

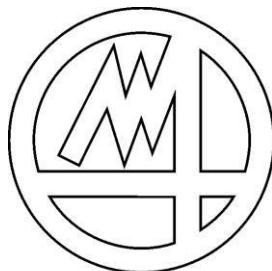


**Probing software**

LATHE WORKPIECE MEASUREMENT SOFTWARE MANUAL  
DEVELOPED FOR HAAS CONTROLS

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## **PROGRAMMING MANUAL**



**MARPOSS**

## **IDENTIFICATION DATA**

<b>Manufactured by</b>	MARPOSS U.S.A.
<b>Address</b>	3300 Cross Creek Parkway, Auburn Hills. MI
<b>Software Type</b>	Mida Probing: Lathes
<b>Function</b>	Lathe workpiece measurement Software Manual developed for Haas controls
<b>Manual Code:</b>	
<b>Issued</b>	May 2018
<b>Edition</b>	(--)

**MARPOSS U.S.A.** is not obliged to notify customers of changes to the product.  
The descriptions in this manual in no way authorize tampering by unauthorized personnel.

The Marposs supply consists of an IT support containing the software and relative documentation (referred to below as "the Product").

The Product was developed for users with knowledge and skills in the use of software applications for machine tools, referred to below as "the User".

The Product is protected by Marposs copyright. The company reserves the right to make any changes considered necessary to any part of the Product in order to improve it. Marposs also reserves all rights relative to the Product with reference to modifications and processing on board the CNC or other data processing systems, as well as with reference to any form of transmission and reproduction. Transmission and reproduction are only allowed after obtaining express authorization to use the Product on multiple units. Any persons breaching the above conditions will be prosecuted.

The measuring cycles are programmed for the acquisition/processing of measuring data generated by Marposs contact or laser probing systems. The cycles can be adjusted to specific application requirements directly on board the machine. The User must:

1. check that the parameters used in the cycles are compatible with the other machine functions;
2. check that the parameters are not changed or overwritten during execution of machine programs, causing malfunctions or dangerous situations;
3. not change the conditions for use of the cycles by changing the CNC operating modes.

The Product has been thoroughly tested. However, Marposs shall not be liable for the completeness and accuracy of data. When using the Product for the first time, the User must test the Product block by block, to confirm that it conforms for the specific application. After start up, the User must record the parameters and addresses substituted and any changes made, indicating the changes in the documentation. The software must be considered a semi-finished product to be integrated in the machine tool design, and as such Marposs cannot be held responsible for any damage to the machine resulting from:

1. incorrect use of the Product or programming errors,
2. Product changes or application faults

Installation in the machine CNC implies acceptance of the above conditions and acknowledgement of the possible exclusion of the warranty in the event of damage.

## ***Preface***

Due to the growing popularity of “On Machine Probing” Marposs USA. has developed a new software package for their *Mida* Machine Tool Touch Probe Systems. This new and innovative software package was designed to help facilitate the use of *Mida* probe systems on a wide variety of machine tools.

As you incorporate these user-friendly software cycles into your manufacturing processes you will understand the importance of your completed single or multi spindle cell or system or a Machine with Y axis capability.

By implementing *Mida* probes and software with a machine tool cell or system you have the Productivity to profit.

This manual details Marposs’ Multi-Purpose Productivity Cycles™ designed for *Mida* Machine Tool Touch Probe Systems.

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# Chapter 1 – Getting Started

## A. MEASUREMENT SOFTWARE CHARACTERISTICS

- ❑ The approach of the probe to the workpiece is "protected": if an unexpected collision occurs before the contact touches the workpiece, and the software generates an alarm that interrupts all the movements.
- ❑ Each macro contains a detailed description of all the variables used as inputs and outputs, in comment format.
- ❑ The modal instructions are reset at the end of each cycle.
- ❑ Both the required and optional parameters for each measurement Macro are checked to make sure that the values programmed by the user are consistent. If the required inputs have not been programmed at the moment they are called up by the Macro, an alarm message is generated on the CN display and the measurement cycle is blocked.
- ❑ The software includes a series of alarm messages that warn the operator about every fault condition that occurs during the measurement Macro; whenever one of these messages is generated it causes all the machine axes to stop immediately.
- ❑ It is possible to calibrate up to four separate probes on the turret.

Every measurement Macro has the following functions:

1. Tolerance check (programmable).
2. Workpiece origin settings.
3. Printing and transmitting measured data via RS232, PCMCIA card, or USB memory stick.
4. Tool compensation (programmable).

## **B. Programs by machine configuration**

Upload the measurement software into the control

- For 2 axis (X, Z) lathe upload 9201, 9202, 9211, 9212, 9214, 9216, 9218, 9226, 9235, 9236, 9241, 9242, 9243, 9244, 9251, 9260, 9261, 9264, 9265, 9266
- For 3 axis (X, Z, C) lathe upload 9201, 9202, 9211, 9212, 9214, 9216, 9218, 9221, 9222, 9223, 9226, 9235, 9236, 9241, 9242, 9243, 9244, 9251, 9260, 9261, 9264, 9265, 92664
- For 4 axis (X, Z, C, Y) lathe upload 9201, 9202, 9203, 9204, 9205, 9206, 9207, 9208, 9211, 9212, 9213, 9214, 9215, 9216, 9217, 9218, 9221, 9222, 9223, 9225, 9226, 9235, 9236, 9241, 9242, 9243, 9244, 9251, 9260, 9261, 9264, 9265, 9266

## **C. Probe Preparation and Testing**

- Check that the workpiece probe (mounted on the turret) has been installed correctly
- Check that the batteries have been installed correctly.
- Check that the receiver and transmitter have a clear path of communication.
- Test the probe on the turret. This test refers to a probe with optical signal transmission.
- Activate the probe in MDI using the activation M-code.
- Insert the following instructions block in MDI mode: G31 U-1. F5.
- If it functions correctly, the probe should move 1"
- Repeat the above point, deflecting the stylus manually during the movement, the probe should stop immediately.
- If the probe does not behave correctly, contact the MARPOSS installation technician for technical support.
- Set tool geometry for probe
- Align the stylus (optional)

## **Chapter 2 – X, Z Machine Configuration Programs**



## A. CALIBRATING THE X AXIS (O9201)

**Call up format: G65 P9201 [X] [S] [D] [K] [C] [M]**

This cycle is used for calibrating the probe in the X axis. The calibration may be performed in one direction only (Radius) or in both directions (Diameter). Either a ring (O.D.) or a cylinder (I.D.) may be used as a calibration master, provided its dimensions are known.

### Start position:

#### - SINGLE TOUCH:

The probe must be positioned in the X axis so that spherical feeler touches the calibration master on the correct side (X+ or X-). The probe must be positioned in the Z axis so that the spherical feeler is at the desired touch depth. Alternatively, the cycle positions the probe automatically at the depth programmed at the input "K".

#### - ID:

The probe must be positioned at the center of the calibration master X axis. The probe must be positioned in the Z axis so that the spherical feeler is at the desired touch depth. Alternatively, the cycle positions the probe automatically at the depth programmed at the input "K".

#### - OD:

The probe must be positioned at the center of the calibration master X axis. The touch depth must be programmed via the input "K".

### FINAL POSITION:

The X and Z axes are returned to the start position.

### REQUIRED INPUTS:

**[X]** = nominal X dimension. (single touch only)

**[S]** = select the master type: S = 1. for ID, S = 2. for OD. If this input is omitted, SINGLE TOUCH calibration is selected automatically.

**[D]** = Calibration master diameter, required only if "S" = 1 or 2, do not enter this value "S" is omitted.

### OPTIONAL INPUTS:

**[K]** = (optional, used for OD calibration) Z touch depth. If this input is omitted it is assumed that the probe is already in the correct position.

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

**[M]** = measurement area (centered on the nominal position). MUST BE A POSITIVE VALUE.

**BEFORE USING THIS MACRO:**

The tool compensation for the probe must be active. The tool geometry should be defined with from the center of the sphere for the X axis, and from the center or the edge for the Z axis.

**EXAMPLE 1:** Single X Axis Calibration

```
G28 U0W0
T0101          (Call the turret probe - activate offset)
G98           (Feed Per Minute)
G31 X2.75 Z - 0.25 F100 (Position the probe for single axis touch)
G65 P9201 X 2.25 (Probe Single Axis Calibration Routine)
G28 U0 W0
G99           (Feed Per Revolution)
M30
```

This example call to the X Axis Calibration Cycle probes the X2.25 axis dimension of the calibration target. A single axis touch is made, the direction of the measurement depends on the starting position of the probe.

 **TIPS**

**EXAMPLE 2:** Diameter X axis ID Calibration

```
G28 U0W0
T0101          (Call the turret probe - activate offset)
G98           (Feed Per Minute)
G65 P9211 X0. Z1. F100 (Position the probe for diameter touch)
G65 P9201 D1.15 S1. K-0.23 (Probe Diameter ID Calibration Routine)
G28 U0W0
G99           (Feed Per Revolution)
M30
```

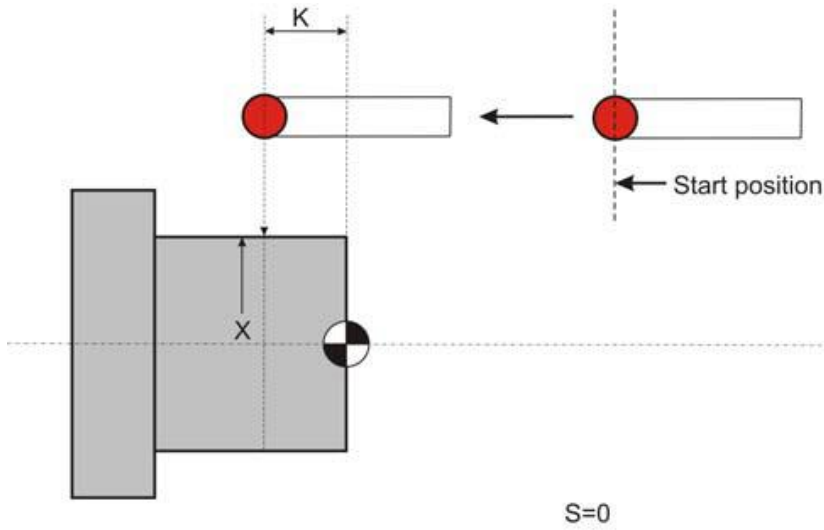
This example calls to the X Axis Calibration Cycle probe's a true internal diameter of the calibration target at a depth of 0.23" from the surface. The given calibration target diameter is 1.15"and the ball diameter of the stylus is 0.236".

If you don't have a calibration gauge, machine a piece and measure the exact diameter within 0.0001". Do not remove the machined piece from the chuck. Use this measurement for calibration

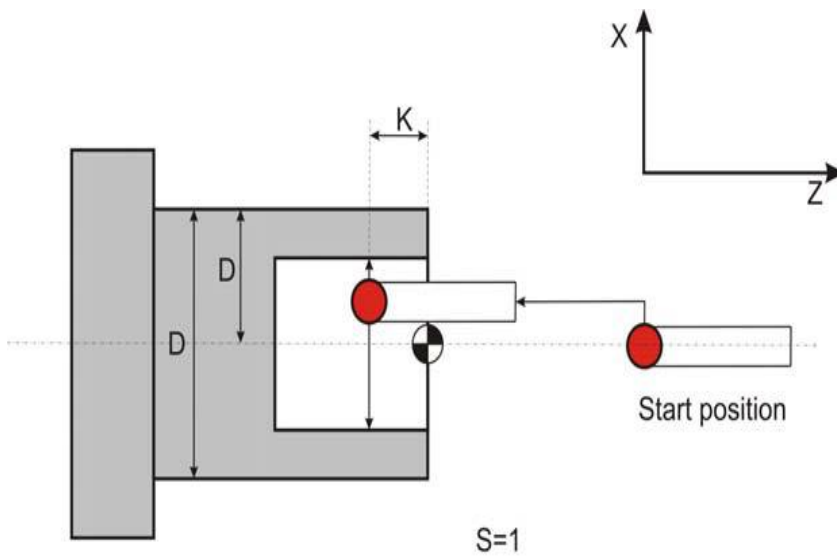
**OUTPUT:**

C1.	C2.	C3.
#561 = X+	#567 = X+	#573 = X+
#562 = X-	#568 = X-	#574 = X-
#563 = Y+	#569 = Y+	#575 = Y+
#564 = Y-	#570 = Y-	#576 = Y-
#565 = Z+	#571 = Z+	#577 = Z+
#566 = Z-	#572 = Z-	#578 = Z-

## OD Calibration Movement



## ID Calibration Movement



## B. CALIBRATING THE Z AXIS (O9202)

**Call up format: G65 P9202 [Z] [S] [D] [K] [C] [M]**

This cycle is used for calibrating the probe in the Z axis. The calibration may be performed in one direction only (Z+ or Z-) or in both directions (Z+ and Z-). Tool compensation must be active.

### **Important:**

The workpiece approach direction depends on the relationship between starting point and the "Z" input corresponding to the calibration master. If the start position on the Z axis is less than the touch position programmed in "Z", the Z+ side of the spherical contact is calibrated; otherwise the Z- side is calibrated. The X axis must be aligned with the touch point before calling up the calibration macro.

If it is necessary to calibrate both sides of the feeler Z+ and Z- (calibration on a groove) the "Z" input must correspond to the nominal position of the groove Z+ surface while the diameter of the groove is defined by the "D" input. If the probe is not already in the touch position, it is positioned automatically in accordance with the "K" input.

### **Final Position:**

The X and Z axes are returned to the start position

### **REQUIRED INPUTS:**

**[Z]** = nominal master Z dimension.

**[S]** = select the master type: S = 1. for ID, S = 2. for OD. If this input is omitted, SINGLE TOUCH calibration is selected automatically.

**[D]** = (calibration on groove/rib only) dimension of the groove (or rib).

### **OPTIONAL INPUTS:**

**[K]** = touch depth in X. If omitted, it is assumed that the probe is already at the correct touch depth.

**[M]** = measurement area (centered on the nominal position). MUST BE A POSITIVE VALUE.

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

**BEFORE USING THIS MACRO:**

The tool compensation for the probe must be active. The tool geometry should be defined with from the center of the sphere for the X axis, and from the center or the edge for the Z axis. The calibration master must be mounted on the spindle

**EXAMPLE 1: Z axis calibration**

```

G28 U0W0
T0101          (Call the probe and activate offset)
G98           (Feed Per Minute)
G65 P9211 X1. Z.5 F100. (Safe position the probe for single axis touch)
G65 P9202 Z-0.5      (Z axis calibration Routine)
G28 U0W0
G99           (Feed Per Revolution)
M30
    
```

This example call to the Z Axis Calibration Cycle probes the Z-0.5 nominal, the direction of travel depends on the Z axis starting point.

**EXAMPLE 2: Z axis groove calibration (double touch)**

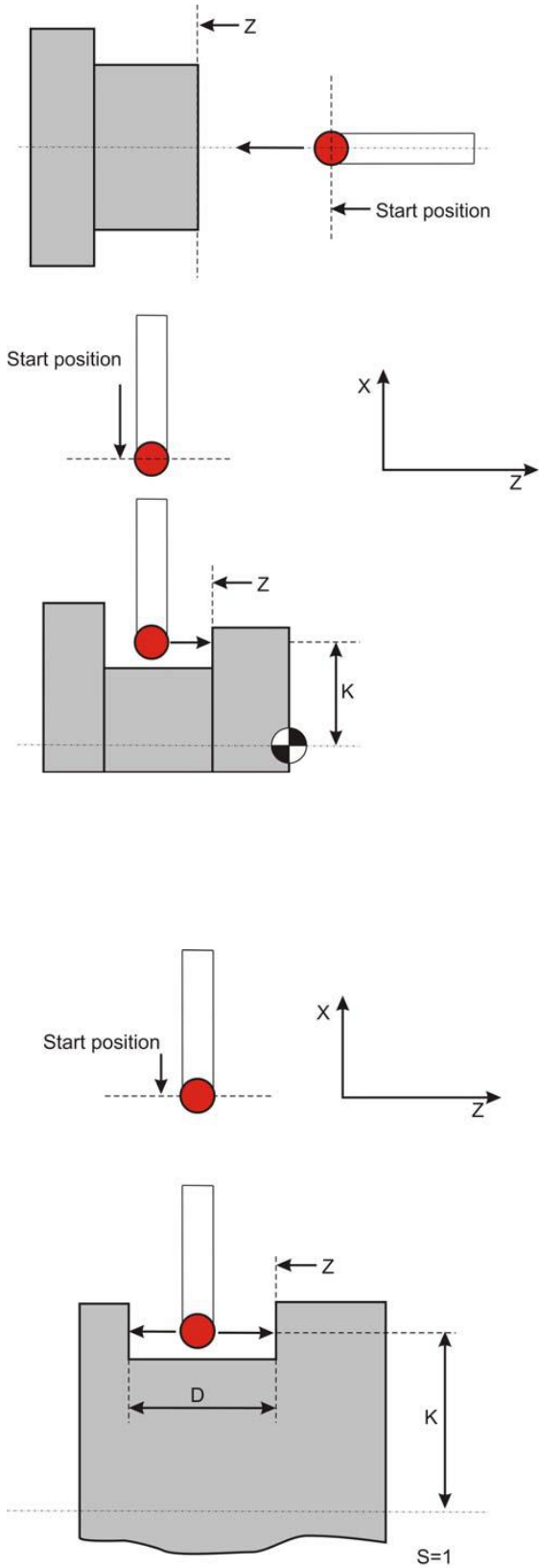
```

G28 U0W0
T0101          (Call the probe and activate offset)
G98           (Feed Per Minute)
G65 P9211 X1.5 Z.-5 F100. (Safe positioning)
G65 P9211 X1.1 F25.      (Safe positioning)
G65 P9202 S1. D.75   (Z axis groove calibration)
G98 U0W0
G99           (Feed Per Revolution)
M30
    
```

This example uses the Z axis calibration cycle on a groove master (OD) with a between groove dimension of .75 inches. The cycle calibrates both Z+ and Z- axes.

**OUTPUTS:**

C1.	C2.	C3.
#561 = X+	#567 = X+	#573 = X+
#562 = X-	#568 = X-	#574 = X-
#563 = Y+	#569 = Y+	#575 = Y+
#564 = Y-	#570 = Y-	#576 = Y-
#565 = Z+	#571 = Z+	#577 = Z+
#566 = Z-	#572 = Z-	#578 = Z-



## C. PROTECTED POSITIONING CYCLE (O9211)

**Call up format: G65 P9211 [X] [Y] [Z] [C] [F]**

This cycle is designed to position the probe close to the workpiece to be measured before executing a measurement or calibration macro. Both "Z" and "X" can be programmed (they may even be programmed simultaneously). All movements are "protected": if an unexpected collision occurs the movement is interrupted and the appropriate error messages appear on the machine display.

### REQUIRED INPUTS:

**[X]** = Absolute position in X.

**[Y]** = Absolute position in Y.

**[Z]** = Absolute position in Z.

**[F]** = Feed rate (default: 1500 mm/min)

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

**Important:** C axis cannot be programmed

**EXAMPLE:**      **G65 P9211 X28.25 Z.8**

This example uses the protected positioning cycle to move the probe to the programmed point; it is monitored for unexpected collisions throughout the movement.

### OUTPUTS:

Alarms in the event of a collision:

PREMATURE X TOUCH DETECTED

PREMATURE Y TOUCH DETECTED

PREMATURE Z TOUCH DETECTED

## D. SINGLE TOUCH IN X (O9212)

**Call up format: G65 P9212 [X] [M] [K] [T] [U] [Q] [C]**

- ❑ This cycle is used to measure an outside or inside diameter in X with a single touch.
- ❑ At the end of the measurement cycle, the X and Z positions coincide with the start positions.
- ❑ It is possible to modify the tool geometry in X.
- ❑ It is possible to print the data on an outside device.
- ❑ The tolerance control is available.

### REQUIRED INPUTS:

**X** = nominal workpiece dimension in X

### OPTIONAL INPUTS:

**[M]** = measurement area (centered on the nominal position). MUST BE A POSITIVE VALUE.

**[K]** = touch depth in Z if omitted it is assumed that the probe is already in position.

**[T]** = tool offset to be compensated, X axis.

**[U]** = +/- workpiece tolerance.

**[W]** = work origin to be set, W54-W59 (G54-G59), W54.001-W54.099 (G54.001-G54.099) for extended work offsets, W110-W129

**[Q]** = print results

**Q** = if omitted no results are printed

**Q** = 1. Print with heading.

**Q** = 2. Print without heading.

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

### BEFORE USING THIS MACRO:

- 1) The probe must be in the measurement position.
- 2) Tool compensation must be active.

**EXAMPLE: G65 P9212 X50. T12. U.025**

This example uses the single touch cycle in X to measure the workpiece with a nominal dimension of 50mm. The workpiece must be within +/- 2mm of the nominal position (50); the tolerance is +/- 0.025mm. The offset applied to tool number 12 (X axis), which corresponds to the tool used to process the measured workpiece, is updated according to the measurement. The cycle is not programmed to print the results

### OUTPUTS:

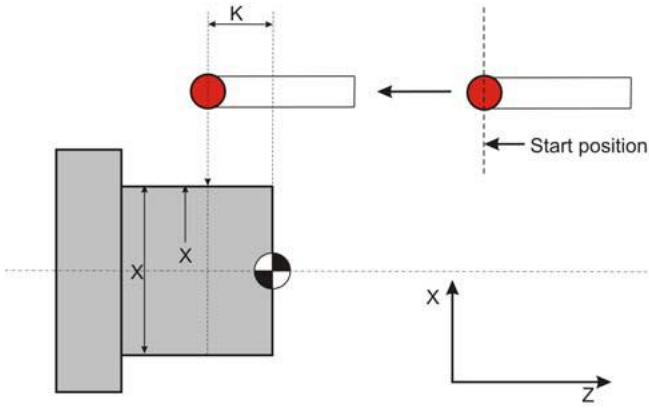
Variable #174 measurement in X.

Error with respect to the nominal dimension in variable #175.

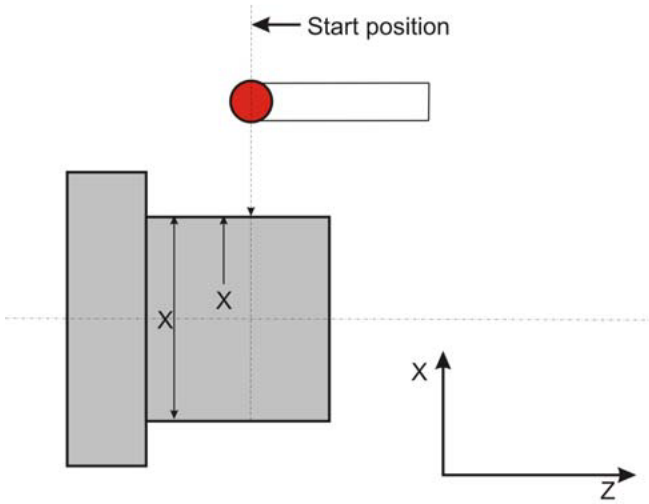
Alarm message: OUT OF TOLERANCE.

Print results (if programmed)





or



## E. SINGLE TOUCH IN Z (O9214)

**Call up format: G65 P9214 [Z] [M] [T] [U] [W] [Q] [C]**

- This cycle is used to measure in Z+ or Z– with a single touch.
- The cycle measures the position in Z.
- It is possible to program the origin shift in Z.
- It is possible to modify the tool offset in Z.

### REQUIRED INPUTS:

**Z** = nominal workpiece position in Z.

### OPTIONAL INPUTS:

**[M]** = measurement area (centered on the nominal position). MUST BE A POSITIVE VALUE.

**[T]** = tool offset to be compensated, Z axis.

**[U]** = +/- workpiece tolerance.

**[W]** = work origin to be set, W54-W59 (G54-G59), W54.001-W54.099 (G54.001-G54.099) for extended work offsets, W110-W129

**[Q]** = print results

**Q** = if omitted no results are printed

**Q = 1.** Print with heading.

**Q = 2.** Print without heading.

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

### BEFORE USING THIS MACRO:

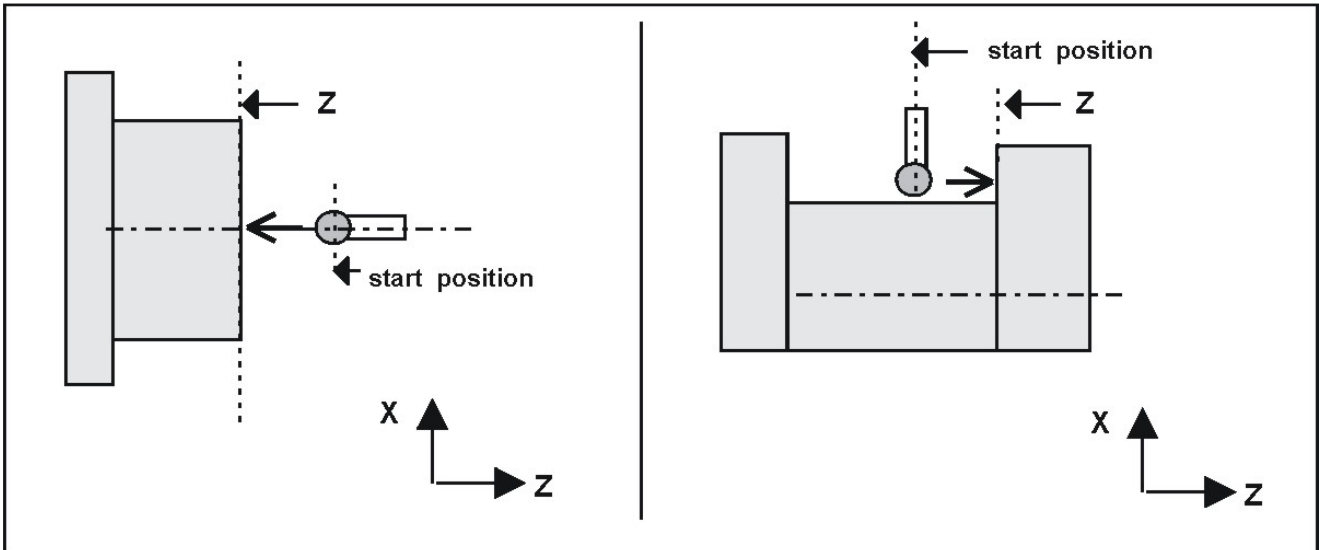
- 1) The probe must be in the measurement position.
- 2) Tool compensation must be active.
- 3) If the tool start position is less than the nominal position ("Z" input) the measurement is performed in direction Z+. Otherwise it is performed in Z–. The position in X must be such that it permits contact with the workpiece during the movement in Z.

**EXAMPLE: G65 P9214 Z-30.25 T12. U.025**

This example uses the single touch cycle in Z to measure the workpiece with a nominal dimension of -30.25mm. The workpiece must be within  $\pm 2$ mm of the nominal position; the tolerance is  $\pm 0.025$ mm. The offset applied to tool number 12 (Z axis), which corresponds to the tool used to process the measured workpiece, is updated according to the measurement. The cycle is not programmed to print the results.

**OUTPUTS:**

Variable #174 measurement in Z.  
 Error with respect to the nominal dimension in variable #175.  
 Alarm message: OUT OF TOLERANCE.  
 Print results (if programmed)



## F. DIAMETER IN X (O9216)

**Call format: G65 P9216 [D] [S] [B] [M] [K] [T] [U] [Q] [C] [W] [A]**

- ❑ This cycle measures an inside or outside diameter with a "touch" in the X axis, a spindle rotation (B), and another "touch" in X axis.
- ❑ It is possible to modify the tool offset in X.
- ❑ At the end of the measurement cycle, the X and Z positions of the axes coincide with the start positions.

### REQUIRED INPUTS:

**D** = nominal workpiece diameter in X.

**S** = select ID – OD.

**S** = 1. Inside diameter (ID)

**S** = 2. Outside diameter (OD)

**S** = 3. Obstructed Inside diameter (ID)

**S** = 4. Cylinder Outside diameter (D) for semi

### OPTIONAL INPUTS:

**[B]** = spindle rotation (180-degree default, range of 45-315)

**[M]** = measurement area (centered on the nominal position). MUST BE A POSITIVE VALUE

**[K]** = touch depth in Z if omitted it is assumed that the probe is already in position

**[T]** = tool offset to be compensated, X axis

**[U]** = +/- workpiece tolerance

**[Q]** = print results

**Q** = if omitted no results are printed.

**Q** = 1. Print with heading.

**Q** = 2. Print without heading.

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

**[W]** = work origin to be set in X with reference to the center of the measured diameter, W54-W59 (G54-G59), W54.001-W54.099 (G54.001-G54.099) for extended work offsets, W110-W129

**[A]** = angle

### BEFORE USING THIS MACRO:

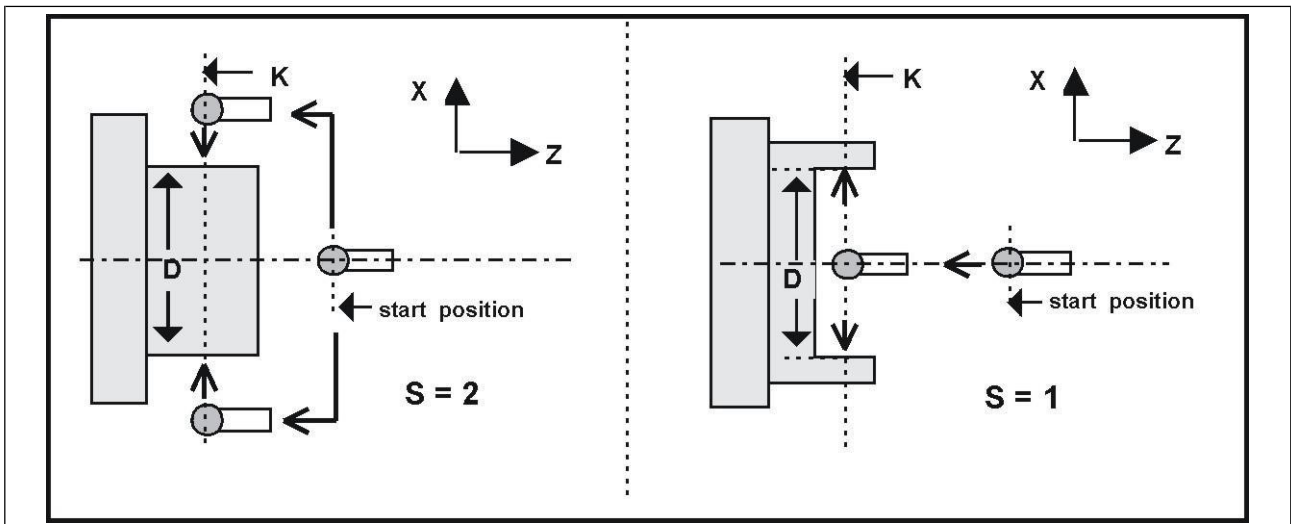
- 1) The probe must be in the measurement position.
- 2) Tool compensation must be active.
- 3) Position the probe at the starting point.
- 4) The X axis must be positioned at the nominal center of the workpiece. The touch depth is determined by the "K" input. If this input is omitted it is assumed that the probe is already in the measurement position.

**EXAMPLE: G65 P9216 D63.10 S1. T12. U.025**

This example measures the nominal inside diameter of 63.10 mm with two touches in X. The measurement area is  $\pm 2$ mm; the tolerance on the diameter is 0.025mm. The offset applied to tool number 12 is modified by a value equivalent to the measured error.

**OUTPUTS:**

- Diameter in X in variable #174.
- Error with respect to the nominal dimension in variable #175.
- Center of the workpiece in X in variable #173.
- Alarm message: OUT OF TOLERANCE
- Print results (if programmed)



## G. MEASURING GROOVES AND RIBS IN Z (O9218)

**Call format: G65 P9218 [D] [S] [M] [K] [U] [Q] [C] [W] [R] [A]**

- This cycle is used to measure grooves or ribs

### REQUIRED INPUTS:

**D** = nominal workpiece diameter in X.

**S** = select ID – OD.

**S** = 1. Inside diameter (ID)

**S** = 2. Outside diameter (OD)

**S** = 3. Obstructed Inside diameter (ID)

**S** = 4. Cylinder Outside diameter (D) for semi

### OPTIONAL INPUTS:

**[M]** = measurement area (centered on the nominal position). **MUST BE A POSITIVE VALUE.**

**[K]** = touch position in X. If omitted it is assumed that the probe is already positioned correctly.

**[R]** = shift height distance in X for rib measurements.

**[U]** = +/- workpiece tolerance.

**[Q]** = print results

**Q** = if omitted no results are printed

**Q** = 1. Print with heading.

**Q** = 2. Print without heading.

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

**[W]** = work origin to be set in Z and C, with reference to the center of the measured groove/rib, W54-W59 (G54-G59), W54.001-W54.099 (G54.001-G54.099) for extended work offsets, W110-W129

**[A]** = angle

### BEFORE USING THIS MACRO:

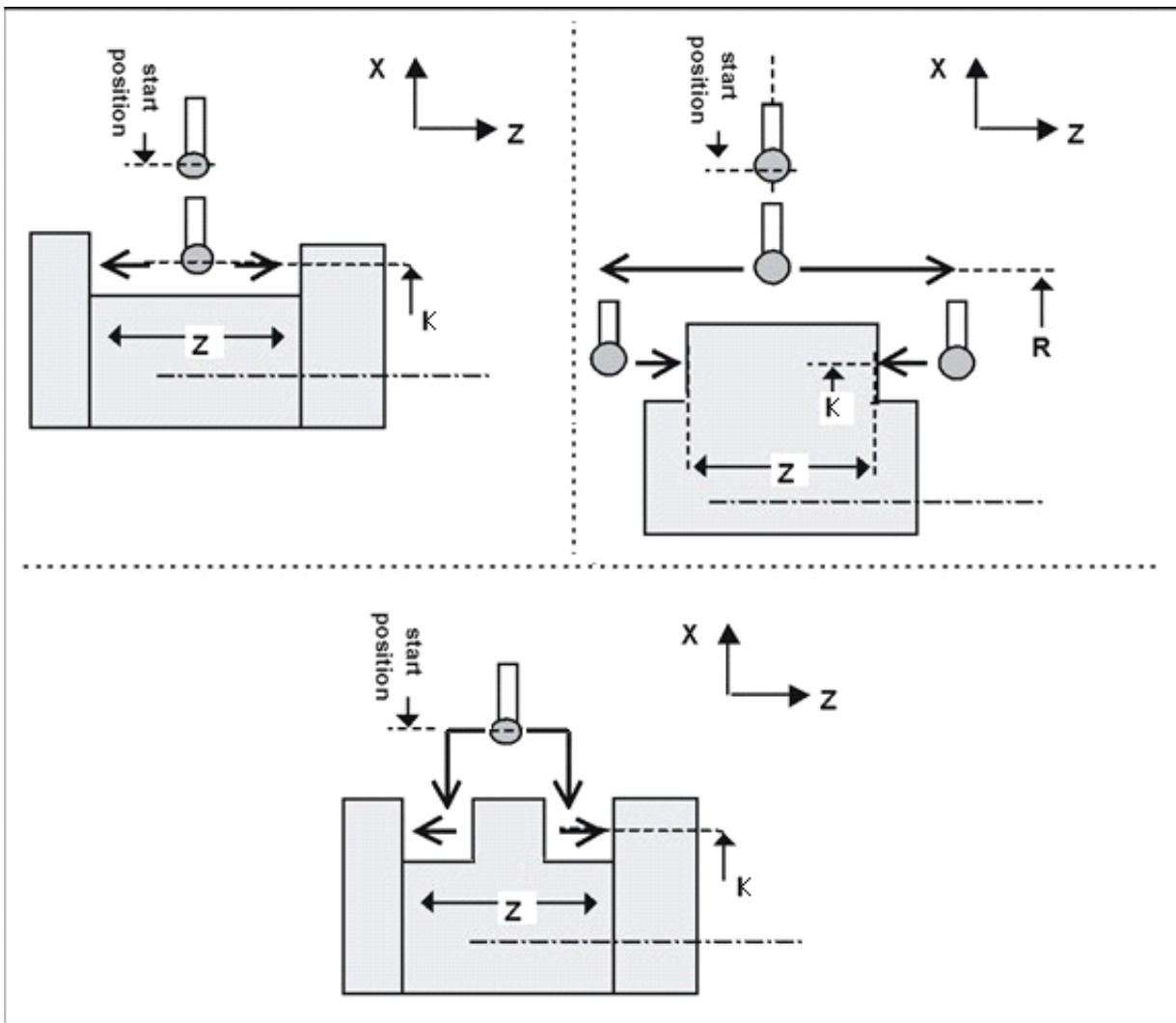
- 1) The probe must be in the measurement position.
- 2) Tool compensation must be active.
- 3) Position the probe at the start point.
- 4) The probe must be positioned in Z so that it corresponds with the nominal center of the groove or rib. The touch position in X is determined by the "I" input. If this input is omitted it is assumed that the probe is already in the measurement position.

**EXAMPLE: G65 P9218 D30.25 S1. U.025**

This example measures a groove (ID) having a nominal dimension of 30.25 mm with two touches in X. The measurement area is  $\pm 2$ mm; the tolerance on the diameter is  $\pm 0.025$ mm. The offset applied to tool number 12 is modified by a value equivalent to the measured error.

**OUTPUTS:**

- Measurement result variable #174.
- Error with respect to the nominal dimension in variable #175.
- Center of the workpiece in Z in variable #173.
- Alarm message: OUT OF TOLERANCE
- Print results (if programmed)



## H. MEASURING GROOVES AND RIBS IN X (O9226)

**Call format: G65 P9226 [D] [S] [M] [K] [U] [Q] [C] [W] [R] [A]**

- This cycle is used to measure grooves or ribs

### REQUIRED INPUTS:

**D** = nominal workpiece diameter in X.

**S** = select ID – OD.

**S** = 1. Inside diameter (ID)

**S** = 2. Outside diameter (OD)

**S** = 3. Obstructed Inside diameter (ID)

**S** = 4. Cylinder Outside diameter (D) for semi

### OPTIONAL INPUTS:

**[M]** = measurement area (centered on the nominal position). **MUST BE A POSITIVE VALUE.**

**[K]** = touch position in X. If omitted it is assumed that the probe is already positioned correctly.

**[R]** = shift height distance in X for rib measurements.

**[U]** = +/- workpiece tolerance.

**[Q]** = print results

**Q** = if omitted no results are printed

**Q** = 1. Print with heading.

**Q** = 2. Print without heading.

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

**[W]** = work origin to be set in Z and C, with reference to the center of the measured groove/rib, W54-W59 (G54-G59), W54.001-W54.099 (G54.001-G54.099) for extended work offsets, W110-W129

**[A]** = angle

### BEFORE USING THIS MACRO:

- 5) The probe must be in the measurement position.
- 6) Tool compensation must be active.
- 7) Position the probe at the start point.
- 8) The probe must be positioned in Z so that it corresponds with the nominal center of the groove or rib. The touch position in X is determined by the "I" input. If this input is omitted it is assumed that the probe is already in the measurement position.

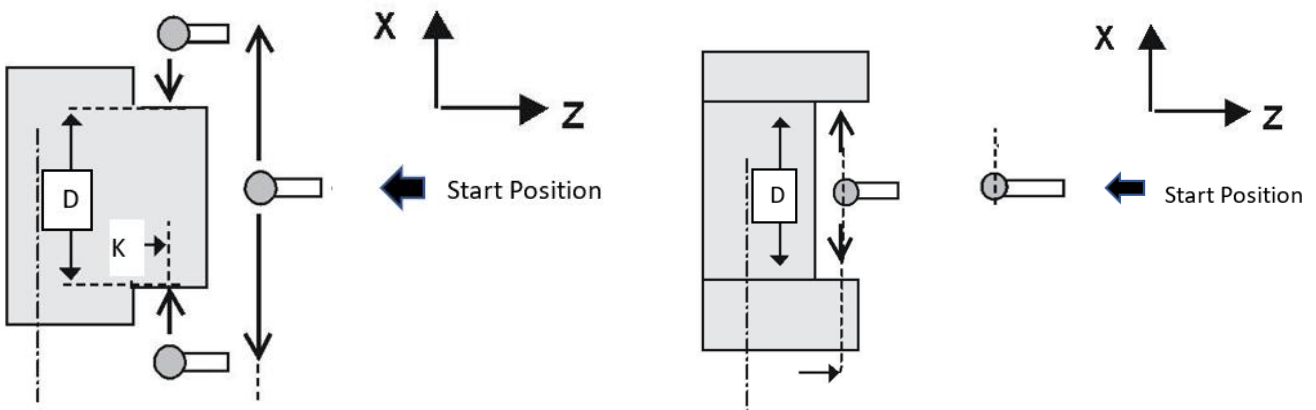


**EXAMPLE: G65 P9226 D30.25 S1. U.025**

This example measures a groove (ID) having a nominal dimension of 30.25 mm with two touches in X. The measurement area is  $\pm 2$ mm; the tolerance on the diameter is  $\pm 0.025$ mm. The offset applied to tool number 12 is modified by a value equivalent to the measured error.

**OUTPUTS:**

Measurement result variable #174.  
 Error with respect to the nominal dimension in variable #175.  
 Alarm message: OUT OF TOLERANCE  
 Print results (if programmed)



## **Chapter 3 – X, Z, C Machine Configuration Programs**

## I. DIAMETER IN X WITH CENTER SEARCH IN C (O9221)

### G65 P9221 [D] [S] [M] [K] [U] [Q] [C] [R] [T] [A] [F] [W]

- This cycle measures an inside and outside diameter calculating them along the rotation axis C first, then using a "double touch" on the X axis (X– and X+).
- It is possible to modify the tool offset in X.
- It is possible to set up a working offset in X and C with respect to the determined center.
- At the end of the measurement cycle, the X and Y positions of the axes coincide with the start positions.

#### REQUIRED INPUTS:

**D** = nominal workpiece dimension in Z.

**S** = select ID – OD.

**S** = 1. Inside diameter (ID)

**S** = 2. Outside diameter (OD)

#### OPTIONAL INPUTS:

**[M]** = measurement area (centered on the nominal position). MUST BE A POSITIVE VALUE

**[K]** = touch depth in Z if omitted it is assumed that the probe is already in position

**[T]** = tool offset to be compensated, X axis

**[U]** = +/- workpiece tolerance

**[R]** = home position in Z [default: start position in Z]

**[Q]** = print results

**Q** = if omitted no results are printed.

**Q** = 1. Print with heading.

**Q** = 2. Print without heading.

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

**[A]** = Angle for C axis [default:30]

**[F]** = feed rate for C axis

**[W]** = work origin to be set, W54-W59 (G54-G59), W54.001-W54.099 (G54.001-G54.099) for extended work offsets, W110-W129

#### BEFORE USING THIS MACRO:

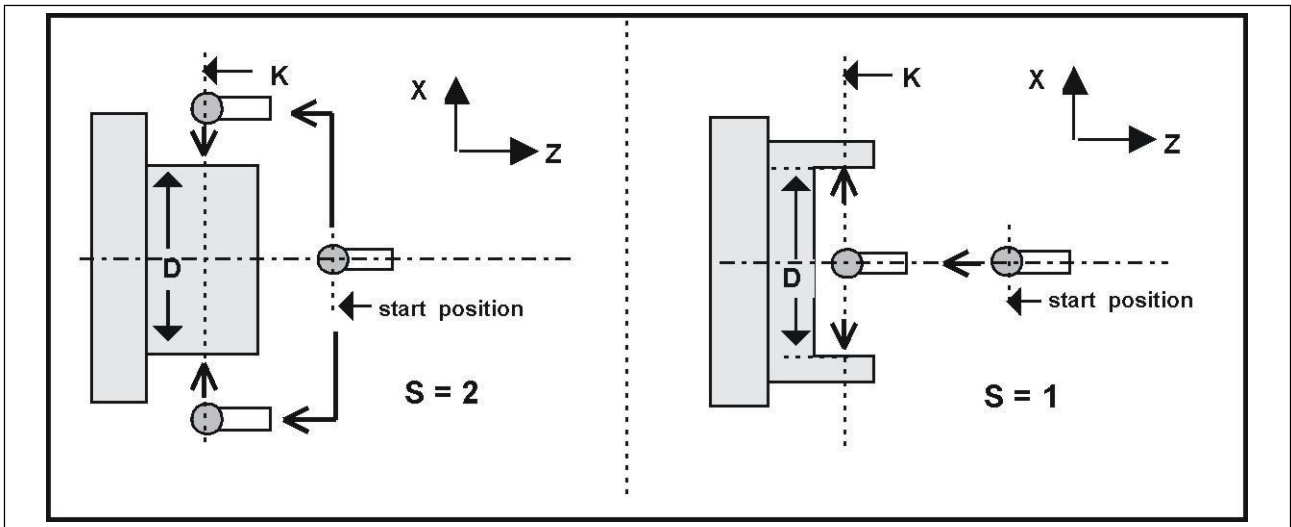
- 1) The probe must be in the measurement position.
- 2) Tool compensation must be active.
- 3) Position the probe at the start point.
- 4) The X axis must be positioned in the nominal center of the workpiece. The touch depth is determined by the "K" input. If this input is omitted it is assumed that the probe is already in the measurement position.

**EXAMPLE: G65 P9221 D63.10 S1. T12. U.025**

This example measures the nominal inside diameter of 63.10 mm with two touches in X. The measurement area is  $\pm 2$ mm; the tolerance on the diameter is 0.025mm. The offset applied to tool number 12 is modified by a value equivalent to the measured error.

**OUTPUTS:**

Diameter in X in variable #174.  
 Error with respect to the nominal dimension in variable #175.  
 Center of the workpiece in X in variable #173.  
 Center of the workpiece in C in variable #172.  
 Alarm message: OUT OF TOLERANCE  
 Print results (if programmed)



## J. MEASURING WIDTH IN Z WITH CENTER SEARCH IN C (O9222)

### G65 P9222 [D] [S] [M] [K] [U] [Q] [C] [R] [T] [W] [A] [F]

- This cycle measures a groove or a rib, calculating them along the rotation axis C first, then using a "double touch" on the Z axis (Z– and Z+).
- It is possible to set up a working offset in Z and C with respect to the determined center.
- At the end of the measurement cycle, the X and Y positions of the axes coincide with the start positions.

#### REQUIRED INPUTS:

**D** = nominal workpiece dimension in Z.  
**S** = select ID – OD.  
**S** = 1. Inside diameter (ID)  
**S** = 2. Outside diameter (OD)

#### OPTIONAL INPUTS:

**[M]** = measurement area (centered on the nominal position). MUST BE A POSITIVE VALUE.  
**[K]** = touch position in X. If omitted it is assumed that the probe is already positioned correctly.  
**[T]** = tool offset to be compensated, X axis.  
**[U]** = +/- workpiece tolerance.  
**[R]** = shift height in X for rib measurements. [default: start position in X]  
**[Q]** = print results  
**Q** = if omitted no results are printed  
**Q** = 1. Print with heading.  
**Q** = 2. Print without heading.  
**[W]** = work origin to be set, W54-W59 (G54-G59), W54.001-W54.099 (G54.001-G54.099) for extended work offsets, W110-W129  
**[C]** = calibration data location [default: 1.-- from 1. to 3.]  
**[A]** = Angle for C axis [default:30]  
**[F]** = feed rate for C axis

#### BEFORE USING THIS MACRO:

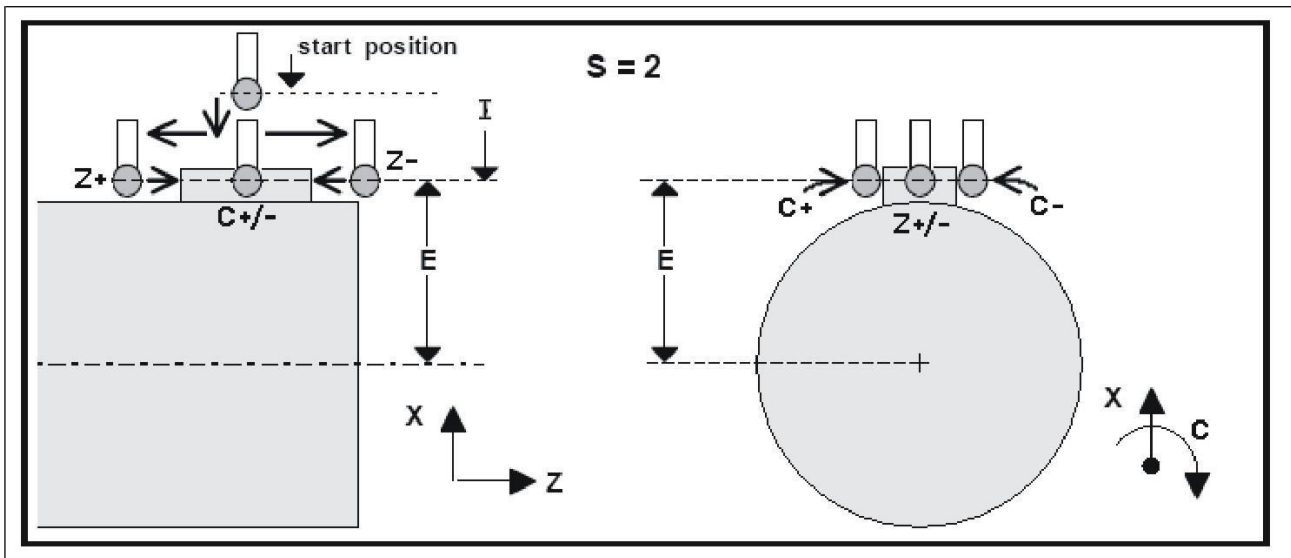
- 1) Tool compensation must be active.
- 2) Position the probe at the start point.
- 3) The probe must be positioned in Z so that it corresponds with the nominal center of the groove or rib. The touch position in X is determined by the "I" input. If this input is omitted it is assumed that the probe is already in the measurement position.

**EXAMPLE: G65 P9222 D30.25 S1. U.025**

This example measures a groove (ID) having a nominal dimension of 30.25 mm with two touches in Z, after having determined the position of the center along the C rotary axis (using two touches). The default measurement area is  $\pm 3$ mm; the tolerance on the diameter is  $\pm 0.025$ mm.

**OUTPUTS:**

Dimension measured in Z in variable #174.  
 Error with respect to the nominal dimension in variable #175.  
 Center of the workpiece in Z in variable #173  
 Center of the workpiece in C in variable #172.  
 Alarm message: GROOVE/RIB IN OUT OF TOLERANCE  
 Print results (if programmed)



## K. CENTER SEARCH WITH C AXIS MOVEMENT (O9223)

### G65 P9223 [S] [C] [A] [F] [J] [K] [R] [W]

- This cycle determines the position of the center of a diameter in X or Y or a groove/rib in Z along the C rotary axis
- It is possible to set up a working offset in C with respect to the determined center.
- At the end of the measurement cycle, the X and Y positions of the axes coincide with the start positions.

#### REQUIRED INPUTS:

**S** = select ID – OD.

**S** = 1. Inside diameter (ID)

**S** = 2. Outside diameter (OD)

#### OPTIONAL INPUTS:

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

**[J]** = axis for depth of touch (1=X, 2=Y, Z=3)

**[K]** = touch position in X or Y or Z If omitted it is assumed that the probe is already positioned correctly.

**[R]** =shift height for outside diameter/rib measurements [default: start position]

**[A]** = Angle for C axis [default:30]

**[F]** = feed rate for C axis

**[W]** = work origin to be set, W54-W59 (G54-G59), W54.001-W54.099 (G54.001-G54.099) for extended work offsets, W110-W129

#### BEFORE USING THIS MACRO:

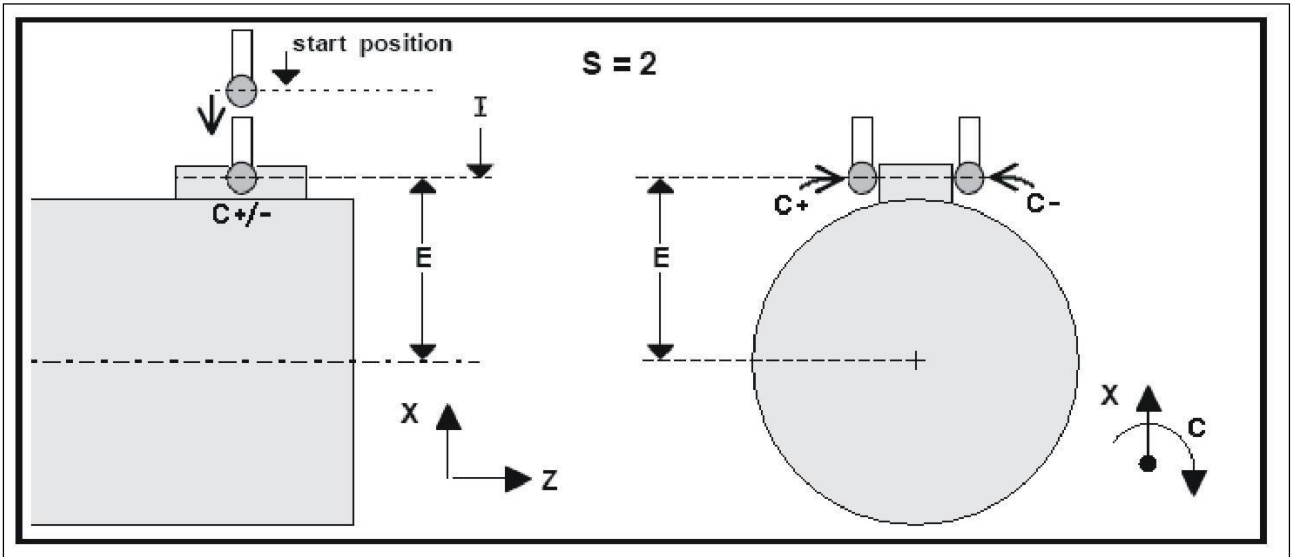
- 1) The probe must be in the measurement position.
- 2) Tool compensation must be active
- 3) Position the probe at the start point.
- 4) The probe must be positioned in X or Y so that it corresponds with the nominal center of the diameter to be measured, or in Z so that it corresponds with the nominal center of the groove or rib. The touch position in either X or Y or Z is determined by the "J" and "K" input. If this input is omitted it is assumed that the probe is already in the measurement position.

**EXAMPLE: G65 P9223 S1.**

This example measures an inside diameter with two touches in C axis.

**OUTPUTS:**

Center of workpiece in C in variable #173.





## **Chapter 4 – X, Y, Z, C Machine Configuration Programs**

## L. CALIBRATING THE Y AXIS (O9203 & O9204)

**Call up format: G65 P9203 [Y] [S] [D] [K] [C] [M] – YZ SIDE**

**Call up format: G65 P9204 [Y] [S] [D] [K] [C] [M] – XY SIDE**

This cycle is used for calibrating the probe in the Y axis. The calibration may be performed in one direction only (Radius) or in both directions (Diameter). Either a ring (O.D.) or a cylinder (I.D.) may be used as a calibration master, provided its dimensions are known.

### **Start position:**

#### **- SINGLE TOUCH:**

The probe must be positioned in the Y axis so that spherical feeler touches the calibration master on the correct side (Y+ or Y-). The probe must be positioned in the Z axis so that the spherical feeler is at the desired touch depth. Alternatively, the cycle positions the probe automatically at the depth programmed at the input "K".

#### **- ID:**

The probe must be positioned at the center of the calibration master Y axis. The probe must be positioned in the Z axis so that the spherical feeler is at the desired touch depth. Alternatively, the cycle positions the probe automatically at the depth programmed at the input "K".

#### **- OD:**

The probe must be positioned at the center of the calibration master Y axis. The touch depth must be programmed via the input "K".

### **FINAL POSITION:**

The Y and Z or X axes are returned to the start position.

### **REQUIRED INPUTS:**

**[Y]** = (single touch only) nominal Y dimension.

**[S]** = select the master type: S = 1. for ID, S = 2. for OD. If this input is omitted, SINGLE TOUCH calibration is selected automatically.

**[D]** = Calibration master diameter, required only if "S" = 1 or 2, do not enter this value "S" is omitted.

### **OPTIONAL INPUTS:**

**[K]** = (optional, used for OD calibration) X or Z touch depth. If this input is omitted it is assumed that the probe is already in the correct position.

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

**[M]** = measurement area (centered on the nominal position). MUST BE A POSITIVE VALUE.

**BEFORE USING THIS MACRO:**

The tool compensation for the probe must be active. The tool geometry should be defined with from the center of the sphere for the Y axis, and from the center or the edge for the Z axis.

**EXAMPLE 1: G65 P9203 Y20.25**

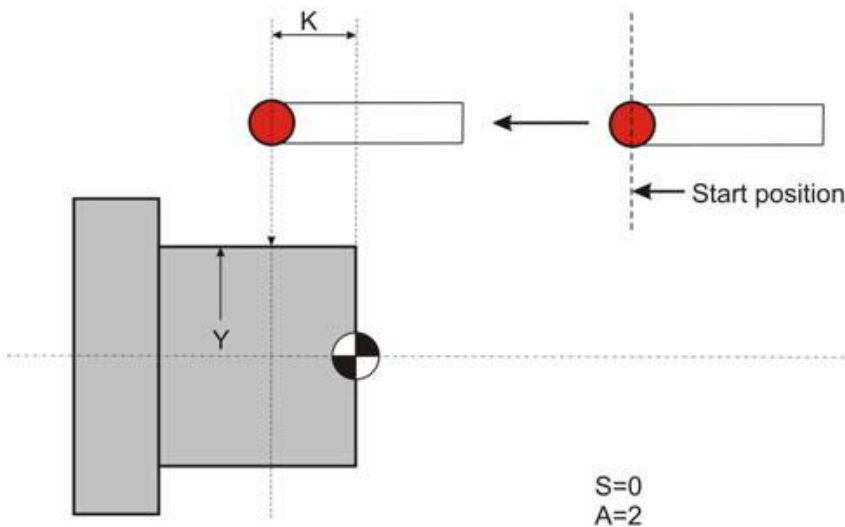
This example uses the Y axis calibration cycle; the nominal Y dimension of the master is 20.25. The cycle executes a single touch. The touch direction (Y+ or Y-) is determined by the probe start position.

**EXAMPLE 2: G65 P9203 S1. D40.15**

This example uses the Y axis calibration cycle on a ring master (ID) with an inside diameter of 40.15 mm.

**OUTPUT:**

C1.	C2.	C3.
#561 = X+	#567 = X+	#573 = X+
#562 = X-	#568 = X-	#574 = X-
#563 = Y+	#569 = Y+	#575 = Y+
#564 = Y-	#570 = Y-	#576 = Y-
#565 = Z+	#571 = Z+	#577 = Z+
#566 = Z-	#572 = Z-	#578 = Z-



## M. CALIBRATING THREE POINT DIAMETER (O9205 & O9206)

Call up instruction: G65 P9205 [A] [B] [C] [S] [D] [E] [K] [M] – XY SIDE

Call up instruction: G65 P9206 [A] [B] [C] [S] [D] [E] [K] [M] – YZ SIDE

- This cycle is used to measure an outside dimension boss, or an inside dimension hole when the approach is at an angle and only 3 points are touched on the circle.
- The X and Y centerline position and size are determined by this cycle.
- Tool cutter compensation offsets may be adjusted to correct for errors from nominal found by probing.
- Work offsets may be set to the probed position of the workpiece in the X or Y axis.
- A printed report may also be generated (see Appendix C).
- Alarm messages may be output if the position or size is out of tolerance.

### REQUIRED INPUTS:

**A = 1st angle of touch (0 - 360.)**

**B = 2nd angle of touch (0 - 360.)**

**C = 3rd angle of touch (0 - 360.)**

**S = ID or OD selection (S1. for ID, S2. for OD)**

### OPTIONAL USER INPUTS:

**[D]** = New Diameter of calibration master.

**[E]** = calibration data location [default: 1.-- from 1. to 3.]

**[K]** = The X or Z axis depth of touch [default: the 'X' or 'Z' position just before the start of the Single Surface Cycle]. K is required for OD calibration

**[M]** = The measuring zone from nominal position [default: .1" or 2.54 mm].



#### TIPS

Either [W]  
or [T] can  
be  
selected

Do not try  
to use both  
in the  
same call.

Set your  
work offset

**BEFORE USING THIS CYCLE:**

The probe must be positioned to the center of the workpiece.

**EXAMPLE: G65 P9205 D1. 3 S2. A30. B150. C270. E2.**

This example calls to the three-point cycle to set the work offset of a 1.3-inch O.D. measured at three different points given by the A, B and C. The O.D. is checked at a depth of 0.25 “. The calibration values are stored in the second probe location (E2.) given by common variable #567, #568 and #569.

**OUTPUTS:**

E1.	E2.	E3.
#561 = Y+/Y-	#567 = Y+/Y-	#573 = Y+/Y-
#562 = Y+/Y-	#568 = Y+/Y-	#574 = Y+/Y-
#563 = Y+/Y-	#569 = Y+/Y-	#575 = Y+/Y-
#564 =	#570 =	#576 =
#565 =	#571 =	#577 =
#566 =	#572 =	#578 =

**NOTE:** This cycle may be called as needed to satisfy manufacturing requirements.



## N. CALIBRATING THE XY OR YZ AXIS ANGLE (O9207 & O9208)

**Call up format: G65 P9207 [A] [S] [D] [K] [C] [M] – XY SIDE**

**Call up format: G65 P9208 [A] [S] [D] [K] [C] [M] – YZ SIDE**

This cycle is used for calibrating the probe in the XY & YZ axis. The calibration performed in both directions (Diameter). Either a ring (O.D.) or a cylinder (I.D.) may be used as a calibration master, provided its dimensions are known.

### Start position:

#### - ID:

The probe must be positioned at the center of the calibration master XY & YZ axis. The probe must be positioned in the Z or X axis so that the spherical feeler is at the desired touch depth. Alternatively, the cycle positions the probe automatically at the depth programmed at the input "K".

#### - OD:

The probe must be positioned at the center of the calibration master XY & YZ axis. The touch depth must be programmed via the input "K" .

### FINAL POSITION:

The X, Y and Z axis are returned to the start position.

### REQUIRED INPUTS:

**[A]** = Angle

**[S]** = select the master type: S = 1. for ID, S = 2. for OD.

**[D]** = Calibration master diameter

### OPTIONAL INPUTS:

**[K]** = (optional, used for OD calibration) Z or X touch depth. If this input is omitted it is assumed that the probe is already in the correct position.

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

**[M]** = measurement area (centered on the nominal position). MUST BE A POSITIVE VALUE.

### BEFORE USING THIS MACRO:

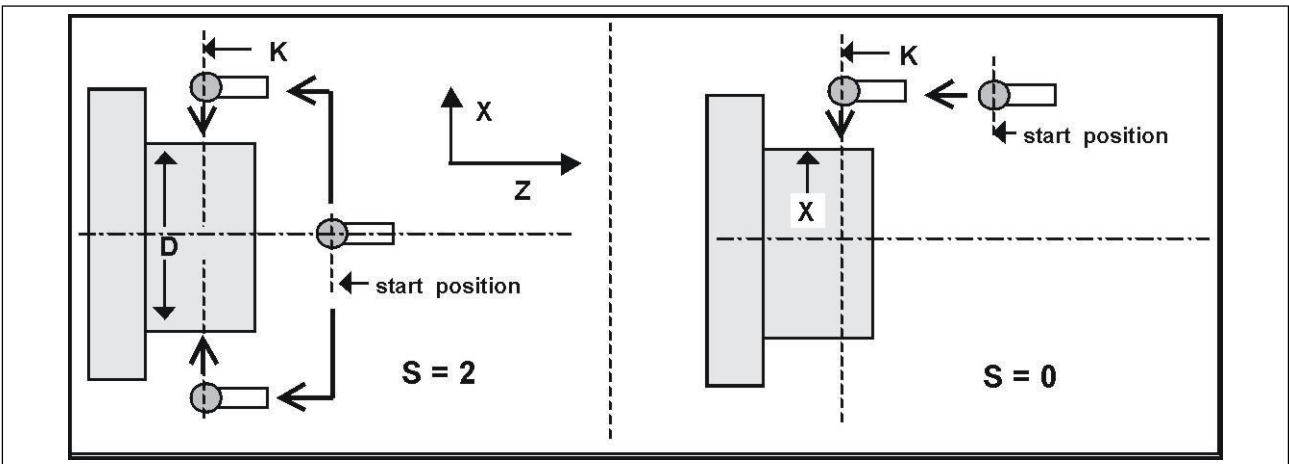
The tool compensation for the probe must be active. The tool geometry should be defined with from the center of the sphere for the XY & YZ axis, and from the center or the edge for the Z or X axis.

**EXAMPLE: G65 P9207 A30. S1. D40.15**

This example uses the 30-degree angle XY & Z axis calibration cycle on a ring master (ID) with an inside diameter of 40.15 mm.

**OUTPUTS:**

E1.	E2.	E3.
#561 = X+	#567 = X+	#573 = X+
#562 = X-	#568 = X-	#574 = X-
#563 = Y+	#569 = Y+	#575 = Y+
#564 = Y-	#570 = Y-	#576 = Y-
#565 = Z+	#571 = Z+	#577 = Z+
#566 = Z-	#572 = Z-	#578 = Z-



## O. SINGLE TOUCH IN Y (O9213)

**Call up format: G65 P9213 [Y] [M] [K] [T] [U] [W] [Q] [C]**

- This cycle is used to measure an outside or inside diameter in Y with a single touch.
- At the end of the measurement cycle, the Y and Z positions coincide with the start positions.
- It is possible to modify the tool geometry in Y.
- It is possible to print the data on an outside device.
- The tolerance control is available.

### REQUIRED INPUTS:

**Y** = nominal workpiece dimension in Y

### OPTIONAL INPUTS:

**[M]** = measurement area (centered on the nominal position). MUST BE A POSITIVE VALUE.

**[K]** = touch depth in Z if omitted it is assumed that the probe is already in position.

**[T]** = tool offset to be compensated, Y axis.

**[U]** = +/- workpiece tolerance.

**[W]** = work origin to be set, W54-W59 (G54-G59), W54.001-W54.099 (G54.001-G54.099) for extended work offsets, W110-W129

**[Q]** = print results

**Q** = if omitted no results are printed

**Q** = 1. Print with heading.

**Q** = 2. Print without heading.

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

### BEFORE USING THIS MACRO:

1. The probe must be in the measurement position.
2. Tool compensation must be active.
3. Probe starting position: In the case of an ID measurement, the probe may be positioned close to the touch surface in Y, and at the definitive touch depth in Z; otherwise, if the probe is a long way from the workpiece, it is positioned at the correct measurement depth, in accordance with the "K" input. The same conditions apply for an OD measurement.

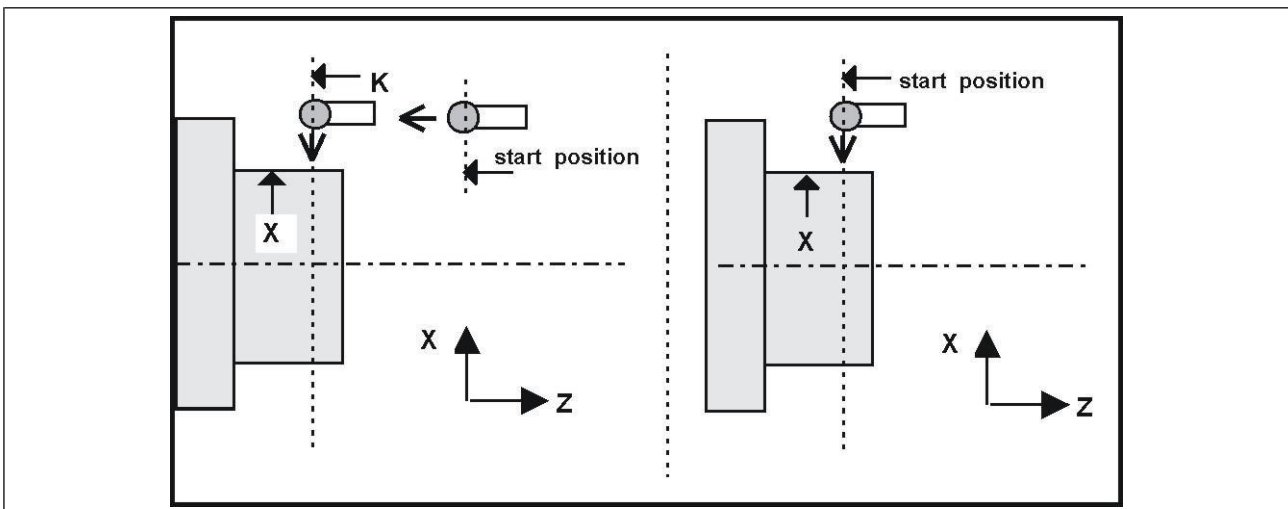


**EXAMPLE: G65 P9213 Y50. T12. U.025**

This example uses the single touch cycle in Y to measure the workpiece with a nominal dimension of 50mm. The workpiece must be within +/- 2mm of the nominal position (50); the tolerance is +/- 0.025mm. The offset applied to tool number 12 (Y axis), which corresponds to the tool used to process the measured workpiece, is updated according to the measurement. The cycle is not programmed to print the results.

**OUTPUTS:**

Variable #174 measurement in Y.  
 Error with respect to the nominal dimension in variable #175.  
 Alarm message: OUT OF TOLERANCE.  
 Print results (if programmed)



## P. THREE POINT DIAMETER MEASUREMENT (O9215 & O9225)

Call format: G65 P9215 [A] [B] [C] [D] [S] [E] [K] [M] [Q] [T] [U] [W] – XY SIDE

Call format: G65 P9225 [A] [B] [C] [D] [S] [E] [K] [M] [Q] [T] [U] [W] – YZ SIDE

- This cycle is used to measure an outside dimension boss, or an inside dimension hole when the approach is at an angle and only 3 points are touched on the circle.
- The X and Y centerline position and size are determined by this cycle.
- Work offsets may be set to the probed position of the workpiece in the X or Y axis.
- A printed report may also be generated (see Appendix C).
- Alarm messages may be output if the position or size is out of tolerance.

### MANDATORY INPUTS:

**A = 1st angle of touch (0 — 360.)**

**B = 2nd angle of touch (0 — 360.)**

**C = 3rd angle of touch (0 — 360.)**

**D = Nominal size or diameter**

**S = ID or OD selection (S1. for ID, S2. for OD, S3. for obstructed center)**

### OPTIONAL USER INPUTS:

**[E] = calibration data location [default: 1.-- from 1. to 3.]**

**[K] = The Z or X axis depth of touch [default: the 'Z' position just before the start of the Single Surface Cycle]. (Not valid for Z axis probing.)**

**K is mandatory for Boss**

**[M] = The measuring zone from nominal position [default: .1" or 2.54 mm].**

**[U] = The ± tolerance on size (if omitted no tolerance check).**

**[T] = The number of times the program needs to be run for better accuracy of true position.**

[default: the program is run once]. The location of the calibration value stored by program **09205**.

**[W] = work origin to be set with reference to the center of the measured diameter, W54-W59 (G54-G59), W54.001-W54.099 (G54.001-G54.099) for extended work offsets, W110-W129**

**[Q] = The print out report flag.**

If Q is omitted no report is generated.

Q = 1. — probe cycle report is generated with headings.

Q = 2. — probe cycle report is generated without headings (for input to a spreadsheet).



TIPS

Either [W]  
or [T] can  
be  
selected

Do not try  
to use both  
in the  
same call.

Set your  
work offset

### BEFORE USING THIS CYCLE:

- 1). The probe must be calibrated using program 09205 (09215) or 09206 (09225)
- 2). The probe must be positioned to the center of the workpiece.

### EXAMPLE: G65 P9215 D1. 3 S2. A30. B150. C270. E2. W59.

This example calls to the three-point cycle to set the work offset of a 1.3-inch O.D. measured at three different points given by the A, B and C. The O.D. is checked at a depth of 0.25 “.

### OUTPUTS:

<p><b>#174 = Average diameter.</b></p> <p><b>#175 = Error compared to nominal.</b></p> <p><b>Selected work offset updated (if ‘W’ option selected).</b></p> <p><b>Alarm (SURFACE LOC. OUT OF TOL.)</b></p>
--

**NOTE:** *This cycle may be called as needed to satisfy manufacturing requirements.*



## Q. DIAMETER IN Y (O9217 & O9219)

**Call format: G65 P9217 [D] [S] [B] [M] [K] [T] [U] [Q] [C] [W] [A] – XY SIDE**

**Call format: G65 P9219 [D] [S] [B] [M] [K] [T] [U] [Q] [C] [W] [A] – YZ SIDE**

- This cycle measures an inside or outside diameter with a "touch" in the Y axis, a spindle rotation (B), and another "touch" in Y axis.
- It is possible to modify the tool offset in Y.
- At the end of the measurement cycle, the Y and Z positions of the axes coincide with the start positions.

### REQUIRED INPUTS:

**D** = nominal workpiece diameter in Y.

**S** = select ID – OD.

**S** = 1. Inside diameter (ID)

**S** = 2. Outside diameter (OD)

**S** = 3. Obstructed Inside diameter (ID)

**S** = 4. Cylinder Outside diameter (OD) for semi

### OPTIONAL INPUTS:

**[B]** = spindle rotation (180-degree default, range of 45-315)

**[M]** = measurement area (centered on the nominal position). **MUST BE A POSITIVE VALUE**

**[K]** = touch depth in **Z** or **X** if omitted it is assumed that the probe is already in position

**[T]** = tool offset to be compensated, Y axis

**[U]** = +/- workpiece tolerance

**[Q]** = print results

**Q** = if omitted no results are printed.

**Q** = 1. Print with heading.

**Q** = 2. Print without heading.

**[C]** = calibration data location [default: 1.-- from 1. to 3.]

**[W]** = work origin to be set in Y with reference to the center of the measured diameter, W54-W59 (G54-G59), W54.001-W54.099 (G54.001-G54.099) for extended work offsets, W110-W129

**[A]** = angle

### BEFORE USING THIS MACRO:

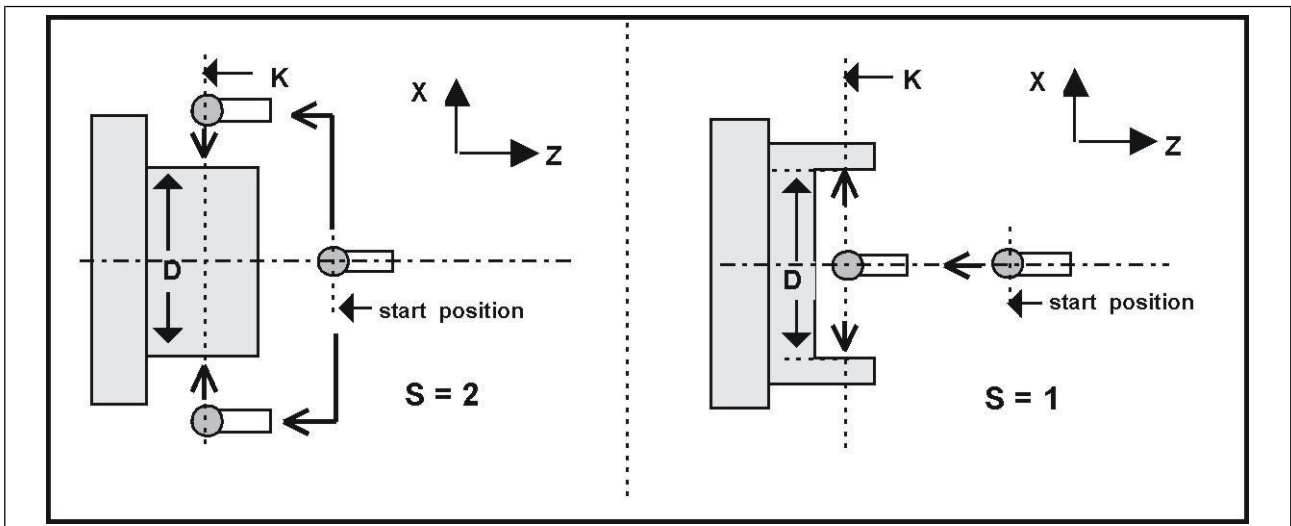
- 1) The probe must be in the measurement position.
- 2) Tool compensation must be active.
- 3) Position the probe at the starting point.

**EXAMPLE: G65 P9217 D63.10 S1. T12. U.025**

This example measures the nominal inside diameter of 63.10 mm with two touches in Y. The measurement area is  $\pm 2$ mm; the tolerance on the diameter is 0.025mm. The offset applied to tool number 12 is modified by a value equivalent to the measured error.

**OUTPUTS:**

**#174 = Average diameter.**  
**#175 = Error compared to nominal.**  
**Selected work offset updated (if 'W' option selected).**  
**Alarm (SURFACE LOC. OUT OF TOL.)**



## **R. APPENDICES**

## 19.1 Basic movement in X Y and Z.

Call format:

- G65 P9200 X
- G65 P9200 Y
- G65 P9200 Z

These cycles are called up directly by the measurement macro and consist of sub-programs that contain the basic movements in X, Y and Z. These cycles are completely transparent to the operator; hence they are not accessible and must not be modified in any way.

### **INPUT (defined in the measurement macro):**

- a. **X** = nominal position in X for the cycle
- b. **Y** = nominal position in Y for the cycle
- c. **Z** = nominal position in Z for the cycle

The measurement window (input M) is defined according to the nominal position in X, Y or Z. The measurement is carried out in three distinct movements. During the first movement the probe is moved to the nominal position minus "M" (e.g. X-M) at high speed, using the function G31. The second movement brings the probe into contact with the workpiece at low speed, again using the function G31. This second movement is extended to the nominal position plus "M" (e.g. X+M). The third movement returns the probe to the start position at high speed. The approach and touch speed values are set up in the cycle O9260.

## 19.2 Printing the Measurement Data

### G65 P9264 Q X Y Z

This sub-program controls the CN serial output and sends the measurement data to a printer or PC. The printout is "driven" by the variable Q that is "transferred" by all the measurement macros. The value of Q determines whether the data are printed with or without headings.

**Q** = print input

**Q** = omitted: no data are printed [default]

**Q** = 1. Print with headings.

**Q** = 2. Print without headings.

**X** = nominal dimension

**Y** = measured dimension.

**Z** = permissible tolerance

The error is determined by subtracting the measurement from the nominal dimension.

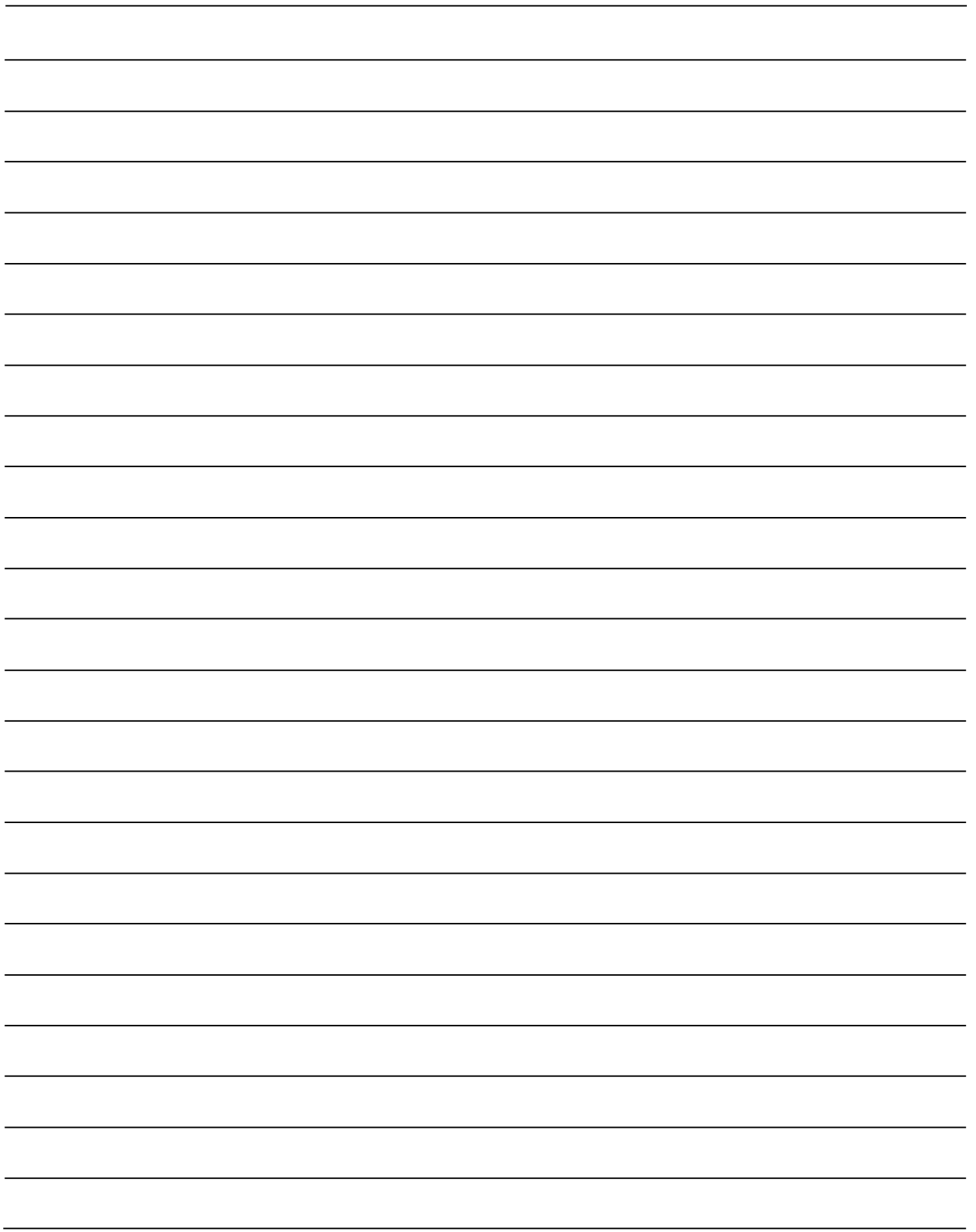
#### EXAMPLE

NOMINAL	ACTUAL	TOL.	ERROR
-----	-----	-----	-----
1.2345	1.2347	0.001	0.0002



### 19.3 Table of Variables

#156				#556
#157				#557
#158				#558
#159				#559
#160				<b>#560 INCH or METRIC</b>
<b>#161 FAST</b>		<b>FEED</b>		<b>#561 X + CALIBRATION (1)</b>
#162				<b>#562 X -</b>
<b>#163 SKIP</b>		<b>FEED</b>		<b>#563 Y +</b>
<b>#164 X WEAR</b>		<b>OFFSET</b>		<b>#564 Y -</b>
<b>#165 Y WEAR</b>		<b>OFFSET</b>		<b>#565 Z +</b>
<b>#166 Z WEAR</b>		<b>OFFSET</b>		<b>#566 Z -</b>
#167				#567 X + CALIBRATION (2)
<b>#168 PROBE</b>		<b>OFF</b>		#568 X -
<b>#169 *</b>				#569 Y +
<b>#170 SKIP WU</b>				#570 Y -
<b>#171 SKIP WX</b>				#571 Z +
<b>#172 SKIP WY</b>				#572 Z -
<b>#173 SKIP WZ</b>				#573 X + CALIBRATION (3)
<b>#174c DIAMETER</b>		<b>STYLUS BALL</b>		#574 X -
<b>#175 1 = 0 ~999.</b>				#575 Y +
#176				#576 Y -
#177				#577 Z +
#178				#578 Z -
#179				#579
#180				#580
#181				#581
#182				#582
<b>#183 INCH or METRIC</b>				#583
<b>#184 C</b>				#584
<b>#185 Y</b>				#585
<b>#186 Z</b>				#586
#187 *				#587
#188 *				#588
#189 *				#589
#190 *				#590
#191 *				#591
#192 *				#592
#193 *				#593
#194				#594
#195				#595
#196				#596
#197				#597
#198				#598
#199				#599





*Printed in USA*