



Spindle Probe Operation & Cycles



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1 General Information about the Cycles

Reoccurring workpiece measurements can be carried out with this software. The following table contains the most important data of this software.

Number of Programs	8
Programs	O8700(MAIN) O8701(XYZ TOUCH) O8702(XY CONTOUR) O8703(PROTECTED MOVE) O8704(MEASURE) O8705(SET WCS) O8706(SET TOOL) O8707(ANGLE DISTANCE)
Memory Requirement	10 KB
Possible Measuring Tasks	Single point touching Corner in two axes Corner in three axes Inside width Outside width Inside diameter Outside diameter Angle measurement Distance measurement
Possible Evaluations	Zero measurement Tolerance check Correction of tool data

The two programs "MAIN" and "PROTECTED MOVE" are the only programs which are directly called by the operator. With „MAIN“ all measuring tasks as well as the evaluation of the results are carried out. The type of measuring task is defined by the call parameters only. With the program „PROTECTED MOVE“ the probe can be displaced safely in the work envelope, i.e. if the stylus is deflected during displacement the machine will stop and the probe moves back into its start position. Therefore collision and damages of the probe can be avoided. The six additional programs are auxiliary programs for internal use of the software.

Before the first measurement is carried out, the following preparations must be made:

- Mechanical preparation of the probe, installation of IR-receiver and electric connection.
- Installation and adaptation of the software
(pls. refer to chapter „Installation of the Software“)
- Calibration of the probe (pls. refer to chapter „Calibration“)

2 Calibration

2.1 Why?

During the measurement cycle the probe stylus is moved towards the workpiece. If the stylus is deflected by the workpiece the machine stops the movement and the actual position of the spindle is stored in the control using special variables. This stored spindle position, however, doesn't match the position of the workpiece edge. This depends on the following three reasons:

- Control delay
- radius of the stylus ball
- eccentricity of the stylus ball

When calibrating, values are measured and stored which include the delay of the control as well as the radius of the probe ball. These calibration values correspond with the theoretic radii of the probe ball. In addition, the eccentricity of the probe ball is determined and stored in two additional values. During later measurement these values are used to get an exact measuring result. Altogether the following five calibration values are determined and stored:

- calibration value X-axis
- calibration value Y-axis
- eccentricity X-axis
- eccentricity Y-axis
- calibration value Z-axis

2.2 When?

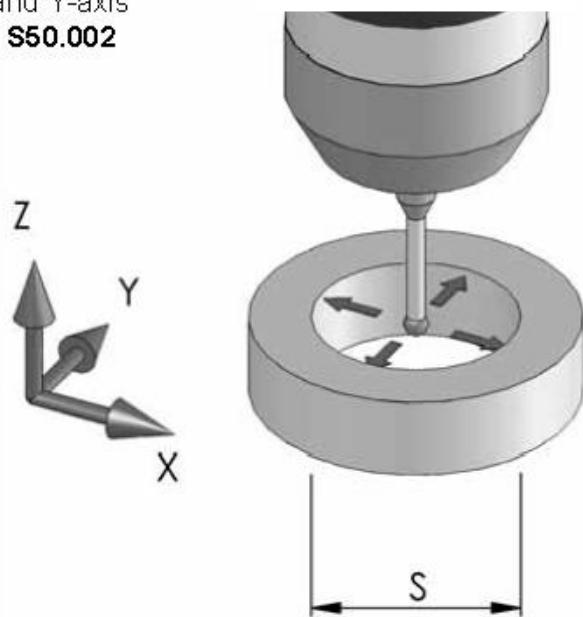
The probe must be calibrated when

- ...this software is commissioned
- ...the parameters in the program „MAIN“ are changed (pls. refer to chapter „Installation of the Software“)
- ...the concentricity of the stylus is re-adjusted
- ...very precise measurements are taken.

2.3 How?

For calibration of the probe a calibration ring with exactly defined inside diameter is required as well as a surface in XY level, which must be known exactly in its Z-position. The calibration itself is carried out with the program „MAIN“. The calibration of the probe in the axes X and Y will be carried out separately from the calibration in the Z-axis.

Example:
Calibration X- and Y-axis
G65 P8700 C1 S50.002



2.4 Calibration in X- and Y-Axes

- Mounting of the calibration ring within the work envelope of the machine.
- Positioning of the probe stylus in the center (by eye) of the calibration ring.
- Program call: **G65 P8700 C1 S ...**

Parameters:

- C1 Calibration is carried out
- S μ -precise diameter of the calibration ring

Results:

Four calibration values of the axes X and Y are stored. The storage location of the calibration parameters is depending on parameter #135 in program „MAIN“.

- #[#135+0] Calibration value X-axis
- #[#135+1] Calibration value Y-axis
- #[#135+2] Eccentricity X-axis
- #[#135+3] Eccentricity Y-axis

2.5 Calibration in Z Axis

- Preparation of a calibration surface (i.e. the upper side of the calibration ring) in the machining area of the machine in XY-level.
- μ -precise definition of the Z-position of the calibration surface in the machine coordinate system (i.e. with gauge)
- Input of Z-position of the calibration surface into any WCS (Work Coordinate System).
- Positioning the probe stylus above the calibration surface. The distance to the stylus ball is irrelevant, however, it should not fall below 5mm.
- Activation of the WCS where the position of the calibration surface is stored:
G ...
- Program call:
G65 P8700 C1 Z ...

Parameter:

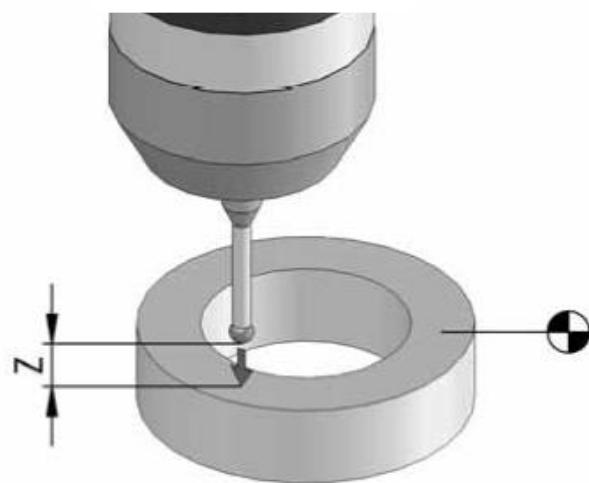
- C1 Calibration is carried out
- Z Distance of probe ball to calibration surface

Results:

The calibration value of the Z-axis is stored. The storage location is depending on parameter #135 in the program „MAIN“.

- #[#135+5] Calibration value Z-axis

Example:
Calibration Z-axis
G54
G65 P8700 C1 Z-10.



3 Workpiece Referencing

The chapter "Workpiece Referencing" describes the initial workpiece referencing on a new workpiece. Prepositioning of the probe is usually carried out by handwheel, however, it also can be carried out by manual data input. (Pls. refer to chapter „Protected Position Movement of the Probe“)

Each measurement will be called with the program „MAIN“. The parameter configuration only decides on the type of measuring point. The software available enables zero measurement on the following measuring points:

- single point
- corner in 2 axes
- corner in 3 axes
- inside width
- outside width
- inside diameter
- outside diameter

Drawings Symbols:



measuring block of the probe



displacement of the probe



workpiece



actual workpiece zero point



dimensioning line

3.1 Workpiece Referencing: Single Point

- Changing in and positioning of the probe in front of the surface which must be touched. The distance of the probe ball to the surface which must be measured should be sufficient for the machine to accelerate up to measuring speed.
- Program call X-axis: G65 P8700 X... W...
 Y-axis: G65 P8700 Y... W...
 Z-axis: G65 P8700 Z... W...

Parameters:

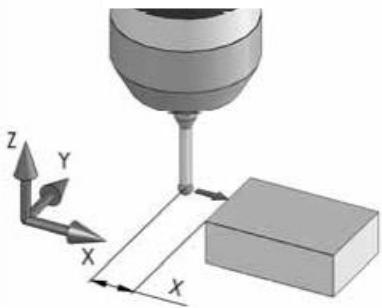
- X/Y/Z Touching axis and distance of probe ball to the workpiece.
- W Number of WCS which must be set.

Results:

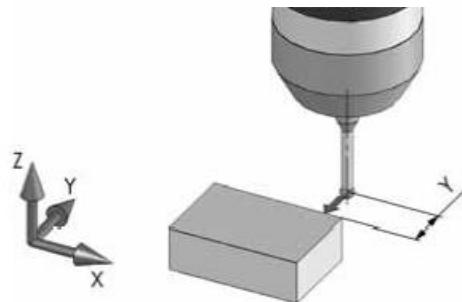
In the WCS which is defined with parameter W, a zero point is set in the corresponding axis.

Optional Parameters:

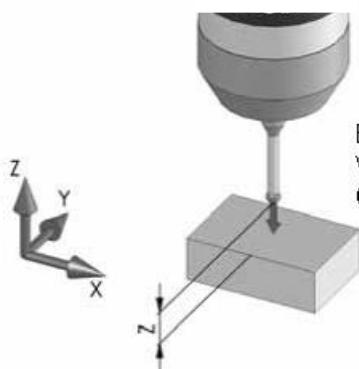
- I/J/K If the edge of the workpiece in the WCS should not be set to zero, it is possible to give a set position with the corresponding parameter.
(X-axis: I, Y-axis: J, Z-axis: K)



Example1:
Workpiece referencing single point X
G65 P8700 X10. W55



Example2:
Workpiece referencing single point Y
G65 P8700 Y-20. W57



Example3:
Workpiece referencing single point Z
G65 P8700 Z-15. W58

3.2 Workpiece Referencing: Corner in 2 Axes

- Changing in and positioning of the probe outside the corners which have to be touched. The prepositioning of the probe decides about the measuring points on the workpiece.
- Program call XY-corner: **G65 P8700 X... Y... W...**
 XZ-corner: **G65 P8700 X... Z... W...**
 YZ-corner: **G65 P8700 Y... Z... W...**

Parameters:

- X/Y/Z Touching axes (2 or 3 moving axes) and the distances of the probe ball to the workpiece in each axis.
- W Number of WCS which must be set.

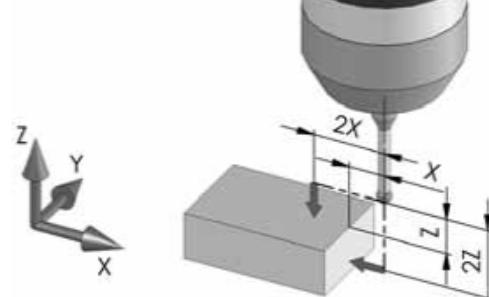
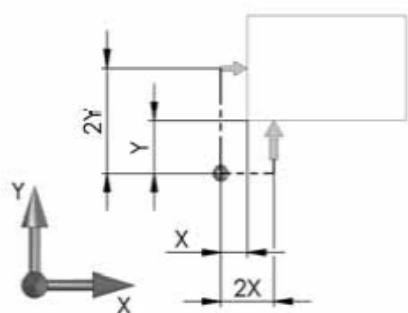
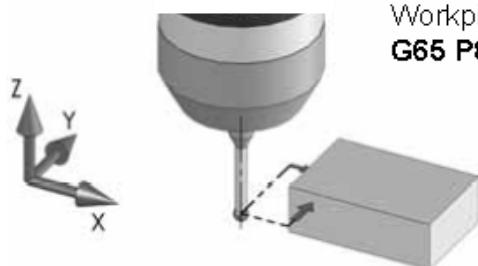
Results:

In the WCS defined with parameter W a zero point will be set in the corresponding axes.

Optional Parameters:

I/J/K If the corner of the workpiece in one or both axes in the WCS should not be set to zero, a set position can be handed over with the corresponding parameters.
(X-axis: I, Y-axis: J, Z-axis: K)

Example1:
Workpiece referencing XY-corner
G65 P8700 X10. Y20. W59



Example2:
Workpiece referencing XZ-corner
G65 P8700 X-15. Z-10. W58

3.3 Workpiece Referencing: Corner in 3 Axes

- Changing in and positioning of the probe outside the corners which have to be touched. The prepositioning of the probe decides about the measuring points on the workpiece.
- Program call: **G65 P8700 X... Y... Z... W...**

Parameters:

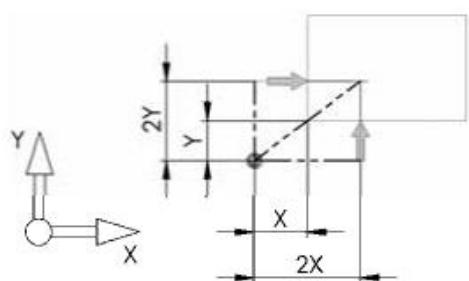
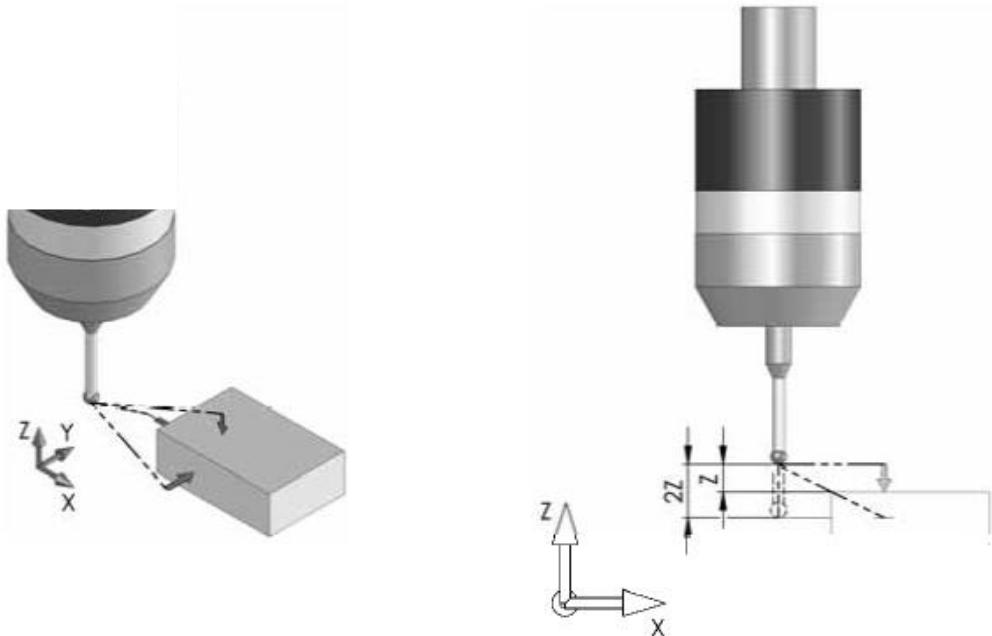
- X, Y, Z Touching axes (all 3 moving axes) and the distances of the probe ball to the workpiece in each axis.
- W Number of WCS which must be set.

Results:

In the WCS defined with parameter W a zero point will be set in the corresponding axes.

Optional Parameters:

- I/J/K If the corner of the workpiece in defined axes in the WCS must not be set to zero, a set position can transferred with the corresponding parameters.
(X-axis: I, Y-axis: J, Z-axis: K)



Example:
Workpiece referencing XYZ-corner
G65 P8700 X10. Y10. Z-10. W59

3.4 Workpiece Referencing: Inside Width (Key ways, grooves)

- Changing in and positioning of the probe in the center (by eye) of the inside width.
- Program call measuring direction X: **G65 P8700 S... X1 W...**
 measuring direction Y: **G65 P8700 S... Y1 W...**

Parameters:

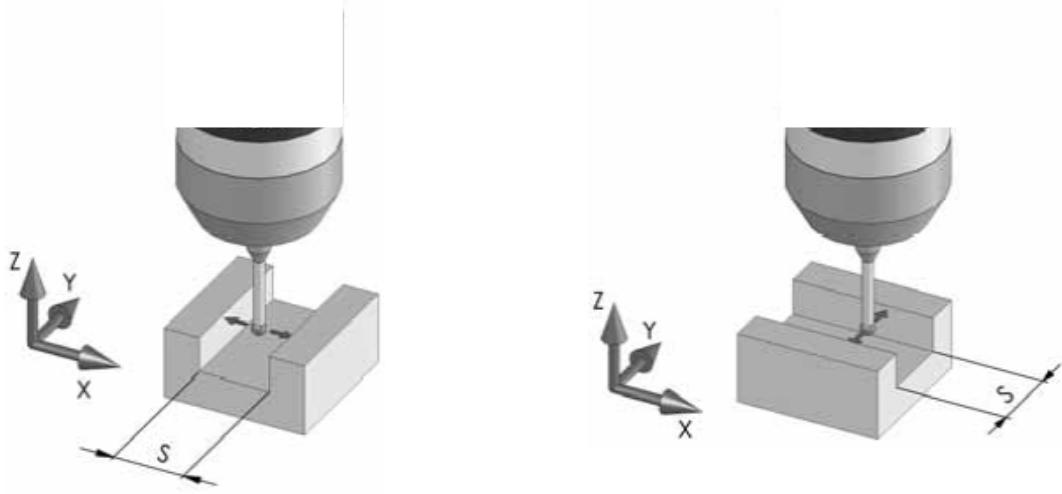
- S Dimension of inside width.
- X1/Y1 Identification of measuring direction
- W Number of WCS which must be set.

Results:

In the WCS defined with parameter W a zero point will be set in the corresponding axis. The position of the zero point refers to the center of the inside width.

Optional Parameters:

- I/J If the center of the inside width in the WCS should not be set to zero, a variable position can be set with the corresponding parameter.
(X-axis: I, Y-axis: J)



Example1:
Workpiece referencing inside width X
G65 P8700 S20. X1 W54

Example2:
Workpiece referencing inside width Y
G65 P8700 S30. Y1 W57

3.5 Workpiece Referencing: Outside Width

- Changing in and positioning of the probe in the center of the probe (by eye) above the outside width.
- Program call Meas. direction X: **G65 P8700 S... X1 Z... W...**
Meas. direction Y: **G65 P8700 S... Y1 Z... W...**

Parameters:

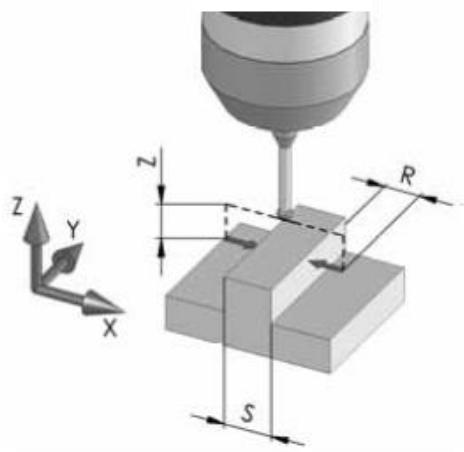
- S Dimension of outside width.
- X1/Y1 Identification of measuring direction (measurement in X- or Y-direction)
- W Number of WCS which must be set.
- Z Distance of probe in the Z-axis from the initial position to the measuring position.

Results:

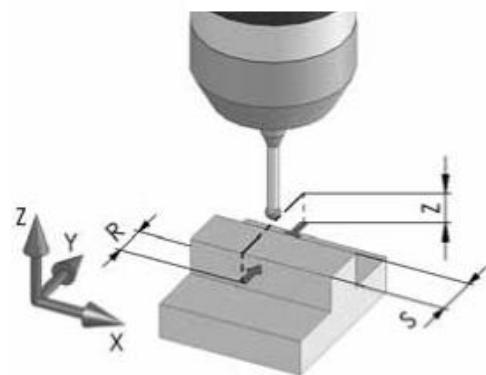
In the WCS defined with parameter W a zero point will be set in the corresponding axis. The position of the zero point refers to the center of the outside width.

Optional Parameters:

- I/J If the center point of the outside width in the WCS should not be set to zero, a variable position can be set with the corresponding parameter.
(X-axis: I, Y-axis: J)
- R Safety distance of the sensor to the workpiece for positioning in Z-direction. Usually the safety distance is 10 mm. For an outside width, R must be plus.



Example1:
Referencing outside width X
G65 P8700 S10. X1 Z-20. W54



Example2:
Referencing outside width Y
G65 P8700 S50. Y1 Z-10. W55

3.6 Workpiece Referencing: Inside Diameter

- Changing in and positioning of the probe in the center (by eye) of the inside diameter.
- Program call: **G65 P8700 S... W...**

Parameters:

- S Diameter of the bore.
- W Number of WCS which must be set.

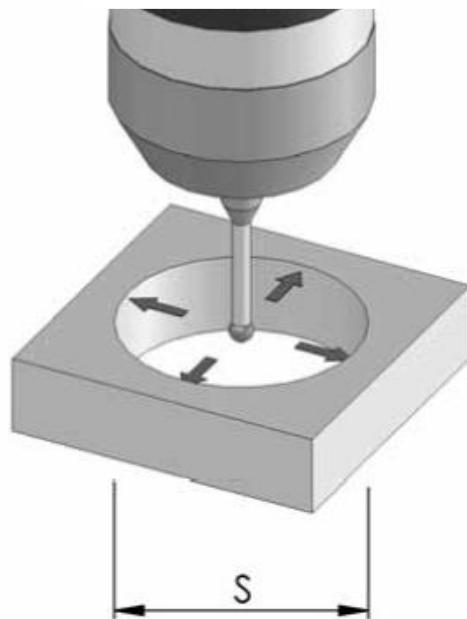
Results:

In the WCS defined with parameter W a zero point will be set in the axes X and Y. The position of the zero point refers to the center of the inside diameter.

Optional Parameters:

- I/J If the center point of the inside diameter in one or both axes in the WCS must not be set to zero, a variable position can be set with the corresponding parameters.
(X-axis: I, Y-axis: J)

Example:
Referencing inside diameter
G65 P8700 S40. W57



3.7 Workpiece Referencing: Outside Diameter

- Changing in and positioning of the probe in the center (by eye) above the outside diameter.
- Program call: **G65 P8700 S... Z... W...**

Parameters:

- S Shaft Diameter.
- W Number of WCS which must be set.
- Z Distance of the probe in Z-axis from the initial position to the measuring position.

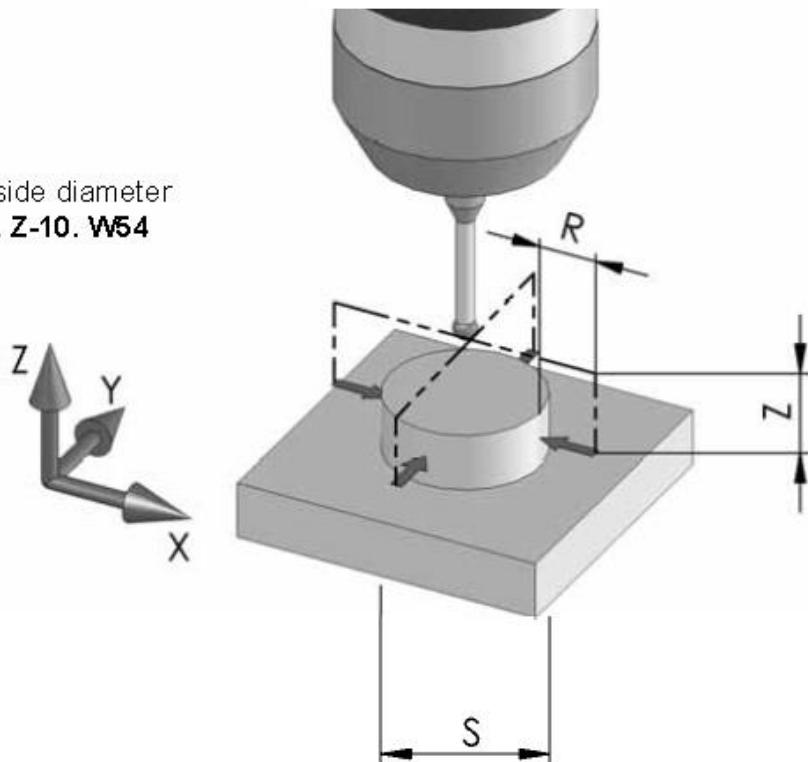
Results:

In the WCS defined with parameter W a zero point will be set in the axes X and Y. The position of the zero point refers to the center of the outside diameter.

Optional Parameters:

- I/J If the center point of the outside diameter in one or both axes in the WCS must not be set to zero, a variable position can be set with the corresponding parameters.
(X-axis: I, Y-axis: J)
- R Safety distance of the sensor to the workpiece for positioning in Z-
Usually the safety distance is 10 mm. For an outside diameter, R must be plus.

Example:
Referencing outside diameter
G65 P8700 S30. Z-10. W54



3.8 Workpiece Referencing: Inside Width or Inside Diameter with Obstacle

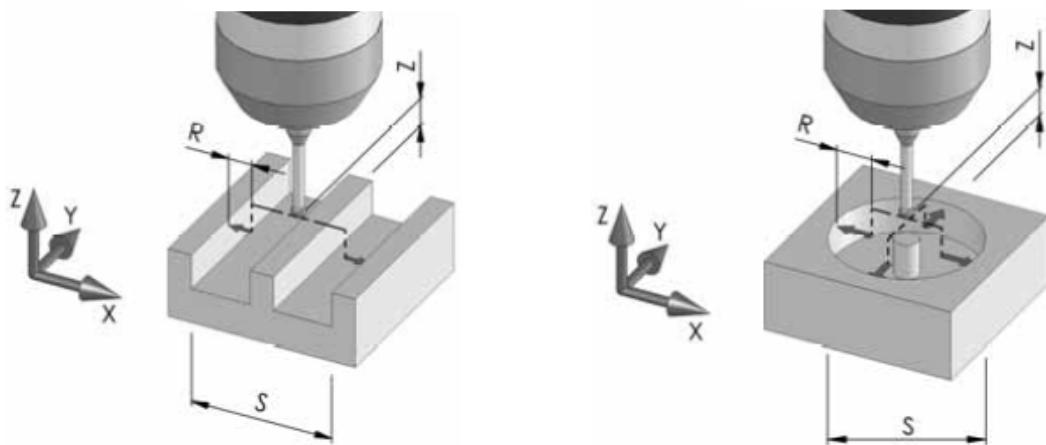
- Changing in or positioning of the probe in the center (by eye) above the inside diameter or inside width.
- Program call
 - Inside diameter: G65 P8700 R... S... Z... W...
 - Inside width meas. dir. X: G65 P8700 R... S... X1 Z... W...
 - Inside width meas. dir. Y: G65 P8700 R... S... Y1 Z... W...

Additional parameters compared with the inside width/inside diameter without obstacle:

- R Safety distance of the stylus to the workpiece for positioning in Z-direction. For inside diameter and inside width, R must be minus.
- Z Distance of the probe in Z-axis from the initial position to the measuring position.

Note:

The results and optional parameters are the same as for inside diameter or inside width.



Example1:
Workpiece referencing inside width X
with obstacle
G65 P8700 R-5. S40. X1 Z-10. W55

Example2:
Workpiece referencing inside diameter
with obstacle
G65 P8700 R-10. S30. Z-15. W56

4 Measurement in Production Process

The following chapter describes measuring tasks which can be carried out within a part program. The prepositioning of the probe is usually made by manual data inputs in the part program (pls. also refer to chapter "Protected Position Movement of the Probe) before the measuring program is called. Each measurement is called with the program „MAIN“. The parameter configuration only decides about the type of measuring point. As for the zero measurement, the measurement of following measuring points is possible:

- single point
- corner in 2 axes
- corner in 3 axes
- inside width
- outside width
- inside diameter
- outside diameter

The software available offers different possibilities to control the production process. The tolerances can be checked, the workpiece zero points can be corrected and the tool wear can be defined.

With parameter T it is possible to check different dimensions concerning tolerance after production of the workpiece. If the tolerance is exceeded, the measuring cycle is interrupted with an error message.

If the approx. workpiece zero point is already defined before the machining of a workpiece, e.g. by a defined setting of the workpiece, the zero point of the workpiece can exactly be determined with parameter W. Besides this it is possible to correct the workpiece zero point between two machining steps.

The parameter E can be used to determine the wear of a tool and to update the values in the tool memory. Due to the deviation to the rated dimension the wear of the tool can be calculated. If the machine diameter differs from the rated diameter the tool wear can be input into the tool table. During the next machining step with this tool the wear of the tool is automatically compensated for.

Important note:

The only logical difference between referencing and measurement during the production process is the type of dimensioning. At referencing the dimensions in the program call are in relation to the workpiece, i.e. the distance from stylus to workpiece is transferred. At the examples for measurement in the program, the dimensions in the workpiece are absolute to the workpiece, i.e. absolute coordinates concerning the active WCS are transferred to the program. This absolute dimensioning will be marked with the additional parameter A1 when calling the program „MAIN“. Apart from this difference, zero measurement and measurement in the program are identical., i.e. all possibilities which are described in the following chapter are available for initial referencing and vice versa.

4.1 Measurement: Single Point

- Changing in and positioning of the probe in front of the surface which must be touched. The distance of the probe ball to the surface which must be touched should be sufficient for the machine to accelerate up to measuring speed.
- Activation of WCS: G...
- Program call X-axis: G65 P8700 A1 X...
Y-axis: G65 P8700 A1 Y...
Z-axis: G65 P8700 A1 Z...

Parameters:

- A1 Use absolute dimensioning.
- X/Y/Z Touching axis and set position of the edge which must be measured in the active WCS.

Results:

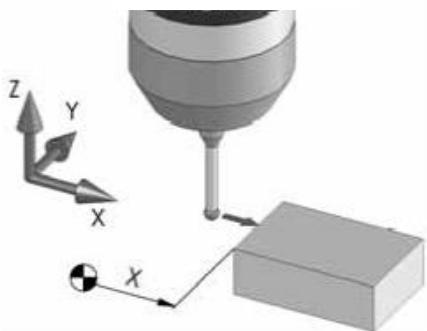
Measurement in X:#100 X-position of the edge in the active WCS
#103 Deviation from set value in X

Measurement in Y:#101 Y-position of the edge in the active WCS
#104 Deviation from set value in Y

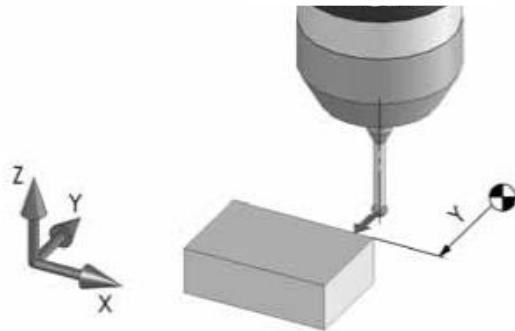
Measurement in Z:#103 Z-position of the edge in the active WCS
#105 Deviation from set value in Z

Optional Parameters:

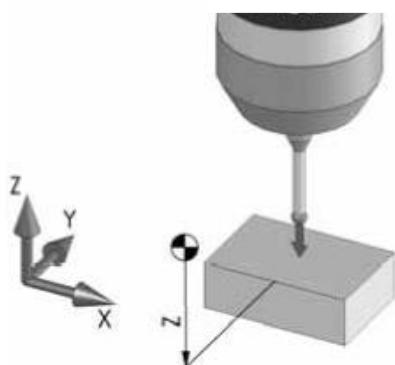
- E Tool number of the tool to be corrected.
- T Position tolerance of the edge
- W Number of a WCS which must be set or corrected
- I/J/K Set position of the edge in a new set WCS if it differs from zero.
(X-axis: I, Y-axis: J, Z-axis: K)



Example1:
Measurement single point X
G54
G65 P8700 A1 X0



Example2:
Measurement single point Y
G54
G65 P8700 A1 Y0



Example3:
Measurement single point Z
G54
G65 P8700 A1 Z0

4.2 Measurement: Corner in 2 Axes

- Positioning of the probe outside the corner which must be touched. The prepositioning of the probe decides about the measuring points on the workpiece.
- Activation of the WCS: **G...**
- Program call XY-corner: **G65 P8700 A1 X... Y...**
 XZ-corner: **G65 P8700 A1 X... Z...**
 YZ-corner: **G65 P8700 A1 Y... Z...**

Parameters:

- **A1** Use absolute dimensioning.
- **X/Y/Z** Touching axes (2 of 3 displacement axes) and the set position of the corner in the actual WCS.

Results:

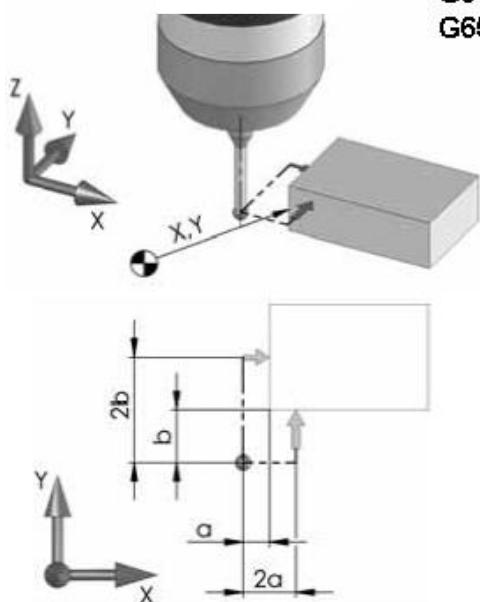
Depending on the measuring axes the results of two measuring directions are stored. . .

Measurement in X: #100	X-position of the edge in the active WCS
#103	Deviation from set value in X
Measurement in Y: #101	Y-position of the edge in the active WCS
#104	Deviation from set value in Y
Measurement in Z: #103	Z-position of the edge in the active WCS
#105	Deviation from set value in Z

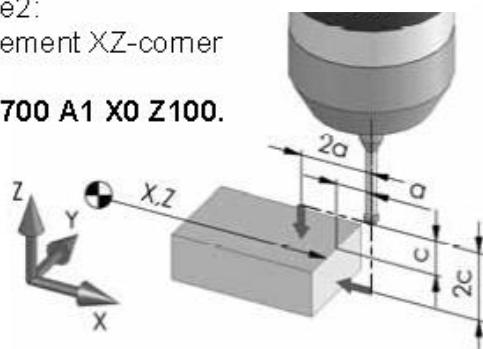
Optional Parameters:

- **T** Position tolerance of the edge
- **W** Number of WCS to be set or corrected.
- **I/J/K** Set position of the edge in a new set WCS if it differs from zero.
(X-axis: I, Y-axis: J, Z-axis: K)

Example1:
Measurement XY-corner
G54
G65 P8700 A1 X50. Y0



Example2:
Measurement XZ-corner
G56
G65 P8700 A1 X0 Z100.



4.3 Measurement: Corner in 3 Axes

- Positioning of the probe outside the corner which must be touched. The prepositioning of the probe decides about the measuring points on the workpiece.
- Activation of the WCS: **G...**
- Program call: **G65 P8700 A1 X... Y... Z...**

Parameters:

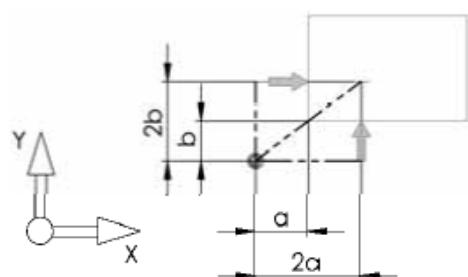
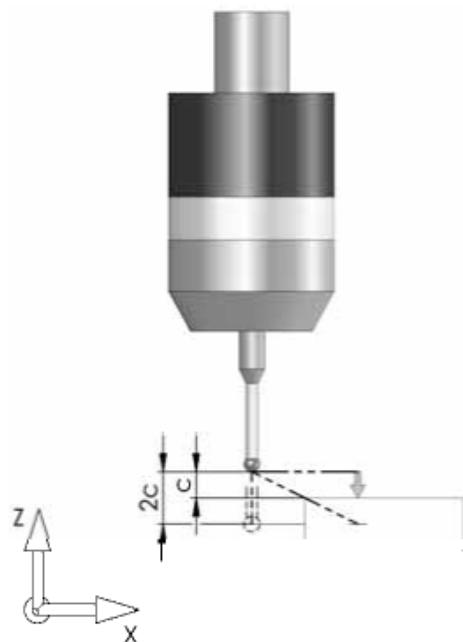
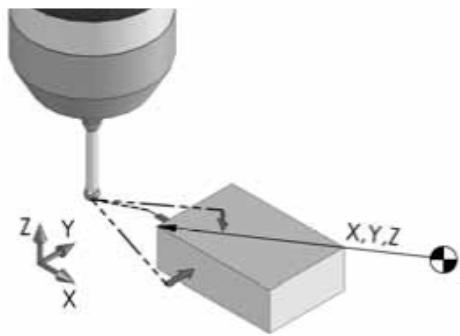
- A1 Use absolute dimensioning.
- X, Y, Z Touching axes (all 3 displacement axes) and the set position of the corner in the actual WCS.

Results:

Measuring direction X:	#100	X-position of the edge in the active WCS
	#103	Deviation from set value in X
Measuring direction Y:	#101	Y-position of the edge in the active WCS
	#104	Deviation from set value in Y
Measuring direction Z:	#102	Z-position of the edge in the active WCS
	#105	Deviation from set value in Z

Optional Parameters:

- T Position tolerance of the corner
- W Number of WCS to be set or corrected.
- I/J/K Set position of the edge in a new set WCS if it differs from zero.
(X-axis: I, Y-axis: J, Z-axis: K)



Example:
Measurement XYZ-corner
G57
G65 P8700 A1 X0 Y0 Z0

4.4 Measurement: Inside Width

- Positioning of the probe in the center of the inside width.
- Activation of the WCS: **G...**
- Program call Meas. direction X: **G65 P8700 A1 S... X1**
Meas. direction Y: **G65 P8700 A1 S... Y1**

Parameters:

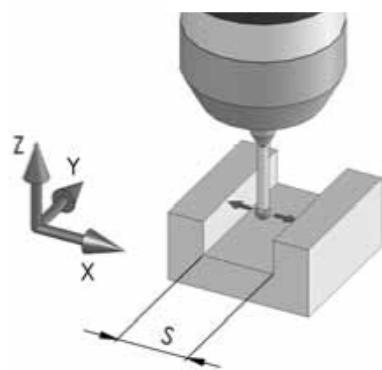
- A1 Use absolute dimensioning. (Important for result parameters)
- S Set inside width.
- X1/Y1 Identification of the measuring direction.

Results:

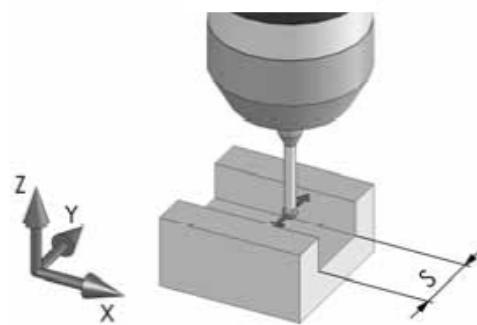
#106	Inside width
#107	Deviation from set width
Meas. direction X: #100	X-position of the center point in the active WCS
#103	Deviation from the set position in X
Meas. direction Y: #101	Y-position of the center point in the active WCS
#104	Deviation from the set position in Y

Optional Parameters:

- E Number of the tool to be corrected.
- T Position tolerance of the center point (T minus), or tolerance of the inside width (T plus).
- W Number of WCS which must be set or corrected.
- I/J Set position of the edge in a new set WCS if it differs from zero. (X-axis: I, Y-axis: J, Z-axis: K)



Example1:
Measurement inside width X
G58
G65 P8700 A1 S20. X1



Example2:
Measurement inside width Y
G59
G65 P8700 A1 S30. Y1

4.5 Measurement: Outside Width

- Positioning of the probe in the center above the outside width.
- Activation of the WCS: **G...**
- Program call Measuring direction X: **G65 P8700 A1 S... X1 Z...**
 Measuring direction Y: **G65 P8700 A1 S... Y1 Z...**

Parameters:

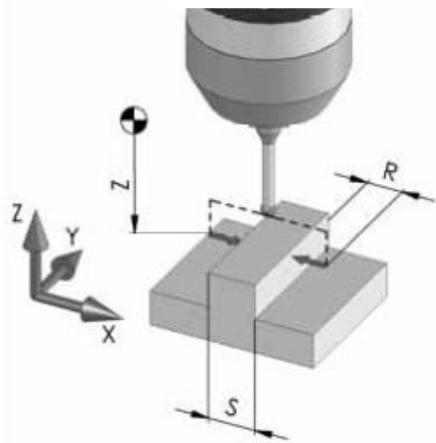
- A1 Use absolute dimensioning.
- S Set outside width.
- X1/Y1 Identification of the measuring direction.
- Z Measuring point in the Z-axis in the active WCS.

Results:

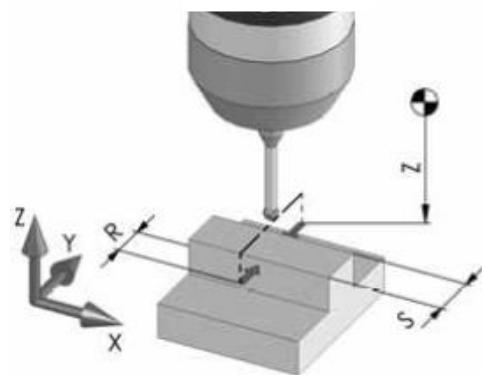
#106	Outside width
#107	Deviation from set width
Meas. direction X: #100	X-position of the center point in the active WCS
#103	Deviation from the set position in X
Meas. direction Y: #101	Y-position of the center point in the active WCS
#104	Deviation from the set position in Y

Optional Parameters:

- E Tool number of the tool to be corrected.
- T Position tolerance of the center point (T minus), or tolerance of outside width (T plus)
- W Number of WCS which must be set or corrected.
- I/J Set position of the edge in a new set WCS if it differs from zero. (X-axis: I, Y-axis: J, Z-axis: K)
- R Safety distance of the sensor to the workpiece for positioning in Z. Usually the safety distance is 10 mm. For an outside width, R must be plus.



Example1:
Measurement outside width X
G57
G65 P8700 A1 S20. X1 Z50.



Example2:
Measurement outside width Y
G54
G65 P8700 A1 S35. Y1 Z0

4.6 Measurement: Inside Diameter

- Positioning of the sensor in the center of the inside diameter.
- Activation of the WCS: G...
- Program call: G65 P8700 A1 S...

Parameters:

- A1 Use absolute dimensioning (important for result parameters)
- S Set diameter of the bore.

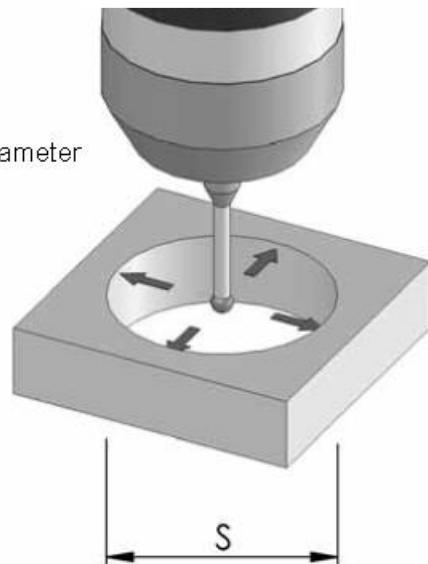
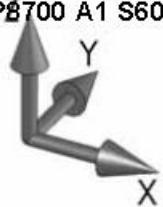
Results:

- #106 Diameter of the bore
#107 Deviation from the set diameter
- #100 X-position of the center point in the active WCS
#103 Deviation from the set position in X
- #101 Y-position of the center point in the active WCS
#104 Deviation from the set position in Y

Optional Parameters:

- E Tool number of the tool to be corrected.
- T Position tolerance of the center point (T minus) or tolerance of the diameter (T plus)
- W Number of WCS which must be set or corrected.
- I/J Set position of the edge in a new set WCS if it differs from zero. (X-axis: I, Y-axis: J, Z-axis: K)

Example:
Measurement inside diameter
G55
G65 P8700 A1 S60.



4.7 Measurement: Outside Diameter

- Positioning of the probe in the center above the outside diameter.
- Activation of the WCS: **G...**
- Program call: **G65 P8700 A1 S... Z...**

Parameters:

- A1 Use absolute dimensioning.
- S Set diameter of the shaft.
- Z Measuring point in the Z-axis in the active WCS.

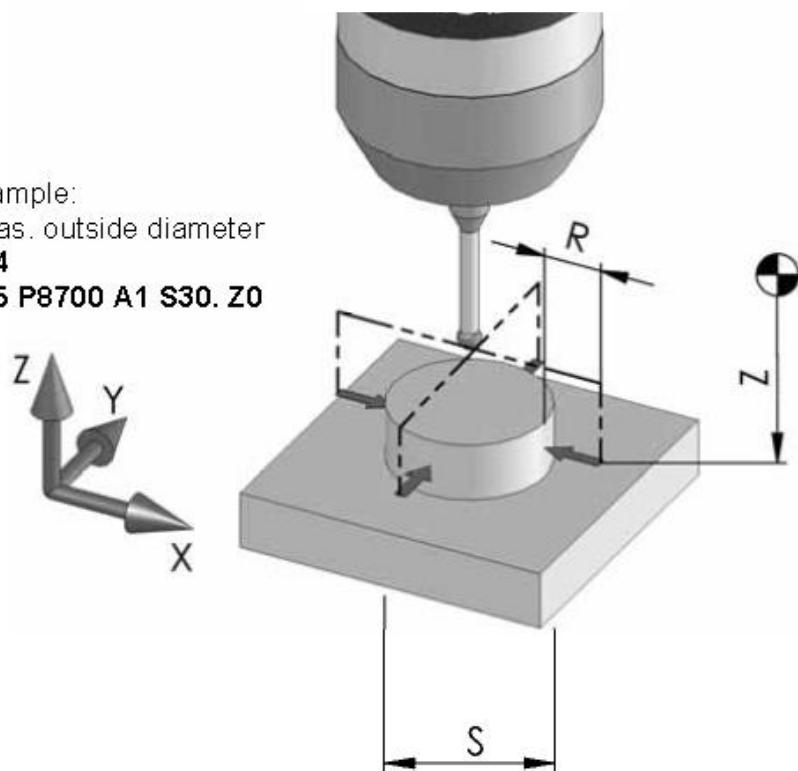
Results:

- #106 Diameter of the shaft
- #107 Deviation from the set diameter
- #100 X-position of the center point in the active WCS
- #103 Deviation from the set position in X
- #101 Y-position of the center point in the active WCS
- #104 Deviation from the set position in Y

Optional Parameters:

- E Tool number of the tool to be corrected.
- T Position tolerance of the center point (T minus), or tolerance of the diameter (T plus)
- W Number of WCS to be set or corrected.
- I/J Set position of the edge in a new set WCS if it differs from zero. (X-axis: I, Y-axis: J, Z-axis: K)
- R Safety distance of the sensor to the workpiece for positioning in Z-direction. Usually the safety distance is 10 mm. For an outside diameter, R must be plus.

Example:
Meas. outside diameter
G54
G65 P8700 A1 S30. Z0



4.8 Measurement: Inside Width or Inside Diameter with Obstacle

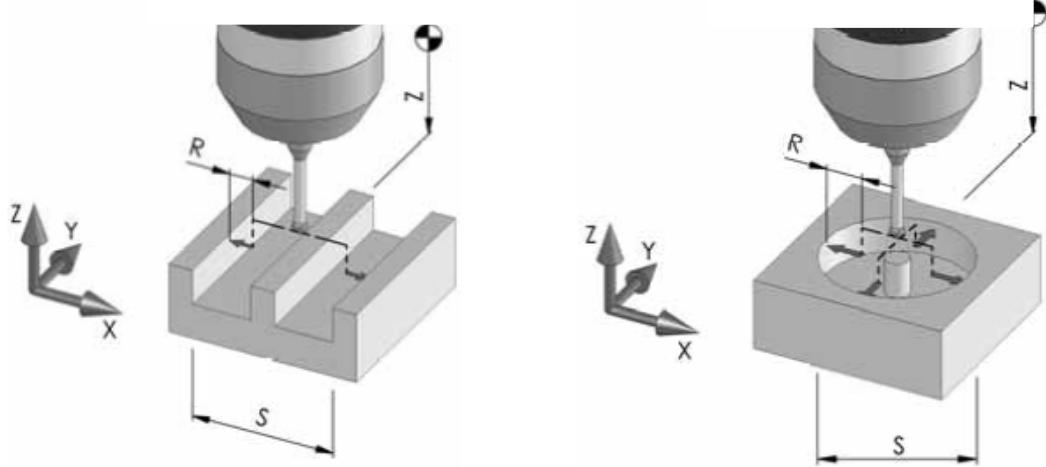
- Positioning of the probe in the center above the inside diameter or inside width.
- Activation of the WCS: **G...**
- Program call inside diameter:
 - Inside width meas. direction X: **G65 P8700 A1 R... S... Z...**
 - Inside width meas. direction Y: **G65 P8700 A1 R... S... X1 Z...**
 - Inside width meas. direction Y: **G65 P8700 A1 R... S... Y1 Z...**

Additional parameters compared with inside width/inside diameter without obstacle:

- R Safety distance of the sensor to the workpiece for positioning in Z.
For inside diameter and inside width, R must be minus.
- Z Measuring position in the Z-axis in the active WCS.

Note:

The results and optional parameters are the same as for inside diameter or inside width.



Example1:

Measurement inside width X
with obstacle

G58
G65 P8700 A1 R-5. S30. X1 Z0

Example2:

Measurement inside diameter
with obstacle

G59
G65 P8700 A1 R-10. S30. Z0

5 Protected Positioning Movement of the Probe

For protected movement in the machining area of the machine tool, it is possible to use program O8703(PROTected MOVE):

- Changing in of the probe
- Activation of WCS: **G...**
- Program call: **G65 P8703 X... Y... Z...**

Parameters:

- X/Y/Z Target position of the movement in the active WCS

Result:

The probe will be displaced from the start position to the transferred target position. If the sensor is deflected during this displacement the movement is stopped and the probe is brought back into the start position.

6 Angle and Distance Measurements

If two measuring points are measured consecutive the distances between these points in the corresponding axes and, depending on the type of measuring point, an angle can be determined. So it is possible to determine e.g. the following data of a workpiece:

- angle of inside width
- angle of outside width
- angle of surface
- distance of two diameters
- distance of two corners
- height or width of a step

Sequence of angle and distance measurement:

- Measure first measuring point as usually.
Program call: **G65 P8700 ...**
- Move probe to the second measuring point by handwheel or by manual data input.
- Measure second measuring point with the additional parameter D.
Program call: **G65 P8700 D... ...**

Additional parameter of second measuring point:

- D Rated angle (mathematical angle definition) at determination of an angle. If distances have to be determined only, D0 is transferred usually.

Optional parameter of second measuring point:

- W To adjust a fourth axis parameter W can be used at angle measurement to store the deviation to the set angle in a WCS.

Results:

Depending on the machine axes the following parameters are stored.

- #110 Distance in X-direction
- #111 Distance in Y-direction
- #112 Distance in Z-direction

- #108 Angle (between +90 and –90 degrees)
- #109 Deviation to the transferred set angle

Important notes:

- To get a correct result it is not allowed to change the active WCS between the first and second measurement or to activate another WCS.
- To get correct results it is not allowed to delete the global parameters (#100 up to #149) between the two measurements (depending on machine parameters this can be activated)

Machine Parameter ?

7 Temperature Compensation

Not available in this moment!

8 Parameter Tables

8.1 Call parameters

Call parameters	Meaning
A1	The positions in the program call are interpreted in the active WCS as absolute coordinates and not as distances of the probe ball to the workpiece or displacement way in Z.
C1	Carrying out calibration.
D	Set angle at angle measurement for distance measurement usually D0.
E	After measurement the data of the tool with which the measuring point was machined are corrected. The tool number is transferred with parameter E. This function can be used for all measuring points except of the measurement of a corner. Depending on the configuration of the parameters in programm „SET TOOL“ either the geometric or wear data of the tool in the tool memory are corrected.
I	X set position of a center point or a surface in the WCS which must be set.
J	Y set position of a center point or a surface in the WCS which must be set.
K	Z set position of a surface in a WCS which must be set.
M	Usually the probe is switched on before each measuring task and switched off afterwards. If several measuring tasks are carried out one after the other the probe is appropriately switched on before the initial measurement only and switched off after the last one. For that the parameter M with the correct value must be transferred to each program call. Parameter M can be used for program „MAIN“ as well as for „PROTECTED MOVE“ . M1 switch on only M3 neither switch on nor switch off M2 switch off only

Call parameters	Meaning
Q	At each measuring block the probe is displaced for a defined distance over the position of the expected surface if there is no trigger point. So to speak the edge is "searched". This distance (overtravel) for touches X, Y is usually defined in program O8700(MAIN), in parameter #141. For touches in Z, (#141/2) is used. If these values are not suited for a special measuring task the overtravel XY can be transferred with Q. The overtravel Z is (XY-travel/2).
R	The safety distance when measuring inside/outside width, inside/outside diameter is usually 10mm and it can be changed with parameter R on requirement. For inside width, inside diameter R must be minus, for outside width, outside diameter R must be plus.
S	Size of a measuring point, i.e. inside width/outside width or diameter of a bore/shaft.
T	If the set position of a surface, of a center point or the set size of a measuring point is known (due to precise positioning of the probe in the center point, transfer of set position in WCS with the parameters X, Y, Z or transfer of set value with the parameters I, J, K, S) it is possible to check the position tolerance of a surface or center point or the size tolerance of a measuring point with parameter T. To check a surface, corner, width or diameter to tolerance the value transferred with parameter T must be plus. To check a center point to tolerance the transferred value must be minus.
W	The number of the WCS which must be set is transferred with parameter W. Usually it is possible to pass 54 to 59. The external zero offset is set with W53. If there are more WCS available by Fanuc option the number of an optional WCS with minus sign is transferred. E.g. the WCS „G54.1 P40“ with „W-40“ is set.

Call parameters	Meaning
X	When measuring inside width, outside width: definition of the measuring direction with X1 or Y1.
	When measuring surface, corner: distance of surface which must be touched in X-direction (without A1), or X-position of the surface which must be touched, corner in active WCS (with A1).
Y	When measuring inside width, outside width: definition of measuring direction with X1 or Y1.
	When measuring surface, corner: distance of surface which must be touched in Y-direction (without A1) or Y-position of surface which must be touched, corner in active WCS (with A1).
Z	When measuring outside width, outside diameter or inside width, inside diameter with obstacle: displacement way in Z-direction to measuring position (without A1) or measuring position in Z in the active WCS (with A1).
	When measuring surface, corner: distance of surface which must be touched in Z-direction (without A1) or Z-position of surface which must be touched, corner in active WCS (with A1).

8.2 Result Parameters

Result parameters	Meaning
#100	X Result of measurement in actual WCS. When measuring surface, corner: position of the surface in X-axis. When measuring inside width, outside width, diameter: position of the center point in X-axis.
#101	Y Result of measurement in actual WCS. When measuring surface, corner: position of the surface in Y-axis. When measuring inside width, outside width, diameter: position of the center point in Y-axis.
#102	Z Result of measurement in actual WCS. Position of surface in Z-axis.

Result parameters	Meaning
#103	Deviation of X measuring result to set position in X. If there is no set position in X this value corresponds with the X measuring result.
#104	Deviation of Y measuring result to set position in Y. If there is no set position in Y this value corresponds with the Y measuring result.
#105	Deviation of Z measuring result to set position in Z. If there is no set position in Z this value corresponds with the Z measuring result.
#106	Measured size of measuring point: inside width, outside width, diameter of a bore, shaft.
#107	Deviation of the measured size of the measuring point to set size of measuring point transferred to S.
#108	Measured angle. The result is always between –90 and +90 degrees.
#109	Deviation of the measured angle to the set angle transferred in D.
#110	Distance X direction to the point measured before. For inside width, outside width, diameter this value refers to center points.
#111	Distance Y direction to the point measured before. For inside width, outside width, diameter this value refers to center points.
#112	Distance in Z direction to the point measured before.

9 Installation of the Software

After mechanical and electric installation of probe and receiver as well as concentricity adjustment of the probe this software can be installed as follows:

- transmission of the programs O8700 up to O8707 to the control
- adaptation of program O8700(MAIN)
- adaptation of program O8705(SET WKS)
- adaptation of program O8706(SET TOOL)
- adaptation of machining data
- input of precise probe length into the tool table of the machine

Transmission of the programs O8700 up to O8707 to the control

Usually all eight programs are transferred to the control. If no distances and angles must be measured program O8707(ANGLE DISTANCE) can be skipped. If no tool data must be updated program O8706(SET TOOL) can be skipped.

Adaptation of the program O8700(MAIN)

In the first lines of the program O8700(MAIN) the following parameters must be set or adapted:

Note: Metric input of distance and feedrate units!

Para-meter	Description
#33	Base address of tool memory for tool length. ("Base address" refers to the address before the address of the first tool)
#15	H-number of the probe (corresponds usually with the magazine location of the probe)
#126	Probe ball radius

Para-meter	Description	
#127	Measuring feed rate in mm/min (depending on the type of measuring input)	
	High-speed skip	X4.7
	The value can be between 1,000 and 5,000 (standard: 2,000). Per each measuring block one touch is carried out with the feed from #127.	The value can be between 30 and 60 (standard: 50). Per each measuring block two touches are carried out. The first touch with feed (#128*0.3), the second touch with feed from #127. The retraction path after the first quick touch is stored in parameter #[#135+4] and should be optimized during commissioning.
	If a value smaller or equal to 200 is input, it is assumed that measuring input X4.7 is used. If the value is more than 200, it is assumed that a high-speed skip is used.	
#128	Feed for a protected manual data input in mm/min. (standard: 5,000)	
#135	When using this software six values must permanently be stored on this control. For that six unused permanent parameters one behind the other must be available which cannot be deleted when the machine is switched off. The starting value of these parameters is stored in #135. If these values should be stored, e.g. in #800 up to #805, #135 must be set to 800.	
#136	Number and direction of a fourth axis. Standard values: After angle measurement, there is never adjusted a fourth axis: 0 Rotation axis around X should be adjustable: +4 Rotation axis around Y should be adjustable: +5 Rotation axis around Z should be adjustable: +6 The symbol is usually plus at normal rotation direction of the axes.	

#141=6 Parameter	Description		
#130	In #130 some of the data which are relevant for the software are stored in bits. The value consists of six bits (Bit0 up to Bit5). After definition of the value of each bit it is possible to calculate the value of #130.		
Bit0	0	The machine has no spindle orientation.	
	1	The machine has spindle orientation.	
Bit1	0	The displacement movements in program O8703(PROTECTED MOVE) are protected (feed from #128). Note: Program O8703(PROTECTED MOVE) is used by program O8700(MAIN) for prepositioning and can also be called directly by the user.	
	1	The displacement movements in program O8703(PROTECTED MOVE) are carried out with G0. NO stop of the movement when the stylus is deflecting.!!!	
Bit2	0	The IR receiver is NOT operated in the permanent auto-flash mode, i.e. there is no permanent voltage of 24 V on the receiver signals IN1 and IN3.	
	1	The IR receiver is operated in the permanent auto-flash mode, i.e. there is a permanent voltage of 24 V on the receiver signals IN1 and IN3.	
Bit3	0	The validity of a trigger point is NOT checked. Note: If the IR transmission is interrupted during a measuring block an invalid trigger point is generated. If there are free control inputs available each trigger point can be checked concerning validity. (Pls. refer to chapter „Optimization of Cycles“)	
	1	The validity of a trigger point is checked.	
Bit4	0	The start conditions (IR transmission, sensor not deflected) before a measuring block are NOT checked. Note: If there are free control inputs available the start conditions can be checked before each measuring block.	
	1	The start conditions before a measuring block are checked. (Pls. refer to chapter „Optimization of Cycles“)	
Bit5	0	Calculation of the length in #5043 without Length correction	
	1	Calculation of the length in #5043 with Length correction Must be set !	

Parameter	Description
#130	Calculation of #130: #130 = Bit0*1 + Bit1*2 + Bit2*4 + Bit3*8 + Bit4*16 + Bit5*32 Bit 5 must be set
#141	At each measuring block the probe is moved by a certain distance over the position of the expected surface, if there is no trigger point. So to speak the edge is "searched". The standard value of this distance (overtravel) for touches in X, Y is defined with #141. For touches in Z, the overtravel is (#141/2). Standard value #141=6

Besides the adaptation of the previous parameters the commands for switch on/off of the probes must be inserted. Usually M-functions of the OEM are used.

- The command for switch on of the probe is inserted in comment line (PROBE ON).
- The command for switch off of the probe is inserted in comment line (PROBE OFF).

Adaptation of the program O8705(SET WCS)

In the first lines of the program O8705(SET WCS) the following parameters must be set:

Parameter	Description
#1	Number of parameters in which the first offset value of the WCS data (X-value of the external offset) is stored.
#2	The difference between the memory location of a value in a WCS to the memory location of the next axis in this WCS. (Delta value between memory locations of adjoining axes)
#3	The difference between the memory location of a value in a WCS to the memory location of the next WCS in this axis. (Delta value between memory locations of adjoining WCS)
#6	Number of the parameter in which the first offset value of the optional WCS data (X value of first optional offset) is stored. If there are no optional WCS the value is set to zero.

Example Brother A00 (optional WCS):

```
#1=5201  
#2=1  
#3=20  
#6=7001
```

Adaptation of program O8706(SET TOOL)

In the first line of program O8706(SET TOOL) the following parameters must be set:

Parameter	Description
#1	Basic address of tool memory for wear of tool length.
#2	Basic address of tool memory for wear of tool radius.

Example: (depending on type of control)

```
#1=10000  
#2=12000
```

Note: At the basic addresses 10000 and 12000, the wear data of the first tool are stored in parameter #10001 and #12001. The basic addresses are those before the addresses of the first tool.

Adaptation of machine data

Input of precise probe length into the tool table of the machine

The not deflected length of the probe must be determined and input into the corresponding position in the tool table. Length measurement can be carried out e.g. with a presetting device or dial gauge.

10 Optimization of the Cycles

If there are links from the PLC side to each of the two inputs or outputs of the control the switch on/off performance as well as the measuring integrity of the cycles can be optimized.

Optimization of the switch on/off performance of the probe

Program O8708(ON OFF) which is included in the software can be used to switch the probe on/off. The signals IN1, IN3 and OUT4 of the IR receiver must therefore be connected to the control and linked in the PLC with parameters. The switch off method „optically off“ of the probe must be programmed (pls. refer to operating instructions of probe). Compared with one of the three switch off variants „timeout off“ the battery is spared and the probability to generate an invalid trigger point is minimized.

- Switch ON:
To switch on the probe the program call **G65 P8708 M1** is inserted in the program O8700(MAIN) under comment line (PROBE ON).
- Switch OFF:
To switch off the probe the program call **G65 P8708 M2** is inserted in the program O8700(MAIN) under comment line (PROBE OFF).
- Setting of parameters:
After the transmission of the program O8708(ON OFF) to the control three parameters in the first line of the program must be adapted:

#1	Value of the parameter which is linked on PLC-side with the signal IN1 of the IR receiver. (Example: #1=1100)
#3	Value of the parameter which is linked on PLC-side with the signal IN3 of the IR receiver. (Example: #3=1101)
#4	Value of the parameter which is linked on PLC-side with the signal OUT4 of the IR receiver. (Example: #4=1003)

Optimization of the measuring integrity of the cycles

If on control side the measuring input is available only, the IR receiver is operated in auto-flash mode (pls. refer to installation instructions of IR receiver). In this case it is not possible to check the validity of a trigger point and the start condition before a measuring block. The option bits (#130), Bit3 and Bit4 are of no meaning in this case. Should it be required to check the validity of a trigger point and the start condition before a measuring block the signals OUT2 or OUT3 (depending on the electric installation) and OUT4 of the IR receiver must be connected to the control and linked in the PLC with parameters.

In this case the measuring integrity of the cycles can be optimized as follows:

- Opening of the file „FANUC_1A_UK.txt” in a text editor
- Searching for text position „OUT2” or „OUT3” (depending on the electric installation) and replacement by the parameter which is linked in the PLC with the corresponding signal. Three text positions are found.
(Example: „OUT2” replaced by „#1010”)
- Searching for text position „OUT4” and replacement by the parameter which is linked in the PLC with this signal. Three text positions are found.
(Example: „OUT4” replaced by „#1015”)
- In each line with a replacement the comment brackets must be removed.
(Example: „(IF[#1010NE1]THEN#121=30)” will change to
„IF[#1010NE1]THEN#121=30”)

After this optimization the option bits Bit3 and Bit4 have their described function and the validity of a trigger point and the start condition before a measuring can be checked.

11 Error Messages

INVALID CALL PARAMETERS

The call parameters are faulty or contradictory.
Please check the program call!

TOLERANCE EXCEEDED

The maximum tolerance transferred with parameter T was exceeded.

UNEXPECTED OBSTRUCTION

The sensor was deflected during a protected manual data input.
Please check the displacement movements of the probe and change the program call if required.

MEASURING BLOCK WITHOUT TRIGGER POINT

No surface was touched during the measuring block.
Please check the displacement movements of the probe and change the program call if required.

ERROR TOOL COMPENSATION

After measurement of one corner no tool data can be setup.
Please check the program call.

ERROR START/END POSITION

First reason:

During the measuring block an invalid trigger point was generated, e.g. because of problems with IR transmission.
Please check IR transmission situation on your machine.

Second reason:

The start conditions (IR-transmission available, sensor not deflected) before the measuring block were not fulfilled.
Please check the IR transmission situation on your machine and the displacement movements of the probe and change the program call if required.

INVALID MEASURING POSITION

Angle and distance measurements can only be carried out at similar measuring positions.

Please check the program call.