CYC.SysRetY	Calculated Y value of corner
V.CYC.SysRetC	Calculated C value, twist of workpiece in relation to X axis

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.12.2 Any corner

This cycle measures any outside or inside corner. This requires four measuring points. Outside and inside corners are distinguished by an appropriate enquiry of the input parameters, as described in the related subsection.

If @P7 is specified, only the corner coordinates in X and Y are written to the zero offset, but not the twist in C. If required, the twist in C can be manually transferred to the related zero offset by evaluating the output variables in the post-program.

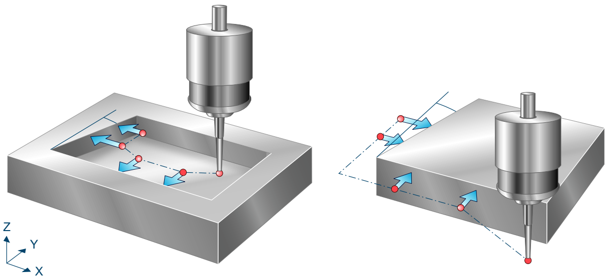

Fig. 55: Any inside and outside corners

3.9.12.2.1 Process (internal cycle)

The internal cycle process can be described as follows

1. Approach the pre-position.
2. Measure in Y axis.
3. Clearance in Y at starting point.
4. Position in X axis.
5. Measure in Y axis.
6. Clearance in Y at second starting point.
7. Position in X axis.
8. Position in Y axis.
9. Measure in X axis.
10. Position in Y axis.
11. Measure in X axis.
12. Description of selected zero offset.

3.9.12.2.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P4	Measurement path in the X axis (incremental) Positive value, the touch probe moves in positive X direction Negative value, the touch probe moves in negative X direction
@P5	Measurement path in the Y axis (incremental) Positive value, the touch probe moves in positive Y direction Negative value, the touch probe moves in negative Y direction

@P17	Pre-position in the X axis (absolute), position of measuring point 1
@P18	Pre-position in the Y axis (absolute), position of measuring point 1
@P41	Relative path distance along X axis from measuring point 1 to measuring point 2
@P42	Relative path distance along X axis from measuring point 2 to measuring point 3
@P43	Relative path distance along Y axis from measuring point 2 to measuring point 3
@P44	Relative path distance along Y axis from measuring point 3 to measuring point 4

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measurement result along the X axis
@P10	Shift the measurement result along the Y axis
@P12	Reference angle [degrees] (default: 0)

Difference between outside and inside corners

An outside corner is traversed when

- @P5 > 0 and @P43 > 0, or
- @P5 < 0 and @P43 < 0.

An inside corner is traversed when

- @P5 > 0 and @P43 < 0, or
- @P5 < 0 and @P43 > 0.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.12.2.3 Syntax

L CYCLE [NAME = SysMeasWcs35.ecy @P.. = ..]

3.9.12.2.4 Programming example

Measuring any outside corner

```
; touch probe activation
T1 D1

; deactivation of the zero offset
G53

; positioning to the starting point
G0 X0 Y0
G0 Z-10

#VAR
  ;input parameters
  V.L.MeasDistX          = 5
  V.L.MeasDistY          = 5
  V.L.ZeroOffsetNumber   = 54
  V.L.PositioningX       = 10
```

```
  V.L.PositioningY       = 10
  V.L.RelativeX1         = -30
  V.L.RelativeX2         = -30
  V.L.RelativeY1         = 30
  V.L.RelativeY2         = 30

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetC
#ENDVAR

;cycle call
L CYCLE[NAME="SysMeasWcs35.ecy"\
        @P4=V.L.MeasDistX\
        @P5=V.L.MeasDistY\
        @P7=V.L.ZeroOffsetNumber\
        @P17=V.L.PositioningX\
        @P18=V.L.PositioningY\
        @P41=V.L.RelativeX1\
        @P42=V.L.RelativeX2\
        @P43=V.L.RelativeY1\
        @P44=V.L.RelativeY2]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX =%f", V.CYC.SysRetX]
#MSG SAVE ["V.CYC.SysRetY =%f", V.CYC.SysRetY]
#MSG SAVE ["V.CYC.SysRetC =%f", V.CYC.SysRetC]

G00 Z10

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▶ 78] in the subsection Programming.

3.9.12.2.5 Output variables

Variable	Value
V.CYC.SysRetX	Calculated X value of corner
V.CYC.SysRetY	Calculated Y value of corner
V.CYC.SysRetC	Calculated C value, twist of workpiece in relation to X axis

For information on the use of output variables, see Handling output variables [▶ 14]

3.9.13 Measuring a sphere

This cycle determines the diameter and centre point of a sphere. The determined value of the sphere centre point is transferred to the selected zero offset.

The touch probe therefore measures the sphere from the top in Z direction and then from the side in positive and negative X and Y directions.

The tip of the touch probe must be round in order to obtain precise results.

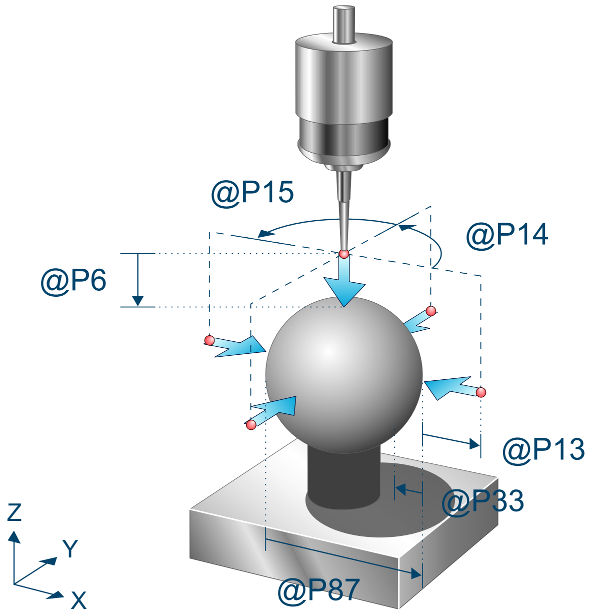

Fig. 56: Measuring a sphere

3.9.13.1 Process (internal cycle)

Starting position before the cycle is called: The touch probe must be positioned either manually or in automatic mode as centrally as possible and at a short clearance above the first sphere. It stands vertically, i.e. the touch probe rotation stands at 0.

The internal cycle process can be described as follows:

1. The spindle must be in its initial position at cycle start.
2. The touch probe first runs a measurement in the Z direction and a total of four lateral measurements, after which it returns to the starting position.
3. If a measurement repetition was specified in @P88 to enhance accuracy, the measurement is repeated, whereby the lateral measurements take place at the calculated height of the equator.
4. The touch probe travels to starting height above the measured centre point of the sphere.

3.9.13.2 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required input parameters

Input parameters	Description
@P6	Measurement path in the direction of the negative Z axis, only positive values permitted

@P87	Estimated diameter of the sphere. Here, an approximate parameter is sufficient. For calculating pre-positioning.

Optional input parameters

Input parameters	Description
@P7	Zero offset to be described (TCS) G159=1 to G159=9 and G54 to G59 Input without address "G159=" or "G" If not specified, then measurement only but no write function Only permitted when G53 is active at cycle call.
@P9	Shift the measurement result along the X axis (shifts origin of the zero offset)
@P10	Shift the measurement result along the Y axis (shifts origin of the zero offset)
@P11	Shift the measurement result along the Z axis (shifts origin of the zero offset)
@P13	Security distance for pre-positioning (default: @P87/4)
@P14	Probe angle of the first lateral measurement in relation to the positive X axis [degrees] (default: 0)
@P15	Difference of the probe angle between the lateral measurements [degrees] (default: 90)
@P33	Crossover range during measurement process [mm, inch] (default: @P87/4)
@P64	Definition of the path to approach to pre-position 0 = linear (default value) 1 = circular (Caution: collision detection disabled)
@P88	Measurement repetition at the height of the equator using calculated parameters from the first pass for enhanced accuracy 1 = yes 2 = no (default)

NOTICE

If circular approach of the pre-position was selected in @P64, collision detection is disabled. This option may only be enabled if safe approach to the pre-position is ensured.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.9.13.3 Syntax

L CYCLE [NAME = SysMeasWcs40.ecy @P.. = ..]

3.9.13.4 Programming example

Measuring a sphere

```
; touch probe activation
T1 D1
M6
; deactivation of the zero offset
G53

; positioning to the starting point
G00 X100 Y300 Z200
```

```
G00 Z10

#VAR
  ;input parameters
  V.L.MeasDistZ         = 100
  V.L.ZeroOffsetNumber = 56
  V.L.SafetyDistance   = 100
  V.L.StartAngle       = 90
  V.L.IncrementalAngle = 45
  V.L.CrossOver        = 100
  V.L.PathDefinition   = 1
  V.L.SphereDiameter   = 400

  ;output variables
  V.CYC.SysRetX
  V.CYC.SysRetY
  V.CYC.SysRetZ
  V.CYC.SysRetDiameter
#ENDVAR

;cycle call
L CYCLE [NAME="SysMeasWcs40.ecy"  @P6  = V.L.MeasDistZ         \
                                  @P7  = V.L.ZeroOffsetNumber  \
                                  @P13 = V.L.SafetyDistance    \
                                  @P14 = V.L.StartAngle        \
                                  @P15 = V.L.IncrementalAngle  \
                                  @P33 = V.L.CrossOver         \
                                  @P64 = V.L.PathDefinition    \
                                  @P87 = V.L.SphereDiameter    ]

; print result
#FILE NAME [MSG="SysMeasWcsResult.txt"]
#MSG SAVE ["V.CYC.SysRetX        =%f", V.CYC.SysRetX       ]
#MSG SAVE ["V.CYC.SysRetY        =%f", V.CYC.SysRetY       ]
#MSG SAVE ["V.CYC.SysRetZ        =%f", V.CYC.SysRetZ       ]
#MSG SAVE ["V.CYC.SysRetDiameter =%f", V.CYC.SysRetDiameter]

M30
```

Another example for handling SysMeasWcs cycles is contained in the Overview section [▸ 78] in the subsection Programming.

3.9.13.5 Output variables

Variable	Value
V.CYC.SysRetX	Calculated X value of sphere centre point with offset added (@P9)
V.CYC.SysRetY	Calculated Y value of sphere centre point with offset added (@P10)
V.CYC.SysRetZ	Calculated Z value of sphere centre point with offset added (@P11)
V.CYC.SysRetDiameter	Calculated sphere diameter

For information on the use of output variables, see Handling output variables [▸ 14]

3.10 Measuring a tool

3.10.1 Overview

These instructions describe the automatic measurement of tools using a tool touch probe.

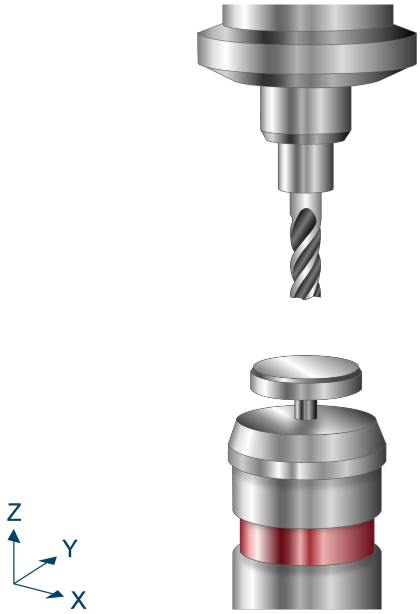

Fig. 57: Measuring a tool

Possible applications

The cycle can also automatically measure the length and/or radius of tools.

Prerequisites

To ensure that the successful measurement of the tool, the following requirements must be met:

1. Tool touch probe is fitted and active
2. The tool touch probe was already calibrated [▸ 36]
3. The required measurement and pre-positioning velocities and the touch probe parameters were entered in the configuration file [▸ 204].

3.10.2 Description

3.10.2.1 Configuration file

The SysCalibConfigToolSettingProbe.nc file is executed within the cycle and helps to parameterise the tool touch probe.

The following variables must be defined to measure a tool. For the value MESS_POS, the number transferred to the cycle by @P20 must be entered.

Variables	Description
V.CYC.SysConf_Meas_feed[MESS_POS]	Measuring feed
V.CYC.SysConf_Meas_feed_max[MESS_POS]	Positioning feed
V.CYC.SysConf_Pos_Ax1[MESS_POS]	Centre of touch probe in the X axis
V.CYC.SysConf_Pos_Ax2[MESS_POS]	Centre of touch probe in the Y axis

V.CYC.SysConf_Pos_Ax3[MESS_POS]	Surface position of touch probe in the Z axis
V.CYC.SysConf_Plate_Diam[MESS_POS]	Diameter of touch probe plate.

For example, the configuration file SysCalibConfigToolSettingProbe.nc may look like this:

Configuration file

```
V.CYC.SysConf_Meas_feed[1]      = 500    (measuring feed rate)
V.CYC.SysConf_Meas_feed_max[1] = 1000   (positioning feed rate)
V.CYC.SysConf_Pos_Ax1[1]        = 10     (probe position in X)
V.CYC.SysConf_Pos_Ax2[1]        = 20     (probe position in Y)
V.CYC.SysConf_Pos_Ax3[1]        = 30     (probe position in Z)
V.CYC.SysConf_Plate_Diam[1]     = 30     (estimated plate diameter)
M17
```

3.10.2.2 Pre- and post-files

For this cycle there is a pre-file which must be called before this cycle and a post-file which is called after this cycle. These files are optional. If they do not exist, this step is skipped. As required, these files must therefore be created as a subroutine. Machine-specific adaptations, e.g. activation of the touch probe, can be carried out in the pre-file. The post-file can be used to process output variables, for example.

Pre- and post-files must have the following names:

- SysMeasToolPre
- SysMeasToolPost

3.10.2.3 Process (internal cycle)

Before cycle start, the tool must be positioned centrally above the tool touch probe.

After cycle start, the following process then results when default parameters are used:

1. In measuring mode 1 or 3, measurement takes place in the Z direction and the probe is then lifted to the starting position.
2. In measuring mode 2 or 3, the tool is positioned in X+ direction next to the measuring plate and measurement takes place in the direction of the plate centre.
3. Optionally, this process is repeated in different directions.

3.10.2.4 Parameters

Required input parameters

Input parameters	Description
@P6	Measurement distance in the direction of the negative Z axis, only positive values permitted [mm, inch]
@P22	Measurement offset in Z for lateral measurements [mm, inch]

Optional input parameters

Input parameters	Description
@P13	Safety clearance for lateral measurements [mm, inch] Default value = 1/4 of measuring plate diameter.
@P14	Probe angle for first lateral measurement [degrees] Default value = 0

@P15	Incremental angle for lateral measurements [degrees] Default value = 360 / number of samples (@P23)
@P16	Measuring feedrate for a slow measurement If defined, the measurements are repeated at the specified feedrate.
@P17	Radial return clearance for the slow measurement [mm, inch] Default value = 1
@P18	Axial return clearance for the slow measurement [mm, inch] Default value = 1
@P20	Measuring station numbering (Required to read out the configuration from SysCalibToolSettingProbe.nc) Default value = 1
@P23	Number of lateral samples Default value = 1
@P25	Measuring mode 1 = Measure only tool length 2 = Measure only tool radius (tool must be known) 3 = Measure tool length tool radius (default value)

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.10.2.5 Syntax

L CYCLE [NAME = SysMeasTool.ecy @P.. = ..]

3.10.2.6 Programming example

Measuring a tool

To execute the programming example, save the configuration file SysCalibConfigToolSettingProbe.nc with the following contents:

```
V.CYC.SysConf_Meas_feed[1]     = 500
V.CYC.SysConf_Meas_feed_max[1] = 1000
V.CYC.SysConf_Pos_Ax1[1]       =  530.219
V.CYC.SysConf_Pos_Ax2[1]       = -210.234
V.CYC.SysConf_Pos_Ax3[1]       = -437.126
V.CYC.SysConf_Plate_Diam[1]    =   39.982
M17
```

Call the cycle using the following program after changing the reference tool and positioning it above the centre of the touch probe:

```
L CYCLE [NAME=SysMeasTool.ecy   \
        @P6  = 30               \
        @P22 = 10               \
        ]
M30
```

3.10.2.7 Output variables

Cycle parameters	Description
V.CYC.SysRetToolLength	Measured tool length.
V.CYC.SysRetToolRadius	Measured tool radius.

See information on use of the output variables [▶ 14].

3.11 Measuring a rotary axis

3.11.1 Overview

This cycle measures a rotary axis in the current coordinate system by scanning a calibration sphere. The result permits a check of the direction of the rotary axis and the angle travelled in the cycle. With stationary rotary axes, the position of the rotary axis can also be determined.

The cycle can measure both manual axes and NC-controlled axes.

Effectiveness

The examples below define conceivable application cases.

- Detecting incorrect positions of the rotary axis, for example after start-up
- Determining the position of a stationary rotary axis, for example a round table or a stationary rotary axis
- Checking the actually traversed angles of the rotary axis

Condition

To ensure that the successful measurement of the rotary axis, the following requirements must be met.

- Calibrated touch probe
- Mounted calibration sphere whose diameter significantly exceeds the touch probe tip
- During the measurement, the measured rotary axis may not be involved in a kinematic transformation (RTCP / complete transformation)
- During pre-positioning within the cycle, only linear axes and rotary axes involved in a complete kinematic transformation may be moved

3.11.2 Description

3.11.2.1 General

The SysCalibConfigTouchprobe.nc calibration file must be present and the corresponding parameters must be configured before the cycles are used, otherwise the cycles cannot run.

If no measuring signal is triggered during the measurement, the machine stops with the error message: "No workpiece detected, please check your measuring section“ P-ERR-13413. If a measurement is detected while positioning the measuring motion during the cycle, the machine stops with the error message: “Collision on positioning, please check your motion range” P-ERR-13414.

The measurement results are saved in V.CYC. variables and can be processed in the post-files. An overview of existing output variables is contained in each of the cycle subsections.

3.11.2.2 Pre- and post-files

For this cycle there is a pre-file which must be called before this cycle and a post-file which is called after this cycle. These files are optional. If they do not exist, this step is skipped. As required, these files must therefore be created as a subroutine. Generally, a post-file is required to process the output variables stored in local V.CYC. variables.

Machine-specific adaptations, e.g. activation of the touch probe, can be carried out in the pre-file. The post-file can be used to process output variables, for example.

Pre- and post-files must have the following names:

- SysMeasRotAxPre.nc

- SysMeasRotAxPost.nc

3.11.2.3 Configuration file

The following items are required to successfully configure the touch probe:

- the radius of the touch probe sphere, the offsets in X and Y and the length of the touch probe must be defined using the tool data.
- The configuration file SysCalibConfigTouchprobe.nc was created, containing at least the measuring and positioning feedrates.

Detailed description

The SysCalibConfigTouchprobe.nc file is executed before each cycle to identify the touch probe parameters. The following variables must then be defined.

Variables	Description
V.CYC.SysConf_Probes_feed	Measuring feedrate.
V.CYC.SysConf_Probes_feed_max	Positioning feedrate between measuring points.
V.CYC.SysConf_Spindle_orientation	Definition whether the touch probe is to be positioned in the measurement direction before every measurement run. 0 = touch probe is not positioned (default value). Touch probe must be in initial position before the start of the cycle. 1 = touch probe is positioned
V.CYC.SysConf_Probes_feed_repeat	Measuring feedrate for a second probing at a slow speed. If defined with a value > 0, the probe is retracted slightly after the first probing and the measurement is repeated. Default value = 0.
V.CYC.SysConf_Probes_dist_repeat	Retraction distance in the measuring direction for the second probing at a slow speed. Only used if V.CYC.SysConf_Probes_feed_repeat is greater than zero. Default value = 2.
V.CYC.SysConf_Spindle_angle	Definition of the basic angle specified to position the touch probe. Only used if V.CYC.SysConf_Spindle_orientation = 1. Corresponds to the spindle position (M19) required for measuring in the positive X direction. Default value = 0.
V.CYC.SysConf_Spindle_Pos_Dir	Position of the spindle final position when positioned with M19. Only used if V.CYC.SysConf_Spindle_orientation = 1. 0 = The spindle positions the touch probe clockwise when the touch probe tip is viewed from below (default value). 1 = The spindle positions the touch probe counter clockwise when the touch probe tip is viewed from below.
V.CYC.SysConf_Probes_spdl_feed	Spindle feedrate for spindle positioning of the touch probe. Default value = 200
V.CYC.SysConf_Probes_spdl_wait	Time in seconds to wait for the spindle to reposition before a corresponding measurement run. Default value = 1

Additional configuration data for the touch probe is read from the current tool data. The touch probe must therefore be defined as a current tool and its tool data must be saved (except for calibration).

The tool data to be considered includes:

- The radius of the touch probe sphere (V.G.WZ_AKT.R)
- The length of the touch probe (V.G.WZ_AKT.L)
- Horizontal offsets of the touch probe tip relative to the spindle flange (V.G.WZ_AKT.V.X and W.G.WZ_AKT.V.Y)

The measurement results are calculated to include the offsets between the touch probe tip and the spindle flange and the radius of the touch probe sphere.

For example, the configuration file SysCalibConfigTouchprobe.nc may look like this:

Configuration file

```
V.CYC.SysConf_Probes_feed          =  500      (measuring feed rate)
V.CYC.SysConf_Probes_feed_max      = 1000      (positioning feed rate)
V.CYC.SysConf_Spindle_orientation =    0      (positioning of probe)
V.CYC.SysConf_Spindle_angle        =    0      (probe basic angle)
M17
```

3.11.2.4 Process and pre-positioning

A calibration sphere is measured a total of three times to measure the rotary axis. Between each of these measurements, the angle of the measured axis must be changed and the calibration sphere re-approached.

Pre-positioning between calls is executed by the user.

During pre-positioning, only linear axes and rotary axes involved in a complete kinematic transformation may be moved. During the measurement, the measured rotary axis may not be involved in a kinematic transformation.

The orientation of the touch probe head in the current coordinate system may only be changed during pre-positioning by the axis to be measured.

Two cases are conceivable to use this cycle:

1. Measuring a stationary rotary axis: The position of the rotary axis in the current coordinate system is fixed or no upstream axis must be moved for pre-positioning (e.g. round table). In this case, the calibration sphere must be mounted so that the position of its centre point in the current coordinate system co-rotates with the rotation of the rotary axis. The position of the touch probe head can be moved for pre-positioning by linear axes or by rotary axes involved in a kinematic transformation.

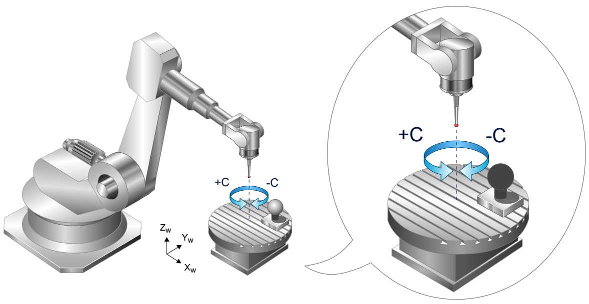

Fig. 58: Measuring a stationary rotary axis

1. Measuring a moved rotary axis: The position of the rotary axis is changed by upstream linear axes (e.g. 5-axis machine with swivel head). In this case, the calibration sphere must be mounted stationary in the current coordinate system. The touch probe head co-rotates with the measured rotary axis. The measured rotary axis may not be involved in any kinematic transformation so that a distinction can be made between the measured centre points of the calibration sphere.

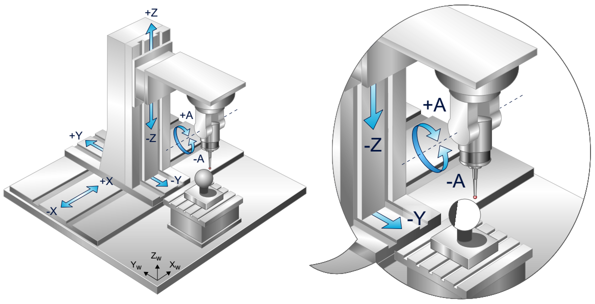

Fig. 59: Measuring a moved rotary axis

3.11.2.5 Mounting the calibration sphere

To measure a stationary rotary axis, the co-rotating calibration sphere must be positioned so that its position is as far as possible away from the centre of rotation. The angle about which the rotary axis rotates between each of the measurements should be selected so that the centre point of the calibration sphere lies far apart between measurements.

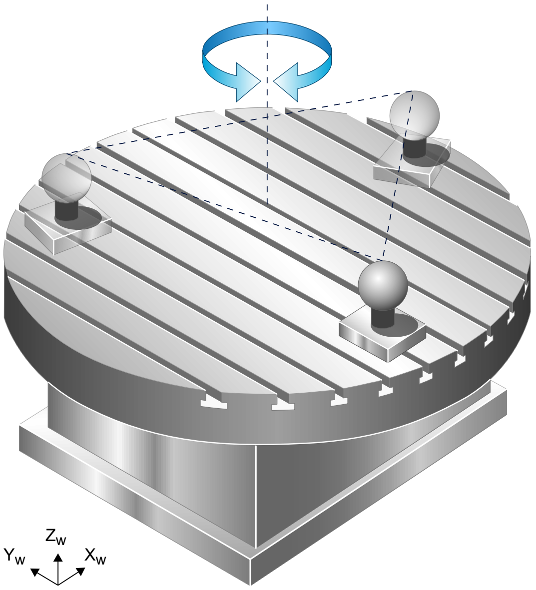

Fig. 60: Mounting the calibration sphere

With moved rotary axes, the angles between measurements should be as large as possible. In addition, the position of the touch probe head tip must change when the measured axis rotates. If this is not the case, an additional rotary axis can be swivelled in at the beginning. However, the additional rotary axis may not be repositioned during the entire cycle. This special case is treated in the programming example “Measuring with inclined touch probe head”.

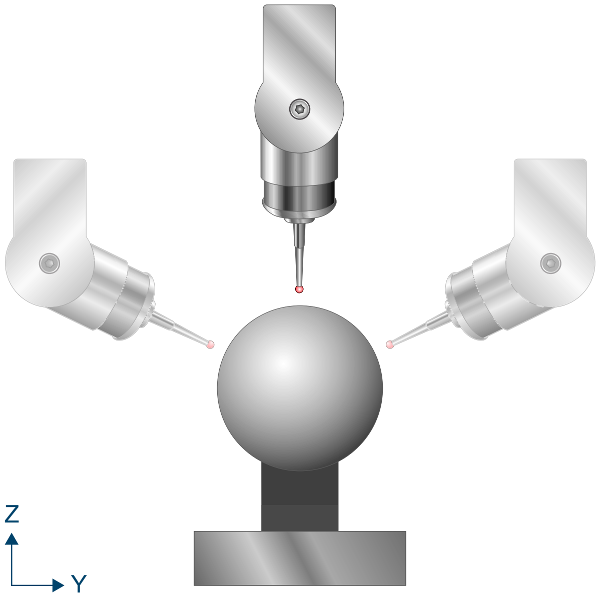

Fig. 61: Positions of the touch probe head tip

3.11.3 Process

The calibration sphere is measured a total of three times within the cycle. The measurement movements of the sphere measurement are oriented towards the measurement cycle for sphere measurement, whereby the measurement movements co-rotate with the measured axis.

Between measurements, the user initiates the approach of the starting position for the next measurement. The Pre-positioning section goes into greater detail on what the user must pay special attention to. The pre-position can be approached manually, in manual mode or also using an NC subroutine.

Before the start of the cycle, the touch head probe must be positioned vertically and as centrally as possible above the calibration sphere. If the touch probe head cannot be positioned vertically before the first measurement, an additional adaptation must be made in the input parameters (for more details, see the section Compensation for an inclined position).

> The measurement movements are co-rotated with the measured axis. In order to obtain a reliable estimate of the resulting measurement movement in advance, it is recommended to rotate the measured axis only by a small angle in a first pass. Of course, another possible alternative is run a preliminary simulation of the cycle.

The process can be described as follows:

Starting position before the cycle is called: The touch probe must be positioned either manually or in automatic mode as centrally as possible and at a short distance above the first sphere. It stands vertically, i.e. the touch probe rotation stands at 0. If this is not possible, a compensation must be executed using input parameters.

After the cycle is called:

1. The touch probe first runs a measurement vertically to its orientation and a total of four lateral measurements, after which it returns to the starting position.
2. The calibration sphere or the touch probe is pre-positioned again. Depending on the input parameters, this is done manually, in manual mode or with NC subroutines. The measured rotary axis must be rotated by the largest possible angle and the touch probe must be repositioned.
3. Repeated measurement of the sphere.
4. The calibration sphere or the touch probe is pre-positioned again.
5. Repeated measurement of the sphere
6. The touch probe travels to the starting point of the third measurement.

The general cycle process with subroutine calls takes place as follows.

```
SysMeasRotAxPre.nc       (optional)
SysCalibConfigTouchprobe.nc
SysMeasRotAxPrePos2.nc   (optional)
SysMeasRotAxPrePos3.nc   (optional)
SysMeasRotAxPost.nc      (optional)
```

3.11.4 Pre-positioning

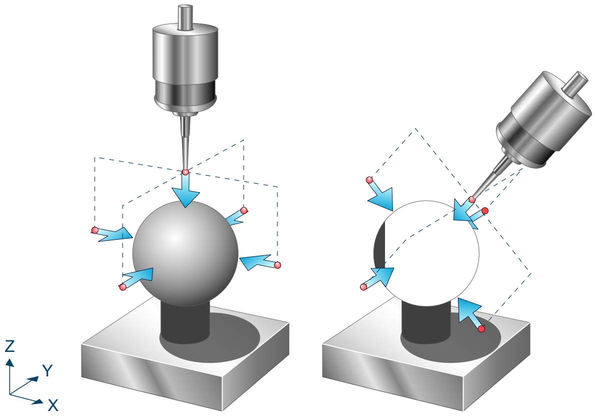

Fig. 62: Pre-positioning example

NOTICE

A collision-free measurement movement must be ensured for all three measurements. Please note here that the measurement movements co-rotate with the measured axis. This also applies to the probe angle and incremental angle.

Pre-position of the first measurement / cycle starting point

The pre-position of the first measurement is obtained from the cycle starting point. The touch probe must be positioned as centrally and vertically as possible above the calibration sphere. If the touch probe head cannot be positioned vertically at the start, an additional adaptation is required in the input parameters (for more details, see the Section Compensation for an inclined position).

Pre-positioning the second and third measurements

To pre-position the second and third measurements, the user must move measured rotary axis through any angle but which is as large as possible. Then the starting position for the next measurement must be selected so that the touch probe head is flush with the sphere centre point, i.e. points to the centre point of the calibration sphere.

During pre-positioning, only linear axes and rotary axes involved in a complete kinematic transformation may be moved. During the measurement, the measured rotary axis may not be involved in a kinematic transformation. The orientation of the touch probe head in the current coordinate system may only be changed during pre-positioning by the axis to be measured.

The measurement movement is co-rotated with the measured axis. The following rotation of the sphere measurement movement is obtained when the measured axis rotates, for example, about the Y axis in the current coordinate system and was turned through 35 degrees.

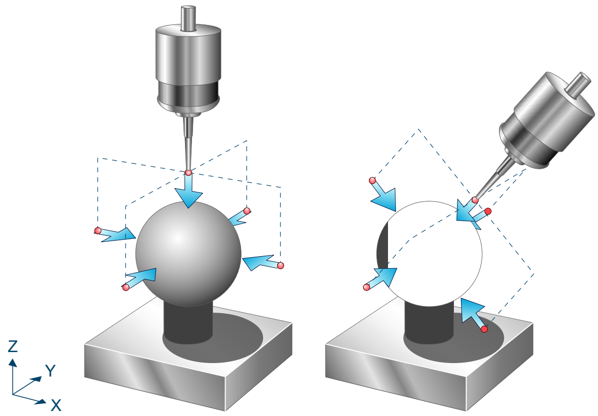

Fig. 63: Pre-positioning with rotation about the Y axis

Co-rotation of measurement movements also applied to the probe angle. If the measured axis rotates about the Y axis and it was turned through 90° for pre-positioning, this rotation would place the X axis on the Z axis in a right-hand coordinate system In this case, the probe angle refers to the Z axis of the original coordinate system.

The rotation vector of the measured axis must be defined by the input parameters to adapt the measurement movement automatically. Minor deviations are insignificant here since these values are only relevant to the measurement movements. However, they have no direct influence on the measurement result. With manual pre-positioning, the traversed angle must also be defined.

Pre-positioning the second and third measurements with NC subroutines

If pre-positioning of the second and third measurement are to take place automatically, suitable NC subroutines can be saved here to execute the corresponding movements. It is recommended to pre-position the cycle in manual mode for the first application. Movements travelled in manual mode and resulting in successful execution of the cycle can then be integrated in the NC subroutines. This permits a completely automated execution of the cycle.

The input parameter @P90 must be set to 0 for automated pre-positioning. In addition, the files SysMeasRotAxPrePos2.nc and SysMeasRotAxPrePos3.nc must be saved. The file SysMeasRotAxPrePos2.nc is called after the first sphere measurement and describes the pre-positioning for the second measurement. The file SysMeasRotAxPrePos3.nc is called after the second sphere measurement and describes the pre-positioning for the third measurement.

Refer to the section Programming examples for an example of how these NC subroutines can look like.

Compensating an inclined position of the touch probe head at the start of the cycle.

If the touch probe head cannot be positioned vertically for the first measurement due to the machine design, the inclined position can be compensated by the parameters @P94-@P97. The inclined position of the touch probe head is defined here by defining a rotary axis and a rotation angle. This permits compensation of the measurement movement to the inclined axis. This adaptation is only required for the first measurement pass.

The inclined position of the touch probe in the graphic below can be described by a rotation of 20° about the Y axis. In this case, the following parameter definition should be transferred in order to execute the cycle successfully.

```
@P94 = 0, @P95 = 1, @P96 = 0, @P97 = 20
```

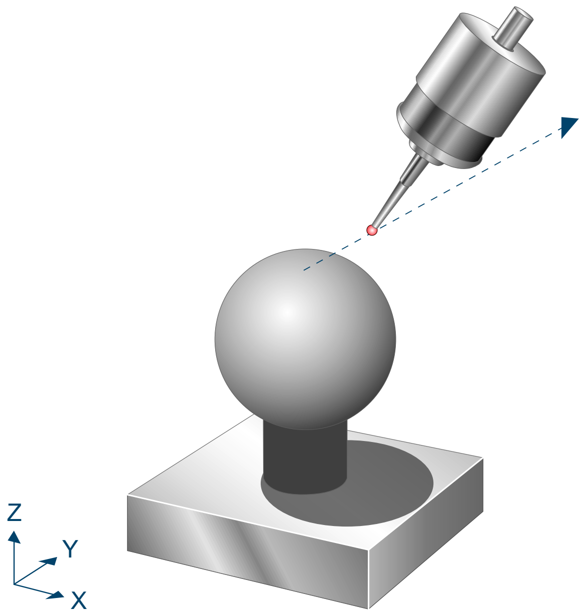

Fig. 64: Touch probe with inclined position

For pre-positioning, the touch probe head must still point to the centre point of the sphere.

The touch probe offsets in the X and Y directions determined by calibrating the touch probe are of no consequence here.

3.11.5 Parameters

The touch probe must be configured in addition to supplying the input parameters described here. For more information on this function, see the section Configuration file [▶ 81].

The (calibrated) parameters of the touch probe (radius, length and offset in X and Y directions) are specified via the tool parameters.

Required parameters

Cycle parameters	Description
@P6	Measurement path in the direction of the (co-rotated) negative Z axis, only positive values permitted
@P87	Estimated diameter of the calibration sphere. Here, an approximate parameter is sufficient. For calculating measurement movements.
@P89	Index of the measured rotary axis (-1 with manual axis).
@P91	Expected X value of measured rotary axis. Here, an approximate parameter is sufficient. For calculating measurement movements.
@P92	Expected Y value of measured rotary axis. Here, an approximate parameter is sufficient. For calculating measurement movements.
@P93	Expected Z value of measured rotary axis. Here, an approximate parameter is sufficient. For calculating measurement movements.

Optional parameters

Cycle parameters	Description
@P13	Safety clearance to sphere during measurement movement Default value = @P87/4

@P14	Probe angle for first sphere measurement [degrees]. Refers to the (co-rotated) X axis. Default value = 0
@P15	Probe angle difference between the co-rotated horizontal measurements for all measurements. [degrees] Default value = 90
@P17	Deactivate spindle movement 0 = Deactivate spindle movement 1 = Activate spindle movement (default value)
@P33	Crossover range during measurement process for all measurements Default value = @P87/4
@P64	Definition of the section for sphere measurement for all measurements. 0 = linear (default value) 1 = circular (Caution: collision detection disabled)
@P90	Pre-positioning mode between sphere measurements 0 = automatic by NC subroutines 1 = manual or in manual mode (default value)
@P94	X value of rotary axis to define the inclined position of the touch probe at cycle start. Default value = 0
@P95	Y value of rotary axis to define the inclined position of the touch probe head at cycle start. Default value = 0
@P96	Z value of rotary axis to define the inclined position of the touch probe head at cycle start. Default value = 0
@P97	Rotation angle to define the inclined position of the touch probe head at cycle start. [degrees] Default value = 0
@P98	Probe angle for second sphere measurement. Refers to the (co-rotated) X axis. [degrees] Default value = 0
@P99	Probe angle for third sphere measurement. Refers to the (co-rotated) X axis. [degrees] Default value = 0
@P100	Angle travelled between measurement 1 and 2 of the measured rotary axis with manual pre-positioning. Here, an approximate parameter is sufficient. For calculating measurement movements. [degrees] Default value = 0
@P101	Angle travelled between measurement 2 and 3 of the measured rotary axis with manual pre-positioning. Here, an approximate parameter is sufficient. For calculating measurement movements. [degrees] Default value = 0

NOTICE

Disabled collision detection when @P64 is active.

If circular approach of the pre-position was selected in @P64, collision detection is disabled. This option may only be enabled if safe approach to the pre-position is ensured.

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

3.11.6 Syntax

L CYCLE [NAME = SysMeasRotAx.ecy @P.. = ..]

3.11.7 Output variables

Variables	Description
V.CYC.SysRetRotAxDirectionX	X value of the measured rotary axis.
V.CYC.SysRetRotAxDirectionY	Y value of the measured rotary axis.
V.CYC.SysRetRotAxDirectionZ	Z value of the measured rotary axis.
V.CYC.SysRetAbsAngleM1ToM2	Amount of the measured rotation of the rotary axis between measurement 1 and 2. (in degrees)
V.CYC.SysRetAbsAngleM1ToM3	Amount of the measured rotation of the rotary axis between measurement 1 and 3. (in degrees)
V.CYC.SysRetRotAxOffsetX	X value of the circle centre point obtained from the three measured calibration sphere positions.
V.CYC.SysRetRotAxOffsetY	Y value of the circle centre point obtained from the three measured calibration sphere positions.
V.CYC.SysRetRotAxOffsetZ	Z value of the circle centre point obtained from the three measured calibration sphere positions.
V.CYC.SysRetAngleM1toX	Angle of the first sphere measurement to the X axis.
V.CYC.SysRetAngleM1toY	Angle of the first sphere measurement to the Y axis.
V.CYC.SysRetAngleM1toZ	Angle of the first sphere measurement to the Z axis.
V.CYC.SysRetAngleM2toX	Angle of the second sphere measurement to the X axis.
V.CYC.SysRetAngleM2toY	Angle of the second sphere measurement to the Y axis.
V.CYC.SysRetAngleM2toZ	Angle of the second sphere measurement to the Z axis.
V.CYC.SysRetAngleM3toX	Angle of the third sphere measurement to the X axis.
V.CYC.SysRetAngleM3toY	Angle of the third sphere measurement to the Y axis.
V.CYC.SysRetAngleM3toZ	Angle of the third sphere measurement to the Z axis.

See information on use of the output variables [▶ 14].

The variables V.CYC.SysRetRotAxDirectionX, V.CYC.SysRetRotAxDirectionY and V.CYC.SysRetRotAxDirectionZ define the measured rotary axis about which the rotary axis is turned.

The output variable V.CYC.SysRetAbsAngleM1toM2 describes the amount of the measured angle about which the rotary axis was turned between the first and second measurements. V.CYC.SysRetAbsAngleM1toM3 describes the amount of the angle between the first and the third measurements.

The variables V.CYC.SysRetRotAxOffsetX, V.CYC.SysRetRotAxOffsetY and V.CYC.SysRetRotAxOffsetZ describe the position of the circle centre point which is obtained from the three measured calibration sphere positions in the current coordinate system. This is of special interest when the cycle was executed with a stationary rotary axis. In this case, this point lies on the rotary axis and therefore defines the axis centre of rotation.

The zero position of the axis is checked with the output variables V.CYC.SysRetAngleM1toX to V.CYC.SysRetAngleM3toZ. To carry out the measurement of the rotary axis, a calibration sphere is scanned in a total of three different positions. For each measurement, the centre point of the calibration sphere is determined in the current coordinate system. A circle can then be calculated from these three centre point positions. The circle is defined by a circle centre point (V.CYC.SysRetRotAxOffsetX-

V.CYC.SysRetRotaxOffsetZ). The output variables V.CYC.SysRetAngleM1toX to V.CYC.SysRetAngleM3toZ supply the angles of the circle centre point vector in relation to each calibration sphere centre point compared to the X, Y or Z axis in each case. For example, if the first measurement was carried out at an axis angle of 0° and the axis should be parallel to the Z axis in zero position, V.CYC.SysRetAngleM1toZ then checks whether this also corresponds to the measurement.

3.11.8 Programming examples

The section below described a number of user scenarios with the related cycle calls.

3.11.8.1 Measuring a swivel axis

A swivel axis will be measured in the cycles. It is expected that the swivel axis rotates about the X axis. Since the swivel axis is moved by the upstream linear axes, it is not stationary. This means that the calibration sphere must be mounted fixed while the swivel axis is moved by the linear axes within the cycle. Since the calibration sphere is mounted fixed, it is not permitted to measure it with an active kinematic transformation as then it is impossible to distinguish the X, Y and Z coordinates of the individual centre point measurements.

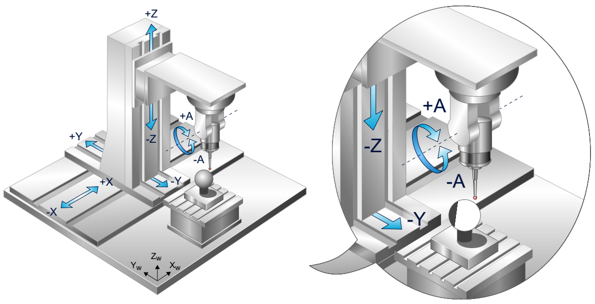

Fig. 65: Measuring a swivel axis

The following parameter settings are conceivable for the successful execution of the cycle.

- It is expected that the measured swivel axis rotates about the X axis: @P91=1, @P92=0, @P93=0
- Pre-positioning is to take place in manual mode: @P90=1
- The index of the measured rotary axis has the value 4: @P89=4
- The diameter of the calibration sphere is 50 mm: @P87=50
- The sphere should be measured with a safety clearance of 50 mm: @P13=50
- Measurement movements in Z direction should have a length of 30 mm. @P6=30
- To ensure the calibration sphere is touched in horizontal measurement movements, the crossover range is set to 10mm: @P33=10

This results in the following cycle call:

```
G90
G1 A0
G1 X90 Y-240 Z-10
L CYCLE [NAME=SysMeasRotAx.ecy  \
        @P6  = 30               \
        @P13 = 50               \
        @P33 = 10               \
        @P87 = 50               \
        @P89 = 4                \
        @P90 = 1                \
        @P91 = 1                \
        @P92 = 0                \
        @P93 = 0                \
        ]
M30
```

If pre-positioning is to be automated, parameter 90 must be set to zero. @P90=0. The saved pre-positioning subroutines could look like this:

```
; SysMeasRotAxPrePos2.nc:
G1 G91 Z50
G1 G90 A50
G1 G91 Y-140
G1 G91 Z-120
G90
M17


; SysMeasRotAxPrePos3.nc:
G1 G91 Z100
G1 G90 A-50
G1 G91 Y280
G1 G91 Z-100
G90
M17
```

3.11.8.2 Measuring a rotary axis with an active kinematic

This example shows the measurement of a round table by a 6-axis articulated robot.

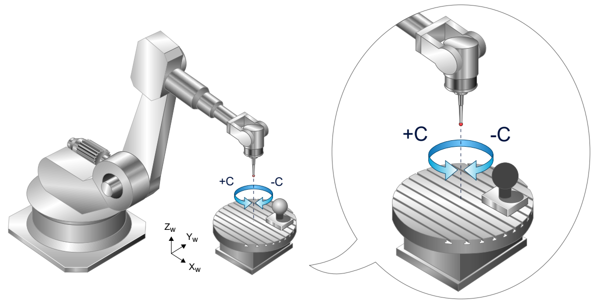

Fig. 66: Measuring a round table with a 6-axis articulated robot

When pre-positioning within the cycle, only linear axes and rotary axes involved in a complete kinematic transformation may be moved. Since the robot only has rotary axes, it must be integrated in a kinematic transformation.

During the measurement, the measured round axis may not be involved in a kinematic transformation.

The measured round table rotates fixed about the Z axis. Since the measured rotary axis is fixed, the calibration sphere must be mounted so that it co-rotates with the round table. In this case, select a position on the round table as far away as possible from the centre of rotation.

The following parameter settings are conceivable for the successful execution of the cycle.

- It is expected that the measured swivel axis rotates about the Z axis: @P91=0, @P92=0, @P93=1
- Pre-positioning is to take place in manual mode: @P90=1
- The index of the measured rotary axis has the value 6: @P89=6
- The diameter of the calibration sphere is 50 mm: @P87=50
- The sphere should be measured with a safety clearance of 30 mm: @P13=50
- Measurement movements in Z direction should have a length of 30 mm. @P6=30
- To ensure the calibration sphere is touched in horizontal measurement movements, the crossover range is set to 10mm: @P33=10

This results in the following cycle call:

```
#TRAFO ON
G90
G1 C0
G1 X1300 Y100 Z315
```

```
L CYCLE [NAME=SysMeasRotAx.ecy  \
        @P6  = 30               \
        @P13 = 50               \
        @P33 = 10               \
        @P87 = 50               \
        @P89 = 6                \
        @P90 = 1                \
        @P91 = 0                \
        @P92 = 0                \
        @P93 = 1                \
        ]
#TRAFO OFF
M30
```

Pre-positioning between measurements takes place in manual mode with an active kinematic transformation. It is important that the orientation of the touch probe is not changed. Only the X, Y and Z coordinates may be changed in the current programming coordinate system.

3.11.8.3 Measuring with an inclined touch probe head in the starting position

This example describes the measurement of the C axis of a 5-axis machine with inclined tough probe head.,

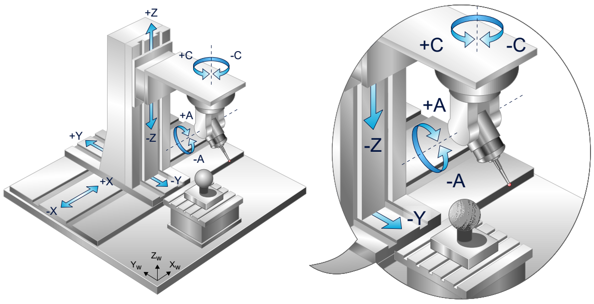

Fig. 67: Measuring with inclined touch probe head

If the touch probe head were vertical at the start (axis A=0), the touch probe head would not change its position in the current coordinate system when the C axis rotates. The X, Y and Z coordinates of the measured centre points of the calibration sphere would then lie above each other, and this would made the calculation impossible.

To permit a successful execution of the cycle, the A axis here can be swivelled in, in this example by 50°. However, this results in the situation that the touch probe head is already inclined at cycle start. In order to adapt the measurement movements, the corresponding parameters must be made in the parameters P94 to P96. The important thing is that the touch probe head points to the centre point of the calibration sphere at cycle start.

The following parameter settings are conceivable for the successful execution of the cycle.

- The touch probe head is inclined since in this example it was swivelled through 50° about the A axis which rotates about the X axis. Rotation about the X axis results in the following parameter settings: @P94=1, @P95=0, @P96=0
- The inclination was caused by an angle of 50°. @P97=50
- It is expected that the measured axis rotates about the Z axis: @P91=0, @P92=0, @P93=1
- Pre-positioning is to take place in manual mode: @P90=1
- The index of the measured rotary axis has the value 3: @P89=3
- The diameter of the calibration sphere is 50 mm: @P87=50
- The sphere should be measured with a safety clearance of 50 mm: @P13=50
- Measurement movements in Z direction should have a length of 30 mm. @P6=30
- To ensure the calibration sphere is touched in horizontal measurement movements, the crossover range is set to 10mm: @P33=10

This results in the following cycle call:

```
G90
G1 A50 C0
G1 X90 Y-340 Z-60
L CYCLE [NAME=SysMeasRotAx.ecy  \
        @P6  = 30               \
        @P13 = 50               \
        @P33 = 10               \
        @P87 = 50               \
        @P89 = 3                \
        @P90 = 1                \
        @P91 = 0                \
        @P92 = 0                \
        @P93 = 1                \
        @P94 = 1                \
        @P95 = 0                \
        @P96 = 0                \
        @P97 = 50               \
        ]
M30
```

4 Calculation cycles

4.1 Introduction

Cycles are additional options and subject to the purchase of a license.

Task

Calculation cycles are used to execute complex calculations that require the user to have a lot of technical knowledge and carry out extensive programming work.

The following calculation cycles are currently available:

- Calculation of the diameter and centre point of a 2-dimensional circle consisting of min. 3 sampling points
- Calculation of the diameter and centre point of a sphere consisting of min. 4 sampling points
- Calculation of a plane consisting of min. 3 sampling points
- Calculation of a circle in 3D space consisting of min. 3 sampling points
- Calculation of a straight line in 3D space consisting of min. 2 sampling points

The calculation cycles use the “method of least squares” to calculate the most probable result from a specific number of sampling points.

Programming and parameterisation

The programming and parameterisation of cycles is described in each of the overviews in the main chapter.

Handling output variables

If the V.CYC output variable is created in the main program (or in the subroutine calling the cycle), the value is written within the cycle and is available in the main program after the calculation.

The calculation cycles described below include programming examples that can be used to understand how to interpret the output variables.

4.2 Cycle for calculation of a circle in 2D

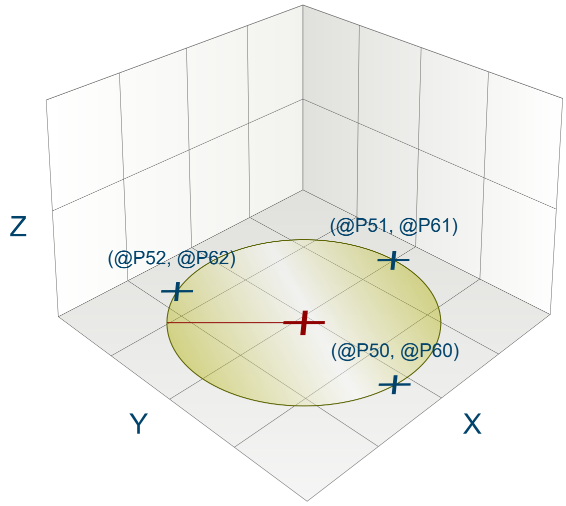

Fig. 68: Calculation of a circle in 2D

4.2.1 Process

When a circle is calculated in the XY plane, the radius and centre of the circle are determined from a specific number of points on the arc (min. 3, max. 10). The points may not be collinear, otherwise no calculation can be performed.

To obtain good calculation results, it is recommended to use points that are as distant from each other as possible.

4.2.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P50	X coordinate point 1
@P51	X coordinate point 2
@P52	X coordinate point 3
@P53 (optional)	X coordinate point 4
@P54 (optional)	X coordinate point 5
@P55 (optional)	X coordinate point 6
@P56 (optional)	X coordinate point 7
@P57 (optional)	X coordinate point 8
@P58 (optional)	X coordinate point 9
@P59 (optional)	X coordinate point 10
@P60	Y coordinate point 1
@P61	Y coordinate point 2
@P62	Y coordinate point 3
@P63 (optional)	Y coordinate point 4
@P64 (optional)	Y coordinate point 5
@P65 (optional)	Y coordinate point 6
@P66 (optional)	Y coordinate point 7
@P67 (optional)	Y coordinate point 8
@P68 (optional)	Y coordinate point 9

@P69 (optional)	Y coordinate point 10

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

4.2.3 Syntax

L CYCLE [NAME = SysCalcCircle.ecy @P.. = ..]

4.2.4 Output variables

Variable	Value
V.CYC.SysRetCenterX	Calculated centre of circle in X
V.CYC.SysRetCenterY	Calculated centre of circle in Y
V.CYC.SysRetRadius	Calculated radius of circle
V.CYC.SysRetVariance	Calculated variance of the distance of the transferred points from the calculated centre of the circle

See information on use of the output variables [▸ 222].

4.2.5 Programming example

Calculation cycle

```
; Definition of return variables
#VAR
  V.CYC.SysRetRadius
  V.CYC.SysRetCenterX
  V.CYC.SysRetCenterY
  V.CYC.SysRetVariance
#ENDVAR

; cycle call
L CYCLE [NAME=SysCalcCircle.ecy   \
@P50 = 0  @P60 = -1               \
@P51 = 0  @P61 =  1               \
@P52 = 1  @P62 = 0                \
@P53 = -1  @P63 = 0 ]

; print result
#FILE NAME [MSG="SysCalcCircleResult.txt"]
#MSG SAVE EXCLUSIVE["Center X = %f",V.CYC.SysRetCenterX]
#MSG SAVE EXCLUSIVE["Center Y = %f",V.CYC.SysRetCenterY]
#MSG SAVE EXCLUSIVE["Radius   = %f", V.CYC.SysRetRadius]
#MSG SAVE EXCLUSIVE["Variance = %f", V.CYC.SysRetVariance]

M30
```

4.3 Cycle for calculation of a plane

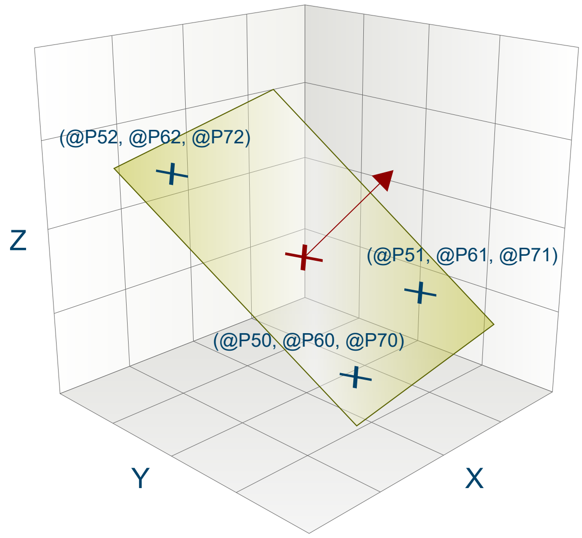

Fig. 69: Calculation of a plane

4.3.1 Process

When a plane is calculated in 3-dimensional space, the normal and support vectors of a plane are determined from a specific number of points (min. 3, max. 10). The points may not be collinear, otherwise no calculation can be performed.

To obtain good calculation results, it is recommended to use points that are as distant from each other as possible.

4.3.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P50	X coordinate point 1
@P51	X coordinate point 2
@P52	X coordinate point 3
@P53 (optional)	X coordinate point 4
@P54 (optional)	X coordinate point 5
@P55 (optional)	X coordinate point 6
@P56 (optional)	X coordinate point 7
@P57 (optional)	X coordinate point 8
@P58 (optional)	X coordinate point 9
@P59 (optional)	X coordinate point 10
@P60	Y coordinate point 1
@P61	Y coordinate point 2
@P62	Y coordinate point 3
@P63 (optional)	Y coordinate point 4
@P64 (optional)	Y coordinate point 5
@P65 (optional)	Y coordinate point 6
@P66 (optional)	Y coordinate point 7
@P67 (optional)	Y coordinate point 8

@P68 (optional)	Y coordinate point 9
@P69 (optional)	Y coordinate point 10
@P70	Z coordinate point 1
@P71	Z coordinate point 2
@P72	Z coordinate point 3
@P73 (optional)	Z coordinate point 4
@P74 (optional)	Z coordinate point 5
@P75 (optional)	Z coordinate point 6
@P76 (optional)	Z coordinate point 7
@P77 (optional)	Z coordinate point 8
@P78 (optional)	Z coordinate point 9
@P79 (optional)	Z coordinate point 10

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

4.3.3 Syntax

L CYCLE [NAME = SysCalcPlane.ecy @P.. = ..]

4.3.4 Output variables

Variable	Value
V.CYC.SysRetNormalX	Calculated normal vector in X
V.CYC.SysRetNormalY	Calculated normal vector in Y
V.CYC.SysRetNormalZ	Calculated normal vector in Z
V.CYC.SysRetSupVectorX	Calculated support vector of plane in X (corresponds to point on the plane)
V.CYC.SysRetSupVectorY	Calculated support vector of plane in Y corresponds to point on the plane)
V.CYC.SysRetSupVectorZ	Calculated support vector of plane in Z (corresponds to point on the plane)

See information on use of the output variables [▶ 222].

4.3.5 Programming example

Calculation cycle

```
; creation of return variables
#VAR
  V.CYC.SysRetNormalX
  V.CYC.SysRetNormalY
  V.CYC.SysRetNormalZ
  V.CYC.SysRetSupVectorX
  V.CYC.SysRetSupVectorY
  V.CYC.SysRetSupVectorZ
#ENDVAR

; calculation of the XY plane
L CYCLE [NAME=SysCalcPlane.ecy \
@P50 = 1  @P60 = 0  @P70 = 0   \
@P51 = 0  @P61 = 1  @P71 = 0   \
@P52 = 1  @P62 = 1  @P72 = 0   ]

; print result
#FILE NAME[MSG="SysCalcPlaneResult.txt"          ]
#MSG SAVE ["Normal X = %f", V.CYC.SysRetNormalX    ]
#MSG SAVE ["Normal Y = %f", V.CYC.SysRetNormalY    ]
#MSG SAVE ["Normal Z = %f", V.CYC.SysRetNormalZ    ]
#MSG SAVE ["Point X  = %f", V.CYC.SysRetSupVectorX ]
```

```
#MSG SAVE ["Point Y  = %f", V.CYC.SysRetSupVectorY ]
#MSG SAVE ["Point Z  = %f", V.CYC.SysRetSupVectorZ ]

M30
```

4.4 Cycle for calculation of a straight line in 3D

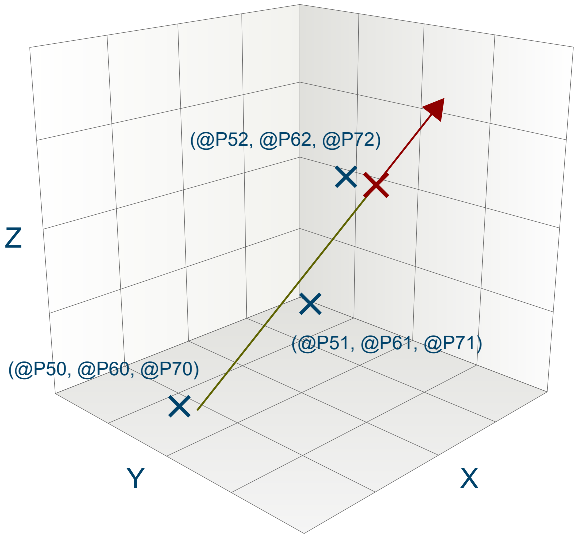

Fig. 70: Calculation of a straight line in 3D

4.4.1 Process

When a straight line is calculated in 3-dimensional space, the distances between the points as well as the direction and support vectors are determined from a specific number of points on the straight line (min. 2, max. 10). The points may not be identical, otherwise no calculation can be performed.

To obtain good calculation results, it is recommended to use points that are as distant from each other as possible.

4.4.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P50	X coordinate point 1
@P51	X coordinate point 2
@P52 (optional)	X coordinate point 3
@P53 (optional)	X coordinate point 4
@P54 (optional)	X coordinate point 5
@P55 (optional)	X coordinate point 6
@P56 (optional)	X coordinate point 7
@P57 (optional)	X coordinate point 8
@P58 (optional)	X coordinate point 9
@P59 (optional)	X coordinate point 10
@P60	Y coordinate point 1
@P61	Y coordinate point 2
@P62 (optional)	Y coordinate point 3

@P63 (optional)	Y coordinate point 4
@P64 (optional)	Y coordinate point 5
@P65 (optional)	Y coordinate point 6
@P66 (optional)	Y coordinate point 7
@P67 (optional)	Y coordinate point 8
@P68 (optional)	Y coordinate point 9
@P69 (optional)	Y coordinate point 10
@P70	Z coordinate point 1
@P71	Z coordinate point 2
@P72 (optional)	Z coordinate point 3
@P73 (optional)	Z coordinate point 4
@P74 (optional)	Z coordinate point 5
@P75 (optional)	Z coordinate point 6
@P76 (optional)	Z coordinate point 7
@P77 (optional)	Z coordinate point 8
@P78 (optional)	Z coordinate point 9
@P79 (optional)	Z coordinate point 10

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

4.4.3 Syntax

L CYCLE [NAME = SysCalcLine.ecy @P.. = ..]

4.4.4 Output variables

Variable	Value
V.CYC.SysRetDirVectorX	Calculated direction vector of straight line in X
V.CYC.SysRetDirVectorY	Calculated direction vector of straight line in Y
V.CYC.SysRetDirVectorZ	Calculated direction vector of straight line in Z
V.CYC.SysRetSupVectorX	Calculated support vector of straight line in X (corresponds to point on the straight line)
V.CYC.SysRetSupVectorY	Calculated support vector of straight line in Y (corresponds to point on the straight line)
V.CYC.SysRetSupVectorZ	Calculated support vector of straight line in Z (corresponds to point on the straight line)
V.CYC.SysRetVariance	Calculated variance of the distance of the points from the calculated straight line

See information on use of the output variables [▸ 222].

4.4.5 Programming example

Calculation cycle

```
; creation of return variables
#VAR
  V.CYC.SysRetDirVectorX
  V.CYC.SysRetDirVectorY
  V.CYC.SysRetDirVectorZ
  V.CYC.SysRetSupVectorX
```

```
  V.CYC.SysRetSupVectorY
  V.CYC.SysRetSupVectorZ
  V.CYC.SysRetVariance
#ENDVAR

; calc line of X-axis from points
L CYCLE [NAME=SysCalcLine.ecy  \
@P50 = 0 @P60 = 0 @P70 = 0     \
@P51 = 1 @P61 = 0 @P71 = 0     \
@P52 = 2 @P62 = 0 @P72 = 0     \
]

#FILE NAME[MSG="SysCalcLineResult.txt"                      ]
#MSG SAVE ["Direction X      = %f", V.CYC.SysRetDirVector[0]]
#MSG SAVE ["Direction Y      = %f", V.CYC.SysRetDirVector[1]]
#MSG SAVE ["Direction Z      = %f", V.CYC.SysRetDirVector[2]]
#MSG SAVE ["Point on Line X = %f", V.CYC.SysRetSupVector[0]]
#MSG SAVE ["Point on Line Y = %f", V.CYC.SysRetSupVector[1]]
#MSG SAVE ["Point on Line Z = %f", V.CYC.SysRetSupVector[2]]
#MSG SAVE ["Variance         = %f", V.CYC.SysRetVariance    ]

M30
```

4.5 Cycle for calculation of a sphere

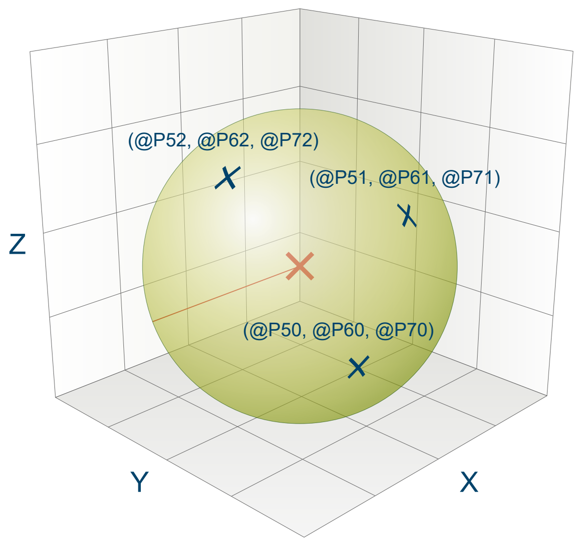

Fig. 71: Calculation of a sphere

4.5.1 Process

When a sphere is calculated in 3-dimensional space, the radius and centre of the sphere are determined from a specific number of points on the sphere's surface (min. 4, max. 10). The points may not be collinear or on the same plane, otherwise no calculation can be performed.

To obtain good calculation results, it is recommended to use points that are as distant from each other as possible.

4.5.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P50	X coordinate point 1
@P51	X coordinate point 2

@P52	X coordinate point 3
@P53	X coordinate point 4
@P54 (optional)	X coordinate point 5
@P55 (optional)	X coordinate point 6
@P56 (optional)	X coordinate point 7
@P57 (optional)	X coordinate point 8
@P58 (optional)	X coordinate point 9
@P59 (optional)	X coordinate point 10
@P60	Y coordinate point 1
@P61	Y coordinate point 2
@P62	Y coordinate point 3
@P63	Y coordinate point 4
@P64 (optional)	Y coordinate point 5
@P65 (optional)	Y coordinate point 6
@P66 (optional)	Y coordinate point 7
@P67 (optional)	Y coordinate point 8
@P68 (optional)	Y coordinate point 9
@P69 (optional)	Y coordinate point 10
@P70	Z coordinate point 1
@P71	Z coordinate point 2
@P72	Z coordinate point 3
@P73	Z coordinate point 4
@P74 (optional)	Z coordinate point 5
@P75 (optional)	Z coordinate point 6
@P76 (optional)	Z coordinate point 7
@P77 (optional)	Z coordinate point 8
@P78 (optional)	Z coordinate point 9
@P79 (optional)	Z coordinate point 10

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

4.5.3 Syntax

L CYCLE [NAME = SysCalcSphere.ecy @P.. = ..]

4.5.4 Output variables

Variable	Value
V.CYC.SysRetCenterX	Calculated centre of sphere in X
V.CYC.SysRetCenterY	Calculated centre of sphere in Y
V.CYC.SysRetCenterZ	Calculated centre of sphere in Z
V.CYC.SysRetRadius	Calculated radius of sphere
V.CYC.SysRetVariance	Calculated variance of the distance of the transferred points from the calculated sphere

See information on use of the output variables [▶ 222].

4.5.5 Programming example

Calculation cycle

```
; creation of return variables
#VAR
  V.CYC.SysRetCenterX
  V.CYC.SysRetCenterY
  V.CYC.SysRetCenterZ
  V.CYC.SysRetRadius
  V.CYC.SysRetVariance
#ENDVAR

; calculation of the unit sphere
L CYCLE [NAME=SysCalcSphere.ecy   \
@P50 =  1 @P60 =  0  @P70 = 0     \
@P51 = -1 @P61 =  0  @P71 = 0     \
@P52 =  0 @P62 =  1  @P72 = 0     \
@P53 =  0 @P63 = -1  @P73 = 0     \
@P54 =  0 @P64 =  0  @P74 = 1     \
]

; print result
#FILE NAME[MSG="SysCalcSphereResult.txt"]
#MSG SAVE EXCLUSIVE["Center X = %f", V.CYC.SysRetCenterX ]
#MSG SAVE EXCLUSIVE["Center Y = %f", V.CYC.SysRetCenterY ]
#MSG SAVE EXCLUSIVE["Center Z = %f", V.CYC.SysRetCenterZ ]
#MSG SAVE EXCLUSIVE["Radius   = %f", V.CYC.SysRetRadius  ]
#MSG SAVE EXCLUSIVE["Variance = %f", V.CYC.SysRetVariance]

M30
```

4.6 Cycle for calculation of a circle in 3D

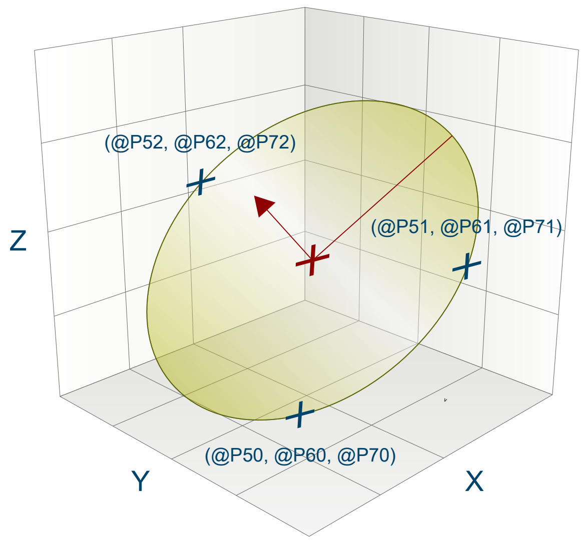

Fig. 72: Calculation of a circle in 3D

4.6.1 Process

When a circle is calculated in 3-dimensional space, the radius, distance from origin and normal vector of the circle are determined from a specific number of points on the arc (min. 3, max. 10). The points may not be collinear, otherwise no calculation can be performed.

To obtain good calculation results, it is recommended to use points that are as distant from each other as possible.

4.6.2 Parameters

The following parameters are required to call the cycle:

Cycle parameters	Description
@P50	X coordinate point 1
@P51	X coordinate point 2
@P52	X coordinate point 3
@P53 (optional)	X coordinate point 4
@P54 (optional)	X coordinate point 5
@P55 (optional)	X coordinate point 6
@P56 (optional)	X coordinate point 7
@P57 (optional)	X coordinate point 8
@P58 (optional)	X coordinate point 9
@P59 (optional)	X coordinate point 10
@P60	Y coordinate point 1
@P61	Y coordinate point 2
@P62	Y coordinate point 3
@P63 (optional)	Y coordinate point 4
@P64 (optional)	Y coordinate point 5
@P65 (optional)	Y coordinate point 6
@P66 (optional)	Y coordinate point 7
@P67 (optional)	Y coordinate point 8
@P68 (optional)	Y coordinate point 9
@P69 (optional)	Y coordinate point 10
@P70	Z coordinate point 1
@P71	Z coordinate point 2
@P72	Z coordinate point 3
@P73 (optional)	Z coordinate point 4
@P74 (optional)	Z coordinate point 5
@P75 (optional)	Z coordinate point 6
@P76 (optional)	Z coordinate point 7
@P77 (optional)	Z coordinate point 8
@P78 (optional)	Z coordinate point 9
@P79 (optional)	Z coordinate point 10

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

4.6.3 Syntax

L CYCLE [NAME = SysCalcPlaneCircle.ecy @P.. = ..]

4.6.4 Output variables

Variable	Value
V.CYC.SysRetCenterX	Calculated centre of circle in X
V.CYC.SysRetCenterY	Calculated centre of circle in Y
V.CYC.SysRetCenterZ	Calculated centre of circle in Z
V.CYC.SysRetRadius	Calculated radius of circle

V.CYC.SysRetNormalX	Calculated normal vector in X
V.CYC.SysRetNormalY	Calculated normal vector in Y
V.CYC.SysRetNormalZ	Calculated normal vector in Z
V.CYC.SysRetRadVariance	Calculated variance of points to radius

See information on use of the output variables [▶ 222].

4.6.5 Programming example

Calculation cycle

```
; creation of return variables
#VAR
  V.CYC.SysRetCenterX
  V.CYC.SysRetCenterY
  V.CYC.SysRetCenterZ
  V.CYC.SysRetNormalX
  V.CYC.SysRetNormalY
  V.CYC.SysRetNormalZ
  V.CYC.SysRetRadius
  V.CYC.SysRetRadVariance
#ENDVAR

; calculation of unit circle in the XY-plane with Z=1
L CYCLE [NAME=SysCalcPlaneCircle.ecy  \
@P50 =  1  @P60 =  0  @P70 = 1        \
@P51 =  0  @P61 =  1  @P71 = 1        \
@P52 = -1  @P62 =  0  @P72 = 1        \
@P53 =  0  @P63 = -1  @P73 = 1        ]

; print result
#FILE NAME[MSG="SysCalcPlaneCircleResult.txt"        ]
#MSG SAVE ["Radius   = %f", V.CYC.SysRetRadius       ]
#MSG SAVE ["Center X = %f", V.CYC.SysRetCenterX      ]
#MSG SAVE ["Center Y = %f", V.CYC.SysRetCenterY      ]
#MSG SAVE ["Center Z = %f", V.CYC.SysRetCenterZ      ]
#MSG SAVE ["Normal X = %f", V.CYC.SysRetNormalX      ]
#MSG SAVE ["Normal Y = %f", V.CYC.SysRetNormalY      ]
#MSG SAVE ["Normal Z = %f", V.CYC.SysRetNormalZ      ]
#MSG SAVE ["Variance = %f", V.CYC.SysRetRadVariance  ]

M30
```

5 High Speed Settings

5.1 Introduction

In general, the machine response can be optimised by means of channel parameters using the High Speed Settings cycle. This allows you to influence the surface quality, speed and accuracy for a specific machine.

Cycles are additional options and subject to the purchase of a license.

Task

The High Speed Setting cycles optimise the machining response of a specific machine by specifying tolerances for

- roughing
- prefinishing
- finishing

. The user can use the cycle to select the required machining state to influence machine response.

Licensing note

Please note that cycles are additional options and subject to the purchase of a license.

5.2 SysHscSettings cycle - High Speed Cutting settings

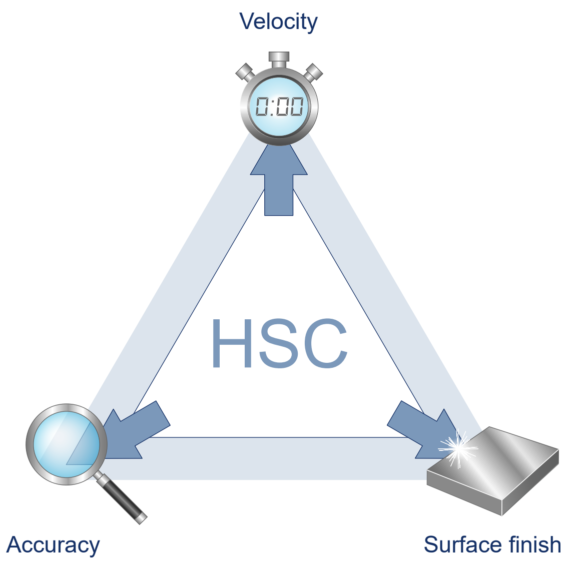

Fig. 73: Operation mode of HSC settings

5.2.1 Process

The SysHscSettings cycle can optimise machine response. NC programs can be specified in the channel-specific lists. They are called depending on the specified mode.

The parameters for this are:

- hscs.deselect.prog

- hscs.deselect.tolerance
- hscs.rough.prog
- hscs.rough.tolerance
- hscs.prefinish.prog
- hscs.prefinish.tolerance
- hscs.finish.prog
- hscs.finish.tolerance

The values for the tolerance data lists are converted internally into mm or inch.

These tolerances can be read in the NC program by the following variables:

```
V.G.HSCS.DESELECT.TOLERANCE
V.G.HSCS.ROUGH.TOLERANCE
V.G.HSCS.PREFINISH.TOLERANCE
V.G.HSCS.FINISH.TOLERANCE
```

5.2.2 Parameterisation

The following input parameters are required to call the cycle:

Input parameters	Description
@P1	Mode default value = 1 1 = Deselect 2 = Rough (roughing) 3 = Medium (prefinishing) 4 = Fine (finishing)

It is recommended using the Syntax check.to verify whether the input parameters have been correctly assigned.

5.2.3 Syntax

L CYCLE [NAME = SysHscSettings.ecy @P.. = ..]

5.2.4 Programming example

General programming example

Mill circular pocket

Mode 4 is called in this example. This mode corresponds to the finishing configuration. As a consequence, the subroutine manufacturerHscFinishSettings.nc specified in the parameter hscs.finish.prg is called. In addition, this makes available the machining tolerance of 0.01 mm in the variable V.G.HSCS.FINISH.TOLERANCE and it is used in the subroutine as an example for the `#HSC` command.

```
; HSC Settings
T9 D9                                    ( Tool data )
M6                                       ( Tool change )
G00 G17 G90 F2000 M03 S6000              ( Technology data )
G00 Z150                                 ( Go to z start position )
G00 X0 Y0                                ( position over the workpiece )

; Finishing Mode
L CYCLE [NAME=SysHscSettings.ecy    \
        @P1 = 4                     \
```

```
        ]


; 3D Milling
;...
;...

M30
```

Programming example for optimisation programs

The specified data are given as an example and cannot simply be adopted. This could cause damage to the machine.

```
% manufacturerHscDeselectSettings.nc
G133 = 100
G134 = 100
#HSC OFF
#FILTER OFF
M17


% manufacturerHscRoughSettings.nc
; example
; G133 = 180 ; example G133 = 180 set 180%
; G134 = 180
; #SLOPE[TYPE=HSC]
; #HSC ON[SURFACE PATH_DEV=V.G.HSCS.ROUGH.TOLERANCE \
                  TRACK_DEV=V.G.HSCS.ROUGH.TOLERANCE]
; #FILTER ON [AX_DEV=V.G.HSCS.ROUGH.TOLERANCE]
M17


% manufacturerHscPrefinishSettings.nc
; example
; G133 = 150 ; example G133 = 150 set 150%
; G134 = 150
; #SLOPE[TYPE=HSC]
; #HSC ON[SURFACE PATH_DEV=V.G.HSCS.PREFINISH.TOLERANCE \
                  TRACK_DEV=V.G.HSCS.PREFINISH.TOLERANCE]
; #FILTER ON [AX_DEV=V.G.HSCS.PREFINISH.TOLERANCE]
M17


% manufacturerHscFinishSettings.nc
; example
; G133 = 80 ; example G133 = 80 set 80%
; G134 = 80
; #SLOPE[TYPE=HSC]
; #HSC ON[SURFACE PATH_DEV=V.G.HSCS.FINISH.TOLERANCE \
           TRACK_DEV=V.G.HSCS.FINISH.TOLERANCE]
; #FILTER ON [AX_DEV=V.G.HSCS.FINISH.TOLERANCE]
M17
```

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