Programming guide
H-2000-6795-0D-A

RENISHAW
apply innovation™

Inspection Plus with tilted working plane software for Doosan SMX machines with Fanuc control

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Form 1

EQUIPMENT REGISTRATION RECORD

Please complete this form (and Form 2 overleaf if applicable) after the Renishaw equipment has been installed on your machine. Keep one copy yourself and return a copy to your local Renishaw Customer Support office (for contact details, see **www.renishaw.com/contact**). The Renishaw Installation Engineer should normally complete these forms.

MACHINE DETAILS

Machine description ....

Machine type ....

Controller ....

Special control options ....

....

....

RENISHAW HARDWARE	**RENISHAW SOFTWARE**
Inspection probe type	Inspection software media ....
Interface type	....
	....
Tool setting probe type	Tool setting software media ....
Interface type	....
	....

SPECIAL SWITCHING M-CODES (OR OTHER) WHERE APPLICABLE

	Dual systems only
Switch (Spin) probe on	Switch on inspection probe ....
Switch (Spin) probe off	Switch on tool setting probe ....
Start/Error signal	Other ....
	....

ADDITIONAL INFORMATION

☐ Tick box if Form 2 overleaf has been filled in.

Customer's name	Date installed ....
Customer's address	
....	Installation engineer ....
....	
....	Date of training ....
Customer's tel. no.	
Customer's contact name	

Form 2

SOFTWARE DEVIATION RECORD

Standard Renishaw kit no.	Software media nos.
Reason for deviation	
Software no. and macro no.	Comments and corrections

The software product for which these changes are authorised is subject to copyright.

A copy of this deviation sheet will be retained by Renishaw plc.

A copy of the software amendments must be retained by the customer – it cannot be retained by Renishaw plc.

Caution – Software safety

The software you have purchased is used to control the movements of a machine tool. It has been designed to cause the machine to operate in a specified manner under operator control, and has been configured for a particular combination of machine tool hardware and controller.

Renishaw has no control over the exact program configuration of the controller with which the software is to be used, nor over the mechanical layout of the machine. Therefore, it is the responsibility of the person putting the software into operation to:

- ensure that all machine safety guards are in position and are correctly working before commencement of operation;
- ensure that any manual overrides are disabled before commencement of operation;
- verify that the program steps invoked by this software are compatible with the controller for which they are intended;
- ensure that any moves which the machine will be instructed to make under program control would not cause the machine to inflict damage upon itself or upon any person in the vicinity;
- be thoroughly familiar with the machine tool and its controller, understand the operation of work co-ordinate systems, tool offsets, program communication (uploading and downloading) and the location of all emergency stop switches.

IMPORTANT: This software makes use of controller variables in its operation. During its execution, adjustment of these variables, including those listed within this manual, or of tool offsets and work offsets, may lead to malfunction. Ensure that all variable and program numbers required and/or used by the Renishaw system are not used by any other function or software package already installed on the CNC machine tool.

Example code format

For clarity, code examples contained within this document are shown with spaces separating each input of the program call. In practice, it is not a requirement that these spaces be included.

For example, the following code:

G65 P9814 D50.005 Z100. E21. F0.8 H0.2 M0.2 Q10. R10. S1. T20. U0.5 V0.5 W2.

may be entered as:

G65P9814D50.005Z100.E21.F0.8H0.2M0.2Q10.R10.S1.T20.U0.5V0.5W2.

NOTE: Code examples may be shown with input data followed by a decimal point. Some controllers may operate correctly with these decimal points omitted, however, care should be taken to determine that this is the case before running any programs.

Programming methods

Two programming methods are available with this version of Inspection Plus software:

- Inspection Plus – traditional G-code programming providing maximum flexibility and functionality.

- GoProbe – easy and intuitive programming allowing the creation of probe routines using simple, single-line commands that call up underlying Inspection Plus code.

  Manual (or “jog”) mode is a quick and easy way of performing part set-up routines without the requirement for an existing work co-ordinate system (WCS).

  Some Inspection Plus functionality is not available when programming using GoProbe – most notably print functionality.

Table of contents

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Chapter 1 – Before you begin

Contained in this chapter

Before you begin

This programming manual contains detailed information on using the Inspection Plus software for programming, operating and controlling your machine tools.

Comprising 12 self-contained chapters and two appendices, the manual is structured to provide the information you require to use the Inspection Plus software effectively:

- Chapter 1, “Before you begin”, describes how to install the Inspection Plus software on your machine.
- Chapter 2, “Optional inputs”, describes the optional inputs that are used with some of the macro cycles.
- Chapter 3, “Variable outputs”, provides a complete list of the outputs that are produced by some of the macro cycles.
- Chapter 4, “Protected positioning cycles”, describes how to use the protected positioning macros (O9610 and O9810). When correctly used, these macros prevent damage to the probe’s stylus in the event of the probe colliding with the workpiece.
- Chapter 5, “Calibrating the probe”, explains why a probe’s stylus must be calibrated before you start using it, then describes how to use macro O8000 that is provided for calibrating a probe using a datum sphere.
- Chapter 6, “Measuring cycles”, describes how to use the non-vector measuring cycle macros.
- Chapter 7, “Vector measuring cycles”, describes how to use the vector measuring cycle macros.
- Chapter 8, “Additional cycles”, describes how to use the macro cycles that are not described in previous chapters.
- Chapter 9, “C-axis cycles”, describes how to use C-axis measuring cycles.
- Chapter 10, “Tilted working plane (TWP) measuring cycles”, describes how to use the probe with G368 or G68.1 active and with the B axis at an angle other than 0° or −90°.
- Chapter 11, “Rotated work co-ordinate system (WCS) setting”, describes how to select and load the rotated WCS setting cycles. The cycles enable the setting of a WCS when the feature co-ordinate system (FCS) is not aligned to the machine co-ordinate system (MCS).
- Chapter 12, “Macro alarms and error messages”, describes the macro alarm numbers or messages that are displayed on the screen of the control when an error occurs. An explanation of the meaning and possible cause of each alarm message is provided, together with typical actions you must take to correct the fault causing the message.

Measurement values used in this manual

Throughout this manual metric units of measurement (for example, millimetres) are used in the examples. Where appropriate, the equivalent imperial values (for example, inches) are shown in brackets.

Inch and metric modes

Renishaw software is written to run in either inch or metric mode; the software automatically detects which mode is being run.

Calibration data is not converted, so either the probe will need recalibrating or the values in macro variables will need to be converted manually.

Associated publications

When you are using the Inspection Plus software, you may find it useful to refer to the following Renishaw publication:

- Installation manual *Probe systems for machine tools* (Renishaw part no. H-2000-6040).

Machine types

This software is intended for use on the SMX/MX range of machines. It may also function on other Y-axis lathes with minor differences.

- Examples in this manual show the program format for SMX/MX machines.
- Axis numbers for SMX/MX machines are normally as follows:

  X=1
  Z=2
  C=3
  B=4
  Y=5

NOTE: The axis numbers may change depending on machine construction. Refer to the settings for further information.

Software kit

The kit comprises the following item:

- Software media assembly: part no. A-4012-1151

The software media contains the following data:

Probe at B−90 cycles	File1
Probe at B0 cycles	File2
C-axis cycles and datum sphere calibration macros	File3
GoProbe cycles	File 4

Macro memory requirements

This section lists the amount of memory (in kilobytes) that is required by all macros contained on the software media. Before you load macros, first calculate the total amount of memory required by the macros you wish to load. Next, check that the machine controller has sufficient memory capacity for these macros.

File1: total amount of memory = 40 KB.

File2: total amount of memory = 35 KB.

File3: total amount of memory = 25 KB.

File4: total amount of memory = 11 KB.

Macro numbers and functions

File1

O9721	X diameter move
O9722	Y diameter move
O9723	Active tool offset macro
O9724	Settings macro
O9726	XYZ basic move
O9727	Vector diameter move
O9730	Print macro
O9731	Vector calibration data find (also used for ATAN calculation)
O9732	Offset update macro
O9744	FCS to MCS calculation
O9800	Bore/boss centre line find
O9801	Probe length calibration
O9802	Stylus XY offset calibration
O9803	XY stylus ball radius calibration
O9804	Vector stylus ball radius calibration
O9810	Protected positioning
O9811	XYZ single surface measure
O9812	Web/pocket measure
O9814	Bore/boss measure
O9819	Bore/boss on PCD

O9821	Angled single surface measure
O9822	Angled web/pocket measure
O9823	3-point bore/boss measure
O9834	Feature-to-feature measure

File2

O9521	Z diameter move
O9522	Y diameter move
O9526	XYZ basic move
O9527	Vector diameter move
O9530	Print macro
O9531	Vector calibration data find (also used for ATAN calculation)
O9600	Bore/boss centre line find
O9601	Probe length calibration
O9602	Stylus ZY offset calibration
O9603	XY stylus ball radius calibration
O9604	Vector stylus ball radius calibration
O9610	Protected positioning
O9611	XYZ single surface measure
O9612	Web/pocket measure
O9614	Bore/boss measure
O9619	Bore/boss on PCD
O9621	Angled single surface measure
O9622	Angled web/pocket measure
O9623	3-point bore/boss measure
O9634	Feature-to-feature measure

File3

O8000	Sphere calibration macro (S1)
O9545	C-axis basic move (S2)
O9551	C-axis offset update (S2)
O9550	C-axis basic move (S1)
O9551	C-axis offset update (S1)
O9618	C-axis measure – B0 (S1)
O9643	ZY angle measure – B0
O9650	C-axis find – B0 (S1)
O9818	C-axis measure – B−90 (S1)
O9830	Multi-stylus store
O9831	Multi-stylus load
O9832	User start
O9833	User end
O9840	C-axis measure – B0 (S2)
O9841	C-axis find – B0 (S2)
O9842	C-axis measure – B−90 (S2)
O9843	XY angle measure – B−90
O9849	C-axis find – B−90 (S2)
O9850	C-axis find – B−90 (S1)

File 4

O8898	GoProbe start config
O8899	GoProbe end config
O9901	B−90 GoProbe cycle
O9902	B0 GoProbe cycle
O9700	GoProbe error messages

Probe set-up

This software will only function correctly if the stylus of the probe is “clocked in” true.

Calibration

The probe must be calibrated before it is used for the first time for measurement, and whenever the stylus is changed. Calibration will set the following:

- The position of the ball centre to tool offset.
- The effective ball radius.
- The effective X or Z tool offset.

Calibrating a probe using a datum sphere

The sphere calibration method is the preferred method for calibrating the probe and is described on pages 5-4 to 5-6 of Chapter 5, “Calibrating the probe”. If you choose to use this method to calibrate your probe and stylus, you will need a datum sphere. A suitable datum sphere calibration kit can be purchased from Renishaw – contact your nearest Renishaw sales office for further details.

Probe on/off

M-codes are used to switch on (M74) and switch off (M73) the probe. These codes must be inserted into the User start and User end macros.

Read-ahead control

Fast machining or smoothing control options can cause block read-ahead problems when running a cycle. Refer to “Editing the active offset and read-ahead program – O9723” in Appendix A, “Features, settings, limitations and applications”.

X-axis positional input

This software works with the X input as a *radius* as if the machine is in milling mode.

The software automatically selects the correct machine modes. See User start and User end for further details.

Order of I, J and K cycle inputs

It is important that the order of these inputs is maintained when programming relevant cycles. Failure to do so may lead to incorrect moves or results.

Examples:

G65 P9xxx I30. J10. K9. ✓

G65 P9xxx K9. J10. I30. ✗

Tool offset

A J input must be used along with the tool number to determine the update type.

Examples:

T20. J1000. = Update X wear, tool offset 20 (turning tool)
T20. J2000. = Update Z wear, tool offset 20 (turning tool)
T20. J3000. = Update radius, tool offset 20 (milling tool)
T20. J4000. = Update length, tool offset 20 (milling tool)

Multiple offsets for the same tool can be updated by using a decimal point followed by the offset number. If no decimal point is used, it will be assumed that offset number 1 is used.

Example:

T20.3 J1000. = Update X wear, tool offset 20, offset number 3

Updating turning tool offsets used at any B-axis angle

The J input can be used to correctly update tools used at B-axis positions other than −90°, 0° or 90°.

The machine corrects the tool wear at B0 and rotates this through to the B-axis angle at which the tool is used. The software calculates the required tool wear update values to apply. The B-axis angle at which the tool is used must be entered using the J input.

Example: Update X turning tool wear used at B−45

T20. J−1045. = Update X wear, tool offset 20 (turning tool)

NOTE: The software will update the X and Z wear values to give the correct X wear at B−45.

Example: Update Z turning tool wear used at B20

T20. J2020. = Update Z wear, tool offset 20 (turning tool)

NOTE: The software will update the X and Z wear values to give the correct Z wear at B20.

Updating tool offsets of the lower turret

The probe cycles used in the upper turret/head program can directly update tools on the lower turret. This can be achieved using the J input.

Examples:

T20. J7000. = Update X wear, lower turret tool offset 20 (turning tool)
T20. J8000. = Update Z wear, lower turret tool offset 20 (turning tool)
T20. J9000. = Update radius, lower turret tool offset 20 (milling tool)

Using the software with multi-buffer options

Some controllers now offer a multi-buffer option. If you intend using this software with the multi-buffer option, you must use the relevant command to read only one block ahead.

NOTE: Your machine controller may have a similar option available and turned on. Please check your controller documentation before proceeding.

The G5.1 command is used to limit read-ahead. Insert this into the O9832 User start macro. Insert the cancellation command into the O9833 User end macro.

Example:

```
O9832(REN*USER/PROBE*START)
(USER*INPUTS*HERE*************)
G5.1 Q0

O9833(REN*USER/PROBE*END)
(USER*INPUTS*HERE*************)
G5.1 Q1
```

Installing the software

It is important that the Inspection Plus software is installed to suit the type of controller and options available. Do this as described below:

1. First, refer to Appendix A, “Features, settings, limitations and applications”, to determine whether the Inspection Plus software is suitable for your needs.
2. Decide which cycles you require before proceeding (see the section titled “Macro memory requirements” earlier in this chapter).
3. Load the basic cycles in File1.
4. If you require cycles for probing at B0, load File2.
5. If you require cycles for probing the C axis, load all files in File3. Probe calibration and User start / User end macros have to be loaded from here.

Setting the #506 back-off distance

For small and medium-sized machines – that is, machines that have less than 1000 mm (40 in) of axis travel – the standard feedrates as supplied are normally acceptable. However, if you need to adjust the #506 back-off distance and #119 fast feedrate, see Appendix A, “Features, settings, limitations and applications”, for a description of the use of macro variables.

Editing the settings macro – O9724

If the default values are not suitable, you will need to edit the settings macro O9724. For a description of macro O9724, see Appendix A, “Features, settings, limitations and applications”.

Set the following options:

- Work offset type.
- Tolerance alarms or flag only (FMS type application).
- Tool offset type.

The examples in this publication are for general guidance only. Note that the exact programming format may not suit either your machine set-up or the method recommended by your machine builder.

Renishaw customer services

Calling Renishaw

If you have a question about the software, first consult the documentation and other information included with your product.

If you cannot find a solution, you can receive information on how to obtain customer support by contacting the Renishaw company that serves your country (for worldwide contact details, see **www.renishaw.com/contact**).

When you call, it will help the Renishaw support staff if you have the appropriate product documentation at hand. Please be prepared to give the following information (as applicable):

- The software version you are using (see the EQUIPMENT REGISTRATION RECORD FORM).
- The type of hardware that you are using (see the EQUIPMENT REGISTRATION RECORD FORM).
- The error number and wording of any message that appears on your screen.
- A description of what happened and what you were doing when the problem occurred.
- A description of how you tried to solve the problem.

Chapter 2 – Optional inputs

This chapter describes the optional inputs that are used with some of the macros. You will be referred to this chapter from other chapters when an optional input is available.

Further information about optional inputs is described in Appendix A, “Features, settings, limitations and applications”.

Contained in this chapter

Optional inputs

The examples described below assume that the controller has been configured for metric values (millimetres). The equivalent inch measurement values are shown in brackets.

Bb b = Angle tolerance of the surface, e.g. 30° ±1° inputs A30. B1.

Example: B5. to set a tolerance of 5°.

Ee e = Experience value.

Specify the number of a spare tool offset where an adjustment value to the measured size is stored (see Appendix A, “Features, settings, limitations and applications”).

Example: E21. causes the experience value stored in tool offset 21 to be applied to the measured size.

Ff f = This can be either of the following:

1. The percentage feedback that is used when updating a tool offset (see Appendix A, “Features, settings, limitations and applications”).

   Enter a value between 0. and 1. (0% and 100%).

   Default value: 1. (100%)

2. The feedrate that is used in the protected positioning macros O9810 and O9610 (see Chapter 4, “Protected positioning cycles”).

   Example: F15. sets a feedrate of 15 mm/min.
   (F0.6 sets a feedrate of 0.6 in/min.)

Jj j = The tool update type. This must be used when using the Tt input.

Example: J1000. = Update X wear (turning tool)
J2000. = Update Z wear (turning tool)
J3000. = Update radius (milling tool)
J4000. = Update length (milling tool)
J7000. = Update lower turret X wear
J8000. = Update lower turret Z wear
J9000. = Update radius (milling tool)
J−1045. = Update X wear (turning tool used at B−45)
J2020. = Update Z wear (turning tool used at B20)

Hh h = The tolerance value of a feature dimension being measured.

Example: For a dimension of 50 mm +0.4 mm –0 mm, the nominal tolerance is 50.2 mm with H0.2.
(For a dimension of 1.968 in +0.016 in –0 in, the nominal tolerance is 1.976 in with H0.008.)

Mm	m =	The true position tolerance of a feature. This is a cylindrical zone about the theoretical position. **Example:** M0.1 sets a true position tolerance of 0.1 mm. (M0.004 sets a true position tolerance of 0.004 in.)
Qq	q =	The probe overtravel distance for use when the default values are unsuitable. The probe will then travel beyond the expected position when it searches for a surface. **Default values:** 4 mm (0.16 in) in the Z axis and 10 mm (0.394 in) in the X and Y axes. **Example:** Q8. sets an overtravel distance of 8 mm. (Q0.3 sets an overtravel distance of 0.3 in.)
Rr	r =	This is an incremental dimension that is used in external features, such as bosses and webs, to give a radial clearance from the nominal target surface prior to a Z-axis move. **Default value:** 5 mm (0.200 in) **Example:** R10. sets a radial clearance of 10 mm. (R0.4 sets a radial clearance of 0.4 in.)
R−r	–r =	This is similar to Rr, except that the clearance is applied in the opposite direction to force an internal boss or web cycle. **Default value:** 5 mm (0.200 in). **Example:** R–10. sets a radial clearance of –10 mm. (R–0.4 sets a radial clearance of –0.4 in.)
Ss	s =	The work offset number that will be set. S1. to S6. (G54 to G59). S0. (external work offset). S101. to S400. (G54.1 P1 to G54.1 P300) additional offsets option. New work offset = active work offset + error. New external offset = external offset + error. **Example:** S3. sets G56.
Tt	t =	The tool offset number to be updated. This must be used with the Jj input. **Example:** T20. J1000. updates the X wear of tool offset number 20
Uu	u =	Upper tolerance limit. If this value is exceeded, no tool offset or work offset is updated and the cycle stops with an alarm. Where applicable, this tolerance applies to both the size and position. **Example:** U2. to set the upper tolerance limit to 2 mm. (U0.08 to set the upper tolerance limit to 0.08 in.)

Vv	v =	Null band.
		This is the tolerance zone in which no tool offset adjustment occurs.
		Default value: 0
		Example: V0.5 for a tolerance zone of ±0.5 mm. (V0.02 for a tolerance zone of ±0.02 in.)
Ww	w =	Print the output data.
		W1. = Increment the feature number only.
		W2. = Increment the component number and reset the feature number.
		Example: W1.

Chapter 3 – Variable outputs

This chapter lists the variable outputs that are produced by some of the macros. You will be referred to this chapter from other chapters when a variable output is produced.

Contained in this chapter

Variable outputs (probe at B−90) – table 1

	Single surface	Web/pocket	Bore/boss	C-axis measure	PCD bore/boss	X/Y angle measure
	G65 P9811	G65 P9812	G65 P9814	G65 P9818/ G65 P9842	G65 P9819	G65 P9843
#135	X position	X position	X position		X position	
#136	Y position	Y position	Y position		Y position	
#137	Z position				PCD	
#138	Size	Size	Size		Size	
#139				Angle	Angle	Angle
#140	X error	X error	X error		X error	
#141	Y error	Y error	Y error		Y error	
#142	Z error				PCD error	
#143	Size error	Size error	Size error	Height error	Size error	Height error
#144				Angle error	Angle error	Angle error
#145	True position error	True position error	True position error		True position error	
#146	Metal condition	Metal condition	Metal condition		Metal condition	
#147	Direction indicator				Hole number	
#148	Out of tolerance flag (1 to 7)					
#149	Probe error flag (0 to 2)					
#150	X error in feature co-ordinate system (FCS) for WCS updating					
#151	Y error in feature co-ordinate system (FCS) for WCS updating					
#152	Z error in feature co-ordinate system (FCS) for WCS updating					

Variable outputs (probe at B−90) – table 2

	Angled single surface	Angled web/ pocket	3-point bore/boss	Feature-to-feature	C-axis find
	G65 P9821	G65 P9822	G65 P9823	G65 P9834	G65 P9850/ G65 P9849
#135	X position	X position	X position	X incremental distance	
#136	Y position	Y position	Y position	Y incremental distance	
#137				Z incremental distance	
#138	Size from start	Size	Size	Minimum distance	
#139				Angle	C position
#140	X error	X error	X error	X error	
#141	Y error	Y error	Y error	Y error	
#142				Z error	
#143	Size error	Size error	Size error	Minimum distance error	
#144				Angle error	C error
#145	True position error	True position error	True position error	True position error	
#146	Metal condition	Metal condition	Metal condition	Metal condition	
#147	Direction indicator				
#148	Out of tolerance flag (1 to 7)				
#149	Probe error flag (0 to 2)				
#150	X error in feature co-ordinate system (FCS) for WCS updating				
#151	Y error in feature co-ordinate system (FCS) for WCS updating				
#152	Z error in feature co-ordinate system (FCS) for WCS updating				

Variable outputs (probe at B0) – table 3

	Single surface	**Web/pocket**	**Bore/boss**	**C-axis measure**	**PCD bore/boss**	**X/Y angle measure**
	G65 P9611	G65 P9612	G65 P9614	G65 P9618/ G65 P9840	G65 P9619	G65 P9643
#135	X position	X position	X position		X position	
#136	Y position	Y position	Y position		Y position	
#137	Z position				PCD	
#138	Size	Size	Size		Size	
#139				Angle	Angle	Angle
#140	X error				X error	
#141	Y error	Y error	Y error		Y error	
#142	Z error	Z error	Z error		PCD error	
#143	Size error	Size error	Size error	Height error	Size error	Height error
#144				Angle error	Angle error	Angle error
#145	True position error	True position error	True position error		True position error	
#146	Metal condition	Metal condition	Metal condition		Metal condition	
#147	Direction indicator				Hole number	
#148	Out of tolerance flag (1 to 7)					
#149	Probe error flag (0 to 2)					
#150	X error in feature co-ordinate system (FCS) for WCS updating					
#151	Y error in feature co-ordinate system (FCS) for WCS updating					
#152	Z error in feature co-ordinate system (FCS) for WCS updating					

Variable outputs (probe at B0) – table 4

	Angled single surface	Angled web/ pocket	3-point bore/boss	Feature-to-feature	C-axis find
	G65 P9621	G65 P9622	G65 P9623	G65 P9634	G65 P9650/ G65 P9841
#135	X position	X position	X position	X incremental distance	
#136	Y position	Y position	Y position	Y incremental distance	
#137				Z incremental distance	
#138	Size from start	Size	Size	Minimum distance	
#139				Angle	C position
#140				X error	
#141	Y error	Y error	Y error	Y error	
#142	Z error	Z error	Z error	Z error	
#143	Size error	Size error	Size error	Minimum distance error	
#144				Angle error	C error
#145	True position error	True position error	True position error	True position error	
#146	Metal condition	Metal condition	Metal condition	Metal condition	
#147	Direction indicator				
#148	Out of tolerance flag (1 to 7)				
#149	Probe error flag (0 to 2)				
#150	X error in feature co-ordinate system (FCS) for WCS updating				
#151	Y error in feature co-ordinate system (FCS) for WCS updating				
#152	Z error in feature co-ordinate system (FCS) for WCS updating				

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Chapter 4 – Protected positioning cycles

As the probe moves around the workpiece, it is important that the stylus is protected against a collision with the workpiece. This chapter describes how to use macros O9810 and O9610 to set up the protected positioning of the probe. After it is correctly set, the probe will stop moving in the event of a collision.

Contained in this chapter

Protected positioning at B−90 (trigger monitoring) – O9810

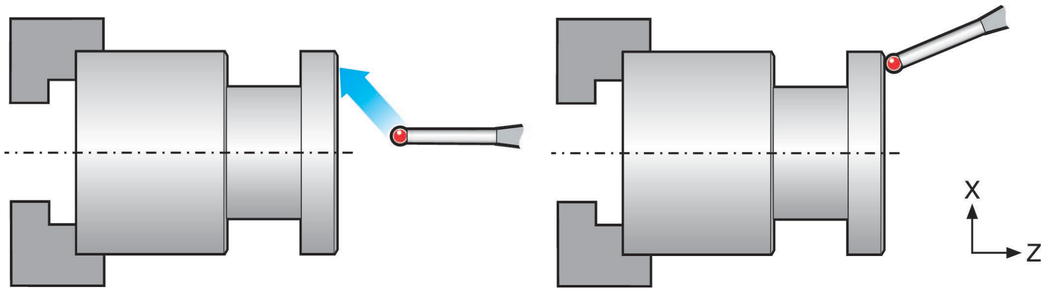

Figure 4.1 Probe protected positioning

Description

It is important to protect the stylus against collision as the probe moves around the workpiece. When this cycle is used, the machine will stop in the event of a collision.

Application

The probe is selected and moved to a safe plane. At this point the probe is made active. It then moves to the measuring position using this macro call.

In the event of a collision, the machine will stop and either a PATH OBSTRUCTED alarm will be generated or an error flag (#148) will be set (see the Mm input).

Format

G65 P9810 Dd or Xx Yy Zz [Ff Mm]
where [ ] denote optional inputs.

Example: G65 P9810 X10. F0.8 M1.0

Compulsory inputs

Dd d = X (diameter) target position for the probe positioning move.

or

Xx x = X (radius) target position for the probe positioning move.

and/or

Yy y = Y target position for the probe positioning move.

and/or

Zz z = Z target position for the probe positioning move.

Optional inputs

Ff	f =	The modal feedrate for all protected positioning moves. The feedrate is modal to this macro and subsequent feedrate calls are unnecessary unless a change of feedrate is required. The maximum safe fast feedrate established during installation must not be exceeded.
Mm	m = 1.0	This will set a probe trigger flag (no PATH OBSTRUCTED alarm). #148 = 0 (No probe trigger). #148 = 7 (Probe triggered).

Example

G54 Z0. Y50.	
G65 P9832	Orientates the probe and switches it on.
G65 P9810 X10. F3000.	Protected positioning move.
G65 P9811 X0. S1.	Single surface measurement.

Protected positioning at B0 (trigger monitoring) – O9610

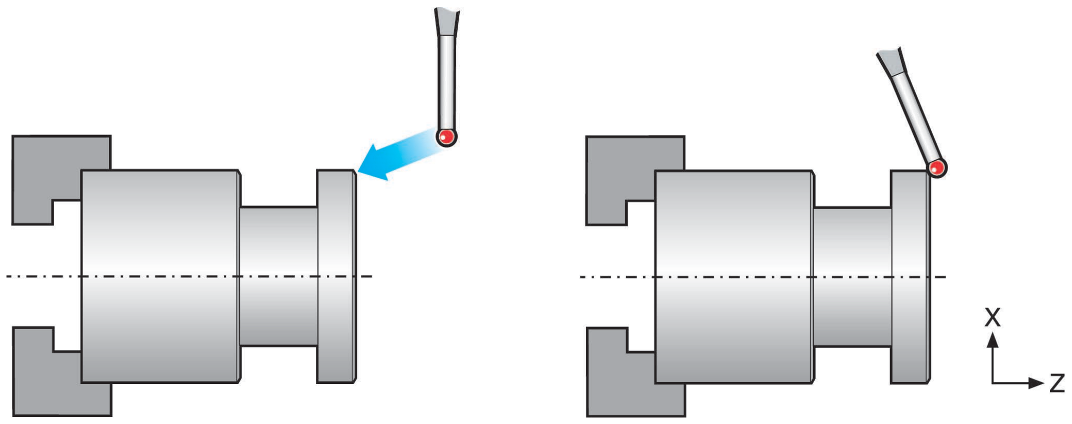

Figure 4.2 Probe protected positioning

Description

It is important to protect the stylus against collision as the probe moves around the workpiece. When this cycle is used, the machine will stop in the event of a collision.

Application

The probe is selected and moved to a safe plane. At this point the probe is made active. It then moves to the measuring position using this macro call.

In the event of a collision, the machine will stop and either a PATH OBSTRUCTED alarm will be generated or an error flag (#148) will be set (see the Mm input).

Format

G65 P9610 Dd or Xx Yy Zz [Ff Mm]
where [ ] denote optional inputs.

Example: G65 P9610 Z10. F0.8 M1.0

Compulsory inputs

Dd d = X (diameter) target position for the probe positioning move.

or

Xx x = X (radius) target position for the probe positioning move.

and/or

Yy y = Y target position for the probe positioning move.

and/or

Zz z = Z target position for the probe positioning move.

Optional inputs

Ff	f =	The modal feedrate for all protected positioning moves. The feedrate is modal to this macro and subsequent feedrate calls are unnecessary unless a change of feedrate is required. The maximum safe fast feedrate established during installation must not be exceeded.
Mm	m = 1.0	This will set a probe trigger flag (no PATH OBSTRUCTED alarm). #148 = 0 (No probe trigger). #148 = 7 (Probe triggered).

Example

G54 X20. Y50.	
G65 P9832	Orientates the probe and switches it on.
G65 P9610 Z10. F3000.	Protected positioning move.
G65 P9611 Z0. S1.	Single surface measurement.

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Chapter 5 – Calibrating the probe

Before a probe is used, it must be calibrated correctly. This chapter explains why it is so important that the probe is calibrated, and then describes how to use macro O8000 to calibrate the probe using a datum sphere.

Contained in this chapter

Why calibrate a probe?

When you fit your probe into the machine shank/holder, it is not necessary for the probe stylus to run true to the spindle centre line. A small amount of run-out can be tolerated, but it is good practice to get the stylus mechanically on-centre to reduce the effects of spindle and tool orientation errors. Without calibration of the probe, run-out will lead to inaccurate results. By calibrating the probe, the run-out is automatically accounted for.

As each Renishaw probe is unique, it is important that you calibrate it in the following circumstances:

- When your probe system is to be used for the first time.
- When a new stylus is fitted to your probe.
- When it is suspected that the stylus has become distorted or that the probe has crashed.
- At regular intervals to compensate for mechanical changes of your machine tool.
- If repeatability of relocation of the probe shank is poor. In this case, the probe may need to be recalibrated each time it is selected.

Three different operations are used to calibrate a probe. They are:

- Calibrating and setting the stylus offset.
- Calibrating the stylus radius.
- Calibrating the probe length.

Calibrating and setting the stylus offset

Calibrating the probe on a diameter with a known position automatically stores values for the offset of the stylus ball to the spindle centre line. The stored values are then automatically used in the measuring cycles. Measured values are compensated by these values so that they are relative to the true spindle centre line.

NOTE: For optimum accuracy, it is recommended that the stylus run-out is eliminated. This can be achieved by clocking the stylus to run true to the milling spindle rotation.

Calibrating the stylus radius

Calibrating the probe on a known diameter automatically stores values for the radius of the stylus ball. These stored values are then automatically used by the measuring cycles to give the true size of the feature. The values are also used to give true positions of single surface features.

NOTE: The stored radii values are based on the true electronic trigger points. These values are different from the physical sizes.

Calibrating the probe length

Calibrating a probe on a known reference surface determines the length, based on the electronic trigger point. This stored value for length is different from the physical length of the probe assembly. Additionally, this operation can automatically compensate for machine and fixture height errors by adjusting the probe length value that is stored.

Full calibration cycle on a datum sphere – O8000

NOTE: This is the preferred method for calibrating the probe. For other methods, please see Appendix B, “Additional calibration cycles”.

This section describes how to fully calibrate a probe and stylus using a datum sphere. This is the quickest and most accurate method of calibrating the spindle probe and is the method recommended by Renishaw. The centre of the sphere can be established automatically without the need for a dial test indicator (DTI) or calibration bars.

If you choose to use this method to calibrate your probe and stylus, you will need a datum sphere. A suitable datum sphere calibration kit can be purchased from Renishaw – contact your nearest Renishaw sales office for further details.

The automatic routine provides a complete calibration solution, calculating the probe length, radius of the stylus ball, and stylus offset for both B0 and B−90 orientations.

Program O8000 is used for sphere calibration and must be edited to suit individual applications. The approximate sphere centre and probe length must be entered into a spare work offset and tool offset.

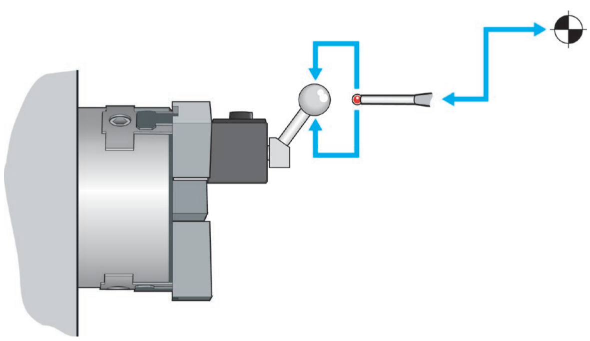
During the program, the B axis is rotated firstly to B−90 and then to B0 before returning to B−90. All B-axis moves take place at a safe return position. Before running the cycle, clearances must be checked to avoid any collision.

The following figures explain sphere calibration in greater detail:

Element 1

Establish the XY centre of the datum sphere.

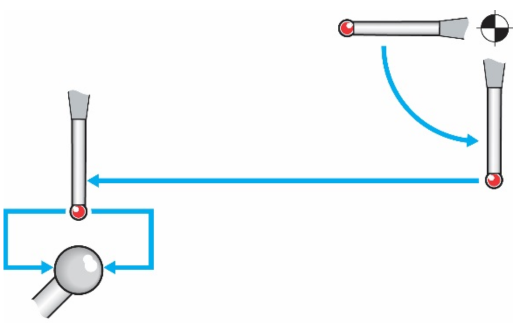
Calibrate the XY stylus offset and the radius of the stylus ball (B−90).



Element 2

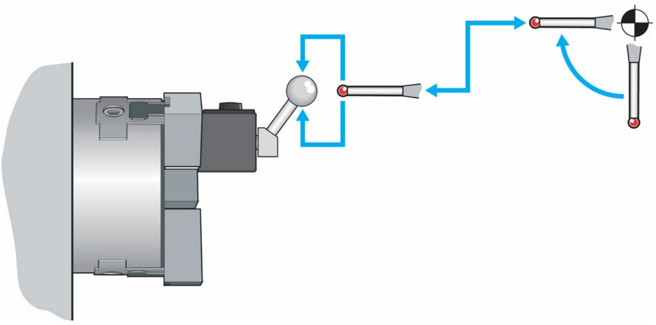
Establish the Z centre of the datum sphere.

Calibrate the ZY stylus offset and the radius of the stylus ball (B0).



Element 3

Calibrate the probe length.



Editing macro O8000

Read the following variable descriptions then edit macro O8000 as described.

```
O8000(SPHERE CALIBRATION - SPINDLE 1)
(****************************************)
N3(*USER*INPUTS*HERE*)
#2=3.(STYLUS RADIUS)
#7=25.(SPHERE SIZE)
#19=2(WORK OFFSET USED)
#20=030030(TOOL NUMBER INCL OFFSET)
(****************************************)
N5(*USER*INPUTS*HERE*)
#21=0(MULTI STYLI STORE 0=NO 11-14=YES)
#22=1(PROBE LENGTH UPDATE 0=NO UPDATE 1=B−90 2=B0)
#25=0(0=9803 STD CAL - 1=9804 VEC CAL)
(****************************************)
```

Settings

#2=3.(STYLUS RADIUS)

Input the radius of the stylus ball (in millimetres or inches).

#7=25.(SPHERE SIZE)

Input the diameter of the sphere (in millimetres or inches).

#19=2(WORK OFFSET USED)

Select the work offset to be used for the sphere centre (1 = G54 to 6 = G59)

#20=030030(TOOL NUMBER INCL OFFSET)

Input the tool number of the probe including the offset number.

#21=0(MULTI STYLI STORE 0=NO 11-14=YES)

Specify whether multiple probes are to be used on the machine.

#22=1(PROBE LENGTH UPDATE 0=NO UPDATE 1=B−90 2=B0)

Specify whether probe length calibration is to take place at B−90 or B0.

#25=0(0=9803 STD CAL - 1=9804 VEC CAL)

Specify whether standard or vector ball radius calibration is to take place. Vector calibration is required when using macros O9621, O9622, O9623, O9821, O9822 or O9823.

Chapter 6 – Measuring cycles

This chapter describes how to use the measuring cycles. Before using these cycles, the radius of the stylus ball must be calibrated using macro O8000 (see Chapter 5, “Calibrating the probe”) or macro O9803 (see Appendix B, “Additional calibration cycles”).

Contained in this chapter

XYZ single surface measurement (B−90) – O9811

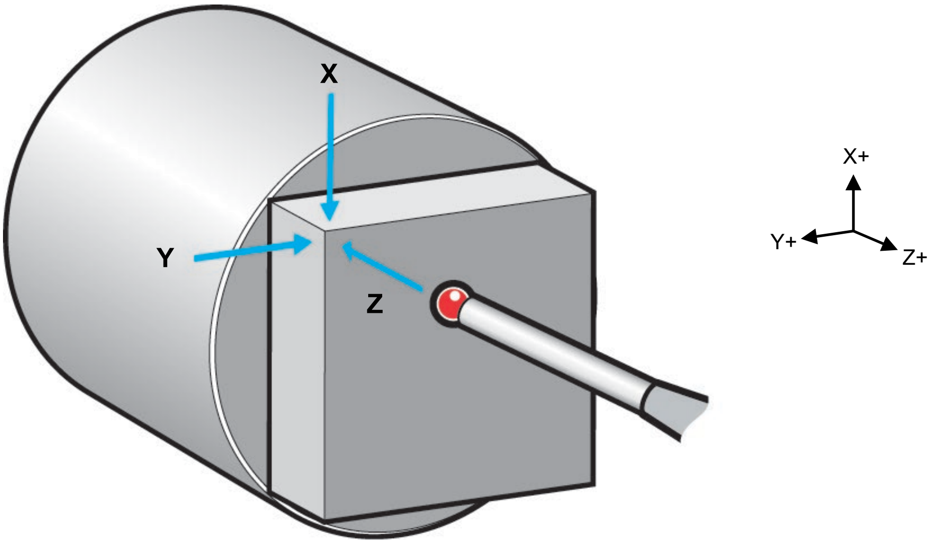


Figure 6.1 Measurement of a single surface

Description

This cycle measures a surface to establish the size or position.

Application

With its tool offset active, position the probe adjacent to the surface. The cycle measures the surface and returns to the start position.

The measured surface can be considered in one of two ways:

1. As a size, where the tool offset is updated in conjunction with the Tt, Jj and Hh inputs.

2. As a reference surface position, for the purpose of adjusting a work offset using the Ss and Mm inputs.

Format

G65 P9811 Xx or Yy or Zz [Ee Ff Hh Mm Qq Ss Tt Jj Uu Vv Ww]
where [ ] denote optional inputs.

Example: G65 P9811 X50. E21. F0.8 H0.2 M0.2 Q10. S1. T20. J2000. U0.5 V0.5 W2.

Compulsory inputs

Xx	x =	
or		
Yy	y =	The surface position or size.
or		
Zz	z =	

Optional inputs

See Chapter 2, “Optional inputs”.

Example: Measuring a single surface in X and Z

T01 M06	Select the probe.
G400 B−90. J0.	Orientate the probe to the B−90 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z−8. F3000.	Protected positioning move to the start position.
G65 P9811 X−50. T10. J3000.	Single surface measurement.
G65 P9810 Z10.	Protected positioning move.
G65 P9810 X−60.	Protected positioning move.
G65 P9811 Z0. T10. J4000.	Single surface measurement.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (where applicable).
G28 Z100.	Reference return.
continue	

The tool length offset (10) is updated by the error of the surface position.

Web/pocket measurement (B−90) – O9812

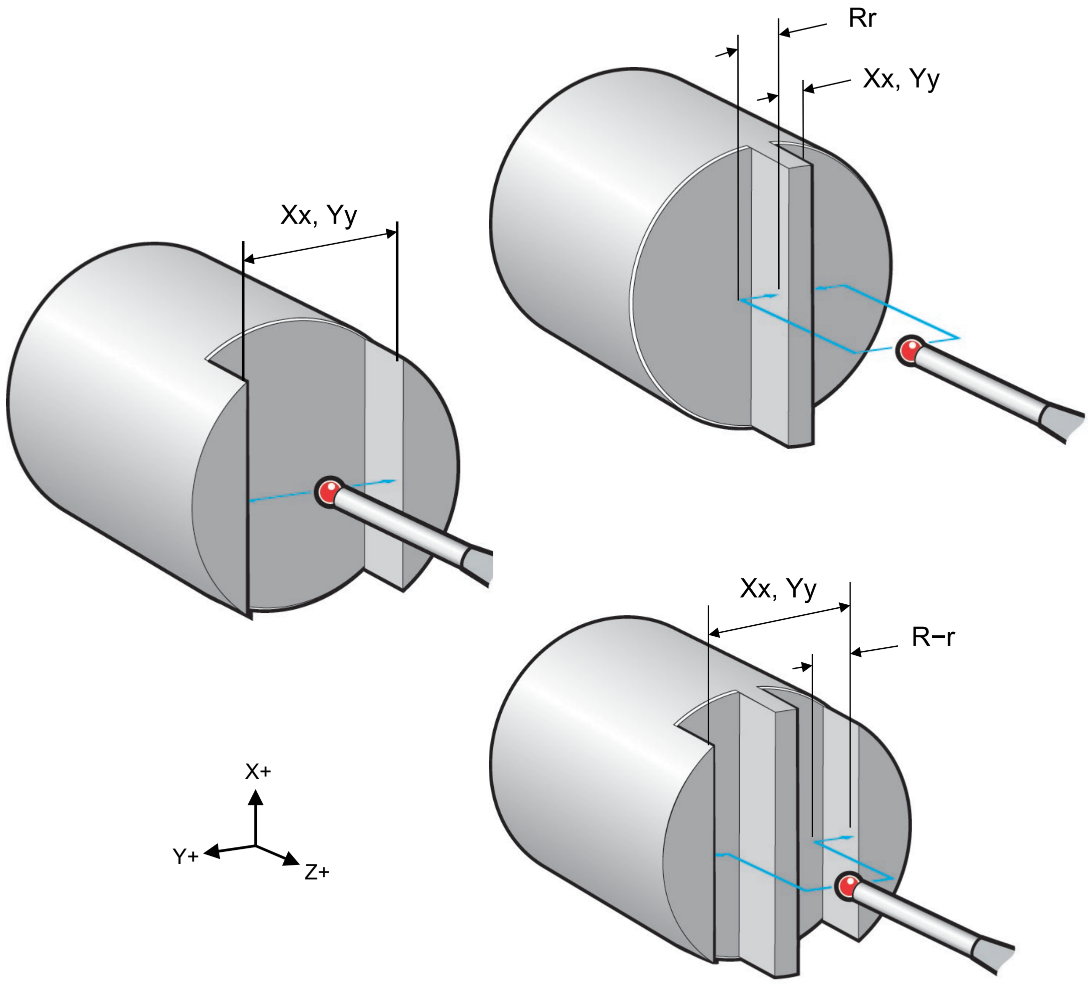


Figure 6.2 Measurement of a web or pocket feature

Description

This cycle measures a web or pocket feature using two measuring moves along the X or Y axis.

Application

With the probe and probe offset active, position the probe to the expected centre line of the feature and at a suitable position in the Z axis. Run the cycle with suitable inputs.

Format

G65 P9812 Xx [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

or

G65 P9812 Yy [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

or

G65 P9812 Xx Zz [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

or

G65 P9812 Yy Zz [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

where [ ] denote optional inputs.

Example: G65 P9812 X50. Z100. E21. F0.8 H0.2 M0.2 Q10. R10. S1. T20. J3000. U0.5 V0.5 W2.

Compulsory inputs

Xx	x =	The nominal size of the feature when measured in the X axis.
or		
Yy	y =	The nominal size of the feature when measured in the Y axis.
Zz	z =	The absolute Z-axis position when measuring a web feature. If this is omitted, a pocket cycle is assumed.

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

Example 1: Measuring a web

T01 M06	Select the probe.
G400 B−90. J0.	Orientate the probe to the B−90 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z10. F3000.	Protected positioning move.
G65 P9812 X50. Z−10. S2.	Measure a 50 mm (1.968 in) wide web.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (where applicable).
G28 Z100.	Reference return.

The centre line of the feature in the X axis is stored in work offset 02 (G55).

Example 2: Measuring a pocket (referred datum)

T01 M06	Select the probe.
G400 B−90. J0.	Orientate the probe to the B−90 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z−10. F3000.	Protected positioning move.
G65 P9812 X30. S2.	Measure a 30 mm (1.181 in) wide pocket.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (where applicable).
G28 Z100.	Reference return.
continue	

The error of the centre line is referred to the datum point X0. The revised X0 position is set in work offset 02 (G55).

Bore/boss measurement (B−90) – O9814

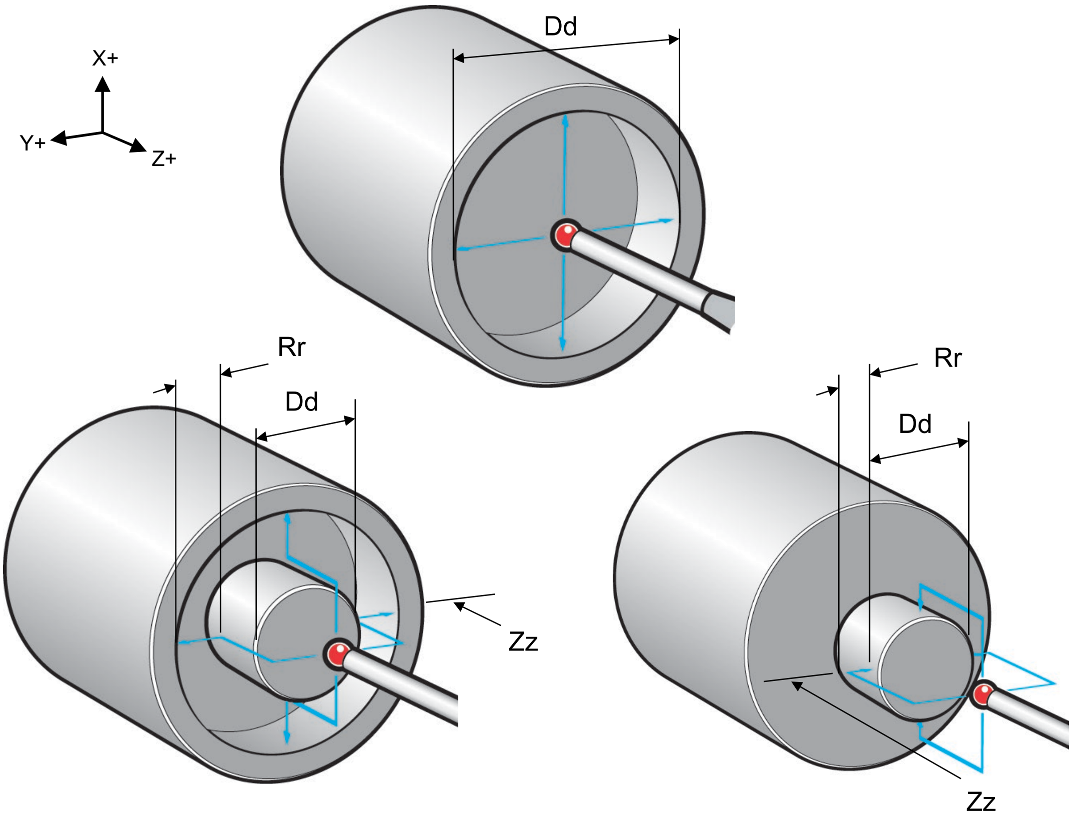


Figure 6.3 Measurement of a bore or boss feature

Description

This cycle measures a bore or boss feature using four measuring moves along the X or Y axis.

Application

With the probe and probe offset active, position the probe to the expected centre line of the feature and at a suitable position in the Z axis. Run the cycle with suitable inputs.

Format

G65 P9814 Dd [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

or

G65 P9814 Dd Zz [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

where [ ] denote optional inputs.

Example: G65 P9814 D50.005 Z100. E21. F0.8 H0.2 M0.2 Q10. R10. S1. T20. J3000. U0.5 V0.5 W2.

Compulsory inputs

Dd	d =	The nominal size of the feature.
Zz	z =	The absolute Z-axis position when measuring a boss feature. If this is omitted, a bore cycle is assumed.

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

Example 1: Measuring a boss

T01 M06	Select the probe.
G400 B−90. J0.	Orientate the probe to the B−90 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z10. F3000.	Protected positioning move.
G65 P9814 D50. Z−10. S2. R10.	Measure a 50 mm (1.968 in) diameter boss.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 Z100.	Reference return.
continue	

The centre line of the feature in the X and Y axis is stored in work offset 02 (G55).

Example 2: Measuring a bore (referred datum)

T01 M06	Select the probe.
G400 B−90. J0.	Orientate the probe to the B−90 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z−10. F3000.	Protected positioning move.
G65 P9814 D30. S2.	Measure a 30 mm (1.181 in) diameter bore.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 Z100.	Reference return.
continue	

The error of the centre line is referred to the datum point X0 Y0. The revised X0 Y0 position is set in work offset 02 (G55).

XYZ single surface measurement (B0) – O9611

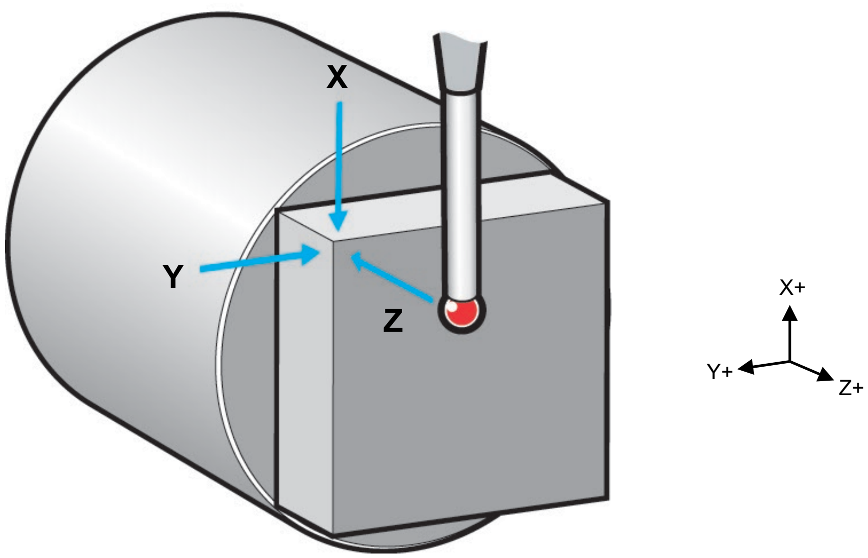


Figure 6.4 Measurement of a single surface

Description

This cycle measures a surface to establish the size or position.

Application

With its tool offset active, position the probe adjacent to the surface. The cycle measures the surface and returns to the start position.

The measured surface can be considered in one of two ways:

1. As a size, where the tool offset is updated in conjunction with the Tt, Jj and Hh inputs.

2. As a reference surface position, for the purpose of adjusting a work offset using the Ss and Mm inputs.

Format

G65 P9611 Xx or Yy or Zz [Ee Ff Hh Mm Qq Ss Tt Jj Uu Vv Ww]
where [ ] denote optional inputs.

Example: G65 P9611 X50. E21. F0.8 H0.2 M0.2 Q10. S1. T20. J3000. U0.5 V0.5 W2.

Compulsory inputs

Xx	x =	
or		
Yy	y =	The surface position or size.
or		
Zz	z =	

Optional inputs

See Chapter 2, “Optional inputs”.

Example: Measuring a single surface in X and Z

T01 M06	Select the probe.
G400 B0. J0.	Orientate the probe to the B0 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9610 X−8. F3000.	Protected positioning move to the start position.
G65 P9611 Z−50. T10. J3000.	Single surface measurement.
G65 P9610 X10.	Protected positioning move.
G65 P9610 Z−60.	Protected positioning move.
G65 P9611 X0. T10. J4000.	Single surface measurement.
G65 P9610 X100.	Protected positioning move.
G65 P9833	Switch the probe off (where applicable).
G28 X0.	Reference return.
continue	

The tool radius offset (10) is updated by the error of the surface position.

Web/pocket measurement (B0) – O9612

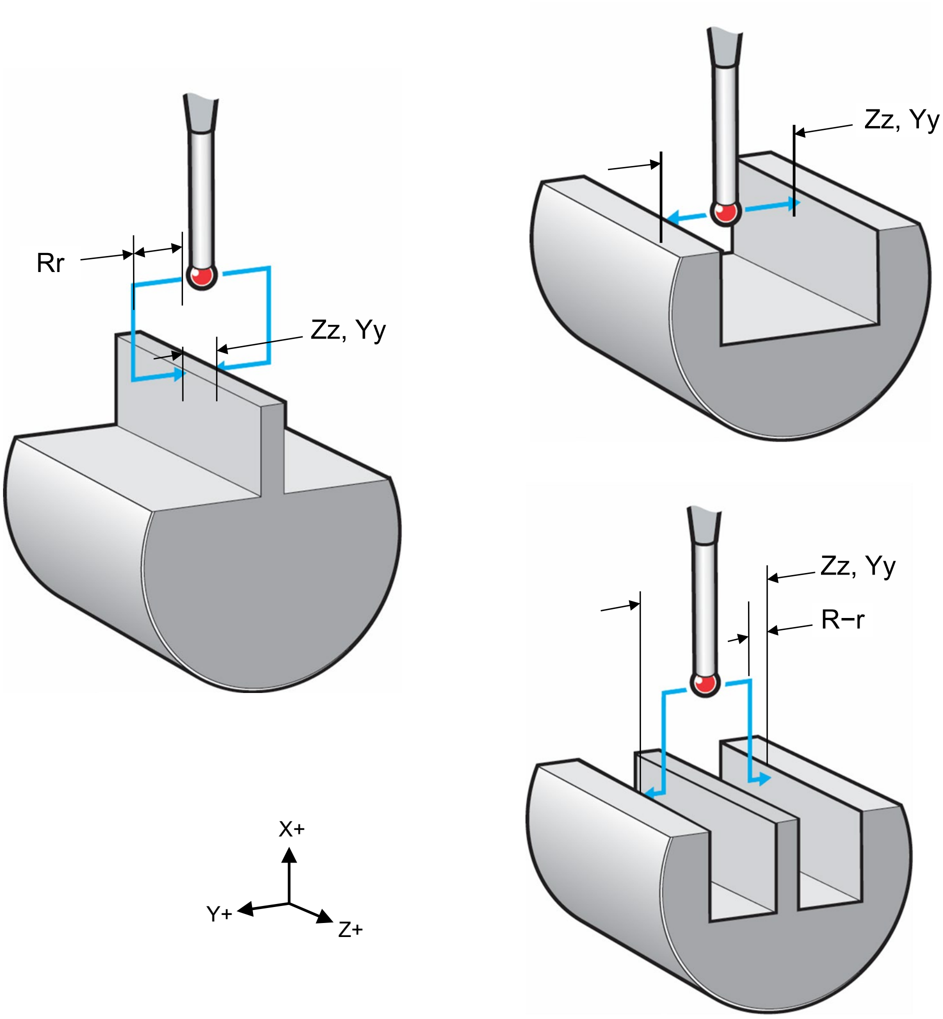


Figure 6.5 Measurement of a web or pocket feature

Description

This cycle measures a web or pocket feature using two measuring moves along the Z or Y axis.

Application

With the probe and probe offset active, position the probe to the expected centre line of the feature and at a suitable position in the X axis. Run the cycle with suitable inputs.

Format

G65 P9612 Yy [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

or

G65 P9612 Zz [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

or

G65 P9612 Yy Xx [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

or

G65 P9612 Zz Xx [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

where [ ] denote optional inputs.

Example: G65 P9612 Z50. X−10. E21. F0.8 H0.2 M0.2 Q10. R10. S1. T20. J3000. U0.5 V0.5 W2.

Compulsory inputs

Yy	y =	The nominal size of the feature when measured in the Y axis.
Zz	z =	The nominal size of the feature when measured in the Z axis.

or

Xx	x =	The absolute X-axis position when measuring a web feature. If this is omitted, a pocket cycle is assumed.

Optional inputs

See Chapter 2, "Optional inputs".

Outputs

See Chapter 3, "Variable outputs".

Example 1: Measuring a web

T01 M06	Select the probe.
G400 B0. J0.	Orientate the probe to the B0 position. Activate the tool offset.
G54 Y0. Z0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9610 X10. F3000.	Protected positioning move to the start position.
G65 P9612 Z50. X−10. S2.	Measure a 50 mm (1.968 in) wide web.
G65 P9610 X100.	Protected positioning move.
G65 P9833	Switch the probe off (where applicable).
G28 X0.	Reference return.
continue	

The centre line of the feature in the Z axis is stored in work offset 02 (G55).

Example 2: Measuring a pocket (referred datum)

T01 M06	Select the probe.
G400 B0. J0.	Orientate the probe to the B0 position. Activate the tool offset.
G54 Y0. Z0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9610 X−10. F3000.	Protected positioning move to the start position.
G65 P9612 Z50. S2.	Measure a 50 mm (1.968 in) wide web.
G65 P9610 X100.	Protected positioning move.
G65 P9833	Switch the probe off (where applicable).
G28 X0.	Reference return.
continue	

The error of the centre line is referred to the datum point Z0. The revised Z0 position is set in work offset 02 (G55).

Bore/boss measurement (B0) – O9614

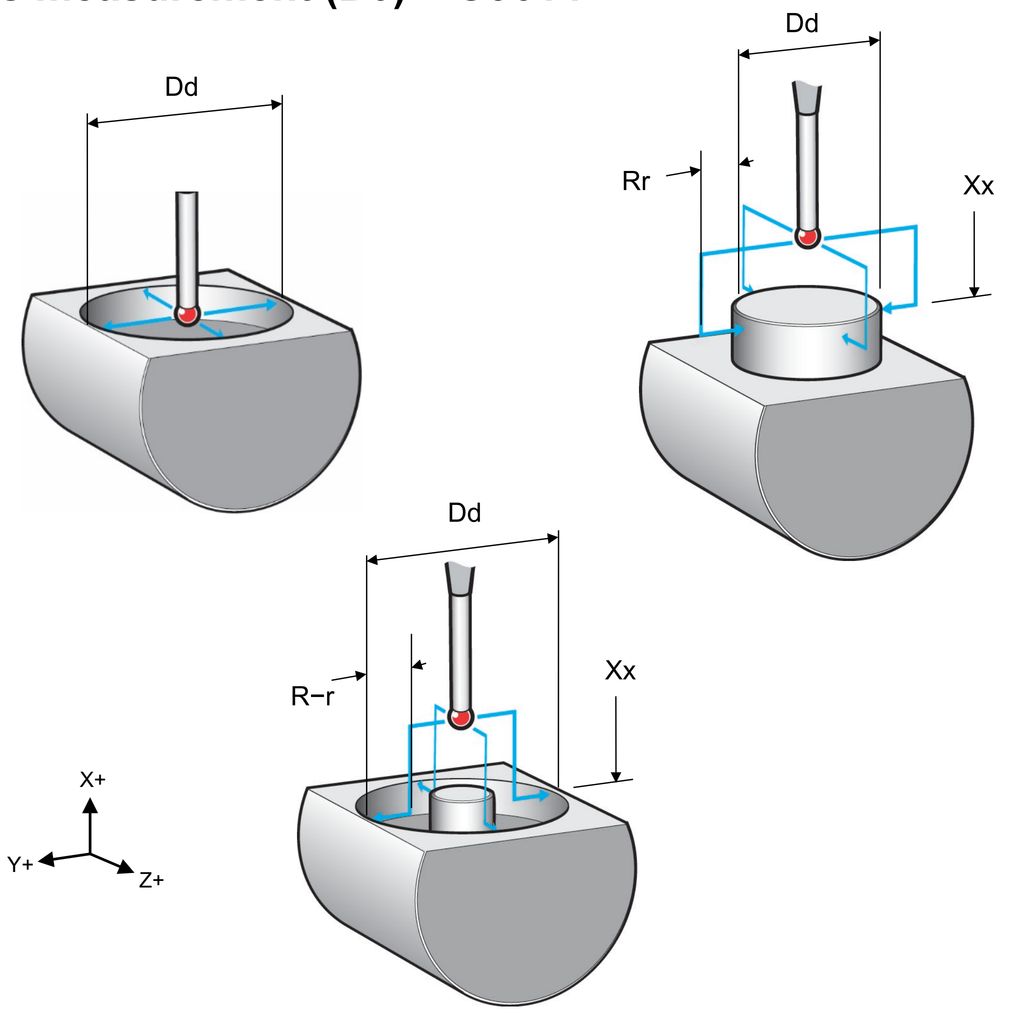


Figure 6.6 Measurement of a bore or boss feature

Description

This cycle measures a bore or boss feature using four measuring moves along the Z or Y axis.

Application

With the probe and probe offset active, position the probe to the expected centre line of the feature and at a suitable position in the X axis. Run the cycle with suitable inputs.

Format

G65 P9614 Dd [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

or

G65 P9614 Dd Xx [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

where [ ] denote optional inputs.

Example: G65 P9614 D50.005 X100. E21. F0.8 H0.2 M0.2 Q10. R10. S1. T20. J3000. U0.5 V0.5 W2.

Compulsory inputs

Dd	d =	The nominal size of the feature.
Xx	x =	The absolute X-axis position when measuring a boss feature. If this is omitted, a bore cycle is assumed.

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

Example 1: Measuring a boss

T01 M06	Select the probe.
G400 B0. J0.	Orientate the probe to the B0 position. Activate the tool offset.
G54 Y0. Z0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9610 X10. F3000.	Protected positioning move to the start position.
G65 P9614 D50. X−10. S2.	Measure a 50 mm (1.968 in) diameter boss.
G65 P9610 X100.	Protected positioning move.
G65 P9833	Switch the probe off (where applicable).
G28 X0.	Reference return.
continue	

The centre line of the feature in the Y and Z axis is stored in work offset 02 (G55).

Example 2: Measuring a bore (referred datum)

T01 M06	Select the probe.
G400 B0. J0.	Orientate the probe to the B0 position. Activate the tool offset.
G54 Y0. Z0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9610 X10. F3000.	Protected positioning move.
G65 P9614 D30. S2.	Measure a 30 mm (1.181 in) diameter bore.
G65 P9610 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 X0.	Reference return.
continue	

The error of the centre line is referred to the datum point Y0 Z0. The revised Y0 Z0 position is set in work offset 02 (G55).

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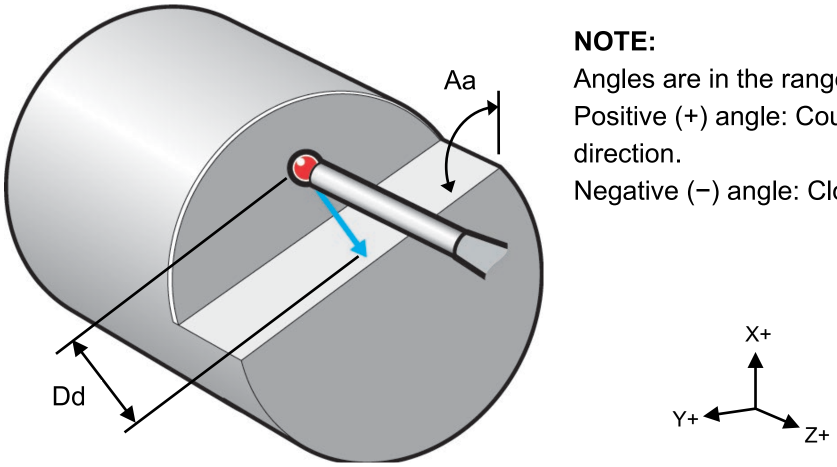
Chapter 7 – Vector measuring cycles

This chapter describes how to use the vector measuring cycles. Before using these cycles, the radius of the stylus ball must be calibrated using macro O8000 (see Chapter 5, “Calibrating the probe”) or macros O9604 and O9804 (see Appendix B, “Additional calibration cycles”). Do **not** use macro O9603 and O9803 to calibrate the probe stylus.

Contained in this chapter

Single angled surface measurement (B−90) – O9821

NOTE: Before using this cycle, the probe must have been calibrated recently using the vector stylus ball radius cycle (O9804) (described in Appendix B, “Additional calibration cycles”). Do **not** use macro O9803 to calibrate the probe.



NOTE:
Angles are in the range ±180°.
Positive (+) angle: Counterclockwise direction.
Negative (−) angle: Clockwise direction.

Figure 7.1 Measuring a single angled surface

Description

This cycle measures an angled surface feature using one vectored measuring move along the XY axis.

Application

With the probe and probe offset active, position the probe to the expected reference point of the feature and at a suitable position in the Z axis. Run the cycle with suitable inputs.

Format

G65 P9821 Aa Dd [Ee Ff Hh Mm Qq Ss Tt Jj Uu Vv Ww]
where [ ] denote optional inputs.

Example: G65 P9821 A135 D50.005 E21. F0.8 H0.2 M0.2 Q10. S1. T20. J3000. U0.5 V0.5 W2.

Compulsory inputs

Aa	a =	The direction of probe measurement when measuring from the X+ axis direction.
Dd	d =	Nominal distance to the surface (radial).

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

Example: Measuring a single angled surface

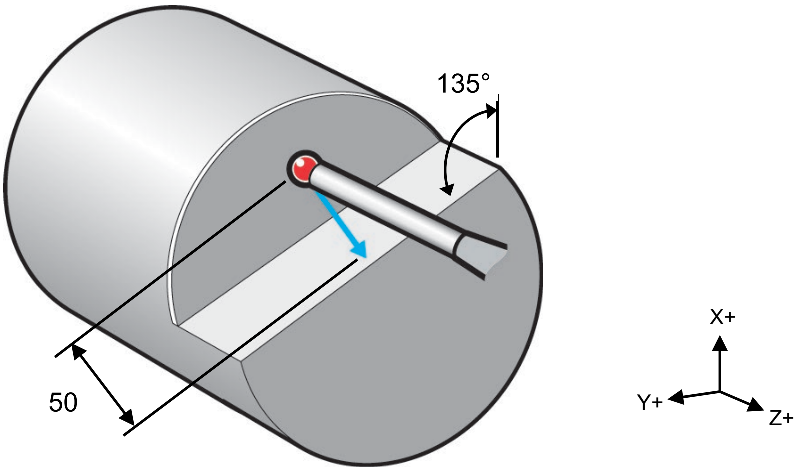


Figure 7.2 Measuring a single angled surface

T01 M06	Select the probe.
G400 B−90. J0.	Orientate the probe to the B−90 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z−8. F3000.	Protected positioning move to the start position.
G65 P9821 A135. D50. T10. J3000.	Single surface measurement.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 Z100.	Reference return.

The tool radius offset (10) is updated by the error of the surface position.

Angled web or pocket measurement (B−90) – O9822

NOTE: Before using this cycle, the probe must have been calibrated recently using the vector stylus ball radius cycle (O9804) (described in Appendix B, "Additional calibration cycles"). Do **not** use macro O9803 to calibrate the probe.

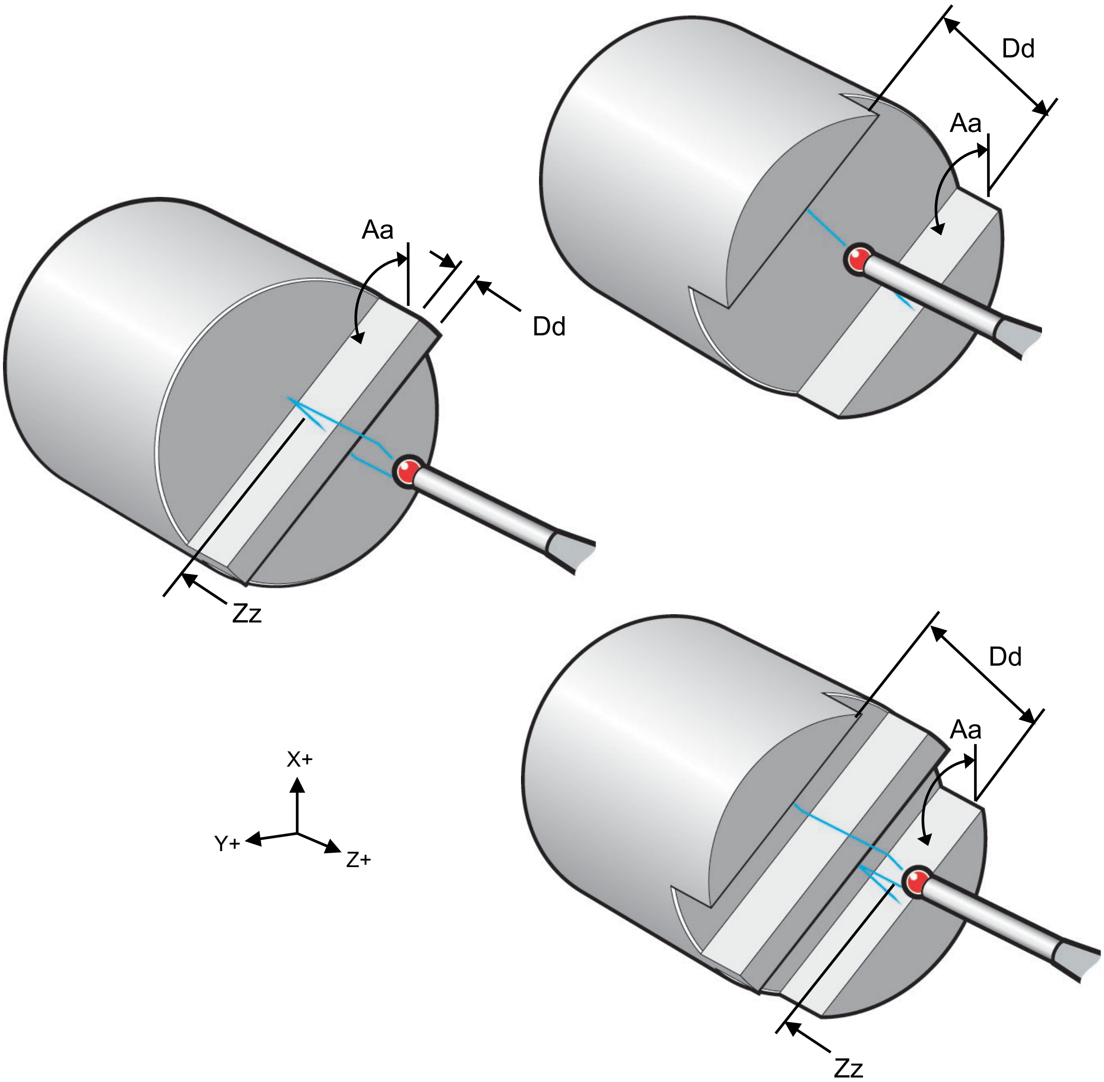


Figure 7.3 Measuring an angled web or pocket

Description

This cycle measures a web or pocket feature using two vectored measuring moves along the XY axis.

Application

With the probe and probe offset active, position the probe to the expected centre line of the feature and at a suitable position in the Z axis. Run the cycle with suitable inputs.

Format

G65 P9822 Aa Dd [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

or

G65 P9822 Aa Dd Zz [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

where [ ] denote optional inputs.

Example: G65 P9822 A135. D50.005 Z50. E21. F0.8 H0.2 M0.2 Q10. R10. S1. T20. J3000. U0.5 V0.5 W2.

Compulsory inputs

Aa	a =	Angle of the surface to be measured from the X+ axis direction.
Dd	d =	Nominal size of the feature.
Zz	z =	The absolute Z-axis position when measuring a web feature. If this is omitted, a pocket cycle is assumed.

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

Example: Measuring an angled pocket

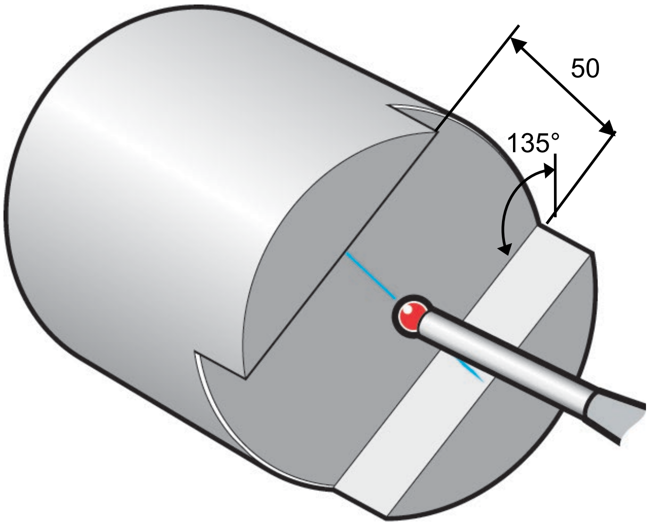


Figure 7.4 Measuring an angled pocket

T01 M06	Select the probe.
G400 B−90. J0.	Orientate the probe to the B−90 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z−10. F3000.	Protected positioning move.
G65 P9822 A135. D50. S2.	Measure a 50 mm (1.968 in) pocket at 135°.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 Z100.	Reference return.
continue	

The centre line of the feature in the X axis is stored in work offset S02 (G55).

3-point bore or boss measurement (B−90) – O9823

NOTE: Before using this cycle, the probe must have been calibrated recently using the vector stylus ball radius macro (O9804) (described in Appendix B, “Additional calibration cycles”). Do **not** use macro O9803 to calibrate the probe.

NOTE:
Angles are in the range ±180°.
Positive (+) angle: Counterclockwise direction.
Negative (–) angle: Clockwise direction.

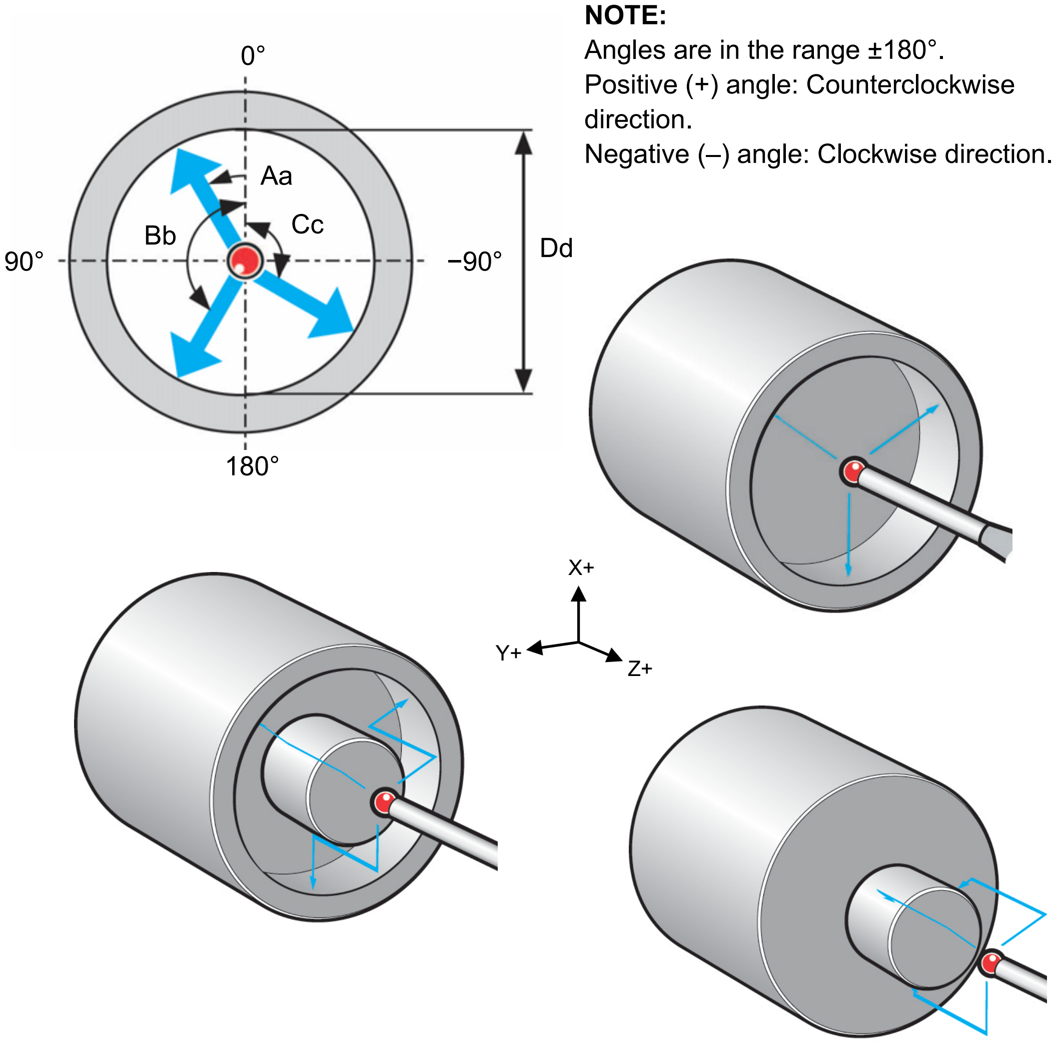


Figure 7.5 3-point bore or boss measurement

Description

This cycle measures a bore or boss feature using three vectored measuring moves along the XY axis.

Application

With the probe and probe offset active, position the probe to the expected centre line of the feature and at a suitable position in the Z axis. Run the cycle with suitable inputs.

Format

G65 P9823 Aa Bb Cc Dd [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

or

G65 P9823 Aa Bb Cc Dd Zz [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

where [ ] denote optional inputs.

Example: G65 P9823 A30. B150. C−135. D50.005 Z50. E21. F0.8 H0.2 M0.2 Q10. R10. S1. T20. J3000. U0.5 V0.5 W2.

Compulsory inputs

Aa	a =	The first angle for vector measurement, measured from the X+ axis direction.
Bb	b =	The second angle for vector measurement, measured from the X+ axis direction.
Cc	c =	The third angle for vector measurement, measured from the X+ axis direction.
Dd	d =	Nominal size of the feature.
Zz	z =	The absolute Z-axis position when measuring a boss feature. If this is omitted, a bore cycle is assumed.

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

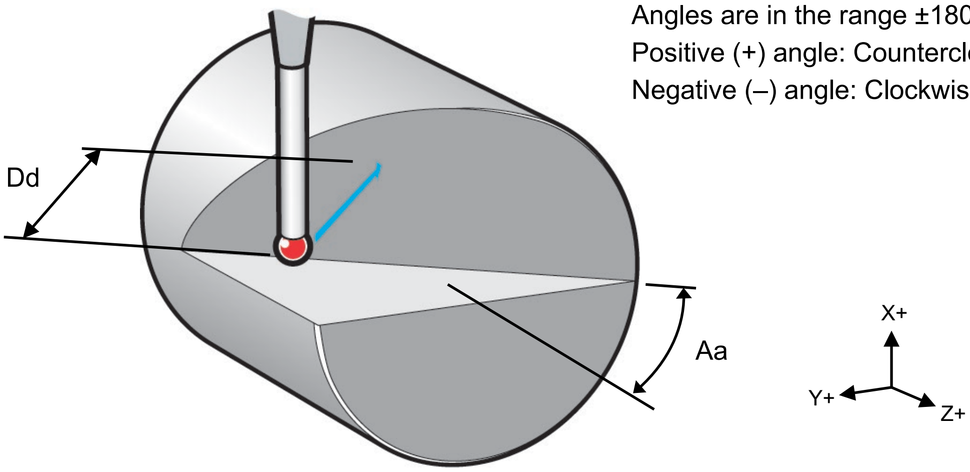
Example: 3-point bore measurement (referred datum)

T01 M06	Select the probe.
G400 B−90. J0.	Orientate the probe to the B−90 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z−10. F3000.	Protected positioning move.
G65 P9823 D30. A30. B150. C−135.	Measure a 30 mm (1.181 in) diameter bore.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 Z100.	Reference return.
continue	

The error of the centre line is referred to the datum point X0 Y0.

Single angled surface measurement (B0) – O9621

NOTE: Before using this cycle, the probe must have been calibrated recently using the vector stylus ball radius cycle (O9604) (described in Appendix B, “Additional calibration cycles”). Do **not** use macro O9603 to calibrate the probe.



NOTE:
Angles are in the range ±180°.
Positive (+) angle: Counterclockwise direction.
Negative (–) angle: Clockwise direction.

Figure 7.6 Measuring a single angled surface

Description

This cycle measures an angled surface feature using one vectored measuring move along the ZY axis.

Application

With the probe and probe offset active, position the probe to the expected reference point of the feature and at a suitable position in the X axis. Run the cycle with suitable inputs.

Format

G65 P9621 Aa Dd [Ee Ff Hh Mm Qq Ss Tt Jj Uu Vv Ww]
where [ ] denote optional inputs.

Example: G65 P9621 A45. D50.005 E21. F0.8 H0.2 M0.2 Q10. S1. T20. J3000. U0.5 V0.5 W2.

Compulsory inputs

Aa	a =	Direction of probe measurement measured from the Z+ axis direction.
Dd	d =	Nominal distance to the surface (radial).

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

Example: Measuring a single angled surface

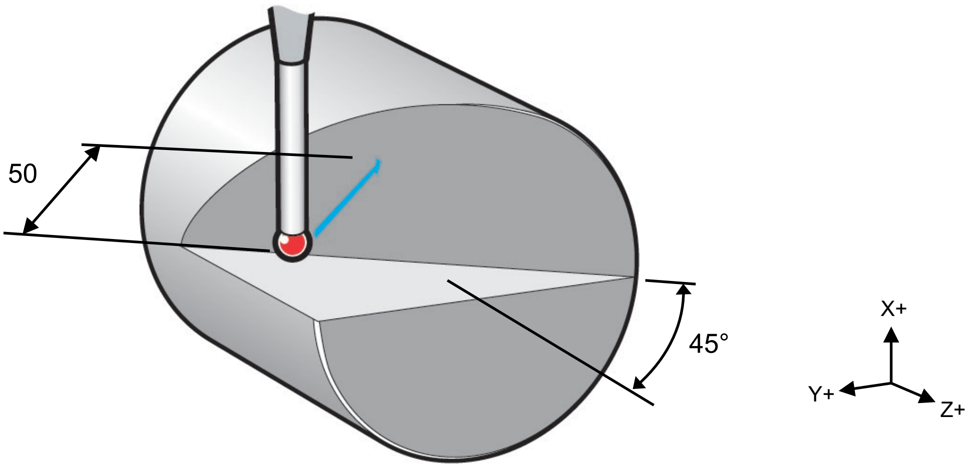


Figure 7.7 Measuring a single angled surface

T01 M06	Select the probe.
G400 B0. J0.	Orientate the probe to the B0 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9610 X−8. F3000.	Protected positioning move to the start position.
G65 P9621 A45. D50. T10. J3000.	Single surface measurement.
G65 P9610 X100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 X100.	Reference return.

The tool radius offset (10) is updated by the error of the surface position.

Angled web or pocket measurement (B0) – O9622

NOTE: Before using this cycle, the probe must have been calibrated recently using the vector stylus ball radius cycle (O9604) (described in Appendix B, “Additional calibration cycles”). Do **not** use macro O9603 to calibrate the probe.

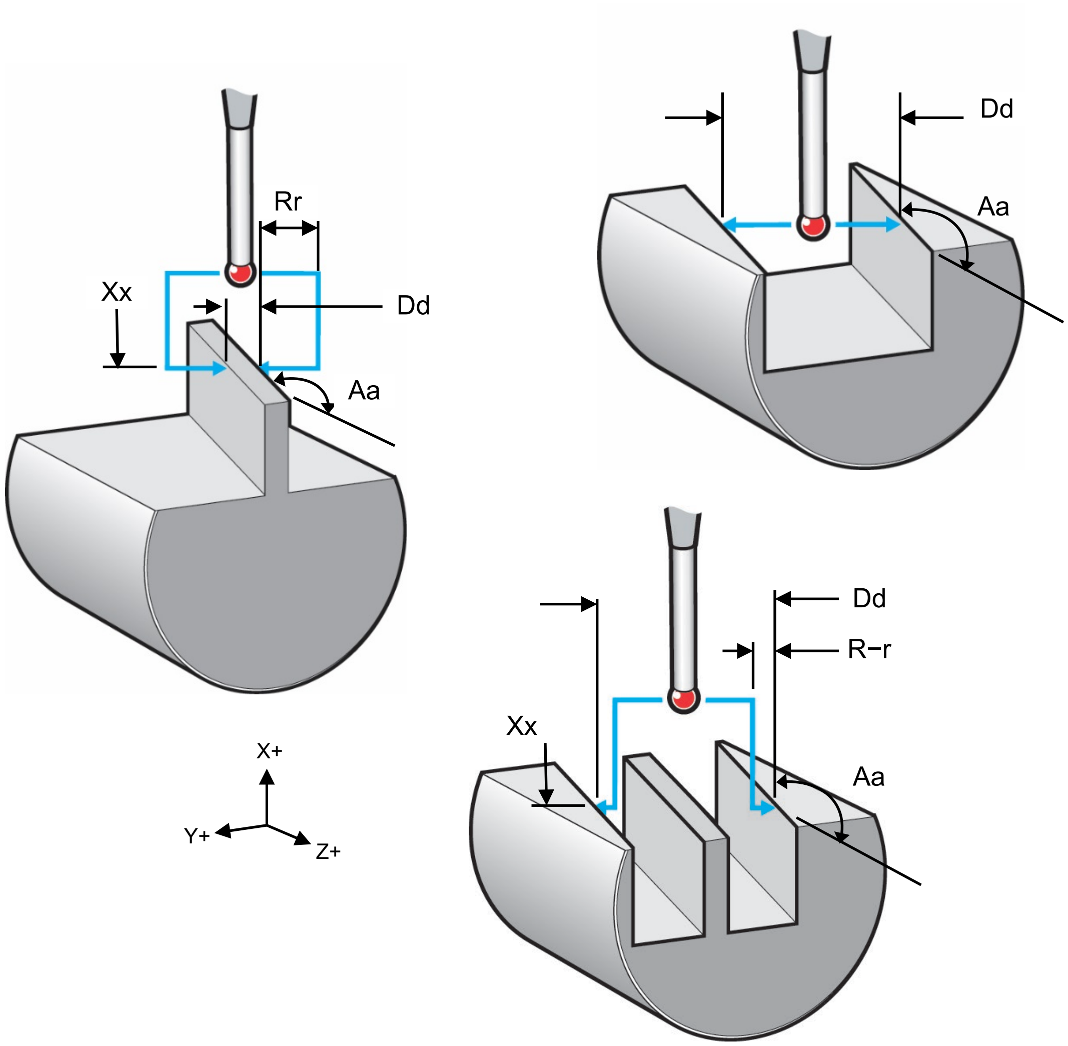


Figure 7.8 Measuring an angled web or pocket

Description

This cycle measures a web or pocket feature using two vectored measuring moves along the ZY axis.

Application

With the probe and probe offset active, position the probe to the expected centre line of the feature and at a suitable position in the X axis. Run the cycle with suitable inputs.

Format

G65 P9622 Aa Dd [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

or

G65 P9622 Aa Dd Xx [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

where [ ] denote optional inputs.

Example: G65 P9622 A135. D50.005 X50. E21. F0.8 H0.2 M0.2 Q10. R10. S1. T20. J3000. U0.5 V0.5 W2.

Compulsory inputs

Aa	a =	Angle of the surface to be measured from the Z+ axis direction.
Dd	d =	Nominal size of the feature.
Xx	x =	The absolute X-axis position when measuring a web feature. If this is omitted, a pocket cycle is assumed.

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

Example: Measuring an angled pocket

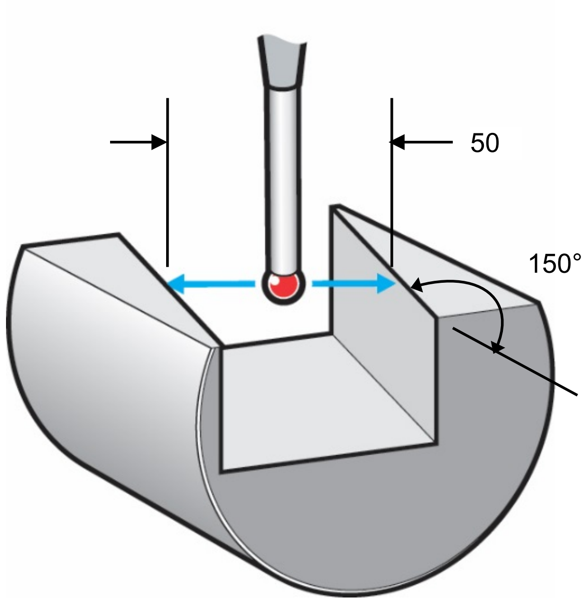


Figure 7.9 Measuring an angled pocket

T01 M06	Select the probe.
G400 B0. J0.	Orientate the probe to the B0 position. Activate the tool offset.
G54 Z0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9610 X10. F3000.	Protected positioning move.
G65 P9622 A150. D50. S2.	Measure a 50 mm (1.968 in) wide pocket at 150°.
G65 P9610 X100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 X0.	Reference return.
continue	

The centre line of the feature in the Z axis is stored in work offset S02 (G55).

3-point bore or boss measurement (B0) – O9623

NOTE: Before using this cycle, the probe must have been calibrated recently using the vector stylus ball radius macro (O9604) (described in Appendix B, “Additional calibration cycles”). Do **not** use macro O9603 to calibrate the probe.

NOTE:
Angles are in the range ±180°.
Positive (+) angle: Counterclockwise direction.
Negative (–) angle: Clockwise direction.

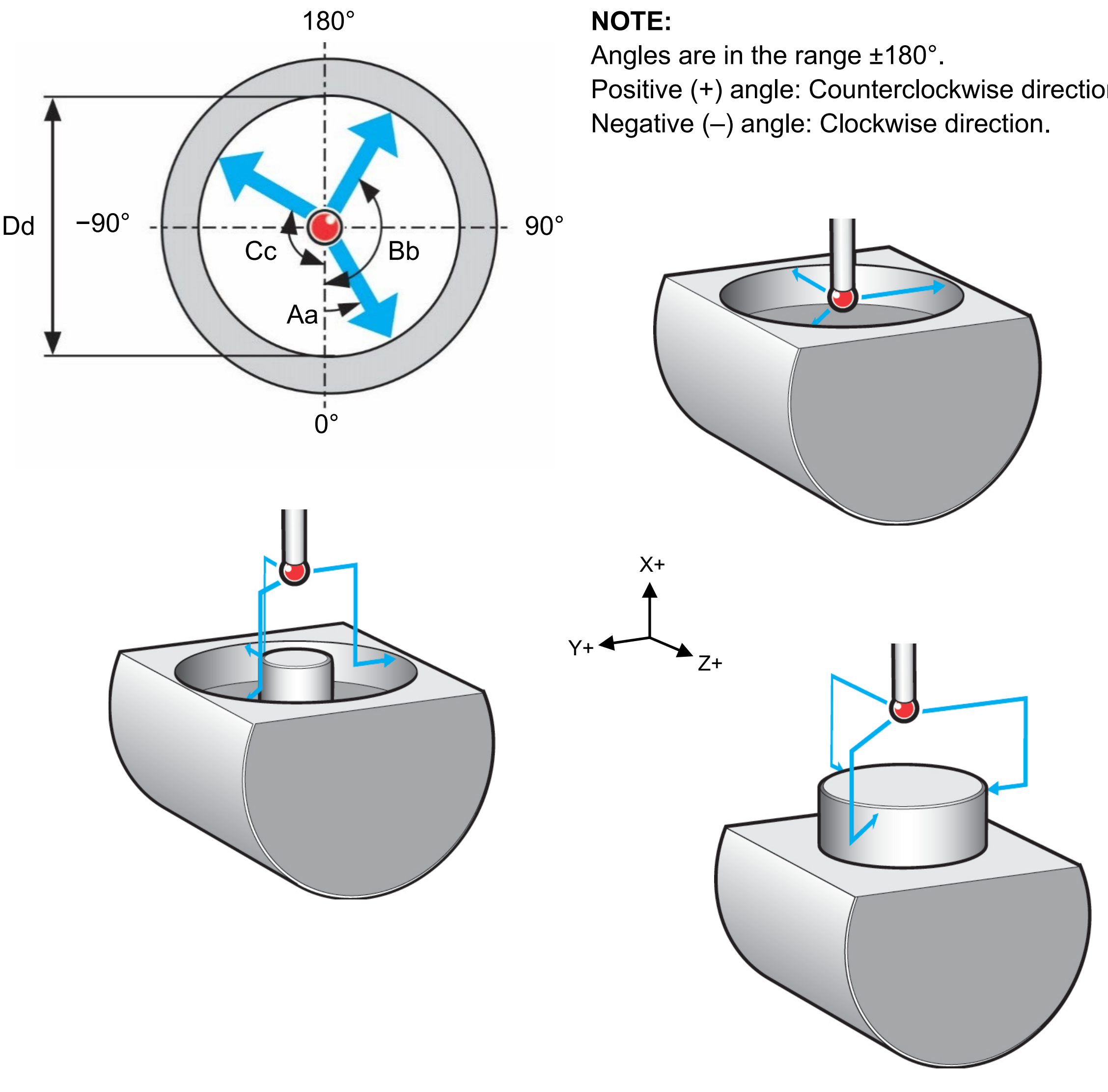


Figure 7.10 3-point bore or boss measurement

Description

This cycle measures a bore or boss feature using three vectored measuring moves along the ZY axis.

Application

With the probe and probe offset active, position the probe to the expected centre line of the feature and at a suitable position in the X axis. Run the cycle with suitable inputs.

Format

G65 P9623 Aa Bb Cc Dd [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

or

G65 P9623 Aa Bb Cc Dd Xx [Ee Ff Hh Mm Qq Rr Ss Tt Jj Uu Vv Ww]

where [ ] denote optional inputs.

Example: G65 P9623 A45. B150. C−120. D50.005 X50. E21. F0.8 H0.2 M0.2 Q10. R10. S1. T20. J3000. U0.5 V0.5. W2.

Compulsory inputs

Aa	a =	The first angle for vector measurement, measured from the Z+ axis direction.
Bb	b =	The second angle for vector measurement, measured from the Z+ axis direction.
Cc	c =	The third angle for vector measurement, measured from the Z+ axis direction.
Dd	d =	Nominal size of the feature.
Xx	x =	The absolute X-axis position when measuring a boss feature. If this is omitted, a bore cycle is assumed.

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

Example: 3-point bore measurement (referred datum)

T01 M06	Select the probe.
G400 B0. J0.	Orientate the probe to the B0 position. Activate the tool offset.
G54 Z0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9610 X−10. F3000.	Protected positioning move.
G65 P9623 D30. A45. B150. C−120.	Measure a 30 mm (1.181 in) diameter bore.
G65 P9610 X100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 X0.	Reference return.
continue	

The error of the centre line is referred to the datum point Z0 Y0.

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Chapter 8 – Additional cycles

The Inspection Plus software contains a number of macro cycles that cannot be categorised under the headings used in chapters 4 to 7 of this manual. This chapter describes how to use these cycles.

Contained in this chapter

Probe start – O9832

Description

This program is used to switch the probe ON and can also be used to select machine-specific modes and commands required.

CAUTION: It is compulsory to run this cycle before other probe cycles, otherwise an alarm will be raised.

The following data may be adjusted to suit during the installation by editing this macro.

#110 values

#110 = 500(PROBE*1*BASE*NUMBER)

Select the location where calibration data for the probe is stored.

NOTE: Spare macro variable locations, in which data can be stored, are dependent on the machine options available and the variables that are already used by your programs.

Probe on M-code

M74(PROBE*1*ON)

Select the M-code to turn the probe on.

Probe dwell

G04X2.0(PROBE*1*DWELL)

Select the dwell after probe on.

User start codes

(-->USER*START*CODE)

(<*ADD*START*CODES*HERE)

(<--USER*START*CODE)

Look for this section near the top of cycle O9832. This is where you can add code that must always be active when running the cycles.

Application

The probe must be loaded into the spindle and moved to a safe start plane before running this cycle. It will activate the probe and select the operational modes for subsequent cycles to use.

Format

G65 P9832

Probe end – O9833

Description

This program is used to switch the probe OFF and can also be used to select machine-specific modes and commands required.

The following data may be adjusted to suit during the installation by editing this macro. The values described are supplied as standard.

Probe off M-code

M73(PROBE*1*OFF)

Select the M-code to turn the probe on.

User stop codes

(-->USER*STOP*CODE)

(<*ADD*STOP*CODES*HERE)

(<--USER*STOP*CODE)

Look for this section near the bottom of cycle O9833. This is where you can add code that must always be read when probing is finished.

Application

The probe should be retracted to a safe plane before using this cycle. It will stop the probe and any other optional functions that have been commanded.

Format

G65 P9833

Bore/boss on PCD measurement (B−90) – O9819

NOTE:
Angles are in the range ±180°.
Positive (+) angle: Counterclockwise direction.
Negative (–) angle: Clockwise direction.

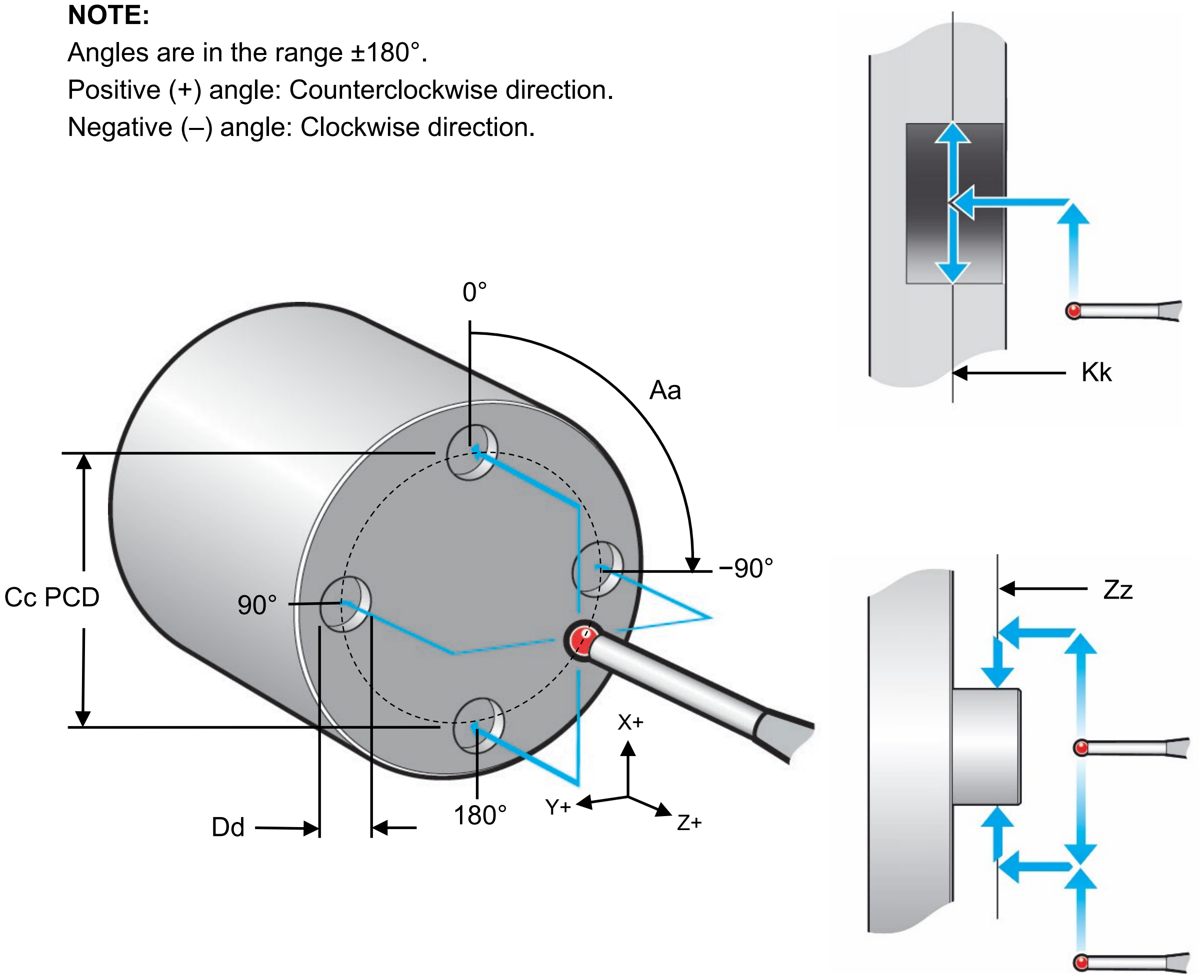


Figure 8.1 Bore/boss on PCD measurement

Description

The macro measures a series of bores or bosses on a PCD (pitch circle diameter). All probe moves occur automatically and return to the start position at the centre of the PCD.

Application

1. Position the probe at the centre of the PCD above the component. The probe moves to each of the bore/boss features and measures each one automatically. At the end of the cycle it returns to the PCD centre.

2. The macro makes use of the bore/boss macro which is nested within the moves. The macro nesting level is four deep, which means that this macro cannot be nested inside a customer macro.

3. If a “probe open” condition occurs during any of the moves between bore/boss features, a PATH OBSTRUCTED alarm occurs. The probe then stays in position instead of returning to the start position as is usual. This is done for safety reasons because the return path to the centre line of the PCD may be obstructed.

Format

Boss: G65 P9819 Cc Dd Zz [Aa Bb Ee Hh Mm Qq Rr Uu Ww]

or

Bore: G65 P9819 Cc Dd Kk [Aa Bb Ee Hh Mm Qq Rr Uu Ww]

where [ ] denote optional inputs.

Example: G65 P9819 C28.003 D50.005 K11. A45.005 B2. E21. H0.2 M0.2 Q10. R10. U0.5 W2.

Compulsory inputs

Cc c = PCD. The pitch circle diameter of the bore/boss feature.

Dd d = Diameter of the bore/boss.

Kk k = Absolute Z-axis position at which the bore is to be measured.
or
Zz z = Absolute Z-axis position at which the boss is to be measured.

Optional inputs

Aa a = The angle measured from the X axis to the first bore/boss feature.

Default value: 0

Bb b = The number of bore/boss features on the PCD.

Default value: 1

For other optional inputs, see Chapter 2, “Optional inputs”.

Outputs

The feature measurements are stored in variables #135 to #149 (see Chapter 3, “Variable outputs”).

W2. Component number (incremented by 1). Feature number (set to 1).

W1. Feature number (incremented by 1).

The data listed below will be output to the online device (printer). For details of the print macro output format, see Appendix A, “Features, limitations, settings and applications”.

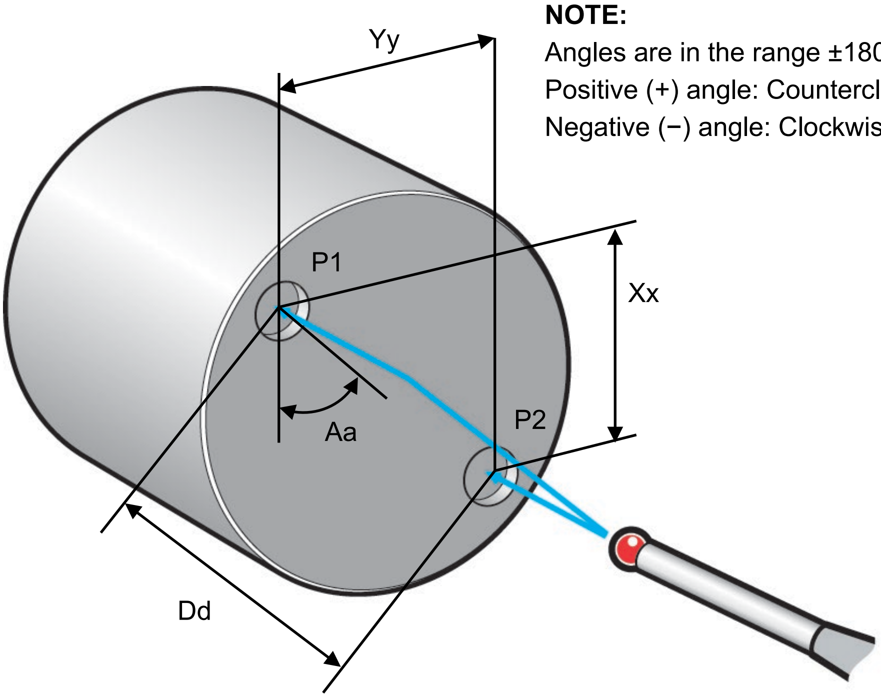
- The diameter of each bore/boss.
- The XY absolute position, angle position and pitch circle diameter of each feature.
- The feature number
- The error of the size and position.

Uu u = When the upper tolerance is exceeded, the macro continues to the end and print data is output for each feature.

If #120 is set, the UPPER TOLERANCE EXCEEDED alarm occurs and #148 = 2 is set. Otherwise, only the flag #148 = 2 is set.

The program continues.

Determining feature-to-feature data in the XY plane (B−90) – O9834



NOTE:
Angles are in the range ±180°.
Positive (+) angle: Counterclockwise direction.
Negative (−) angle: Clockwise direction.

Figure 8.2 Determining feature-to-feature data in the XY plane

Description

This is a no movement macro that is used after two measuring cycles to determine feature-to-feature data.

Application

Data for P1 and P2 must already be stored in variables #130 to #134 (for P1) and #135 to #139 (for P2) by running suitable measuring cycles.

NOTE: The order P1 and P2 is important, because the data calculated is that of P2 with respect to P1.

Values for P1 are obtained by programming G65 P9834 without any inputs after the first measuring cycle.

Values for P2 are obtained by running a second measuring cycle. The feature-to-feature data is established by programming G65 P9834 with suitable inputs after the second measuring cycle.

Format

G65 P9834 Xx [Ee Ff Hh Mm Ss Tt Jj Uu Vv Ww]
or
G65 P9834 Yy [Ee Ff Hh Mm Ss Tt Jj Uu Vv Ww]
or
G65 P9834 Xx Yy [Bb Ee Hh Mm Ss Uu Ww]
or
G65 P9834 Aa Dd [Bb Ee Hh Mm Ss Uu Ww]
or
G65 P9834 (with no inputs)

where [ ] denote optional inputs.

Examples: G65 P9834 X100. E21. F0.8 H0.2 M0.2 S1. T20. J3000. U0.5 V0.5 W2.
or
G65 P9834 Y100. E21. F0.8 H0.2 M0.2 S1. T20. J3000. U0.5 V0.5 W2.
or
G65 P9834 X100. Y100. B2. E21. H0.2 M0.2 S1. U0.5 W2.
or
G65 P9834 A45.005 D50.005 B2. E21. H0.2 M0.2 S1. U0.5 W2.

NOTES:

1. Updating a tool offset with the T input is possible only if either O9811 or O9821 is used for the P2 data. Otherwise a T INPUT NOT ALLOWED alarm results.
2. This cycle cannot be used in conjunction with the web/pocket cycle macro O9812.
3. Angles. The XY plane is with respect to the X+ axis direction. Use angles in the range ±180°.
4. When G65 P9834 (without any inputs) is used, the following data is then stored:

from	#135	to	#130
	#136		#131
	#137		#132
	#138		#133
	#139		#134

Compulsory inputs

Aa a = The angle of P2 with respect to P1 when measured from the X+ axis (angles are between ±180°).

Dd d = The minimum distance between P1 and P2.

Xx x = The nominal incremental distance in the X axis.

Yy y = The nominal incremental distance in the Y axis.

(no inputs) This is used to store output data of the last cycle for P1 data.

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

Example 1: Measuring the incremental distance between two holes

G65 P9810 X30. Y50. F3000.	Protected positioning move.
G65 P9810 Z−10.	Protected positioning move.
G65 P9814 D20.	P1 20 mm (0.787 in) bore.
G65 P9834	Store the data.
G65 P9810 Z10.	Protected positioning move.
G65 P9810 X80. Y78.867	Move to the new position.
G65 P9810 Z−10.	Protected positioning move.
G65 P9814 D30.	P2 30 mm (1.181 in) bore.

And either this

G65 P9834 X50. Y28.867 M0.1	Incremental distance measurement with 0.1 mm (0.0039 in) true position tolerance.

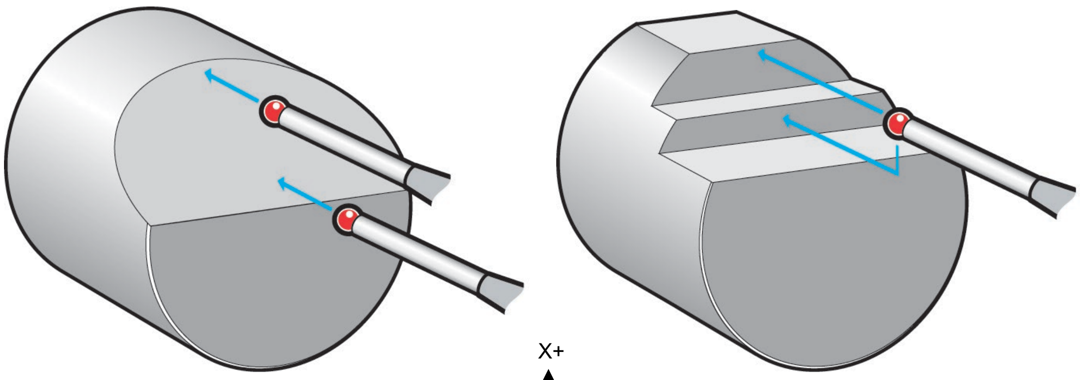
or this

G65 P9834 A30. D57.735 M0.1

Example 2: Measuring a surface to bore

G65 P9810 X10. Y50. F3000.	Protected positioning move.
G65 P9810 Z−10.	Protected positioning move.
G65 P9811 X0.	P1 at X0 mm (0 in) position.
G65 P9834	Store the data.
G65 P9810 Z10.	Protected positioning move.
G65 P9810 X−50.	Move to the new position.
G65 P9810 Z−10.	Protected positioning move.
G65 P9814 D20.5	P2 20.5 mm (0.807 in) bore.
G65 P9834 X−50. H.2	Measure distance −50 mm (−1.968 in).

Determining feature-to-feature data in the Z plane (B−90) – O9834

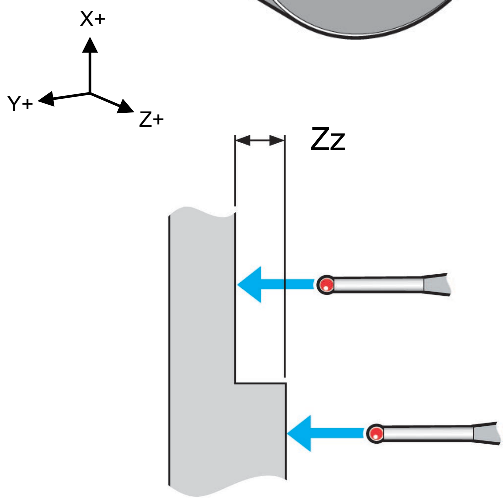


NOTE:

Angles are in the range ±180°.

Positive (+) angle: Counterclockwise direction.

Negative (−) angle: Clockwise direction.



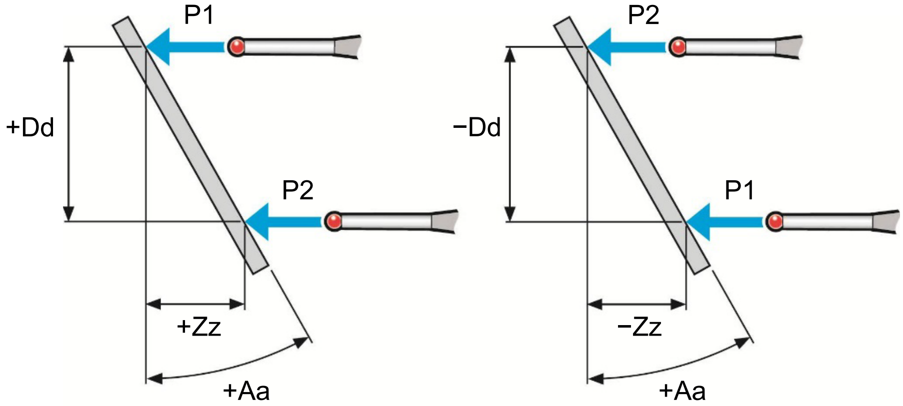


Figure 8.3 Determining feature-to-feature data in the Z plane

Description

This is a no movement macro that is used after two measuring cycles to determine feature-to-feature data.

Application

Data for P1 and P2 must already be stored in variables #130 to #134 (for P1) and #135 to #139 (for P2) by running suitable measuring cycles.

NOTE: The order of P1 and P2 is important because the data calculated is that of P2 with respect to P1.

Values for P1 are obtained by programming G65 P9834 without any inputs after the first measuring cycle.

Values for P2 are obtained by running a second measuring cycle. The feature-to-feature data is established by programming G65 P9834 with suitable inputs after the second measuring cycle.

Format

G65 P9834 Zz [Ee Ff Hh Mm Ss Tt Jj Uu Vv Ww]

or

G65 P9834 Aa Zz [Bb Ww]

or

G65 P9834 Dd Zz [Bb Ww]

or

G65 P9834 (with no inputs)

where [ ] denote optional inputs.

Examples: G65 P9834 Z50. E21. F0.8 H0.2 M0.2 S1. T20. J2000. U0.5 V0.5 W2.

or

G65 P9834 A45.005 Z50. B2. W2.

or

G65 P9834 D50.005 Z50. B2. W2.

or

G65 P9834 (with no inputs)

NOTES:

1. Updating a tool offset with the T input is possible only if O9811 is used for the P2 data. Otherwise a T INPUT NOT ALLOWED alarm results.

2. Angles. These are with respect to the XY. Use angles in the range ±180°.

3. When G65 P9834 (without any inputs) is used, the following data is then stored:

from	#135	to	#130
	#136		#131
	#137		#132
	#138		#133
	#139		#134

Inputs

Aa and Zz, or Dd and Zz inputs

1. The +Dd/−Dd values should be used to indicate the direction of P2 with respect to P1.

2. Angles are between ±180°.

3. A positive Aa (+Aa) angle is in the counterclockwise direction.

Zz input only

The +Zz/–Zz values should be used to indicate the direction of P2 with respect to P1.

Compulsory inputs

Aa   a =   This is the angle of P2 with respect to P1 measured from the XY plane (angles are between ±180°).

Zz   z =   The nominal incremental distance in the Z axis.
or
Dd   d =   The minimum distance between P1 and P2 measured in the XY plane.

Zz   z =   The nominal incremental distance in the Z axis.
or
(No inputs)   This is used to store output data of the last cycle for P1 data.

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

Example 1: Measuring the incremental distance between two surfaces

G65 P9810 X30. Y50. F3000.	Protected positioning move.
G65 P9810 Z30.	Protected positioning move.
G65 P9811 Z20.	P1 20 mm (0.787 in) surface.
G65 P9834	Store the data.
G65 P9810 X50.	Move to the new position.
G65 P9811 Z15.	P2 15 mm (0.591 in) surface.
G65 P9834 Z−5. H0.1	The feature to feature is at –5 mm (–0.197 in).

Example 2: Measuring an angled surface

G65 P9810 X30. Y50. F3000.	Protected positioning move.
G65 P9810 Z30.	Protected positioning move.
G65 P9811 Z20.	P1 at the 20 mm (0.787 in) position.
G65 P9834	Store the data.
G65 P9810 X77.474	Move to the new position.
G65 P9811 Z10.	P2 at the 10 mm (0.394 in) position.

and either this

G65 P9834 D27.474 Z−10. B0.5	Measure the slope –20° (clockwise), angle tolerance ±0.5°.

or this

G65 P9834 A−20. Z−10. B0.5

Angle measurement in the X or Y plane (B−90) – O9843

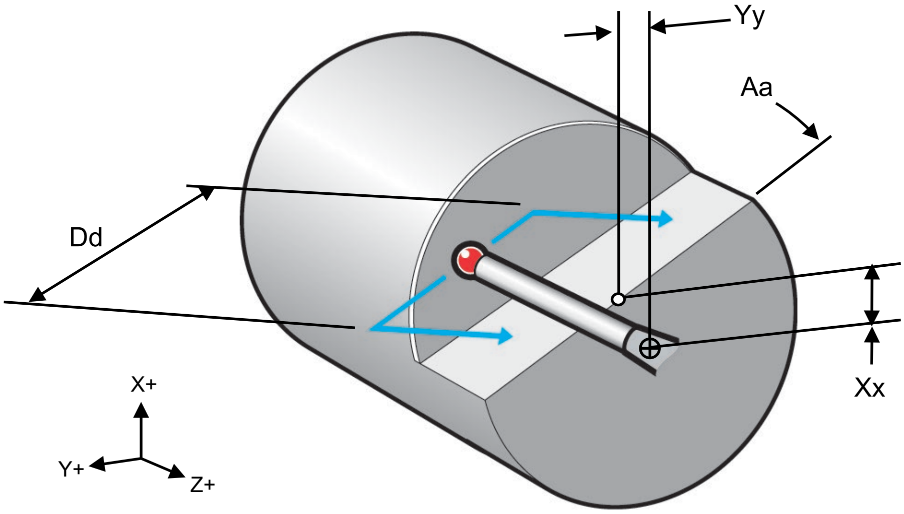


Figure 8.4 Measuring an angled surface in the X plane

NOTE:
Angles are in the range ±180°.
Positive (+) angle: Counterclockwise direction.
Negative (−) angle: Clockwise direction.

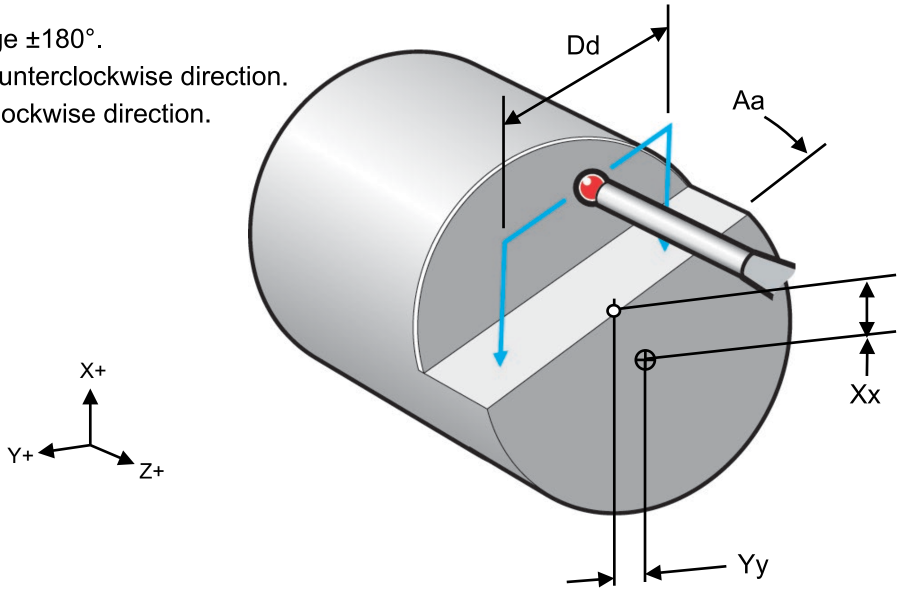


Figure 8.5 Measuring an angled surface in the Y plane

Description

This cycle measures an X-axis or Y-axis surface at two positions to establish the angular position of the surface.

Application

To provide a suitable start position, the stylus is positioned adjacent to the surface and at the required Z-axis position. The cycle makes two measurements, symmetrically about the start position, to establish the surface angle.

Format

G65 P9843 Xx Dd [Aa Bb Qq Ww]
or
G65 P9843 Yy Dd [Aa Bb Qq Ww]

where [ ] denote optional inputs.

Example: G65 P9843 X50. D30. A45. B0.2 Q15. W1.

Compulsory inputs

Dd	d =	The distance moved parallel to the X axis or Y axis between the two measuring positions.
Xx	x =	The mid-point position of the surface. An Xx input results in a cycle measuring in the X-axis direction.
Yy	y =	The mid-point position of the surface. A Yy input results in a cycle measuring in the Y-axis direction.

NOTE: Do not mix the Xx and Yy inputs.

Optional inputs

Aa	a =	The nominal angle of the surface measured from the X+ axis direction positive angles (counterclockwise). Specify angles between ±90° of the default value. **Defaults:** X-axis measuring 90°. Y-axis measuring 0°.

For other optional inputs, see Chapter 2, “Optional inputs”.

Outputs

#139 The surface angle measured from the X+ direction.

#143 The measured height difference.

#144 The surface angle error.

Example: Measuring an angled surface

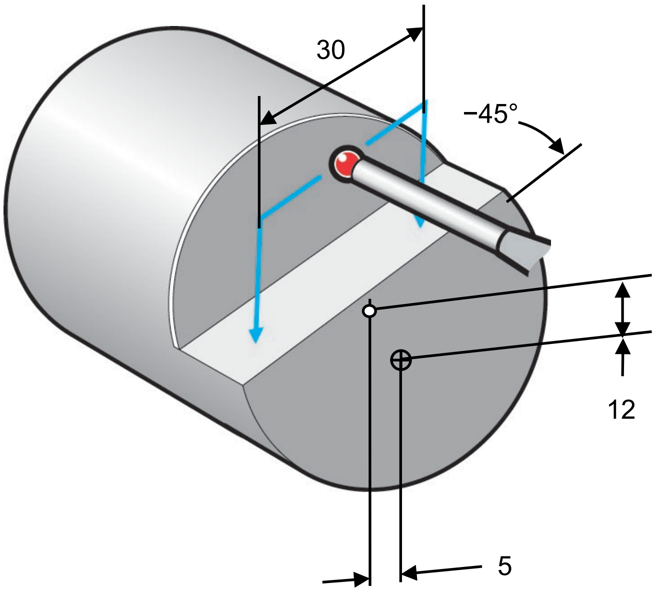


Figure 8.6 Example of an angled surface measurement

G65 P9810 X12. Y5. Z100. F3000.	Protected positioning move.
G65 P9810 Z−15.	Protected move to the start position.
G65 P9843 Y30. D30. A−45.	Angle measurement.
G65 P9810 Z100.	Retract to a safe position.

Bore/boss on PCD measurement (B0) – O9619

NOTE:
Angles are in the range ±180°.
Positive (+) angle: Counterclockwise direction.
Negative (−) angle: Clockwise direction.

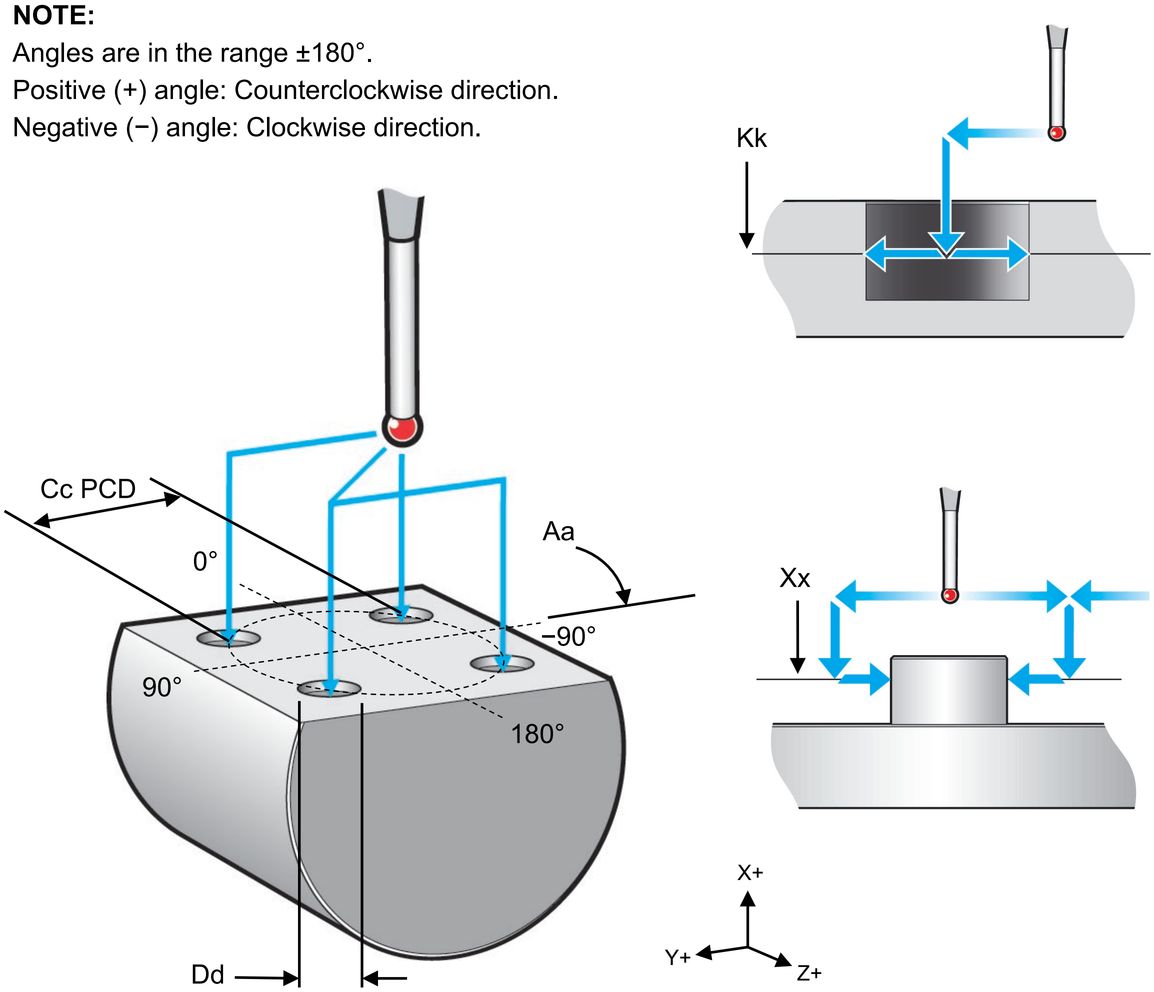


Figure 8.7 Bore/boss on PCD measurement

Description

The macro measures a series of bores or bosses on a PCD (pitch circle diameter). All probe moves occur automatically and return to the start position at the centre of the PCD.

Application

1. Position the probe at the centre of the PCD above the component. The probe moves to each of the bore/boss features and measures each one automatically. At the end of the cycle it then returns to the PCD centre.

2. The macro makes use of the bore/boss macro which is nested within the moves. The macro nesting level is four deep, which means that this macro cannot be nested inside a customer macro.

3. If a "probe open" condition occurs during any of the moves between bore/boss features, a PATH OBSTRUCTED alarm occurs. The probe then stays in position instead of returning to the start position as is usual. This is done for safety reasons because the return path to the centre line of the PCD may be obstructed.

Format

Boss: G65 P9619 Cc Dd Xx [Aa Bb Ee Hh Mm Qq Rr Uu Ww]

or

Bore: G65 P9619 Cc Dd Kk [Aa Bb Ee Hh Mm Qq Rr Uu Ww]

where [ ] denote optional inputs.

Example: G65 P9619 C28.003 D50.005 K11. A45.005 B2. E21. H0.2 M0.2 Q10. R10. U0.5 W2.

Compulsory inputs

Cc c = PCD. The pitch circle diameter of the bore/boss feature.

Dd d = Diameter of the bore/boss.

Kk k = Absolute X-axis position at which the bore is to be measured.
or
Xx x = Absolute X-axis position at which the boss is to be measured.

Optional inputs

Aa a = The angle measured from the Z axis to the first bore/boss feature.

Default value: 0

Bb b = The number of bore/boss features on the PCD.

Default value: 1

For other optional inputs, see Chapter 2, "Optional inputs".

Outputs

The feature measurements are stored in variables #135 to #149 (see Chapter 3, “Variable outputs”).

W2. Component number (incremented by 1). Feature number (set to 1).

W1. Feature number (incremented by 1).

The data listed below will be output to the online device (printer). For details of the print macro output format, see Appendix A, “Features, limitations, settings and applications”.

- The diameter of each bore/boss.
- The ZY absolute position, angle position and pitch circle diameter of each feature.
- The feature number.
- The error of the size and position.

Uu u = When the upper tolerance is exceeded, the macro continues to the end and print data is output for each feature.

If #120 is set, the UPPER TOLERANCE EXCEEDED alarm occurs and #148 = 2 is set. Otherwise, only the flag #148 = 2 is set.

The program continues.

Determining feature-to-feature data in the ZY plane (B0) – O9634

NOTE:
Angles are in the range ±180°.
Positive (+) angle: Counterclockwise direction.
Negative (−) angle: Clockwise direction.

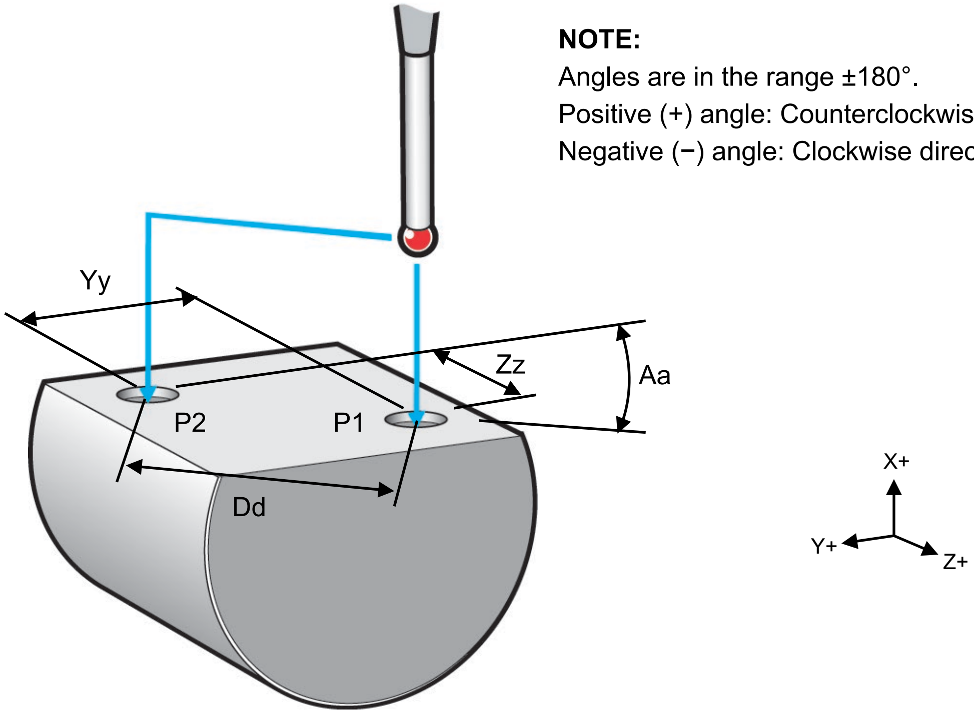


Figure 8.8 Determining feature-to-feature data in the ZY plane

Description

This is a no movement macro that is used after two measuring cycles to determine feature-to-feature data.

Application

Data for P1 and P2 must already be stored in variables #130 to #134 (for P1) and #135 to #139 (for P2) by running suitable measuring cycles.

NOTE: The order P1 and P2 is important, because the data calculated is that of P2 with respect to P1.

Values for P1 are obtained by programming G65 P9634 without any inputs after the first measuring cycle.

Values for P2 are obtained by running a second measuring cycle. The feature-to-feature data is established by programming G65 P9634 with suitable inputs after the second measuring cycle.

Format

G65 P9634 Zz [Ee Ff Hh Mm Ss Tt Jj Uu Vv Ww]
or
G65 P9634 Yy [Ee Ff Hh Mm Ss Tt Jj Uu Vv Ww]
or
G65 P9634 Zz Yy [Bb Ee Hh Mm Ss Uu Ww]
or
G65 P9634 Aa Dd [Bb Ee Hh Mm Ss Uu Ww]
or
G65 P9634 (with no inputs)

where [ ] denote optional inputs.

Examples: G65 P9634 Z100. E21. F0.8 H0.2 M0.2 S1. T20. J3000. U0.5 V0.5 W2.
or
G65 P9634 Y100. E21. F0.8 H0.2 M0.2 S1. T20. J3000. U0.5 V0.5 W2.
or
G65 P9634 Z100. Y100. B2. E21. H0.2 M0.2 S1. U0.5 W2.
or
G65 P9634 A45.005 D50.005 B2. E21. H0.2 M0.2 S1. U0.5 W2.

NOTES:

1. Updating a tool offset with the T input is possible only if either O9611 or O9621 is used for the P2 data. Otherwise a T INPUT NOT ALLOWED alarm results.
2. This cycle cannot be used in conjunction with the web/pocket cycle macro O9612.
3. Angles. The ZY plane is with respect to the Z+ axis direction. Use angles in the range ±180°.
4. When G65 P9634 (without any inputs) is used, the following data is then stored:

from	#135	to	#130
	#136		#131
	#137		#132
	#138		#133
	#139		#134

Compulsory inputs

Aa	a =	The angle of P2 with respect to P1 when measured from the X+ axis (angles are between ±180°).
Dd	d =	The minimum distance between P1 and P2.
Zz	z =	The nominal incremental distance in the Z axis.
Yy	y =	The nominal incremental distance in the Y axis.
(no inputs)		This is used to store output data of the last cycle for P1 data.

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

Example 1: Measuring the incremental distance between two holes

G65 P9610 Z−30. Y50. F3000.	Protected positioning move.
G65 P9610 X−10.	Protected positioning move.
G65 P9614 D20.	P1 20 mm (0.787 in) bore.
G65 P9634	Store the data.
G65 P9610 X10.	Protected positioning move.
G65 P9610 Z−80. Y78.867	Move to the new position.
G65 P9610 X−10.	Protected positioning move.
G65 P9614 D30.	P2 30 mm (1.181 in) bore.

And either this

G65 P9634 Z−50. Y28.867 M0.1	Incremental distance measurement with 0.1 mm (0.0039 in) true position tolerance.

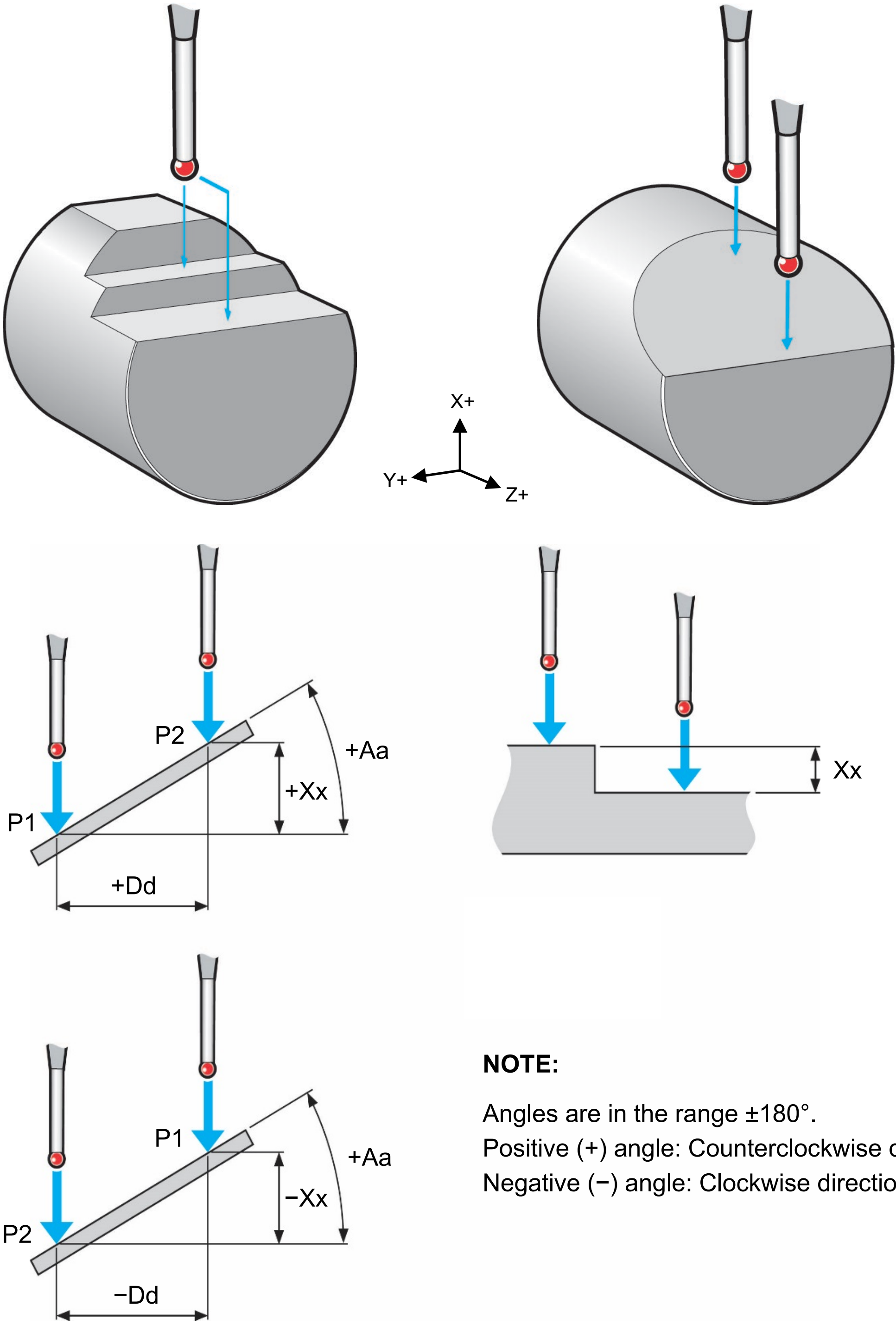
or this

G65 P9634 A30. D57.735 M0.1

Example 2: Measuring a surface to bore

G65 P9610 Z10. Y50. F3000.	Protected positioning move.
G65 P9610 X−10.	Protected positioning move.
G65 P9611 Z0.	P1 at Z0 mm (0 in) position.
G65 P9634	Store the data.
G65 P9610 X10.	Protected positioning move.
G65 P9610 Z−50.	Move to the new position.
G65 P9610 X−10.	Protected positioning move.
G65 P9614 D20.5	P2 20.5 mm (0.807 in) bore.
G65 P9634 Z−50. H.2	Measure distance −50 mm (−1.968 in).

Determining feature-to-feature data in the X plane (B0) – O9634



NOTE:

Angles are in the range ±180°.
Positive (+) angle: Counterclockwise direction.
Negative (−) angle: Clockwise direction.

Figure 8.9 Determining feature-to-feature data in the X plane

Description

This is a no movement macro that is used after two measuring cycles to determine feature-to-feature data.

Application

Data for P1 and P2 must already be stored in variables #130 to #134 (for P1) and #135 to #139 (for P2) by running suitable measuring cycles.

NOTE: The order of P1 and P2 is important because the data calculated is that of P2 with respect to P1.

Values for P1 are obtained by programming G65 P9634 without any inputs after the first measuring cycle.

Values for P2 are obtained by running a second measuring cycle. The feature-to-feature data is established by programming G65 P9634 with suitable inputs after the second measuring cycle.

Format

G65 P9634 Xx [Ee Ff Hh Mm Ss Tt Jj Uu Vv Ww]

or

G65 P9634 Aa Xx [Bb Ww]

or

G65 P9634 Dd Xx [Bb Ww]

or

G65 P9634 (with no inputs)

where [ ] denote optional inputs.

Examples: G65 P9634 X50. E21. F0.8 H0.2 M0.2 S1. T20. J2000. U0.5 V0.5 W2.

or

G65 P9634 A45.005 X50. B2. W2.

or

G65 P9634 D50.005 X50. B2. W2.

or

G65 P9634 (with no inputs)

NOTES:

1. Updating a tool offset with the T input is possible only if O9611 is used for the P2 data. Otherwise a T INPUT NOT ALLOWED alarm results.

2. Angles. These are with respect to the ZY. Use angles in the range ±180°.

3. When G65 P9634 (without any inputs) is used, the following data is then stored:

from	#135	to	#130
	#136		#131
	#137		#132
	#138		#133
	#139		#134

Inputs

Aa and Xx, or Dd and Xx inputs

1. The +Dd/−Dd values should be used to indicate the direction of P2 with respect to P1.

2. Angles are between ±180°.

3. A positive Aa (+Aa) angle is in the counterclockwise direction.

Xx input only

The +Xx/–Xx values should be used to indicate the direction of P2 with respect to P1.

Compulsory inputs

Aa	a =	This is the angle of P2 with respect to P1 measured from the ZY plane (angles are between ±180°).
Xx	x =	The nominal incremental distance in the X axis.
or		
Dd	d =	The minimum distance between P1 and P2 measured in the ZY plane.
Xx	x =	The nominal incremental distance in the X axis.
or		
(No inputs)		This is used to store output data of the last cycle for P1 data.

Optional inputs

See Chapter 2, “Optional inputs”.

Outputs

See Chapter 3, “Variable outputs”.

Example 1: Measuring the incremental distance between two surfaces

G65 P9610 Z30. Y50. F3000.	Protected positioning move.
G65 P9610 X30.	Protected positioning move.
G65 P9611 X20.	P1 20 mm (0.787 in) surface.
G65 P9634	Store the data.
G65 P9610 Z50.	Move to the new position.
G65 P9611 X15.	P2 15 mm (0.591 in) surface.
G65 P9634 X−5. H0.1	The feature to feature is at −5 mm (−0.197 in).

Example 2: Measuring an angled surface

G65 P9610 Z30. Y50. F3000.	Protected positioning move.
G65 P9610 X30.	Protected positioning move.
G65 P9611 X20.	P1 at the 20 mm (0.787 in) position.
G65 P9634	Store the data.
G65 P9610 Z77.474	Move to the new position.
G65 P9611 X10.	P2 at the 10 mm (0.394 in) position.

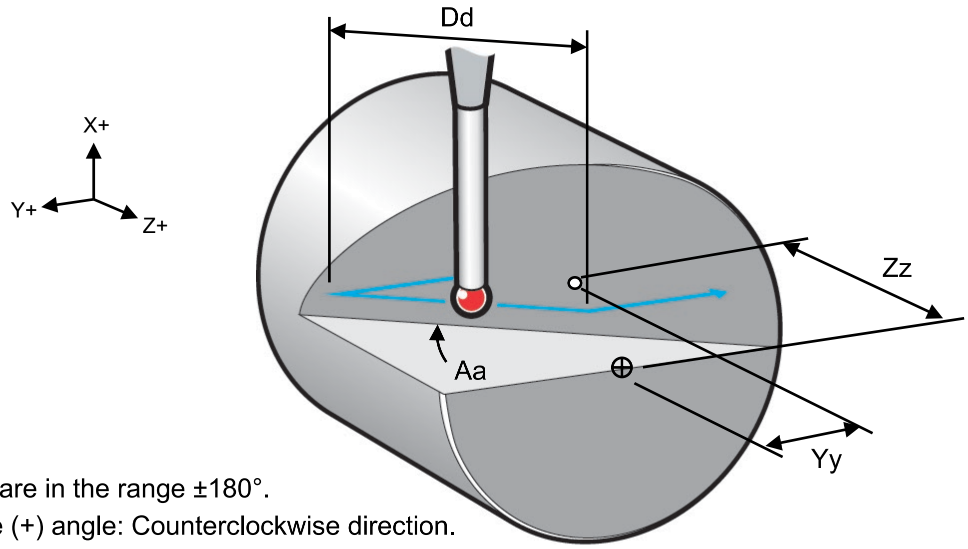
and either this

G65 P9634 D27.474 X−10. B0.5	Measure the slope −20° (clockwise), angle tolerance ±0.5°.

or this

G65 P9634 A−20. X−10. B0.5

Angle measurement in the Z or Y plane (B0) – O9643



NOTE:
Angles are in the range ±180°.
Positive (+) angle: Counterclockwise direction.
Negative (–) angle: Clockwise direction.

Figure 8.10 Measuring an angled surface in the Z plane

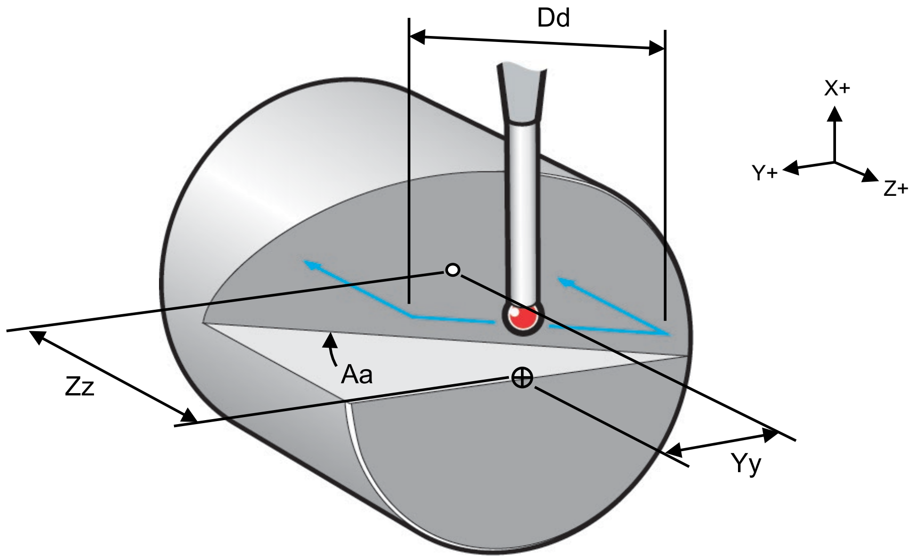


Figure 8.11 Measuring an angled surface in the Y plane

Description

This cycle measures a Z-axis or Y-axis surface at two positions to establish the angular position of the surface.

Application

To provide a suitable start position, the stylus is positioned adjacent to the surface and at the required X-axis position. The cycle makes two measurements, symmetrically about the start position, to establish the surface angle.

Format

G65 P9643 Zz Dd [Aa Bb Qq Ww]
or
G65 P9643 Yy Dd [Aa Bb Qq Ww]

where [ ] denote optional inputs.

Example: G65 P9643 Y−15. D30. A−135. B0.2 Q15. W1.

Compulsory inputs

Dd	d =	The distance moved parallel to the Z axis or Y axis between the two measuring positions.
Zz	z =	The mid-point position of the surface. A Zz input results in a cycle measuring in the Z-axis direction.
Yy	y =	The mid-point position of the surface. A Yy input results in a cycle measuring in the Y-axis direction.

NOTE: Do not mix the Zz and Yy inputs.

Optional inputs

Aa	a =	The nominal angle of the surface measured from the Z+ axis direction positive angles (counterclockwise). Specify angles between ±90° of the default value. **Defaults:** Z-axis measuring 90°. Y-axis measuring 0°.

For other optional inputs, see Chapter 2, “Optional inputs”.

Outputs

#139 The surface angle measured from the Z+ direction.

#143 The measured height difference.

#144 The surface angle error.

Example: Measuring an angled surface

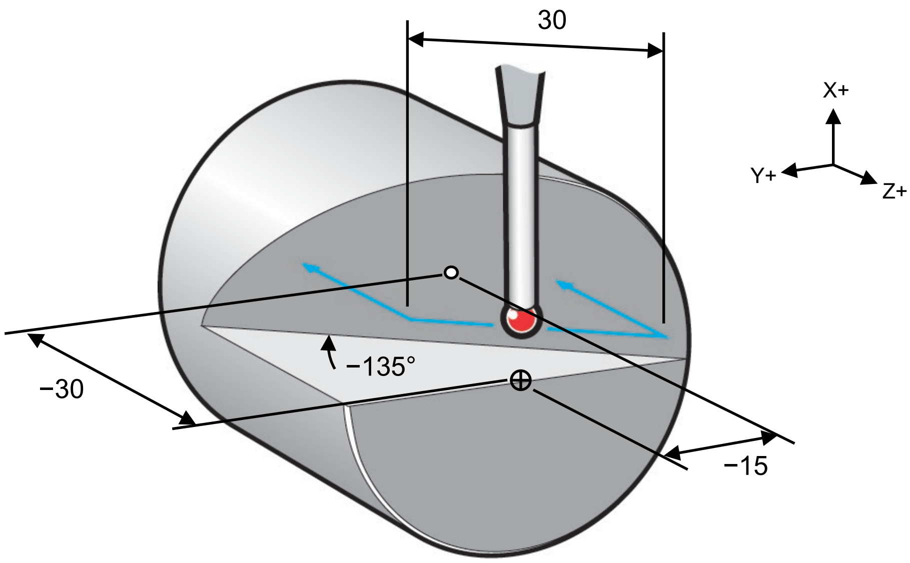


Figure 8.12 Example of an angled surface measurement

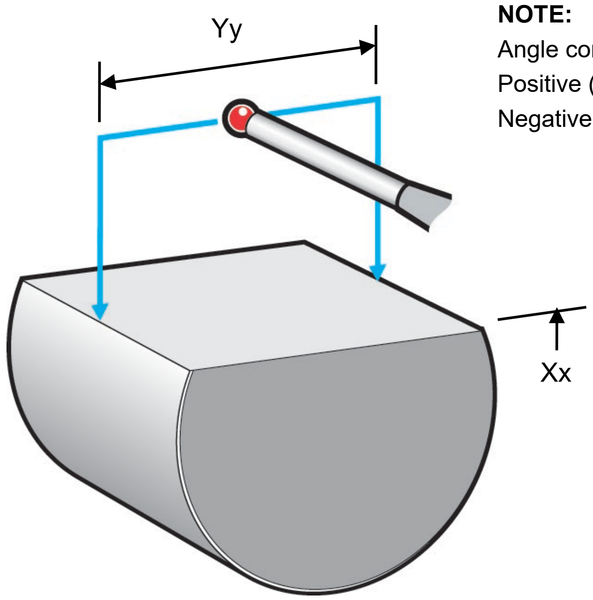
G65 P9610 X100. Y−15. Z−20. F3000.	Protected positioning move.
G65 P9610 X15.	Protected move to the start position.
G65 P9643 Y−15. D30. A−135.	Angle measurement.
G65 P9610 X100.	Retract to a safe position.
continue	

Chapter 9 – C-axis cycles

This chapter describes how to use the C-axis macros that are supplied as part of the Inspection Plus software.

Contained in this chapter

C-axis measurement (B−90) – O9818 (S1) / O9842 (S2)



NOTE:
Angle correction to the C axis:
Positive (+) angle: Counterclockwise direction.
Negative (–) angle: Clockwise direction.

Figure 9.1 C-axis measurement (probe at B−90)

Description

This macro is used to find the slope of a surface between two points X1 and X2. The C axis can then be rotated to compensate for the surface error.

Application

The C axis must be positioned to the expected angular position of the feature; that is, the surface normal to the X axis. If the Ss input is used, the work offset register is adjusted by the error amount.

NOTE: To make the new work offset active on most machines, it is normally necessary to restate the work offset and move to the angular position after the cycle.

Format

G65 P9818 or P9842 Yy Xx [Qq Bb Ss Ww]
where [ ] denote optional inputs.

Example: G65 P9818 Y100. X50. Q10. B2. S1. W2.

Compulsory inputs

Yy y = The Y-axis distance between the X1 and X2 measurement positions.

Xx x = The expected surface position in the X axis.

Optional inputs

Bb b = Set a tolerance on the angular position of the feature. It is equal to half the total tolerances.

Example: With a component dimension of 45° ±0.25°, the C axis would be positioned to 45° and B0.25 tolerance.

For other optional inputs, see Chapter 2, “Optional inputs”.

Outputs

#139 This will show the measured position in the C axis.

#143 This will show the (X1 – X2) value.

#144 This will show the angle correction value.

NOTE: Different machines and applications may require the C-axis system variable number to be changed. This is done by editing macro O9818 (or O9842 if S2 required) to suit your machine when the macro is installed.

#3 = 5 (C-axis number).

Change the axis number as required.

Axis direction change

#4 = 1 (1 = clockwise, and –1 = counterclockwise).

Change as required.

Example: Set the C axis to a milled flat

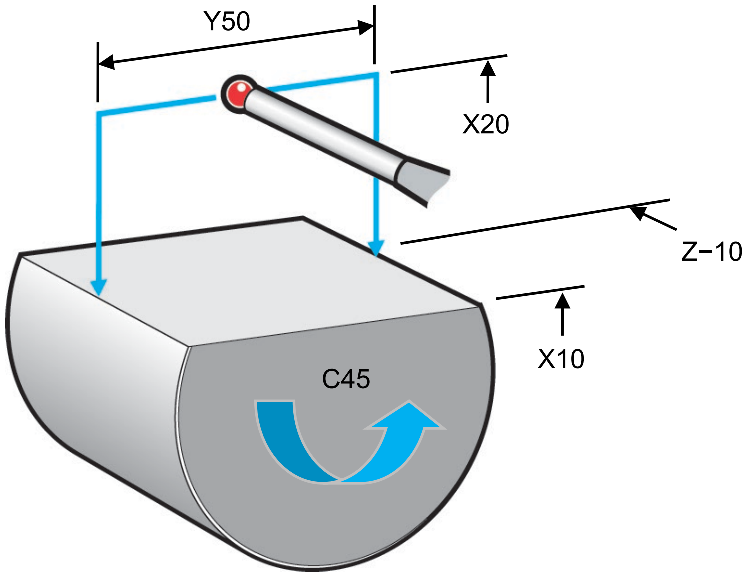


Figure 9.2 Probe movements

This example assumes that the G10.9 X0. (radius mode) is active.

T01 T00 M06	Select the probe.
G0 C45.	Position the C axis to 45°.
G65 P9810 Z−10. Y0. X20. F3000.	Position 10 mm (0.394 in) above the surface.
G65 P9818 Y50. X10. S1. B5.	Measure at 50 mm (1.968 in) centres, update G54 and set a tolerance of 5°.
G65 P9810 X200.	Protected positioning move.
G91 G28 X0.	Reference return.
G90	Absolute mode.
continue	

C-axis find (B−90) – O9850 (S1) / O9849 (S2)

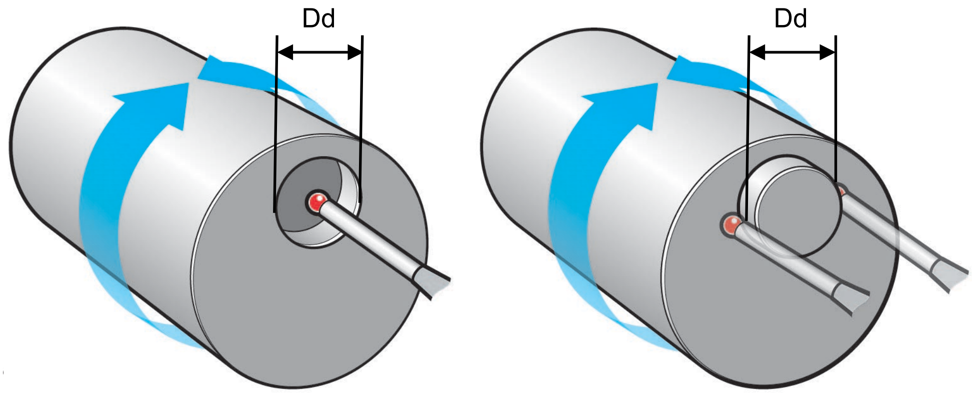


Figure 9.3 C-axis find (probe at B−90)

Description

This cycle will take two readings by moving the C axis. External features can also be measured by moving the Z axis. The results can be used to update a work shift.

Application

The stylus must be programmed to a start position that is either above an external feature or inside the internal feature. The C axis must be engaged before calling up the cycle.

The inclusion of a Zz input indicates that an external feature is to be measured.

Format

G65 P9850 or P9849 Dd [Zz Qq Rr Hh Ss]
where [ ] denote optional inputs.

Example: G65 P9850 D25. Z−4.0

Compulsory inputs

Dd d = The linear width of the feature.

Optional inputs

Hh h = Half the total positional tolerance.

Qq q = Amount of scan past the nominal surface position and the clearance for external features.

Default: 10°

Rr	r =	Clearance move amount in C for an external feature only (angle value). **Default:** 5 mm plus ball radius converted into an angle.
Zz	z =	The absolute Z position at which a reading is taken when measuring an external feature.

For the Ss optional input, see Chapter 2, “Optional inputs”.

Example: Bore

This example assumes that the G10.9 X0. (radius mode) is active.

Bore size = 20.

X position = X60.

Y position = Y0.

Z position = Z−40.

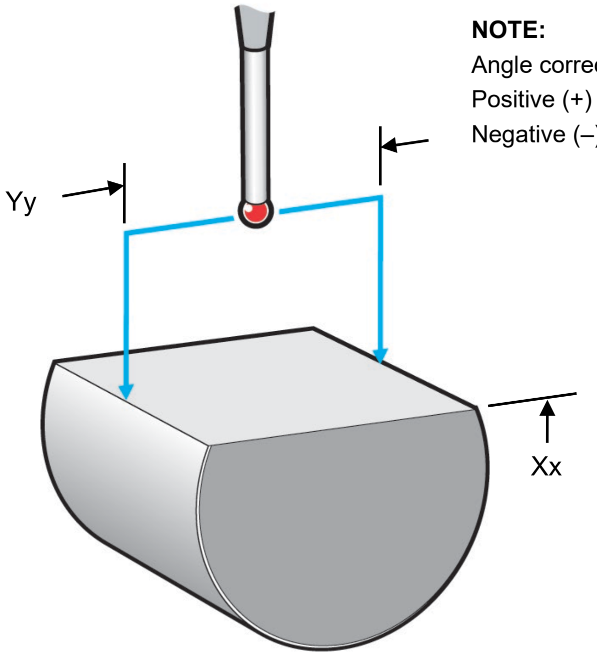
X100.0 Y0. Z20. C0.	Move to the safe position.
G65 P9810 X60.	Move over the bore.
G65 P9810 Z–40.	Move into the bore.
G65 P9850 D20. S1.	Measure the bore. Update G54.
G65 P9810 Z20.	Move out of the bore.

NOTE: The C-axis positioning feed can be optimised for this cycle.

The measure feedrate = (#23×0.25)

Sample of macro O9850: #23=3000 (C*POSITIONING*FEED*DEG/MIN)

C-axis measurement (B0) – O9618 (S1) / O9840 (S2)



NOTE:
Angle correction to the C axis:
Positive (+) angle: Counterclockwise direction.
Negative (–) angle: Clockwise direction.

Figure 9.4 C-axis measurement (probe at B0)

Description

This macro is used to find the slope of a surface between two points X1 and X2. The C axis can then be rotated to compensate for the surface error.

Application

The C axis must be positioned to the expected angular position of the feature; that is, the surface normal to the X axis. If the Ss input is used, the work offset register is adjusted by the error amount.

NOTE: To make the new work offset active on most machines, it is normally necessary to restate the work offset and move to the angular position after the cycle.

Format

G65 P9618 or P9840 Yy Xx [Qq Bb Ss Ww]
where [ ] denote optional inputs.

Example: G65 P9618 Y100. X50. Q10. B2. S1. W2.

Compulsory inputs

Yy y = The Y-axis distance between the X1 and X2 measurement positions.

Xx x = The expected surface position in the X axis.

Optional inputs

Bb b = Set a tolerance on the angular position of the feature. It is equal to half the total tolerances.

Example: With a component dimension of 45° ±0.25°, the C axis would be positioned to 45° and B0.25 tolerance.

For other optional inputs, see Chapter 2, “Optional inputs”.

Outputs

#139 This will show the measured position in the C axis.

#143 This will show the (X1 – X2) value.

#144 This will show the angle correction value.

NOTE: Different machines and application may require the C-axis system variable number to be changed. This is done by editing macro O9618 (or O9840 if S2 required) to suit your machine when the macro is installed.

#3 = 5 (C-axis number).

Change the axis number as required.

Axis direction change

#4 = 1 (1 = clockwise, and –1 = counterclockwise).

Change as required.

Example: Set the C axis to a milled flat

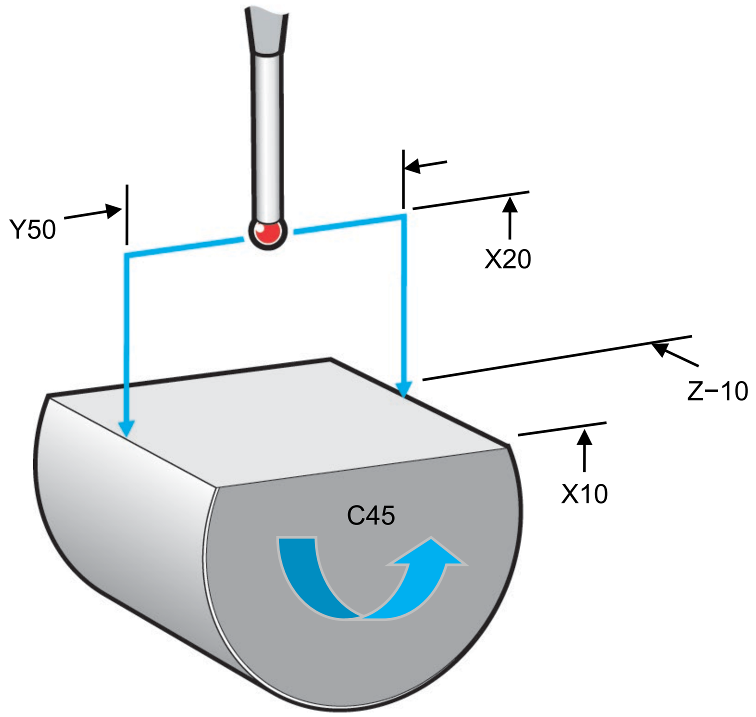


Figure 9.5 Probe movements

This example assumes that the G10.9 X0. (radius mode) is active.

T01 T00 M06	Select the probe.
G0 C45.	Position the C axis to 45°.
G65 P9610 Z0. Y0. X20. F3000.	Position 10 mm (0.394 in) above the surface.
G65 P9618 Y50. X10. S1. B5.	Measure at 50 mm (1.968 in) centres, update G54 and set a tolerance of 5°.
G65 P9610 Z200.	Protected positioning move.
G91 G28 X0.	Reference return.
G90	Absolute mode.
continue	

C-axis find (B0) – O9650 (S1) / O9841 (S2)

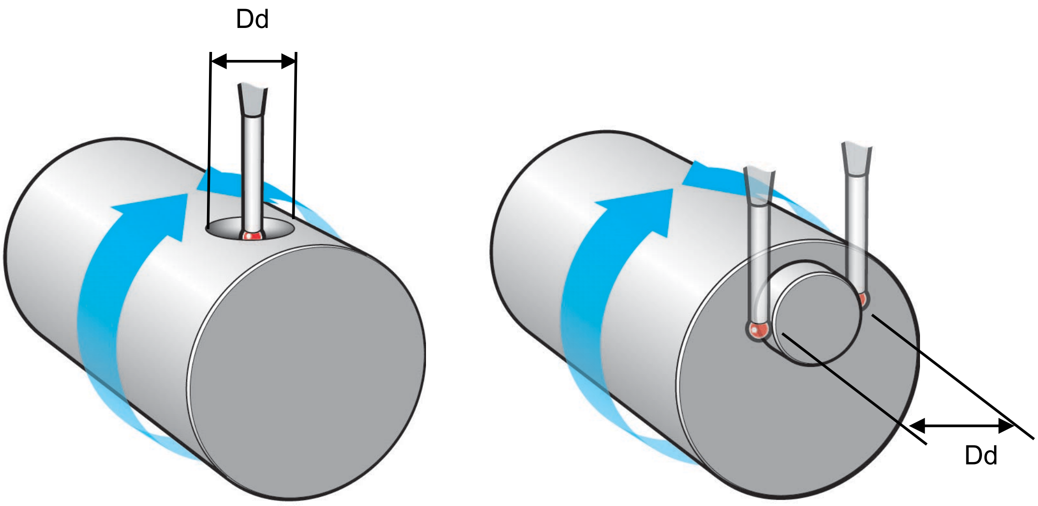


Figure 9.6 C-axis find (probe at B0)

Description

This cycle will take two readings by moving the C axis. External features can also be measured by moving the X axis. The results can be used to update a work shift.

Application

The stylus must be programmed to a start position that is either above an external feature or inside the internal feature. The C axis must be engaged before calling up the cycle.

The inclusion of an Xx input indicates that an external feature is to be measured.

Format

G65 P9650 or P9841 Dd [Xx Qq Rr Hh Ss]
where [ ] denote optional inputs.

Example: G65 P9650 D25.

Compulsory inputs

Dd	d =	The linear width of the feature.

Optional inputs

Hh	h =	Half the total positional tolerance.
Qq	q =	Amount of scan past the nominal surface position and the clearance for external features. **Default:** 5 mm.

Rr	r =	Clearance move amount in C for an external feature only (angle value). **Default:** 5 mm plus ball radius converted into an angle.
Xx	x =	The absolute X position at which a reading is taken when measuring an external feature.

For the Ss optional input, see Chapter 2, “Optional inputs”.

Example: Bore

This example assumes that the G10.9 X0. (radius mode) is active.

Bore size = 20.

X position = X60.

Y position = Y0.

Z position = Z−40.

X100.0 Y0. Z20. C0.	Move to the safe position.
G65 P9610 Z–40.	Move over the bore.
G65 P9610 X60.	Move into the bore.
G65 P9650 D20. S1.	Measure the bore. Update G54.
G65 P9610 X100.	Move out of the bore.

NOTE: The C-axis positioning feed can be optimised for this cycle.

The measure feedrate = (#23×0.25)

Sample of macro O9650: #23=3000 (C*POSITIONING*FEED*DEG/MIN)

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Chapter 10 – Tilted working plane (TWP) measuring cycles

This chapter describes how to use the probe with G368 or G68.1 active and with the B axis at an angle other than 0° or −90°. Program G368 or G68.1 as described in the Doosan SMX/MX programming manual.

Only Renishaw cycles O9800 to O9834 (probe at B−90) are to be used. The cycles O9600 to O9634 (probe at B0) **must not** be used.

The probe must be switched off when moving the B-axis head and switched on again when the head is in its new position. This is to be done using the User start and User end cycles.

It is possible to update or set the WCS whilst probing using TWP functions. Please refer to Chapter 11, “Rotated work co-ordinate system (WCS) setting”, for details of rotated WCS setting and TWP functions.

Contained in this chapter

XYZ single surface measurement at any B-axis angle – O9811

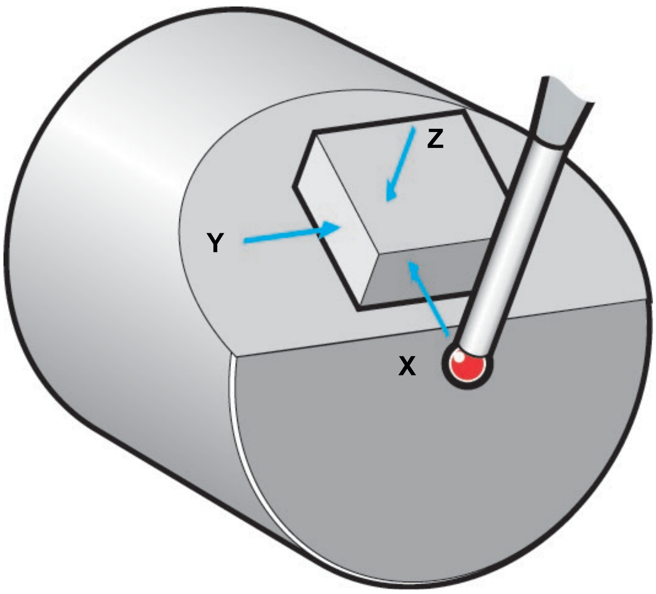


Figure 10.1 Measurement of a single surface

Example: Measuring a single surface in X at B−45

T01 M06	Select the probe.
G400 B−45. J0.	Orientate the probe to the B−45 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G68.1 X0. Y0. Z0. I0. J1. K0. R45.	**Plane rotated by 45°.**
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z−8. F3000.	Protected positioning move to the start position.
G65 P9811 X−50. T10. J3000.	Single surface measurement.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (where applicable).
G28 Z100.	Reference return.
continue	

The tool radius offset (10) is updated by the error of the surface position.

Web/pocket measurement at any B-axis angle – O9812

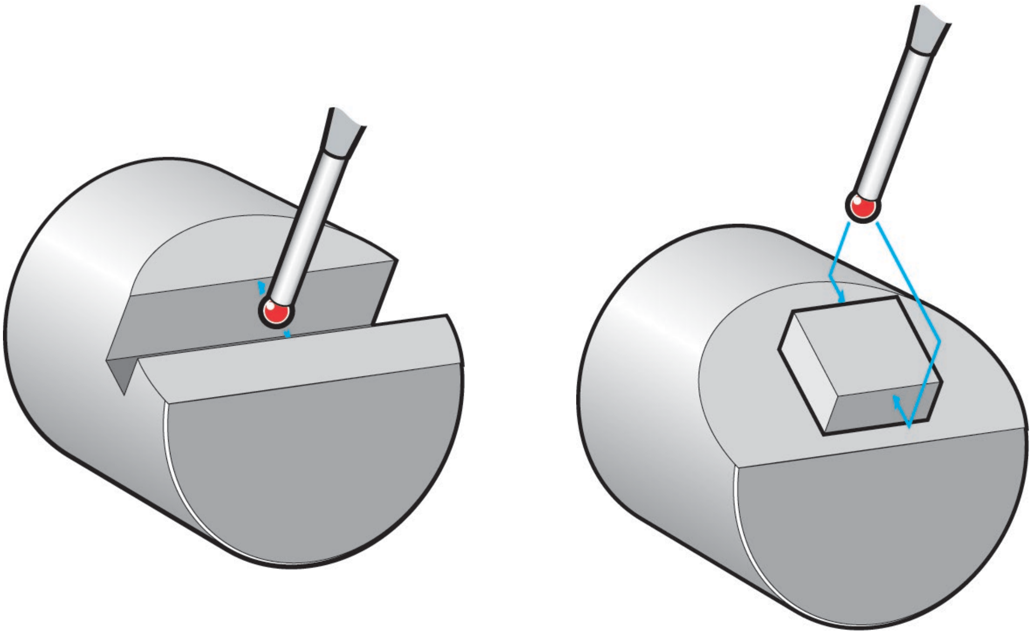


Figure 10.2 Measurement of a web or pocket feature

Example 1: Measuring a web in X at B−45

T01 M06	Select the probe.
G400 B−45. J0.	Orientate the probe to the B−45 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G68.1 X0. Y0. Z0. I0. J1. K0. R45.	**Plane rotated by 45°.**
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z10. F3000.	Protected positioning move.
G65 P9812 X50. Z−10.	Measure a 50 mm (1.968 in) wide web.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (where applicable).
G28 Z100.	Reference return.

Example 2: Measuring a pocket in X at B−45 (referred datum)

T01 M06	Select the probe.
G400 B−45. J0.	Orientate the probe to the B−45 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G68.1 X0. Y0. Z0. I0. J1. K0. R45.	**Plane rotated by 45°.**
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z−10. F3000.	Protected positioning move.
G65 P9812 X30.	Measure a 30 mm (1.181 in) wide pocket.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (where applicable).
G28 Z100.	Reference return.
continue	

Bore/boss measurement at any B-axis angle – O9814

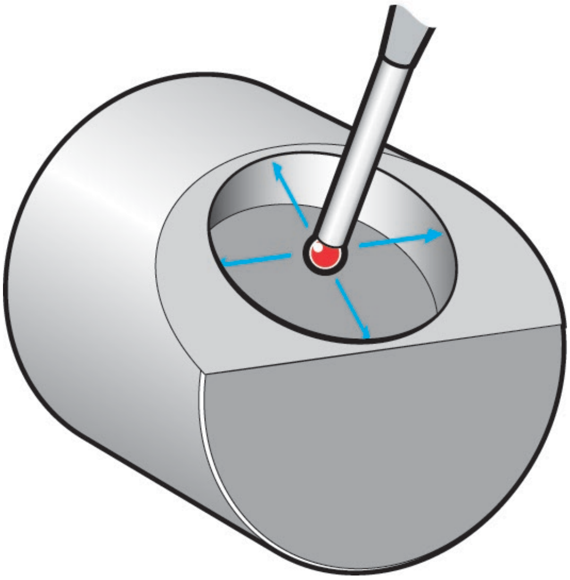


Figure 10.3 Measurement of a bore or boss feature

Example 1: Measuring a boss at B−45

T01 M06	Select the probe.
G400 B−45. J0.	Orientate the probe to the B−45 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G68.1 X0. Y0. Z0. I0. J1. K0. R45.	**Plane rotated by 45°.**
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z10. F3000.	Protected positioning move.
G65 P9814 D50. Z−10.	Measure a 50 mm (1.968 in) diameter bore.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 Z100.	Reference return.
continue	

Example 2: Measuring a bore at B−45

T01 M06	Select the probe.
G400 B−45. J0.	Orientate the probe to the B−45 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G68.1 X0. Y0. Z0. I0. J1. K0. R45.	**Plane rotated by 45°.**
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z−10. F3000.	Protected positioning move.
G65 P9814 D30.	Measure a 30 mm (1.181 in) diameter bore.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 Z100.	Reference return.
continue	

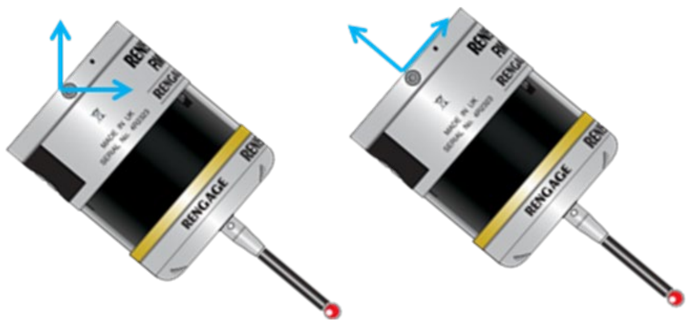
Parameters

The following parameters need to be set when using this Inspection Plus software.

CAUTION: Any parameter changes may affect the functionality of other systems on the machine. Confirm any parameter changes prior to use. Existing Renishaw installations (tool setters, lasers etc.) may be affected by parameter changes, owing to how tool lengths are applied and calculated in the software.

Parameter P5400.5 = 1

Set P5400 bit 5 to 1. This allows the co-ordinates of the skip position (#5061 to #5063) and current position (#5041 to #5043) to be read in the active feature co-ordinate system (FCS).



WCS P5400.5 = 0 **FCS P5400.5 = 1**

Figure 10.4 Parameter P5400.5

With parameter P5400.5 set to 1, the Z of the FCS will always be aligned to the probe centre line.

Parameter P6019.4 = 1

With P6019 bit 4 set to 1, the current tool length is added to the co-ordinates of the skip position (#5061 to #5063) and current position (#5041 to #5043). This allows the end of the probe to be the controlled and measuring point.

No tool length
P6019.4 = 0

Tool length added
P6019.4 = 1

Figure 10.5 Parameter P6019.4

NOTE: If parameter P6019.4 is set to 1, then #116 in O9723 needs to be set to 0. #116=0 will mean no tool length is added to any Z measurements.

Chapter 11 – Rotated work co-ordinate system (WCS) setting

This chapter describes how to select and load the rotated WCS setting cycles. The cycles enable the setting of a work co-ordinate system when the feature co-ordinate system (FCS) is not aligned to the machine co-ordinate system (MCS).

Contained in this chapter

About rotated WCS setting

When a feature co-ordinate system (FCS) is not aligned to the machine co-ordinate system (MCS), then the Fanuc system does not allow the correct update or setting of the WCS.

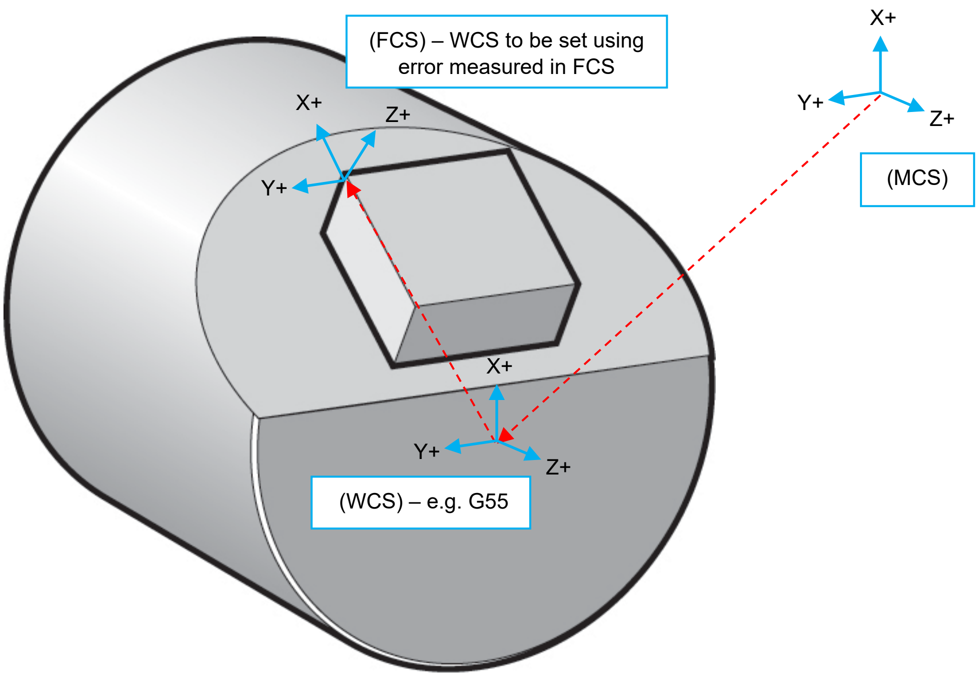


Figure 11.1 MCS – WCS – FCS

Renishaw provides a solution to enable the update or setting of a WCS by identifying the active FCS rotation and “back-calculating” the errors.

The Renishaw solution consists of two parts, the first of which is the “Identity move”. The data from the Identity move obtained here is used for further calculations in the WCS updating.

NOTE: Rotated WCS updates are directly related to machine tool performance. Inaccuracies in machine tool alignments and axis rotation centres will directly affect the tracking and updating of WCS positions.

Calculations

To calculate the FCS errors into the MCS for setting the WCS, three errors in X, Y and Z are required.

The X, Y, Z errors are automatically stored within the macros when running measuring cycles. These errors are then used for rotated WCS setting when required. The stored error values are cleared when a rotated WCS is set.

The calculation method requires the three errors (X, Y, Z) to be present before the identity move, and thus WCS, can be set.

NOTE: The three measurement errors in X, Y, and Z must be found when setting a rotated WCS. Failure to achieve this will result in an alarm.

Program

The File1 folder contains the following macro. The program needs to be loaded into the control in order for the update function to work correctly.

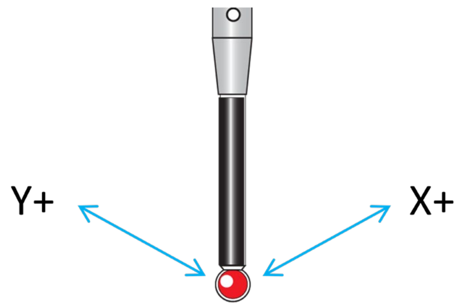
O9744 (REN*FCS*TO*WCS) FCS identity and calculation macro

This program is automatically called in O9732 when setting a WCS with a TWP command active.

Cycle description – O9744

When updating a WCS with any 3+2 or 5-axis functions active, this program is automatically called by the Inspection Plus software. This program is not used if the machine is in standard mode.

This program identifies the active FCS rotation. The program then calculates the measured errors back into MCS for correct WCS setting or updating.



This program produces a small XY move to identify the active FCS rotation from the MCS. The program then calculates the correct errors for WCS setting or updating.

O9744 (REN*FCS*TO*WCS)

#24=1. (IDENTITY*MOVE*DISTANCE*IN*MM) ***** edit 1**

#25=1000. (IDENTITY*MOVE*FEEDRATE*MM/MIN) ***** edit 2**

***** edit 1**

Adjust this value if the move may cause the probe stylus to collide on its Identity move.

NOTE: Reduction of this value may decrease the accuracy of the WCS calculation.

***** edit 2**

Adjust this value if the move is too fast for the machine.

NOTE: Reduction of this value may increase the cycle time of the Identity move.

Reading rotary axis machine positions

The reading of machine rotary axis positions is required in the O9744 macro. These are set by default when loading into the machine. These settings may change depending on the machine configuration.

These are usually #5043 to #5046 for rotary axis machine co-ordinates. Looking at the order of the axis on the “POSITION” display will define the axis numbers:

X = #5041
Z = #5042
C = #5043
Y = #5044
B = #5045

Set the system variables for the rotary axis machine positions in #1, #2 and #3.

O9744 (REN*FCS*TO*WCS)

#1=0 (WCS FOR THE A AXIS - = 0 IF NO A AXIS OR TOOL TYPE)
#2=0 (WCS FOR THE B AXIS - = 0 IF NO B AXIS OR TOOL TYPE)
#3=#5043 (WCS FOR THE C AXIS - = 0 IF NO C AXIS OR TOOL TYPE) ***** edit 3**

***** edit 3**

Specify the system variable for reading each rotary axis machine position into the variables #1, #2 and #3.

NOTE: If the rotary axis is a 'TOOL' type or there is no axis, then a setting of '0' is required.

Example: Measuring a single surface and boss and setting WCS

T01 M06	Select the probe.
G400 B−45. J0.	Orientate the probe to the B−45 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G43 H1 Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G68.1 X0. Y0. Z0. I0. J1. K0. R45.	**Plane rotated by 45°.**
G65 P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65 P9810 X0. Y0. Z10. F3000.	Protected positioning move over the centre of the boss clear of the Z surface.
G65 P9811 Z0.	**Z surface measure (Z error stored. No update selected yet.)**
G65 P9814 D50. Z−10. S2.	**Measure a 50 mm (1.968 in) diameter boss. (XY error stored. G55 set using XYZ errors in rotated calculations.)**
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 Z100.	Reference return.
continue	

The centre line of the feature in the X and Y axis and Z surface is stored in work offset 02 (G55).

Chapter 12 – Macro alarms and error messages

When an error occurs during use of the Inspection Plus software, an alarm number or message is generated. This may be displayed on the screen of the controller.

This chapter describes the meaning and likely cause of each alarm message that is displayed on the screen of the controller. It then describes typical actions you need to take to clear the fault.

Contained in this chapter

General alarms

Format:

			#148 flag
3006 =	1 (OUT OF TOL)	Updates the offset if the cycle start button is pressed to continue.	1
	1 (OUT OF POS)		2
	1 (ANGLE OUT OF TOL)		4
	1 (DIA OFFSET TOO LARGE)		5
	1 (UPPER TOL EXCEEDED)	No offset update if the cycle start button is pressed to continue.	3
	1 (EXCESS STOCK)		6

NOTE: On Fanuc controls, the 3006 alarms described above indicate a reset condition. Restart the program from a safe position.

Format: #3000 = 91 (MESSAGE)

91 (FORMAT ERROR)

91 (A INPUT MISSING)
91 (B INPUT MISSING)
91 (C INPUT MISSING)
91 (D INPUT MISSING)
91 (I INPUT MISSING)
91 (J INPUT MISSING)
91 (K INPUT MISSING)
91 (X INPUT MISSING)
91 (XYZ INPUT MISSING)
91 (Y INPUT MISSING)
91 (Z INPUT MISSING)

91 (DATA #130 TO #139 MISSING)

91 (H INPUT NOT ALLOWED)
91 (T INPUT NOT ALLOWED)
91 (X0 INPUT NOT ALLOWED)
91 (Y0 INPUT NOT ALLOWED)

91 (IJK INPUTS 5 MAX)

91 (SH INPUT MIXED)
91 (ST INPUT MIXED)
91 (TM INPUT MIXED)
91 (XY INPUT MIXED)
91 (XYZ INPUT MIXED)
91 (ZK INPUT MIXED)

91 (K INPUT OUT OF RANGE)

Action: Edit the program and start again from a safe start position.

This is a reset condition.

Format: #3000 = 86 (PATH OBSTRUCTED)

Cause: The probe has made contact with an obstruction. This occurs only during a protected positioning cycle.

Action: Edit the program. Clear the obstruction and start again from a safe position.

This is a reset condition.

Format: #3000 = 88 (NO FEED RATE)

Cause: This occurs only during a protected positioning cycle.

Action: Edit the program. Insert the F___ code input and start again from a safe position.

This is a reset condition.

Format: #3000 = 89 (NO TOOL LENGTH ACTIVE)

Cause: G43 or G44 must be active before the cycle is called.

Action: Edit and start again from a safe position.

This is a reset condition.

Format: #3000 = 92 (PROBE OPEN)

Cause: This alarm occurs if the probe is already triggered before a move.

The stylus may be in contact with a surface or the probe has failed to reseat.

This could be due to swarf trapped around the probe eyelid.

Action: Clear the fault and start again from a safe start position.

This is a reset condition.

Format: #3000 = 93 (PROBE FAIL)

Cause: This alarm occurs if the probe did not trigger during the move.

Either the surface was not found or the probe has failed.

Action: Edit the program and start again from a safe start position.

This is a reset condition.

Format: #3000 = 123 (ILLEGAL WCS UPDATE IN TWP)

Cause: This alarm occurs if an X, Y or Z error is not stored in #150–#152 prior to setting a rotated WCS.

Action: Make sure a measurement error is present in #150, #151 and #152 prior to setting a rotated WCS whilst in TWP mode

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Appendix A – Features, settings, limitations and applications

Contained in this appendix

Features of the Inspection Plus software

- Protected positioning.
- Measurement of internal and external features to determine both size and position. This includes:
  - Obtaining a hard-copy printout of feature data.
  - Applying tolerances to both size and position.
- Additional features for feedback of errors include:
  - Experience values can be applied to the measured size.
  - Percentage feedback of the error can be applied.
  - Null band zone for no tool offset update.
- Software option to turn off the tolerance alarms and provide a flag-only alarm. Suitable for FMS and unmanned applications.
- Built-in stylus collision and false trigger protection for all cycles.
- Diagnostic and format error-checking routines for all cycles.

Cycles

- Protected positioning.
- Measurement:
  - XYZ single surface.
  - Web/pocket.
  - Bore/boss (four measuring points).

General limitations

- The probe cycles will not run if ‘mirror image’ is active.
- Consider macro variable availability.

Settings – O9724

Macro G65 P9724 is called at the beginning of all top-level macros to establish the necessary modal information.

The following data may be adjusted to suit during the installation by editing this macro. The values described are supplied as standard.

Note: For probe settings (including probe calibration data base number), please refer to Chapter 8 “Additional cycles” and the sections “Probe start - O9832” and “Probe stop - O9833”.

#111 values

#111 = 1(X*AXIS*NUMBER)

Select the axis number for the X axis.

#112 values

#112 = 5(Y*AXIS*NUMBER)

Select the axis number for the Y axis.

#113 values

#113 = 2(Z*AXIS*NUMBER)

Select the axis number for the Z axis.

#114 values

#114 = 3(C*AXIS*NUMBER)

Select the axis number for the C axis.

#115 values

#115 = 4(B*AXIS*NUMBER)

Select the axis number for the B axis.

#119 values

#119 = 5000 (FAST FEED MM)
#119 = 200 (FAST FEED INCH)

The fast feedrate of the cycles can be adjusted by this variable to suit the machine characteristics and should be optimised.

- The fast feedrate of the Z-axis O9726 basic move macro is at the #119 × 0.6 value (3 m/min (118.11 in/min) as standard).
- The fast feedrate of all Z-axis positioning moves is also at the #119 × 0.6 value (3 m/min (118.11 in/min) as standard).
- The fast feedrate of all XY-axis positioning moves is at the #119 value (5 m/min (196.85 in/min) as standard).

#120 values

#120 = 1 (SELECT OPTIONS)

Alarm flag settings:

#120 = 1	Flag and alarms
#120 = 11	Flag only

It is expected that the settings to enable "Flag only alarms" will suit FMS machining set-ups where the requirement is to run unmanned. The process error flag #148 will be set and should be monitored after relevant probe cycles for corrective action.

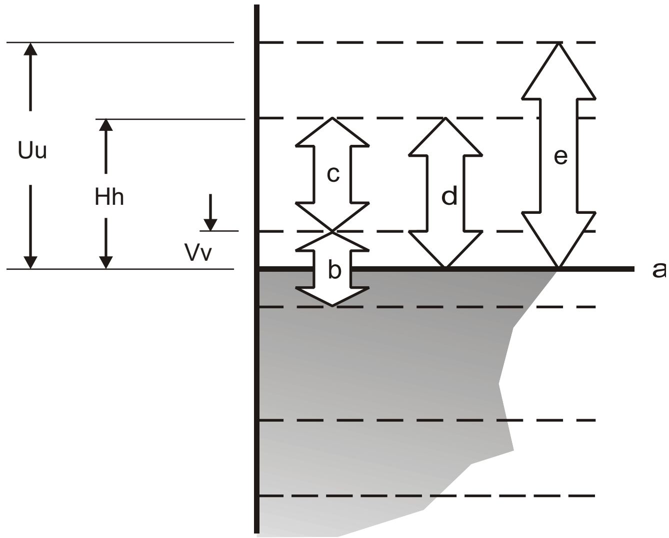
#123 values

#123 = 0.05 (POSITION ZONE MM)

This is the zone at either the start or end of the block in which the cycle is aborted with either a PROBE OPEN or PROBE FAIL alarm.

Tolerances

Inputs Uu, Hh and Vv apply to size and tool offset updates only.



a = Nominal size.

b = Null band. This is the tolerance zone where no tool offset adjustment occurs.

c = Area where the Ff input is effective in percentage feedback. F (0 to 1) gives 0% to 100% feedback to the tool offset.

d = OUT OF TOLERANCE alarm occurs. The tolerance value that applies to the size of the feature is defined by input Hh.

e = Uu upper tolerance. If this value is exceeded, no tool offset or work offset is updated and the cycle stops with an alarm. This tolerance applies to both size and position where applicable.

Figure A.1 Size and tool offset update tolerances

True position tolerances

For a true position tolerance (Mm input), see Figure A.2 below.

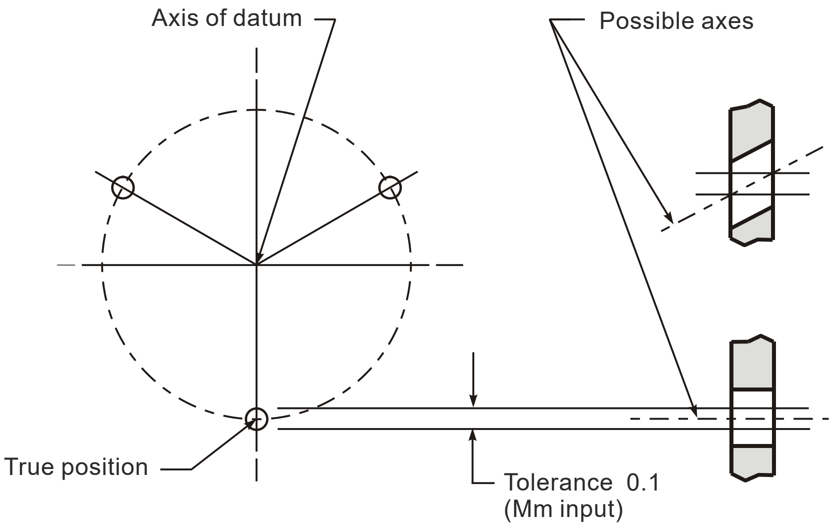


Figure A.2 Cylinders centred on true positions

Experience values Ee

The measured size can be adjusted by an amount stored in a spare tool offset.

Example: Measure a 40 mm diameter and update tool offset 20

G65 P9814 D40. T20. E21.

An experience value stored in tool offset 21 will be applied to the measured size.

NOTE: The experience value is always added to the measured size.

Reason for using this option

Component clamping forces in some applications can influence the measured size. Therefore, an adjustment value to relate measurement to a traceable standard, such as a co-ordinate measuring machine, is desirable. Thermal effects can also be compensated for using this method.

Example of printing a macro output

```
----------------------------------------------------------------------
COMPONENT NO 31              FEATURE NO 1
----------------------------------------------------------------------

POSN R 79.0569  ACTUAL 79.0012  TOL TP 0.2000  DEV −0.0557
POSN X−45.0000  ACTUAL −45.1525  TOL TP 0.2000 DEV −0.1525
POSN Y−65.0000  ACTUAL −64.8263  TOL TP 0.2000 DEV 0.1737

          +++++OUT OF POS+++++ ERROR TP 0.1311 RADIAL

ANG −124.6952  ACTUAL −124.8578  DEV −0.1626

---------------------------------------------------------------------
COMPONENT NO 31              FEATURE NO 2
---------------------------------------------------------------------

SIZE D71.0000  ACTUAL 71.9072  TOL 0.1000  DEV 0.9072

           +++++OUT OF TOL+++++ ERROR 0.8072

POSN X−135.0000  ACTUAL −135.3279  DEV −0.3279
POSN Y−65.0000  ACTUAL −63.8201  DEV 1.1799
```

Variables

Local variables

#1 to #32	These are used within each macro as required for calculation etc.

Common variables

#100 to #105	These are not used by this software.
#106	B-axis head offset value.
#107	B-axis head length value.
#108	X diameter/radius input conversion.
#109	X skip conversion.
#110	Base number storage location of calibration data.
#111	Axis number of the X axis.
#112	Axis number of the Y axis.
#113	Axis number of the Z axis.
#114	Axis number of the C axis.
#115	Axis number of the B axis.
#116	Active tool length, which is calculated in macro O9723.
#117	Modal feedrate value used in the protected positioning macros (O9810 and O9610).
#118	Radius and angle flag.
#119	Fast feedrate value. This is set in macro O9724 at 5000 mm/min (200 in/min) default value.
#120	Setting variable used in macro O9724.
#121	Print option. The component number is incremented by 1 with each heading. To reset, state #121 = 0.
#122	Print option. The feature number is incremented by 1 with each print macro call. To reset, state #122 = 0.
#123	Start and end of block position zone. Normal setting = 0.05 mm (0.002 in). If the skip position is within this zone, the cycle aborts with either a PROBE OPEN or PROBE FAIL alarm.
#124	Stored X skip position at the end of the basic move macro (O9726).

#125	Stored Y skip position at the end of the basic move macro (O9726).
#126	Stored Z skip position at the end of the basic move macro (O9726).
#127	X average skip position at the end of the X diameter move macro (O9721).
#128	Y average skip position at the end of the Y diameter move macro (O9722).
#129	Inch/metric multiplier (0.04/1.0).
#130 to #134	Output data.
#135 to #152	See Chapter 3, “Variable outputs”, for an output reference chart.
#153 onwards	These are not used by the software.

Tool offset macros – O9732 and O9723

Macros O9732 and O9723 are used to address the correct tool offset registers during the execution of macros.

The macros use the #2--- system variables, which permit access to the 200 tool offset option.

Additional tool offsets can be addressed by changing the system variable numbers to #10--- type, when available.

Editing macro O9732

Edit macro O9732 as follows:

O9732 (REN OFFSET TYPE)
#27 = 2000 (L WEAR 10000)
#28 = 2100 (L G-W 11000)
#29 = 2200 (R WEAR 12000)
#30 = 2400 (R GEOM 13000)

Numbers in brackets are the possible alternative system variable numbers.

Tool offset setting	200 tool offsets or less
Length wear, #27=	2000
Length geometry, #28=	2100
Radius wear, #29=	2200
Radius geometry, #30=	2400

TIP: Check the system variable numbers on the machine. It has been known for the wear and geometry registers to be swapped between controller models. This can easily be verified on the machine as follows:

1. Enter a value for tool offset 1 geometry and wear or make a note of the existing values.
2. In MDI mode run this:

```
#100=#2001
#101=#2201
```

3. Check #100 / #101 values – it will be clear which setting to use.

Editing the active offset and read-ahead program – O9723

The primary role of this program is to read the active tool offset amount, but it also has a role in controlling read-ahead.

Fast machining or smoothing control options can cause block read-ahead problems when running a cycle. Read-ahead control, in the form of G53, is resident in program O9723. This program is called at strategic positions within the cycles. If further code is required to suppress read-ahead, add it to this program.

Adjustment is not normally required, but customisation is possible. Please consult a Renishaw representative for advice if changes are being considered.

Examples of changes:

- Use G31 instead of G53. The read-ahead control is performed with the G53 command, but G31 can also be used (if using G31, it may also require a feedrate, for example G31 F1).
- Add a dwell. Sometimes adding a small pause can help resolve spurious behaviour, but excessive dwells will impact on overall cycle time. Examples: G4 X.1 (or G4 P100).
- It is also possible to add M98 P9723 program calls within the software at strategic positions.

Edit macro O9723 as follows:

```
O9723 (REN ACT OFFSET)
#27 = 2000 (L wear 10000)      Numbers in brackets are the alternative
#28 = 2100 (L G-W 11000)       system variable numbers.
```

Where more than 200 tool offsets are available, it is necessary to use the alternative system variable numbers.

Multiple probe support

The default setting is to use one probe, but up to three additional probes can be supported using the settings outlined below. The “Extended macro variables” controller option may be required to support multiple probes.

NOTE: Configuring the software for more than one probe is not recommended unless necessary, owing to the additional code overhead and the requirement for additional variables for probe data storage. In principle, it is possible to support more than four probes. If this is necessary, consult a Renishaw representative for advice on how to do this.

Edit cycle O9832 as follows:

Remove GOTO

GOTO10(<DELETE*TO*ENABLE*MULTI*PROBES)

To activate multiple probes, either delete the GOTO10 line or comment it out by enclosing it in brackets.

Define H number

#12=#0(H*OFFSET*PROBE*2)

#13=#0(H*OFFSET*PROBE*3)

#14=#0(H*OFFSET*PROBE*4)

For each additional probe, define a probe offset (H) number. Any left set as #0 will not be used.

#110 values

#110=#0(PROBE*2*BASE*NO)

...

#110=#0(PROBE*3*BASE*NO)

...

#110=#0(PROBE*4*BASE*NO)

This sets the variable base number #110 for each probe – each requires its own data storage variables (allow 38 variables per probe).

Probe on M-code

M00(PROBE*2*ON)

...

M00(PROBE*3*ON)

...

M00(PROBE*4*ON)

Select the M-code to turn each probe on.

Probe dwell

G04X2.0(PROBE*2*DWELL)

...

G04X2.0(PROBE*3*DWELL)

...

G04X2.0(PROBE*4*DWELL)

Select the dwell after probe on for each probe.

Edit cycle O9833 as follows:

Remove GOTO

GOTO10(<DELETE*TO*ENABLE*MULTI*PROBES)

To activate multiple probes, either delete the GOTO10 line or comment it out by enclosing it in brackets.

Define H number

#12=#0(H*OFFSET*PROBE*2)

#13=#0(H*OFFSET*PROBE*3)

#14=#0(H*OFFSET*PROBE*4)

For each additional probe, define a probe offset (H) number. Any left set as #0 will not be used.

Probe off M-code

M00(PROBE*2*OFF)

...

M00(PROBE*3*OFF)

...

M00(PROBE*4*OFF)

Select the M-code to turn each probe off.

Probe dwell

G04X2.0(PROBE*2*DWELL)

...

G04X2.0(PROBE*3*DWELL)

...

G04X2.0(PROBE*4*DWELL)

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Appendix B – Additional calibration cycles

Contained in this appendix

Calibration cycles – an overview

Individual calibration cycles are provided with the Inspection Plus software. The purpose of each macro is summarised below.

Macro O8000	Macro O8000 combines all of the below macros into a complete calibration solution. They are used only in conjunction with a datum sphere to fully calibrate a probe/stylus configuration.

NOTE: The sphere calibration method is the preferred method for calibrating the probe. Please refer to Chapter 5, “Calibrating the probe”.

Macro O9800	Used to establish the position of a bore or boss at the B−90 position.
Macro O9801	Used to establish the length of the probe in its tool shank at the B−90 position.
Macro O9802	Used to establish the off-centre values of the stylus at the B−90 position.
Macro O9803	Used to establish the radius values of the stylus ball at the B−90 position. Not suitable for cycles O9821, O9822 and O9823.
Macro O9804	Used to establish the vector radius values of the stylus ball at the B−90 position. Suitable for all measuring cycles, including O9821, O9822 and O9823.
Macro O9600	Used to establish the position of a bore or boss at the B0 position.
Macro O9601	Used to establish the length of the probe in its tool shank at the B0 position.
Macro O9602	Used to establish the off-centre values of the stylus at the B0 position.
Macro O9603	Used to establish the radius values of the stylus ball at the B0 position. Not suitable for cycles O9621, O9622 and O9623.
Macro O9604	Used to establish the vector radius values of the stylus ball at the B0 position. Suitable for all measuring cycles, including O9621, O9622 and O9623.

For complete calibration of a probe system, use macros O9600, O9601, O9602 and O9603 or O9604 for calibrating a probe at the B0 position, and O9800, O9801, O9802 and O9803 or O9804 for calibrating a probe at the B−90 position.

Calibrating the probe length (B−90) – O9801

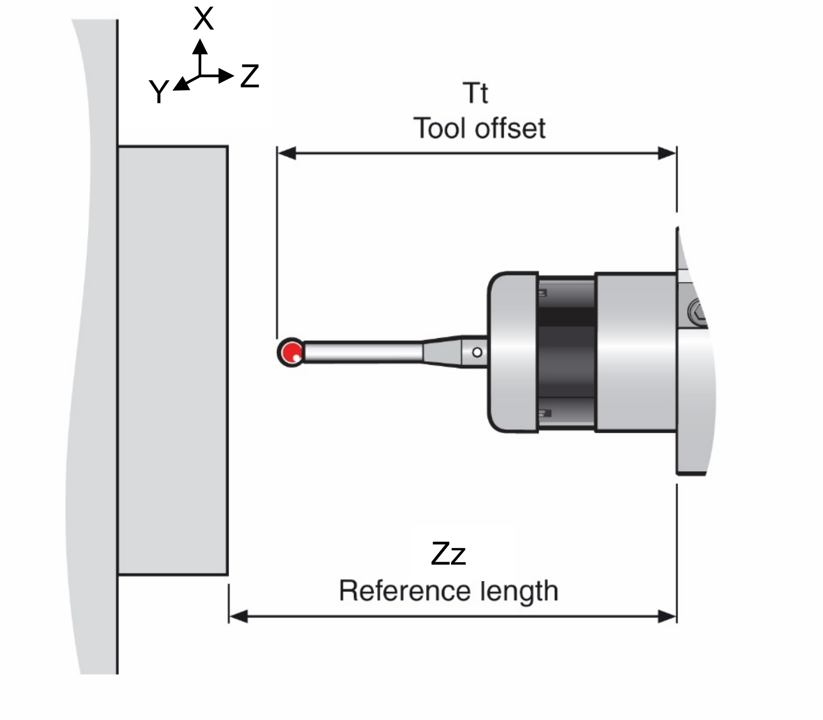


Figure B.1 Calibrating the probe length

Description

The probe is positioned adjacent to a Z-axis reference surface. When the calibration cycle is completed, the active probe tool offset is adjusted to the reference surface.

Application

First load an approximate tool offset. Position the probe adjacent to the reference surface. When the cycle is run, the surface is measured and the tool offset is reset to a new value. The probe then returns to the start position.

Format

G65 P9801 Zz Tt Jj

Example: G65 P9801 Z50. T20. J4000.

Compulsory inputs

Tt	t =	The active tool offset number.
Jj	j =	The tool update type.
Zz	z =	The position of the reference surface.

Outputs

The active tool offset is set.

Example

Set the XYZ values in a work offset (this example uses G54).

NOTE: The tool offset must be active. The active tool offset H word number must be the same as the T input number.

O0001	
G90 G80 G40 G0	Preparatory codes for the machine.
G400 B−90. J0.	Orientate the probe to the B−90 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9810 Z10. F3000.	Protected positioning move.
G65 P9801 Z0. T1. J4000.	Datum Z direction.
G65 P9810 Z100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 Z100.	Reference return.
M30	End of the program.

Calibrating the stylus X and Y offsets (B−90) – O9802

NOTE: This figure assumes that the default calibration base number is set to 500.

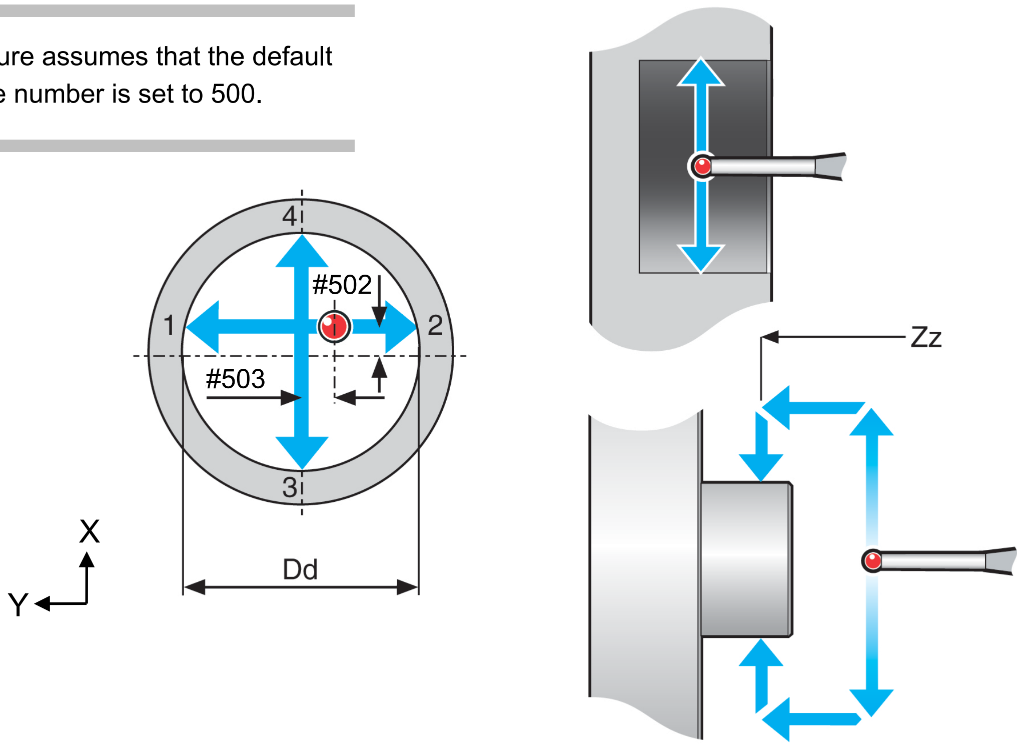


Figure B.2 Calibrating the stylus X and Y offsets

Description

The probe is positioned inside a premachined hole at a height suitable for calibration. When this cycle is completed, the stylus offset amounts in the X and Y axes are stored.

Application

Machine a hole with a suitable boring bar so that the exact centre of the hole is known. With the spindle orientation active, position the probe to be calibrated inside the hole and the spindle on the known centre position.

When the cycle is run, four measuring moves are made to determine the X offset and Y offset of the stylus. The probe is then returned to the start position.

Format

G65 P9802 Dd [Zz]

where [ ] denote optional inputs.

Example: G65 P9802 D50.005 Z50.

Compulsory input

Dd	d =	The nominal size of the feature.

Optional input

Zz	z =	The absolute Z-axis measuring position when calibrating on an external feature. If this is omitted, a bore cycle is assumed.

Outputs

The following data is stored:

#502 X-axis stylus offset

#503 Y-axis stylus offset

Example: Calibrating the stylus XY offset

A tool offset must be active before running this program.

Position the stylus in the bored hole at the required depth. The spindle centre must be positioned exactly on the centre line of the bored hole.

O0002

G90 G80 G40 G0	Preparatory codes for the machine.
G400 B−90. J0.	Orientate the probe to the B−90 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9802 D50.	Calibrate in a 50 mm (1.968 in) diameter bored hole.
G65 P9833	Switch the probe off (when applicable).
M30	End of the program.

Calibrating the stylus ball radius (B−90) – O9803

NOTE: Do not use this cycle to calibrate the radius of the stylus ball if, subsequently, you intend using vector measuring macros O9821, O9822, or O9823. The stylus ball radius must be calibrated using macro O9804 instead.

NOTE: This figure assumes that the default calibration base number is set to 500.

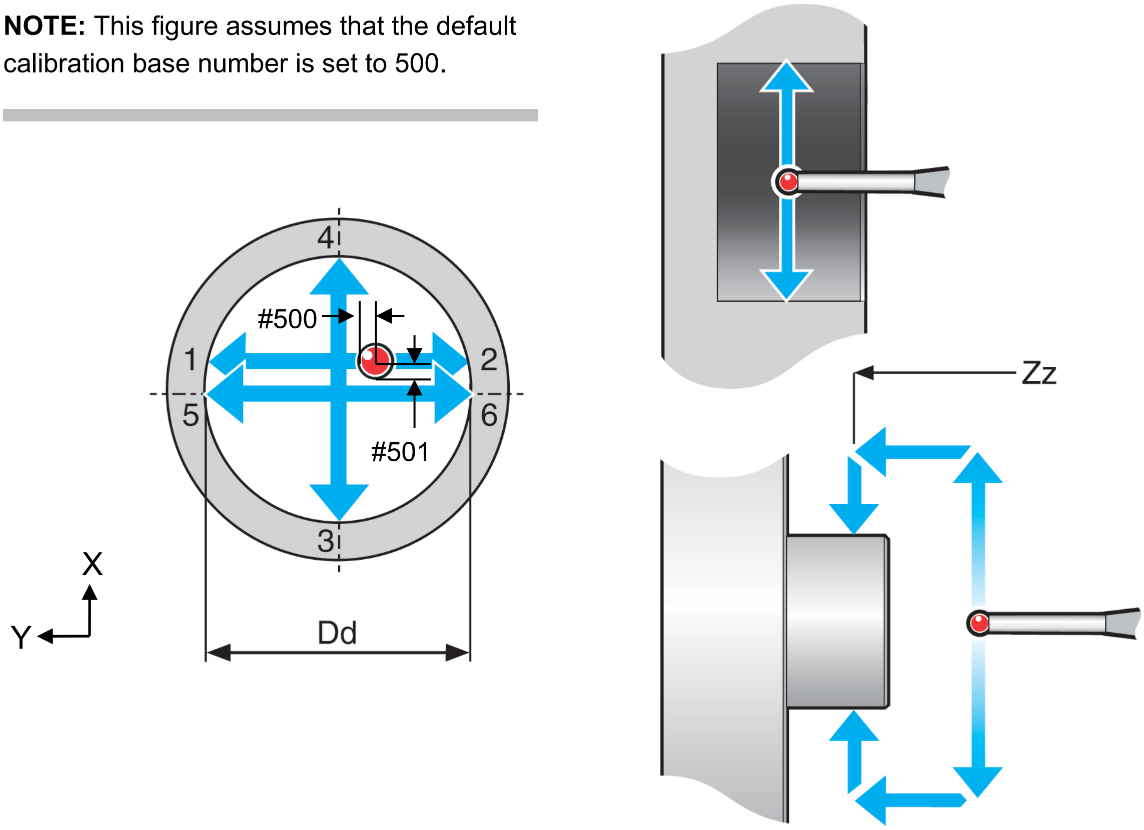


Figure B.3 Calibrating the stylus ball radius

Description

The probe is positioned inside a calibrated ring gauge at a height suitable for calibration. When this cycle is completed, the radius values of the stylus ball are stored.

Application

Clamp a calibrated ring gauge on the machine table at an approximately known position. With spindle orientation active, position the probe to be calibrated inside the ring gauge on the approximate centre position.

When the cycle is run, six moves are made to determine the radius values of the stylus ball. The probe is then returned to the start position.

Format

G65 P9803 Dd [Zz Ss]
where [ ] denote optional inputs.

Example: G65 P9803 D50.005 Z50. S1.

Compulsory input

Dd	d =	The size of the reference ring gauge.

Optional inputs

Zz	z =	The absolute Z-axis measuring position when calibrating on an external feature. If this is omitted, a ring gauge cycle is assumed.

For optional input Ss, see Chapter 2, “Optional inputs”.

Outputs

The following data is stored:

#500	X+, X−, stylus ball radius (XRAD)
#501	Y+, Y−, stylus ball radius (YRAD)

Example 1: Calibrating the radius of a stylus ball

A tool offset must be active before running this program. If your machine does not retain the offset, then use the alternative example described below.

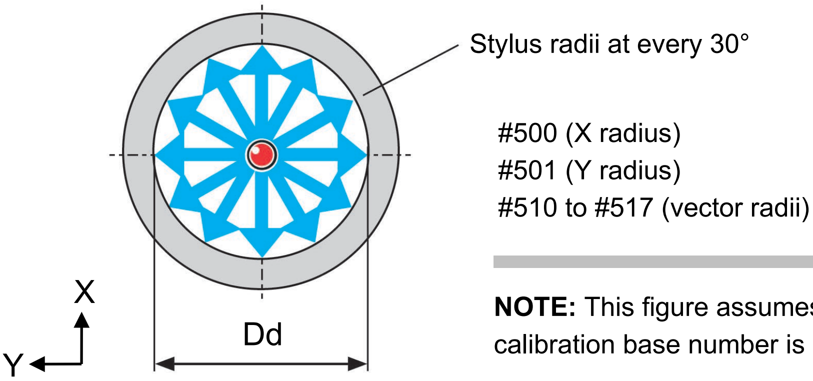
Position the stylus approximately on-centre in the ring gauge and at the required depth.

O0003

G90 G80 G40 G0	Preparatory codes for the machine.
G400 B−90. J0.	Orientate the probe to the B−90 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9803 D50.001	Calibrate in a 50.001 mm (1.9685 in) diameter ring gauge.
G65 P9833	Switch the probe off (when applicable).
M30	End of the program.

Calibrating the vector stylus ball radius (B−90) – O9804

NOTE: You must use this cycle to calibrate the radius of the stylus ball if you intend using vector measuring macros O9821, O9822, or O9823 (described in Chapter 7, “Vector measuring cycles”). Do not calibrate the stylus ball radius using macro O9803.



NOTE: This figure assumes that the default calibration base number is set to 500.

Figure B.4 Calibrating the vector radius of a stylus ball

Description

The probe is positioned inside a calibrated ring gauge at a height suitable for calibration. When the cycle is completed, the radius values of the stylus ball are stored. A total of 12 calibration radii at 30° intervals are established.

Application

Clamp a calibrated ring gauge on the machine table at an approximately known position. With spindle orientation active, position the probe to be calibrated inside the ring gauge on the approximate centre position.

When the cycle is run, 14 moves are made to determine the radius values of the stylus ball. The probe is then returned to the start position.

Format

G65 P9804 Dd [Zz Ss]
where [ ] denote optional inputs.

Example: G65 P9804 D50.005 Z50. S1.

Compulsory inputs

Dd	d =	Size of the reference ring gauge.

Optional inputs

Zz	z =	The absolute Z-axis measuring position when calibrating on an external feature. If this is omitted, a ring gauge cycle is assumed.

For optional input Ss, see Chapter 2, “Optional inputs”.

Outputs

The following data is stored (as O9803):

#500	X+, X−, stylus ball radius	(XRAD)
#501	Y+, Y−, stylus ball radius	(YRAD)

Additional vector calibration data:

#510	30° stylus ball radius	(VRAD)
#511	60° stylus ball radius	(VRAD)
#512	120° stylus ball radius	(VRAD)
#513	150° stylus ball radius	(VRAD)
#514	210° stylus ball radius	(VRAD)
#515	240° stylus ball radius	(VRAD)
#516	300° stylus ball radius	(VRAD)
#517	330° stylus ball radius	(VRAD)

Example: Calibrating the vector stylus ball radius

A tool offset must be active before running this program.

Position the probe approximately on-centre in the ring gauge and at the required depth.

O0004	
G90 G80 G40 G0	Preparatory codes for the machine.
G400 B−90. J0.	Orientate the probe to the B−90 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9804 D50.001	Calibrate in a 50.001 mm (1.9685 in) diameter ring gauge.
M98 P9833	Switch the probe off (when applicable).
M30	End of the program.

Calibrating the probe length (B0) – O9601

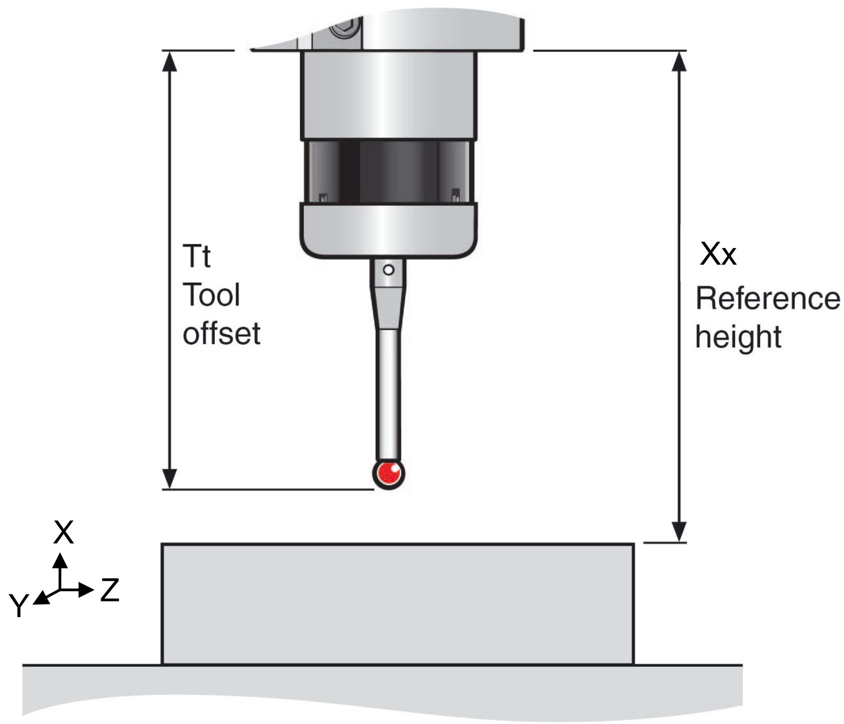


Figure B.5 Calibrating the probe length

Description

The probe is positioned adjacent to an X-axis reference surface. When the calibration cycle is completed, the active probe tool offset is adjusted to the reference surface.

Application

First load an approximate tool offset. Position the probe adjacent to the reference surface. When the cycle is run, the surface is measured and the tool offset is reset to a new value. The probe then returns to the start position.

Format

G65 P9601 Xx Tt Jj

Example: G65 P9601 X50. T20. J4000.

Compulsory inputs

Tt	t =	The active tool offset number.
Jj	j =	The tool update type.
Xx	x =	The position of the reference surface.

Outputs

The active tool offset is set.

Example

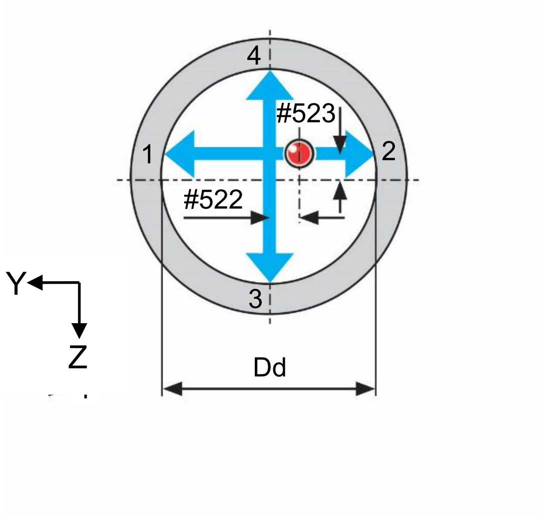
Set the XYZ values in a work offset (this example uses G54).

NOTE: The tool offset must be active. The active tool offset H word number must be the same as the T input number.

O0001	
G90 G80 G40 G0	Preparatory codes for the machine.
G400 B0. J0.	Orientate the probe to the B0 position. Activate the tool offset.
G54 X0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9610 X10. F3000.	Protected positioning move.
G65 P9601 X0. T1. J4000.	Datum X direction.
G65 P9610 X100.	Protected positioning move.
G65 P9833	Switch the probe off (when applicable).
G28 X100.	Reference return.
M30	End of the program.

Calibrating the stylus Z and Y offsets (B0) – O9602

NOTE: This figure assumes that the default calibration base number is set to 500.



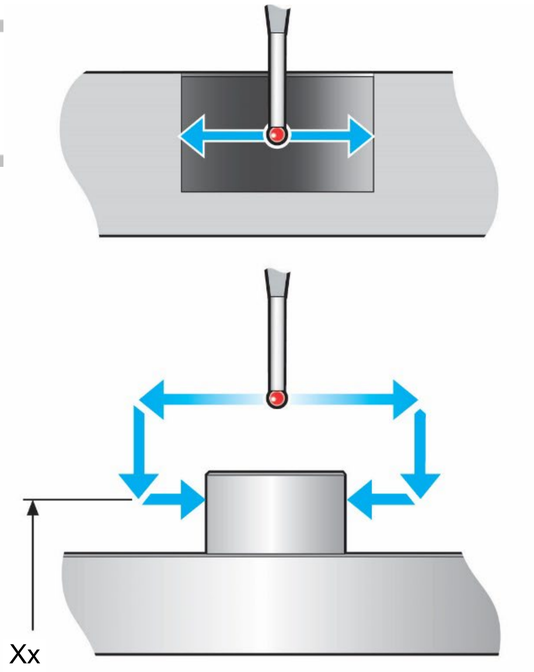


Figure B.6 Calibrating the stylus Z and Y offsets

Description

The probe is positioned inside a premachined hole at a height suitable for calibration. When this cycle is completed, the stylus offset amounts in the Z and Y axes are stored.

Application

Machine a hole with a suitable boring bar so that the exact centre of the hole is known. With the spindle orientation active, position the probe to be calibrated inside the hole and the spindle on the known centre position.

When the cycle is run, four measuring moves are made to determine the Z offset and Y offset of the stylus. The probe is then returned to the start position.

Format

G65 P9602 Dd [Xx]
where [ ] denote optional inputs.

Example: G65 P9602 D50.005 X50.

Compulsory input

Dd d = The nominal size of the feature.

Optional input

Xx	x =	The absolute X-axis measuring position when calibrating on an external feature. If this is omitted, a bore cycle is assumed.

Outputs

The following data is stored:

#522	Z-axis stylus offset
#523	Y-axis stylus offset

Example: Calibrating the stylus ZY offset

A tool offset must be active before running this program.

Position the stylus in the bored hole at the required depth. The spindle centre must be positioned exactly on the centre line of the bored hole.

G90 G80 G40 G0	Preparatory codes for the machine.
G400 B0. J0.	Orientate the probe to the B0 position. Activate the tool offset.
G54 Z0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9602 D50.	Calibrate in a 50 mm (1.968 in) diameter bored hole.
G65 P9833	Switch the probe off (when applicable).
M30	End of the program.

Calibrating the stylus ball radius (B0) – O9603

NOTE: Do not use this cycle to calibrate the radius of the stylus ball if, subsequently, you intend using vector measuring macros O9621, O9622, or O9623. The stylus ball radius must be calibrated using macro O9604 instead.

NOTE: This figure assumes that the default calibration base number is set to 500.

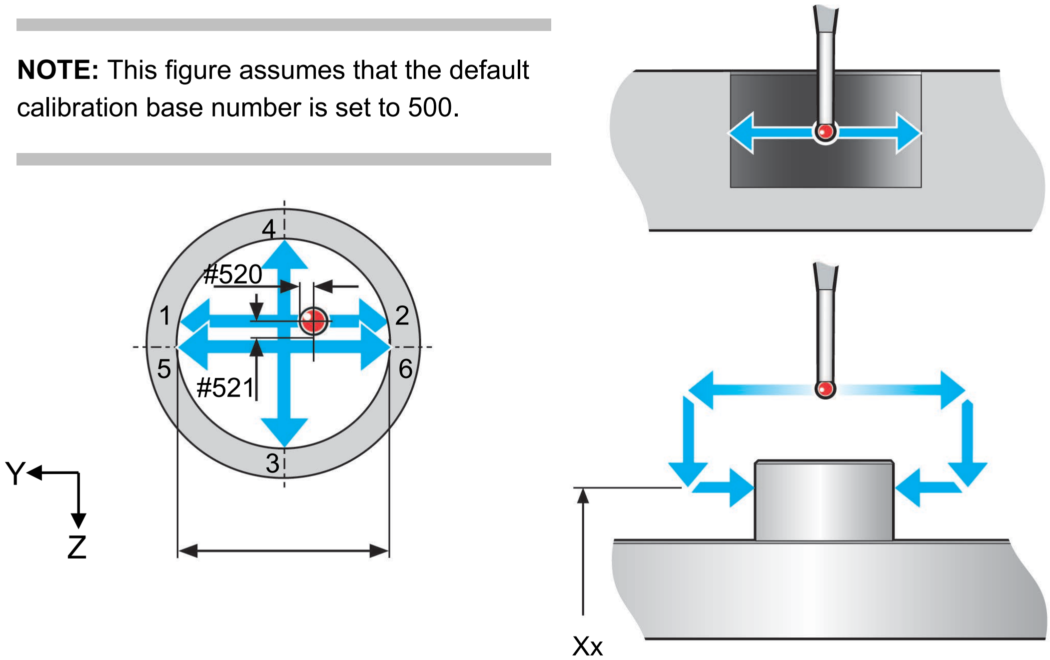


Figure B.7 Calibrating the stylus ball radius

Description

The probe is positioned inside a calibrated ring gauge at a height suitable for calibration. When this cycle is completed, the radius values of the stylus ball are stored.

Application

Clamp a calibrated ring gauge on the machine table at an approximately known position. With spindle orientation active, position the probe to be calibrated inside the ring gauge on the approximate centre position.

When the cycle is run, six moves are made to determine the radius values of the stylus ball. The probe is then returned to the start position.

Format

G65 P9603 Dd [Xx Ss]
where [ ] denote optional inputs.

Example: G65 P9603 D50.005 X50. S1.

Compulsory input

Dd	d =	The size of the reference ring gauge.

Optional inputs

Xx	x =	The absolute X-axis measuring position when calibrating on an external feature. If this is omitted, a ring gauge cycle is assumed.

For optional input Ss, see Chapter 2, “Optional inputs”.

Outputs

The following data is stored:

#520	Z+, Z−, stylus ball radius (ZRAD)
#521	Y+, Y−, stylus ball radius (YRAD)

Example: Calibrating the radius of a stylus ball

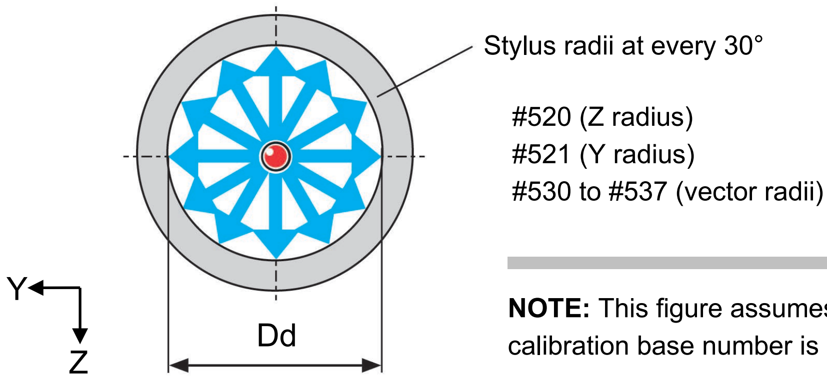
A tool offset must be active before running this program.

Position the stylus approximately on-centre in the ring gauge and at the required depth.

G90 G80 G40 G0	Preparatory codes for the machine.
G400 B0. J0.	Orientate the probe to the B0 position. Activate the tool offset.
G54 Z0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9603 D50.001	Calibrate in a 50.001 mm (1.9685 in) diameter ring gauge.
G65 P9833	Switch the probe off (when applicable).
M30	End of the program.

Calibrating the vector stylus ball radius (B0) – O9604

NOTE: You must use this cycle to calibrate the radius of the stylus ball if you intend using vector measuring macros O9621, O9622, or O9623 (described in Chapter 7, “Vector measuring cycles”). Do not calibrate the stylus ball radius using macro O9603.



NOTE: This figure assumes that the default calibration base number is set to 500.

Figure B.8 Calibrating the vector radius of a stylus ball

Description

The probe is positioned inside a calibrated ring gauge at a height suitable for calibration. When the cycle is completed, the radius values of the stylus ball are stored. A total of 12 calibration radii at 30° intervals are established.

Application

Clamp a calibrated ring gauge on the machine table at an approximately known position. With spindle orientation active, position the probe to be calibrated inside the ring gauge on the approximate centre position.

When the cycle is run, 14 moves are made to determine the radius values of the stylus ball. The probe is then returned to the start position.

Format

G65 P9604 Dd [Xx Ss]
where [ ] denote optional inputs.

Example: G65 P9604 D50.005 X50. S1.

Compulsory inputs

Dd	d =	Size of the reference ring gauge.

Optional inputs

Xx	x =	The absolute X-axis measuring position when calibrating on an external feature. If this is omitted, a ring gauge cycle is assumed.

For optional input Ss, see Chapter 2, “Optional inputs”.

Outputs

The following data is stored (as O9803):

#520	Z+, Z−, stylus ball radius	(ZRAD)
#521	Y+, Y−, stylus ball radius	(YRAD)

Additional vector calibration data:

#530	30° stylus ball radius	(VRAD)
#531	60° stylus ball radius	(VRAD)
#532	120° stylus ball radius	(VRAD)
#533	150° stylus ball radius	(VRAD)
#534	210° stylus ball radius	(VRAD)
#535	240° stylus ball radius	(VRAD)
#536	300° stylus ball radius	(VRAD)
#537	330° stylus ball radius	(VRAD)

Example 1: Calibrating the vector stylus ball radius

A tool offset must be active before running this program.

Position the probe approximately on-centre in the ring gauge and at the required depth.

G90 G80 G40 G0	Preparatory codes for the machine.
G400 B0. J0.	Orientate the probe to the B0 position. Activate the tool offset.
G54 Z0. Y0.	Start position.
G65 P9832	Orientates the probe and switches it on.
G65 P9604 D50.001	Calibrate in a 50.001 mm (1.968 in) diameter ring gauge.
G65 P9833	Switch the probe off (when applicable).
M30	End of the program.

Appendix C – GoProbe cycle details

This appendix contains general information on the GoProbe option, including the definition of the required inputs.

Contained in this appendix

Introduction

This appendix provides an overview of the manual GoProbe cycles.

The user manually moves (jogs) the probe to the start position, approximately 10 mm from the feature.

The single-line command is manually entered in MDI mode.

There are two measurement programs: O9901 for measurement at B−90 and B90, and O9902 for measurement at B0.

Program O8898 needs the spindle probe tool number set in #29 where labelled. This is used to check the probe is in the spindle before running GoProbe cycles.

The machine must be in milling mode before running GoProbe cycles, so command M35 (C1-axis) or M135 (C2-axis) accordingly.

The S input defines the WCS to be set. If no S input is selected, the measurement takes place but the WCS is not set. The location to which the WCS is set depends on the feature being measured and the start position of the probe.

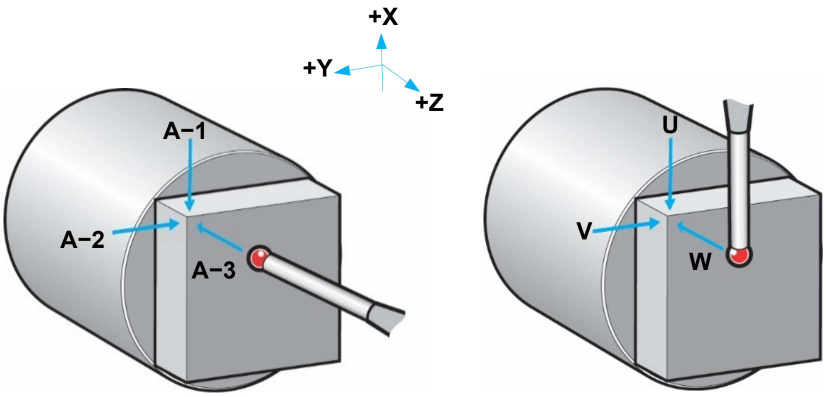
At the end of the cycle the probe returns to the start position.

Outputs

Please refer to Chapter 3, “Variable outputs”, for the basic cycle outputs.

NOTE: Some input definitions vary between cycles and differ from standard Inspection Plus.

XYZ single surface (M1)



B−90 and B90
O9901

B0
O9902

Description

Measures a single surface in X, Y or Z.

Format

G65 P9901 M1. Aa. Uu. or Vv. or Ww. [Qq. Ss.]
G65 P9902 M1. Aa. Uu. or Vv. or Ww. [Qq. Ss.]

where [ ] denote optional inputs.

Example: G65 P9902 M1. A−3. W−5. S54.

Compulsory inputs

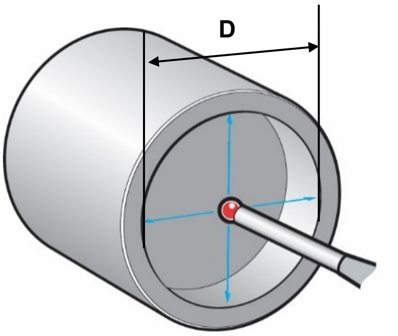
M1.		Single surface measurement.
Aa	a =	Measurement direction: A1.=X, A2.=Y, A3.=Z. Entering a minus value will force the probe to measure in the minus direction.
Uu or	u =	X-axis feature position relative to the active WCS.
Vv or	v =	Y-axis feature position relative to the active WCS.
Ww	w =	Z-axis feature position relative to the active WCS.

Optional inputs

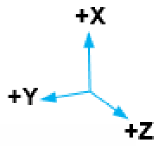
Qq	q =	Additional search distance. The default search distance is 5 mm.
Ss	s =	WCS to update.

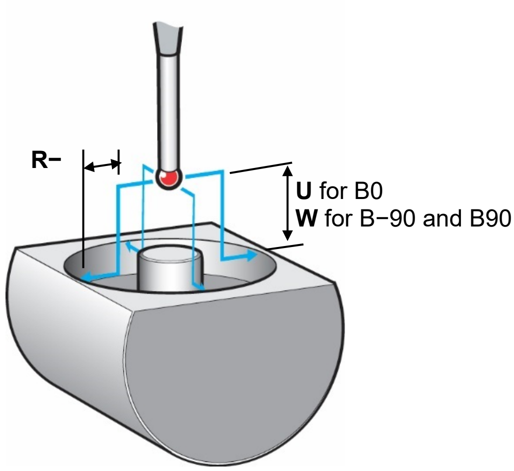
S54. to S59.	G54 to G59.
S101. to S400.	Extended work offsets G54.1 P1 to G54.1 P300.

Bore (M2)



B−90 and B90
O9901





B0
O9902

Description

Measures a bore feature.

Format

G65 P9901 M2. Dd. [Qq. R−r. Ss. Ww.]
G65 P9902 M2. Dd. [Qq. R−r. Ss. Uu.]

where [ ] denote optional inputs.

Example: G65 P9902 M2. D20. S54.

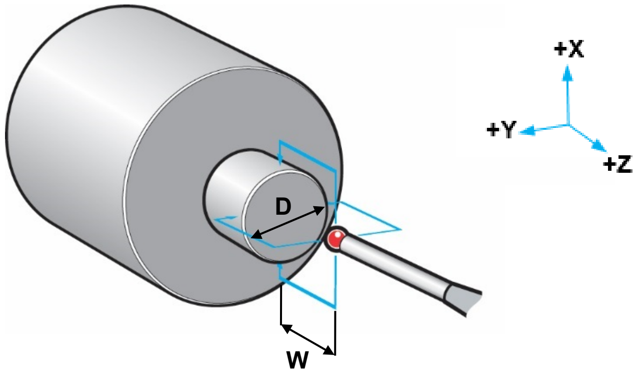
Compulsory inputs

M2.		Bore measurement.
Dd	d =	Diameter of the bore to be measured.

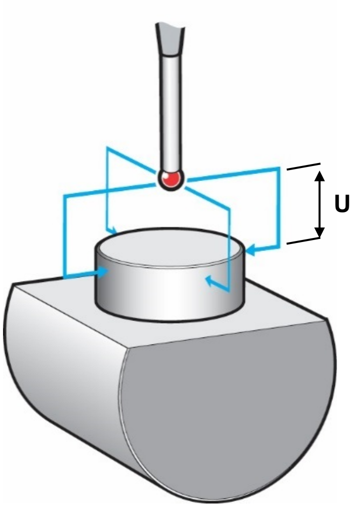
Optional inputs

Qq	q =	Additional search distance. The default search distance is 5 mm.
R−r	−r =	Radial distance (use with a U or W input).
Ss	s =	WCS to update. S54. to S59. — G54 to G59. S101. to S400. — Extended work offsets G54.1 P1 to G54.1 P300.
Uu	u =	Distance between the start position and the measurement point in X (use with an R− input) (B0 only).
Ww	w =	Distance between the start position and the measurement point in Z (use with an R− input) (B−90 and B90 only).

Boss (M3)



B-90 and B90
O9901



B0
O9902

Description

Measures a boss feature.

Format

G65 P9901 M3. Dd. Ww. [Qq. Rr. Ss.]
G65 P9902 M3. Dd. Uu. [Qq. Rr. Ss.]

where [ ] denote optional inputs.

Example: G65 P9901 M3. D20. W−20. S54.

Compulsory inputs

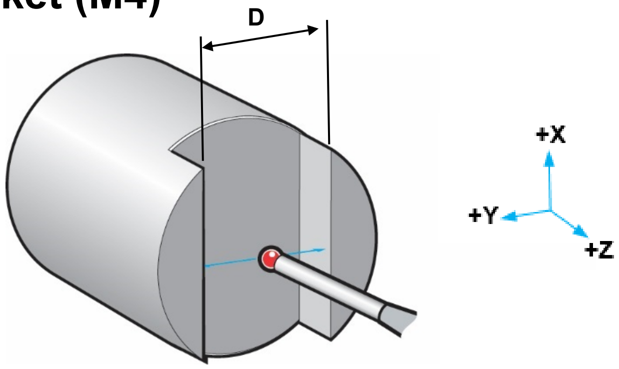
M3.		Boss measurement.
Dd	d =	Diameter of the boss to be measured.
Uu	u =	Distance between the start position and measurement position in X (B0 only).
Ww	w =	Distance between the start position and measurement position in Z (B−90 and B90 only).

Optional inputs

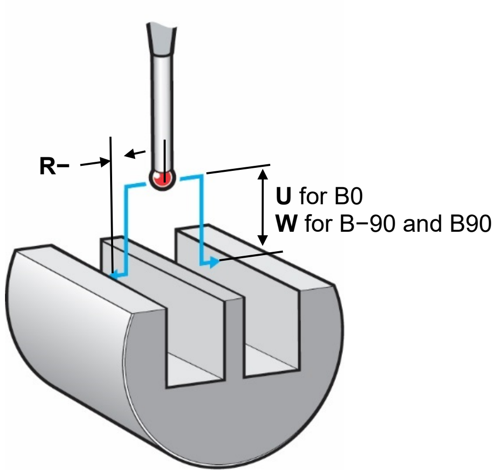
Qq	q =	Additional search distance. The default search distance is 5 mm.
Rr	r =	Radial distance (use with a U or W input).
Ss	s =	WCS to update.

S54. to S59.	G54 to G59.
S101. to S400.	Extended work offsets G54.1 P1 to G54.1 P300.

Pocket (M4)



B−90 and B90
O9901



B0
O9902

Description

Measures a pocket feature.

Format

G65 P9901 M4. Aa. Dd. [Qq. R−r. Ss. Ww.]
G65 P9902 M4. Aa. Dd. [Qq. R−r. Ss. Uu.]

where [ ] denote optional inputs.

Example: G65 P9901 M4. A2. D20. S54.

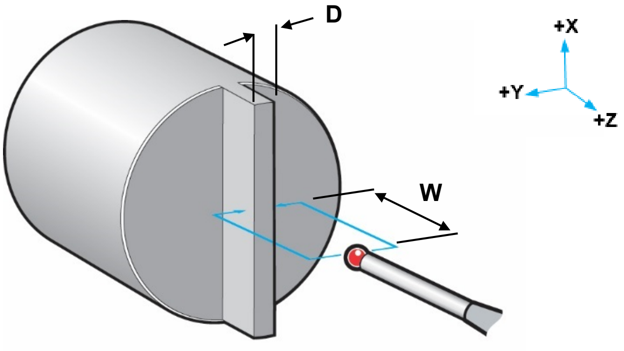
Compulsory inputs

M4.		Pocket measurement.
Aa	a =	Measurement direction: A1.=X, A2.=Y, A3.=Z.
Dd	d =	Pocket dimension in X, Y or Z.

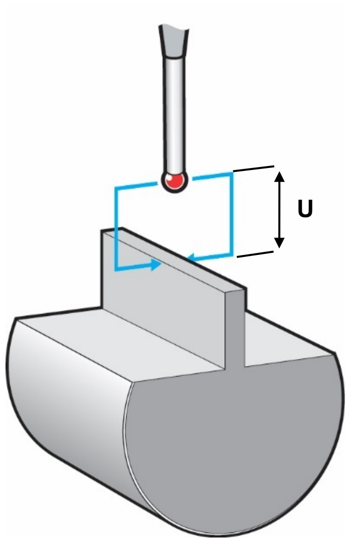
Optional inputs

Qq	q =	Additional search distance. The default search distance is 5 mm.
R−r	−r =	Radial distance (use with a U or W input).
Ss	s =	WCS to update. S54. to S59. G54 to G59. S101. to S400. Extended work offsets G54.1 P1 to G54.1 P300.
Uu	u =	Distance between the start position and the measurement point in X (use with an R− input) (B0 only).
Ww	w =	Distance between the start position and the measurement point in Z (use with an R− input) (B−90 and B90 only).

Web (M5)



B−90 and B90
O9901



B0
O9902

Description

Measures a web feature.

Format

G65 P9901 M5. Aa. Dd. Ww. [Qq. Rr. Ss.]
G65 P9902 M5. Aa. Dd. Uu. [Qq. Rr. Ss.]

where [ ] denote optional inputs.

Example: G65 P9901 M5. A2. D20. W−15. S54.

Compulsory inputs

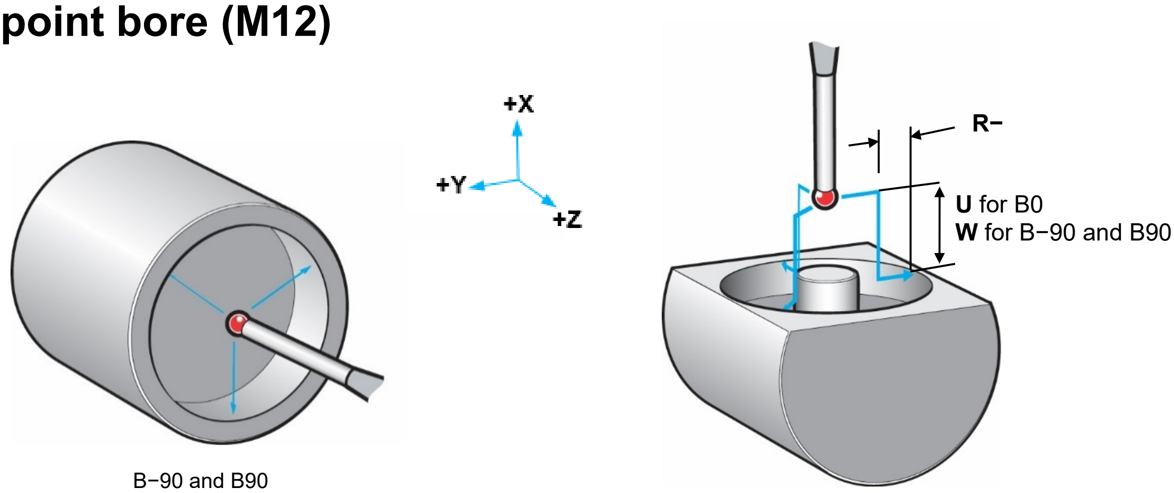
M5.		Web measurement.
Aa	a =	Measurement direction: A1.=X, A2.=Y, A3.=Z.
Dd	d =	Web dimension in X, Y or Z.
Uu	u =	Distance between the start position and measurement position in X (B0 only).
Ww	w =	Distance between the start position and measurement position in Z (B−90 and B90 only)

Optional inputs

Qq	q =	Additional search distance. The default search distance is 5 mm.
Rr	r =	Radial distance (use with a U or W input).
Ss	s =	WCS to update.

S54. to S59.	G54 to G59.
S101. to S400.	Extended work offsets G54.1 P1 to G54.1 P300.

3-point bore (M12)



B−90 and B90
O9901

B0
O9902

Description

Measures a bore using three vectored measure moves.

Format

G65 P9901 M12. Dd. Uu. Vv. Ff. [Qq. R−r. Ss. Ww.]
G65 P9902 M12. Dd. Ww. Vv. Ff. [Qq. R−r. Ss. Uu.]

where [ ] denote optional inputs.

Examples: G65 P9901 M12. D20. U0. V125. F−125. S54.
G65 P9902 M12. D20. W0. V125. F−125. S54.

Compulsory inputs

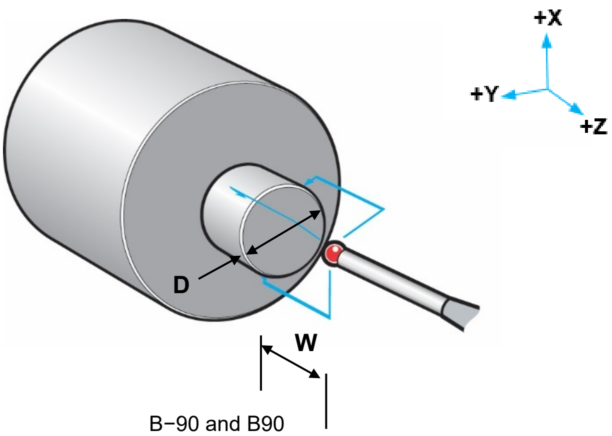
M12.		3-point bore measurement.	
Dd	d =	Diameter of the bore to be measured.	
Uu	u =	B−90 O9901	The first angle for vector measurement from the +X direction.
		B0 O9902 (optional)	The distance from the start position to the measurement point in X (use with an R− input).
Ww	w =	B0 O9902	The first angle for vector measurement from the +Z direction.
		B−90 O9901 (optional)	The distance from the start position to the measurement point in Z (use with an R− input).
Vv	v =	The second angle for vector measurement (from the +X direction for B−90 O9901, and the +Z direction for B0 O9902).	
Ff	f =	The third angle for vector measurement (from the +X direction for B−90 O9901, and the +Z direction for B0 O9902).	

Optional inputs

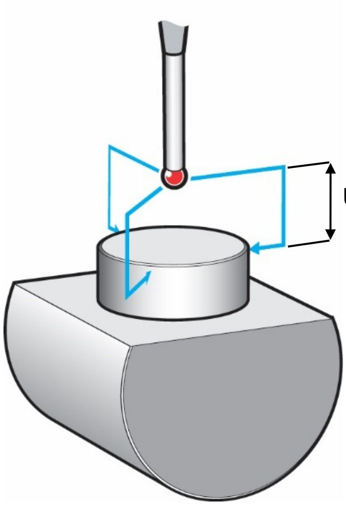
Qq	q =	Additional search distance. The default search distance is 5 mm.
R−r	−r =	Radial distance (use with a U or W input).
Ss	s =	WCS to update.

S54. to S59.	G54 to G59.
S101. to S400.	Extended work offsets G54.1 P1 to G54.1 P300.

3-point boss (M13)



B−90 and B90
O9901



B0
O9902

Description

Measures a boss using three vectored measure moves.

Format

G65 P9901 M13. Dd. Uu. Vv. Ff. Ww. [Qq. Rr. Ss.]
G65 P9902 M13. Dd. Ww. Vv. Ff. Uu. [Qq. Rr. Ss.]

where [ ] denote optional inputs.

Examples: G65 P9901 M13. D20. U0. V125. F−125. W−15. S54.
G65 P9902 M13. D20. W0. V125. F−125. U−15. S54.

Compulsory inputs

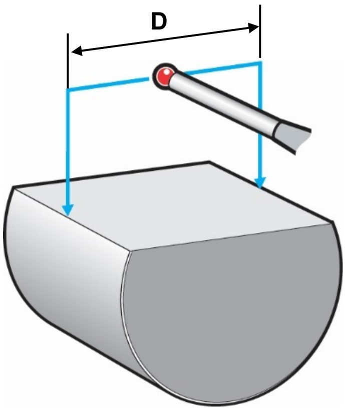
M13.		3-point boss measurement.	
Dd	d =	Diameter of the boss to be measured.	
Uu	u =	B−90 O9901	The first angle for vector measurement from the +X direction.
		B0 O9902	The distance from the start position to the measurement point in X.
Ww	w =	B0 O9902	The first angle for vector measurement from the +Z direction.
		B−90 O9901	The distance from the start position to the measurement point in Z.
Vv	v =	The second angle for vector measurement (from the +X direction for B−90 O9901, and the +Z direction for B0 O9902).	
Ff	f =	The third angle for vector measurement (from the +X direction for B−90 O9901, and the +Z direction for B0 O9902).	

Optional inputs

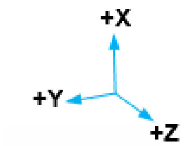
Qq	q =	Additional search distance. The default search distance is 5 mm.
Rr	r =	Radial distance (use with a U or W input).
Ss	s =	WCS to update.

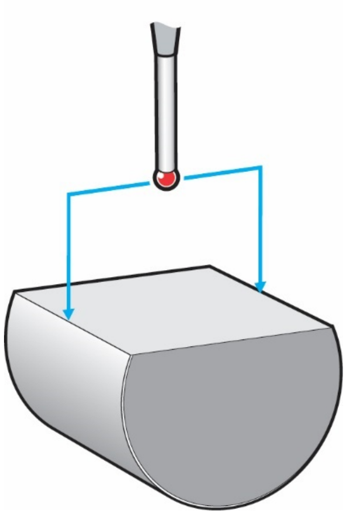
S54. to S59.	G54 to G59.
S101. to S400.	Extended work offsets G54.1 P1 to G54.1 P300.

Rotary axis update (M15)



B−90 and B90
O9901





B0
O9902

Description

Measures the angular error of a surface in the X plane and updates the work offset for the rotary axis.

Format

G65 P9901 M15. Dd. [Qq. Ss.]
G65 P9902 M15. Dd. [Qq. Ss. V2.]

where [ ] denote optional inputs.

Example: G65 P9901 M15. D50. S54.

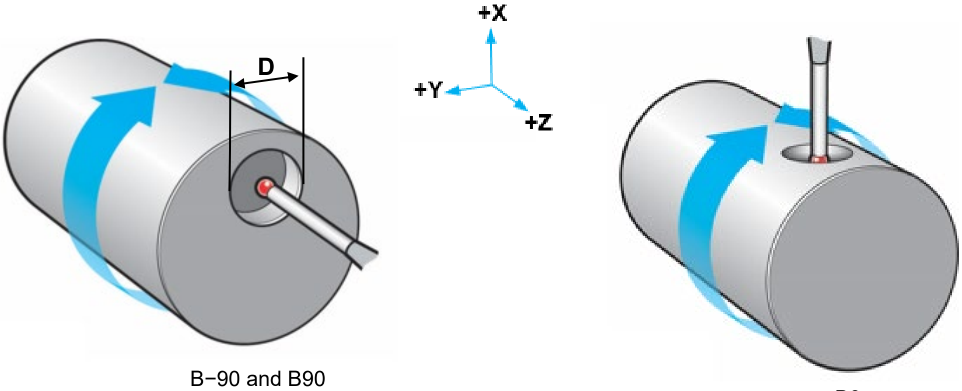
Compulsory inputs

M15.		Rotary axis update.
Dd	d =	Measurement distance in Y.

Optional inputs

Qq	q =	Additional search distance. The default search distance is 5 mm.	
Ss	s =	WCS to update.	
		S54. to S59.	G54 to G59.
		S101. to S400.	Extended work offsets G54.1 P1 to G54.1 P300.
V2.		Defines measurement on C axis 2 (B0 only).	

C-axis centre find – internal feature (M16)



B−90 and B90
O9901

B0
O9902

Description

Rotates the C axis to find the centre of an internal feature, for example a bore.

Format

G65 P9901 M16. Dd. [Ii. Qq. Ss.]
G65 P9902 M16. Dd. [Ii. Qq. Ss. V2.]

where [ ] denote optional inputs.

Example: G65 P9902 M16. D20. S54.

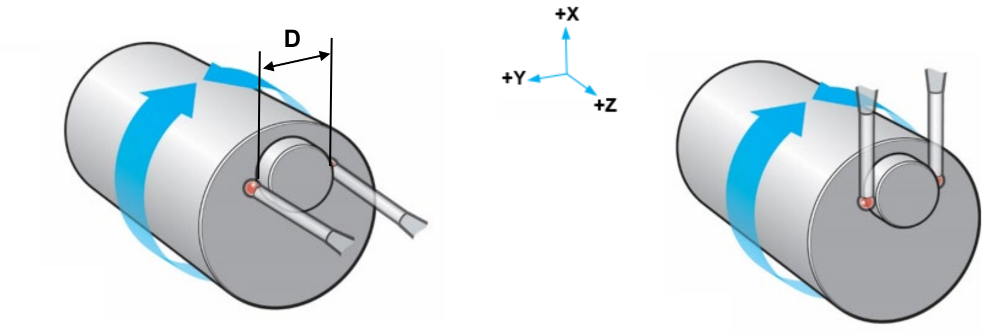
Compulsory inputs

M16.		C-axis centre find – internal feature.
Dd	d =	Linear distance across the feature.

Optional inputs

Ii	i =	Angular amount to shift the work offset (use with an S input).	
Qq	q =	Additional search distance. The default search distance is 5 mm.	
Ss	s =	WCS to update.	
		S54. to S59.	G54 to G59.
		S101. to S400.	Extended work offsets G54.1 P1 to G54.1 P300.
V2.		Defines measurement on C axis 2 (B0 only).	

C-axis centre find – external feature (M17)



B−90 and B90
O9901

B0
O9902

Description

Rotates the C axis to find the centre of an external feature, for example a boss.

Format

G65 P9901 M17. Dd. Ww. [Ii. Qq. Ss. Rr.]
G65 P9902 M17. Dd. Uu. [Ii. Qq. Ss. Rr. V2.]

where [ ] denote optional inputs.

Example: G65 P9901 M17. D30. W−15. S54.

Compulsory inputs

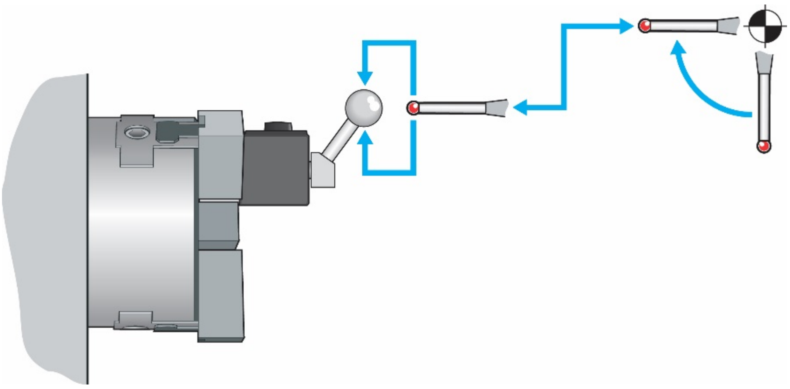
M17.		C-axis find – external feature.
Dd	d =	Linear distance across the feature.
Uu	u =	Distance between the start position and measurement point in X (B0 only).
Ww	w =	Distance between the start position and measurement point in Z (B−90 and B90 only).

Optional inputs

Ii	i =	Angular amount to shift the work offset (use with an S input).
Qq	q =	Additional search distance. The default search distance is 5 mm.
Rr	r =	Pre-measurement clearance distance for external features only. **Default:** 5 mm (0.2 in) + ball radius.

Ss	s =	WCS to update.	
		S54. to S59.	G54 to G59.
		S101. to S400.	Extended work offsets G54.1 P1 to G54.1 P300.
V2.		Defines measurement on C axis 2 (B0 only).	

Sphere calibration (M105)



Description

Full sphere calibration of the probe at B−90 and B0. The approximate XYZ centre of the sphere needs to be set to the active WCS before running. This cycle runs on the main spindle only.

Format

G65 P9901 M105. Bb. Dd. Ss. Tt. [Ii. Kk.]

where [ ] denote optional inputs.

Example: G65 P9901 M105. B6. D25. S54. T030030.

Compulsory inputs

M105.		Sphere calibration.
Bb	b =	Diameter of the stylus ball.
Dd	d =	Diameter of the calibration sphere.
Ss	s =	The work offset that is set to the approximate centre of the calibration sphere (for example, S54.=G54).
Tt	t =	Tool number including offset number.

Optional inputs

Ii	i =	Safe X-axis position to rotate the B axis. This is the machine position from the X-axis home position. A default value of 0 (home position) is assumed if no input is used.
Kk	k =	Safe Z-axis position to rotate the B axis. This is the machine position from the Z-axis home position. A default value of 0 (home position) is assumed if no input is used.

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