

# Inspection Plus software

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04.2003

# 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 (refer to the manual for the address and telephone number). The Renishaw Installation Engineer should normally complete these forms.

<b>MACHINE DETAILS</b>	
Machine description.....	
Machine type.....	
Controller.....	
Special control options.....	
.....	
.....	
<b>RENISHAW HARDWARE</b>	<b>RENISHAW SOFTWARE</b>
Inspection probe type .....	Inspection disk(s).....
Interface type .....	.....
.....	.....
Tool setting probe type .....	Tool setting disk(s) .....
Interface type .....	.....
<b>SPECIAL SWITCHING M CODES (OR OTHER) WHERE APPLICABLE</b>	
	<b>Dual systems only</b>
Switch (Spin) probe on .....	Switch on inspection probe .....
Switch (Spin) probe off .....	Switch on tool setting .....
Start/Error signal .....	Other .....
.....	
<b>ADDITIONAL INFORMATION</b>	
<input type="checkbox"/> 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.....	

# SOFTWARE DEVIATION RECORD

Standard Renishaw kit no.	Software disk nos.
Reason for deviation	
Software no. and macro no.	Comments and corrections
<p>The software product for which these changes are authorised is subject to copyright.</p> <p>A copy of this deviation sheet will be retained by Renishaw plc.</p> <p>A copy of the software amendments must be retained by the customer – they cannot be retained by Renishaw plc.</p>	



## 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 have no control over the exact program configuration of the controller with which the software is to be used, nor of 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 and know the location of all emergency stop switches.

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## Before you begin

This programming manual contains detailed information about how to use the Inspection Plus software for programming, operating and controlling your machine tools.

Split into ten self-contained chapters, the manual is structured to provide the information that you require to use the Inspection Plus software effectively:

- Chapter 1 explains why your probe must be calibrated before you start using it.
- Chapter 2 describes how to install and customise the Inspection Plus software on your machine.
- Chapter 3 provides a complete list of the optional inputs that are required by some of the macro cycles.
- Chapter 4 provides a complete list of the optional outputs that are produced by some of the macro cycles.
- Chapter 5 describes how to use the protected positioning macro (O9810). When correctly used, this macro prevents damage to the probe stylus in the event of the probe colliding with the workpiece.
- Chapter 6 describes how to use the four macros that are provided for calibrating a probe.
- Chapter 7 describes how to use the non-vector measuring cycle macros.
- Chapter 8 describes how to use the three vector measuring cycle macros.
- Chapter 9 describes how to use the macro cycles that have not been described in previous chapters.
- Chapter 10 describes the macro alarm numbers or messages that may be displayed on the screen of the machine tool controller 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, i.e. millimetres, are used in the examples. The equivalent imperial measurements, i.e. inches, are shown in brackets.

## List of associated publications

When you are working with the Inspection Plus software, you may find it useful to refer to the following Renishaw publications:

- Probe systems – Installation manual for machine tools (Renishaw part no. H-2000-6040).
- Probe software for machine tools – Data sheet (Renishaw part no. H-2000-2289).

## About the Inspection Plus software

For a comprehensive description of the facilities provided by the software and also the limitations of the software, you should refer to Appendix B, "Features, cycles and limitations of the Inspection Plus software".

## Software kit

Inspection Plus software – Renishaw part no. A-4012-0516

This comprises the following item:

- Floppy disk assembly – part no. A-4012-0518

### Floppy disk assembly A-4012-0518

This assembly comprises one 3½ inch floppy disk, MS-DOS format (720K).

The disk contains the following data:

Basic cycles	(File 40120519)
Option 1 cycles	(File 40120520)
Option 2 cycles	(File 40120521)
One-touch probe cycle	(File 40120727)

### File 40120519 – Basic cycles

O9721 O9722 O9723 O9724 O9726 O9727 O9731 O9732 O9801  
O9802 O9803 O9810 O9811 O9812 O9814

The disk is formatted to multi-load all macros.

**File 40120520 – Option 1 cycles**

O9730 O9804 O9815 O9816 O9817 O9818 O9821 O9822 O9823  
O9834 O9843

The disk is formatted to multi-load all macros.

**File 40120521 – Option 2 cycles**

O9819 O9820 O9830 O9831 O9832 O9833 O9835 O9836

The disk is formatted to multi-load all macros.

**File 40120727 – One-touch probe cycle**

O9726

## Macro memory requirements

This section lists the amount of memory (in Kbytes) that is required by each macro contained in each of the Inspection Plus software floppy disks. Before you load macros, you should first work out the total amount of memory required by the macros you wish to load. Next, you should check that the machine controller has sufficient memory capacity for these macros.

Useful memory size conversions:

1 Kb = 2.5 m (8.2 ft) of software tape

8 Kb = 20 m (65.6 ft) of software tape

**File 40120519**

The total amount of memory required for all macros in this file is 14.8 Kb. The memory requirements for each macro are as follows:

<b>Macro number</b>	<b>Function</b>	<b>Memory (Kbytes)</b>
O9721	X diameter move	0.594
O9722	Y diameter move	0.578
O9723	Active tool offset macro	0.156
O9724	Settings macro	0.371
O9726	X,Y,Z, basic move	1.526
O9727	Vector diameter move	0.510

O9731	Vector calibration data find (also used for ATAN calculation)	0.658
O9732	Offset update macro	2.160
O9801	Probe length calibration	0.387
O9802	Stylus X,Y offset calibration	0.463
O9803	Stylus ball radius calibration	0.677
O9810	Protected positioning	0.429
O9811	XYZ single surface measure	2.487
O9812	Web/pocket measure	2.109
O9814	Bore/boss measure	1.673

## File 40120520

The total amount of memory required for all macros in this file is 26.0 Kb. The memory requirements for each macro are as follows:

Macro number	Function	Memory (Kbytes)
O9730	Print macro	3.771
O9804	Vector stylus ball radius calibration	0.991
O9815	Internal measure	2.813
O9816	External measure	2.941
O9817	4th axis X measure	1.448
O9818	4th axis Y measure	1.440
O9821	Angled single surface measure	1.983
O9822	Angled web/pocket	2.452
O9823	3-point bore/boss	2.839
O9834	Feature-to-feature measure	3.893
O9843	XY plane angle measure	1.401

## File 40120521

The total amount of memory required for all macros in this file is 7.5 Kb. The memory requirements for each macro are as follows:

Macro number	Function	Memory (Kbytes)
O9819	Bore/boss on PCD	1.715
O9820	Stock allowance	2.445
O9830	Multi-stylus store	0.453
O9831	Multi-stylus load	0.453
O9832	Spin on macro	0.387
O9833	Spin off macro	0.381

---

O9835	SPC tool offset update	0.515
O9836	Optimisation macro	1.159

## File 40120727

The total amount of memory required for all macros in this file is 1.68 Kb. The memory requirements for each macro are as follows:

Macro number	Function	Memory (Kbytes)
O9726	One-touch probe cycle	1.680

See Appendix L for installation and usage details.

## Renishaw customer services

### Calling a Renishaw subsidiary office

If you have a question about the software, first consult the documentation and other printed 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 subsidiary company that serves your country.

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 version of the product you are using (see the Equipment registration record form).
- The type of hardware that you are using (see the Equipment registration record form).
- The exact wording of any messages that appear 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.

## Using the software with multi-buffer options

Various 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.

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

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### Fanuc 15M-A02B-0094-J986

With this control the G5.1 command is used to limit read ahead.

#### Example

G5.1 P1	Read only one block ahead
G65P9810Z10.	Protected positioning move
G65P9814D50.Z-10.	Measure cycle
G65P9810Z100.	Protected positioning move
G5.1	Cancel read ahead

# Chapter 1

## Getting started

Before you start to use the Inspection Plus software, take time to read this chapter. It will provide you with a basic understanding of the importance of accurately calibrating the probe you intend to use for measuring. Only when the probe is accurately calibrated can you achieve total quality control over your manufacturing process.

### Contained in this chapter

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## Why calibrate a measurement probe?

In Chapter 6 of this manual you will find details of the macros used to calibrate your Renishaw probe, but why is it so important that the probe is calibrated?

When you assemble a Renishaw probe into its 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 your probe, the run-out is automatically accounted for. The 'calibration in a bored hole' cycle (macro O9802) provides the data to allow for this run-out.

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

- If it is the first time your probe system is to be used.
- If a new stylus is fitted to your probe.
- If 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 in a bored hole;
- Calibrating in a ring gauge; and
- Calibrating the probe length.

## Calibrating in a bored hole

Calibrating your probe in a bored hole 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. They compensate the measured values so that they are relative to the true spindle centre-line.

## Calibrating in a ring gauge

Calibrating your probe in a ring gauge of a known diameter automatically stores one or more values for the radius of the stylus ball. The 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.

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

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## Calibrating the probe length

Probe length calibration on a known reference surface stores the length based on the electronic trigger point. This 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.

## Calibration cycles

Four calibration cycles are provided with the Inspection Plus software. These may be used in conjunction with one another for complete calibration of the probe. The four macros are summarised below. For further details, see Chapter 6, "Calibration cycles".

Macro O9801 This is used to establish the probe length in its tool shank.

Macro O9802 This is used to establish the stylus off-centre values.

Macro O9803 This is used to establish the stylus ball radius values. It is suitable for all measuring cycles except O9821, O9822 and O9823.

Macro O9804 This is used to establish the vector stylus ball radius values. It is suitable for all measuring cycles, including O9821, O9822 and O9823.

For complete calibration of a probe system, you must use macros O9801, O9802, and either O9803 or O9804.

The calibration cycles are split into separate cycles for flexibility. If, however, the calibration feature is accurately known for both size and position, e.g. a ring gauge where the size is known, and the position is accurately found using a dial test indicator (DTI), it is then possible for you to write a program which completes the full calibration procedure in one operation by calling all of the above macros.

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## Chapter 2

# Installing the software

This chapter describes how to load and customise the Inspection Plus software. It supplements the information described in the "Software installation" section of the manual titled "Probe systems – Installation manual for machine tools" (Renishaw part no. H-2000-6040).

## Contained in this chapter

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## Installing the software

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

1. First, refer to Appendix B, "Features, cycles and limitations of the Inspection Plus software" 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" in the preliminary part of this manual titled "Before you begin").
3. Load the basic cycles on file 40120519.
  - (1) Delete any unwanted O98-- series cycles.
  - (2) If the vector cycles are to be used, delete the following macro:  
O9803 (macro O9804 is used instead)  
Otherwise delete the following macros:  
O9727, O9731, and O9804 (these macros are used only for vector cycles)
  - (3) If the print option is not to be used, delete the following macro:  
O9730
4. Establish which of the Option 1 file 40120520 cycles you require.  
Load the Option 1 file if required. Delete all unwanted macros from the control before loading further macros.
5. Establish which of the Option 2 file 40120521 cycles you require.  
Load the Option 2 file if required. Delete all unwanted macros from the control.

## #506 back-off distance

Run the optimisation macro (O9836) to establish the #506 back-off distance and #119 fast feedrate.

Refer to:

- Appendix I, "Use of macro variables", for a description of the use of macro variables; and
- Chapter 9, "Additional cycles", for a description on using the optimisation macro O9836.

For small and medium size machines, i.e. machines having less than 1000 mm (40 in) of axis travel, the standard feedrates as supplied are normally acceptable. This macro may be deleted by the operator after optimisation is completed.

## Settings macro O9724

If the default values are not suitable, you will need to change the settings macro (O9724). Refer to Appendix C, "Settings macro details", for a description of macro O9724.

Set the following settings macro options:

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

The examples in this document are for general guidance only. Please note that the exact programming format may not suit either your machine set or recommended method as specified by your machine builder.

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## Chapter 3

# Optional inputs

This chapter lists and describes the optional inputs that may be applied to some of the macros. You will be referred to this chapter from other chapters when an optional input is required.

Further information regarding optional inputs is described in the appendices to this manual.

## Contained in this chapter

Optional inputs ..... 3-2

## Optional inputs

The examples described below assume that the controller has been configured for metric values, i.e. millimetres. The equivalent imperial measurement values, i.e. inches, are shown in brackets.

- Bb**    **b=**    Angle tolerance of the surface, e.g. 30 degrees  $\pm$  1 degree inputs A30.B1.  
**Example:** B5. to set a tolerance of 5 degrees.
- Ee**    **e=**    Experience value.  
Specify the number of a spare tool offset where an adjustment value to the measured size is stored (see Appendix E, "Experience value Ee").  
**Example:** E21. causes the experience value stored in tool offset 21 to be applied to the measured size.
- Ff**    **f=**    Percent feedback when updating a tool offset (see Appendix D, "Tolerances"). Enter a value between 0 and 1 (0% and 100%).  
**Default** = 100%.  
Also:  
Feedrate in the protected positioning macro (O9810) (see Chapter 5, "Protected positioning cycles").  
**Example:** F15 sets a feedrate of 15 mm/min.  
(F.6 sets a feedrate of 0.6 in/min.)
- Hh**    **h=**    Tolerance value of a feature dimension being measured.  
**Example:** For dimension 50.0 mm +0.4 mm -0 mm, the nominal tolerance is 50.2 mm with H.2.  
(For dimension 1.968 in +0.016 in -0 in, the nominal tolerance is 1.976 in with H.008.)
- li**    **i=**  
**Jj**    **j=**    See the relevant measuring cycles and specific macro calls.  
**Kk**    **k=**
- Mm**    **m=**    True position tolerance of a feature. A cylindrical zone about the theoretical position.  
**Example:** M.1 sets a true position tolerance of 0.1 mm.  
(M.004 sets a true position tolerance of 0.004 in.)

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Qq	q=	<p>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.</p> <p><b>Default</b> = 4 mm (0.16 in) in the Z-axis, and 10 mm (0.394 in) in the X and Y axes.</p> <p>Also used in the optimisation macro (O9836) (see Chapter 9, "Additional cycles", for details).</p> <p><b>Example:</b> Q8. sets an overtravel distance of 8 mm. (Q.3 sets an overtravel distance of 0.3 in.)</p>
Rr	r=	<p>An incremental dimension that is used in external features, e.g. bosses and webs, to give a radial clearance from the nominal target surface prior to a Z-axis move.</p> <p><b>Default</b> = 5 mm (0.200 in).</p> <p><b>Example:</b> R10. sets a radial clearance of 10 mm. (R.4 sets a radial clearance of 0.4 in.)</p>
R-r	-r=	<p>Similar to Rr, except that the clearance is applied in the opposite direction to force an internal boss or web cycle.</p> <p><b>Default</b> = 5 mm (0.200 in).</p> <p><b>Example:</b> R-10. sets a radial clearance of -10 mm. (R-.4 sets a radial clearance of -0.4 in.)</p>
Ss	s=	<p>Work offset number which will be set. The work offset number will be updated. S1 to S6 (G54 to G59) S0 (external work offset). S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option. New work offset = active work offset + error. New external offset = external offset + error.</p> <p><b>Example:</b> S3.</p>
Tt	t=	<p>Tool offset number to be updated</p> <p><b>Example:</b> T20 updates tool offset number 20.</p>
Uu	u=	<p>Upper tolerance limit. If this value is exceeded there is no tool offset or work offset updated and the cycle is stopped with an alarm. This tolerance is applied to both size and position where applicable.</p> <p><b>Example:</b> U2. to set the upper tolerance limit to 2 mm. (U.08 to set the upper tolerance limit to 0.08 in.)</p>

---

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

**Default = 0**

**Example:** V.5 for a tolerance zone of  $\pm 0.5$  mm.

(V.02 for a tolerance zone of  $\pm 0.02$  in.)

Ww w= Print data

1. = Increment the feature number only.

2. = Increment the component number, and reset the feature number.

**Example:** W1.

# Chapter 4

## Variable outputs

This chapter lists the variable outputs that may be 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

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Variable outputs – chart 2 .....	4-3

## Variable outputs – chart 1

	Single surface	Web/pocket	Bore/boss	Internal corner	External corner	4th axis	X/Y angle measure
	G65P9811	G65P9812	G65P9814	G65P9815	G65P9816	G65P9817/18	G65P9843
# 135	X position	X position	X position	X position	X position		
# 136	Y position	Y position	Y position	Y position	Y position		
# 137	Z position						
# 138	Size	Size	Size				
# 139				X surface angle	X surface angle	4th angle	Angle
# 140	X error	X error	X error	X error	X error		
# 141	Y error	Y error	Y error	Y error	Y error		
# 142	Z error			Y surface angle	Y surface angle		
# 143	Size error	Size error	Size error	Y angle error	Y angle error	Height error	Height error
# 144				X angle error	X angle error	Angle error	Angle error
# 145	True position error	True position error	True position error	True position error	True position error		
# 146	Metal condition	Metal condition	Metal condition				
# 147	Direction indicator						
# 148	Out of tolerance flag (1 to 7)						
# 149	Probe error flag (0 to 2)						

## Variable outputs – chart 2

	PCD bore/boss	Stock allowance	Angled single surface	Angled web/pocket	3-point bore/boss	Feature to feature
	G65P9819	G65P9820	G65P9821	G65P9822	G65P9823	G65P9834
# 135	X position		X position from start	X position	X position	X incremental distance
# 136	Y position		Y position from start	Y position	Y position	Y incremental distance
# 137	PCD					Z incremental distance
# 138	Size		Size from start	Size	Size	Minimum distance
# 139	Angle					Angle
# 140	X error		X error	X error	X error	X error
# 141	Y error		Y error	Y error	Y error	Y error
# 142	PCD error					Z error
# 143	Size error		Size error	Size error	Size error	Minimum distance error
# 144	Angle error	Maximum value				Angle error
# 145	True position error	Minimum value	True position error	True position error	True position error	True position error
# 146	Metal condition	Variation (stock)	Metal condition	Metal condition	Metal condition	Metal condition
# 147	Hole number		Direction indicator			
# 148	Out of tolerance flag (1 to 7)					
# 149	Probe error flag (0 to 2)					

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## Chapter 5

### Protected positioning cycle

When 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 macro O9810 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 (probe trigger monitor) (O9810) ..... 5-2

## Protected positioning (probe trigger monitor) (O9810)

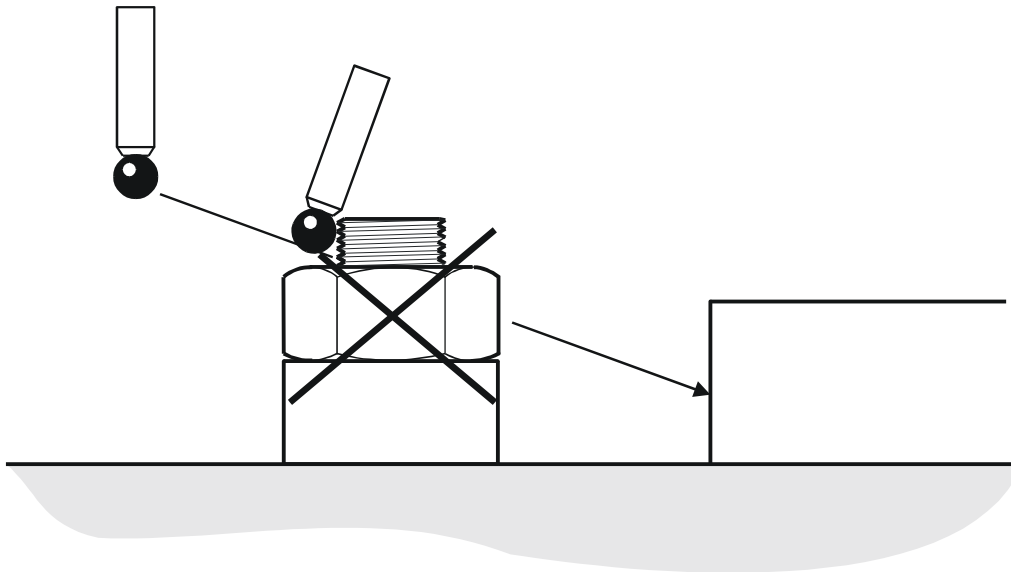


Figure 5.1 Probe protected positioning

### Description

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

### Application

Select the probe and move to a safe plane. The probe should be made active at this point and then it can be moved to a measuring position using this macro call. In the event of a collision, the machine will stop and either a PATH OBSTRUCTED alarm will result, or an error flag #148 will be set (see Mm input).

### Format

G65 P9810 Xx Yy Zz [Ff Mm]  
where [ ] denotes optional inputs

**Example:** G65P9810 Z10. F0.8 M0.2

**Compulsory inputs**

Xx    x=  
Yy    y=    The target positions for the probe positioning move.  
Zz    z=

**Optional inputs**

Ff    f=    The modal feedrate for all protected positioning moves. The feedrate will be 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 should not be exceeded.

Mm    m=1.0 Will set a probe trigger flag (no PATH OBSTRUCTED alarm)  
#148 = 0 (no probe trigger)  
#148 = 7 (probe triggered)

**Example**

G1G54X20.Y50.

G43H20Z100.                      Move to a safe plane.

G65P9832                          Spin the probe on (includes M19) or M19 for spindle orientation.

G65P9810Z10.F3000              Protected positioning move.

G65P9811Z0S1                    Single surface measure.

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## Chapter 6

# Calibrating the probe

Before a probe is used, it is important that you calibrate it correctly. This chapter describes the four macros you should use for calibrating a probe. If you need to know more about calibrating a probe, you will find helpful information contained in Chapter 1, "Getting started".

### Contained in this chapter

Calibration cycles – an overview.....	6-2
Calibrating the probe length (O9801).....	6-3
Calibrating the stylus X and Y offsets (O9802).....	6-5
Calibrating the stylus ball radius (O9803).....	6-8
Calibrating the vector stylus ball radius (O9804).....	6-11
Example 1 – Full calibration in an internal feature.....	6-14
Example 2 – Full calibration on an external feature.....	6-16

## Calibration cycles – an overview

Four calibration cycles are provided with the Inspection Plus software. These may be used in conjunction with one another for complete calibration of the probe. The purpose of each macro is summarised below.

Macro O9801	This is used to establish the probe length in its tool shank.
Macro O9802	This is used to establish the stylus off-centre values.
Macro O9803	This is used to establish the stylus ball radius values. It is suitable for all measuring cycles except for O9821, O9822 and O9823.
Macro O9804	This is used to establish the vector stylus ball radius values. It is suitable for all measuring cycles, including O9821, O9822 and O9823.

For complete calibration of a probe system, you must use macros O9801, O9802, and either O9803 or O9804. Examples of full calibration procedures are described in the sections "Example 1 – Full calibration in an internal feature" and "Example 2 – Full calibration on an external feature" at the end of this chapter.

The Renishaw calibration cycles are split into separate cycles for flexibility. If, however, the calibration feature is accurately known for both size and position, e.g. a ring gauge where the size is known, and the position is accurately found using a dial test indicator, it is then possible for you to write a program which completes the full calibration procedure in one operation by calling all of the above macros.

## Calibrating the probe length (O9801)

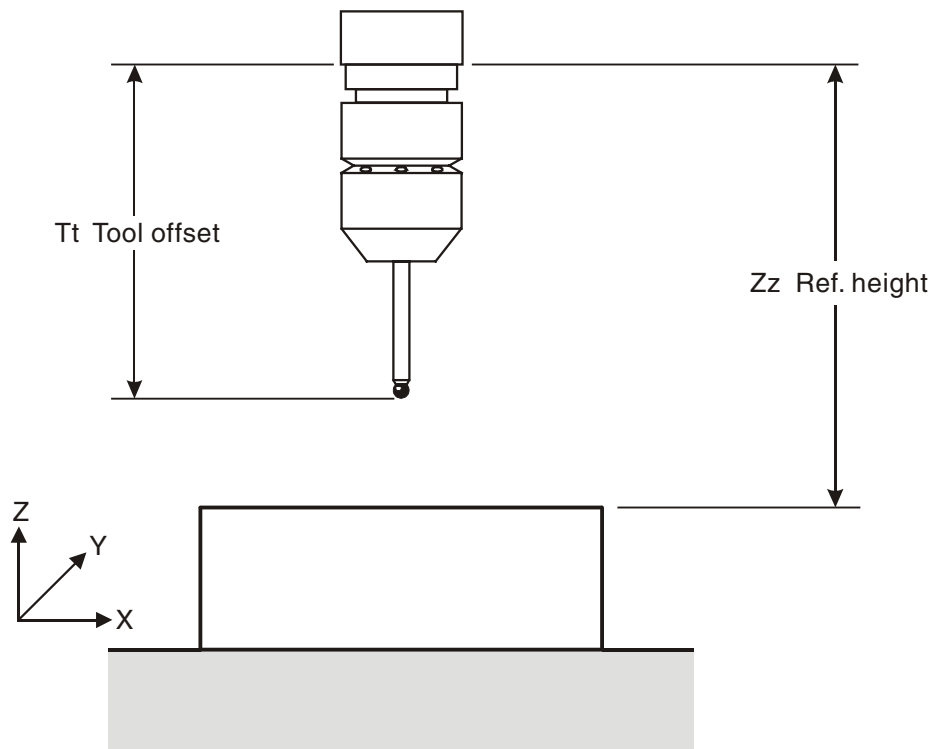


Figure 6.1 Calibrating the probe length

### Description

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

### Application

Load an approximate tool offset. The probe should be positioned 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 is returned to the start position.

### Format

G65 P9801 Zz Tt

**Example:** G65 P9801 Z50. T20

### Compulsory inputs

Tt     t=     Active tool offset number.

Zz     z=     Reference surface position.

### Outputs

The active tool offset will be set.

### Example

Set X, Y, Z values in work offset G54

O 0001

G90G80G40G0                      Preparatory codes for the machine.

G54X0Y0                              Start position.

G43H1Z100.                          Activate offset 1, go to 100 mm (3.94 in).

G65P9832                              Spin the probe on (includes M19) or M19 for spindle orientation.

G65P9810Z10.F3000                  Protected positioning move.

G65P9801Z0I1                        Datum Z direction.

G65P9810Z100.                      Protected positioning move.

G65P9833                              Spin the probe off (when applicable).

G28Z100.                              Reference return.

H00                                      Cancel offset.

M30                                      End of program.

**NOTE:** The tool offset must be active. The active tool offset H word number must be the same as the T input number (see above)

## Calibrating the stylus X and Y offsets (O9802)

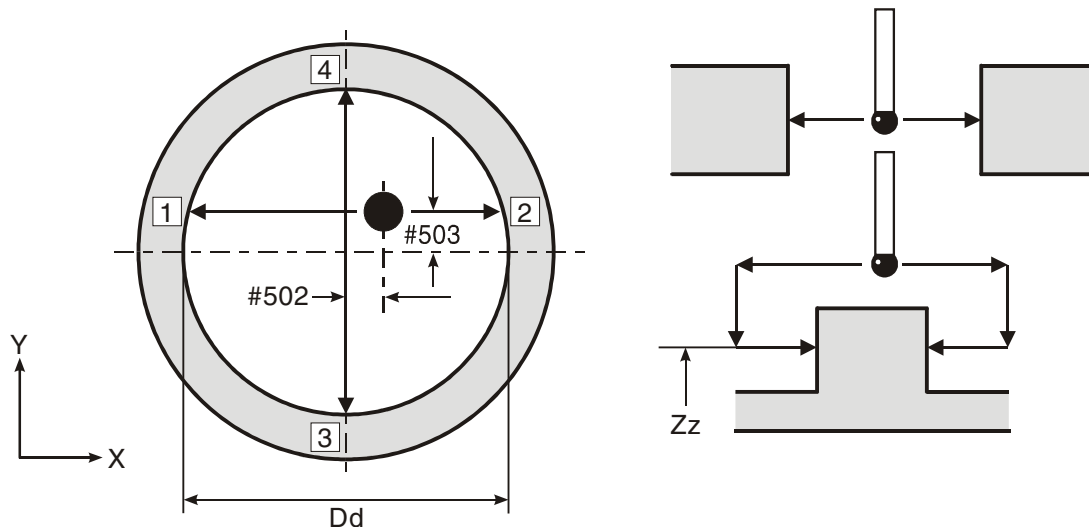


Figure 6.2 Calibrating the stylus X and Y offsets

### Description

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

### Application

Pre-machine a hole with a suitable boring bar, so that the exact centre of the hole is known. Position the probe to be calibrated inside the hole, and the spindle on the known centre position with the spindle orientation active. When the cycle is run, four measuring moves are made in order 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 [ ] denotes optional inputs

**Example:** G65 P9802 D50.005 Z50.

### Compulsory input

Dd     d=     Nominal size of 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 will be stored:

#502 = X-axis stylus offset

#503 = Y-axis stylus offset

**Example 1: Stylus X, Y offset calibration**

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 bored hole centre-line.

O0002

G90G80G40G0                      Preparatory codes for the machine.

G65P9832                              Spin the probe on (includes M19), or M19 for spindle orientation.

G65P9802D50.                      Calibrate in a 50 mm (1.97 in) diameter bored hole.

G65P9833                              Spin the probe off (when applicable).

M30                                      End of program.

**Example 2: Alternative stylus X, Y offset calibration**

Run a complete positioning and calibration program as follows.

Set the exact X, Y, and Z feature positions in a work offset (example using G54).

O0002

G90G80G40G0                      Preparatory codes for the machine.

G54X0Y0                              Move to centre of the feature.

G43H1Z100.                              Activate offset 1, go to 100 mm (3.94 in) above.

G65P9832                              Spin the probe on (includes M19), or M19 for spindle orientation.

G65P9810Z-5.F3000	Protected positioning move into hole.
G65P9802D50.	Calibrate in a 50 mm (1.97 in) diameter bored hole.
G65P9810Z100.F3000	Protected positioning move retract to 100 mm (3.94 in).
G65P9833	Spin the probe off (when applicable).
G28Z100.	Reference return.
H00	Cancel offset (when applicable).
M30	End of program

## Calibrating the stylus ball radius (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.

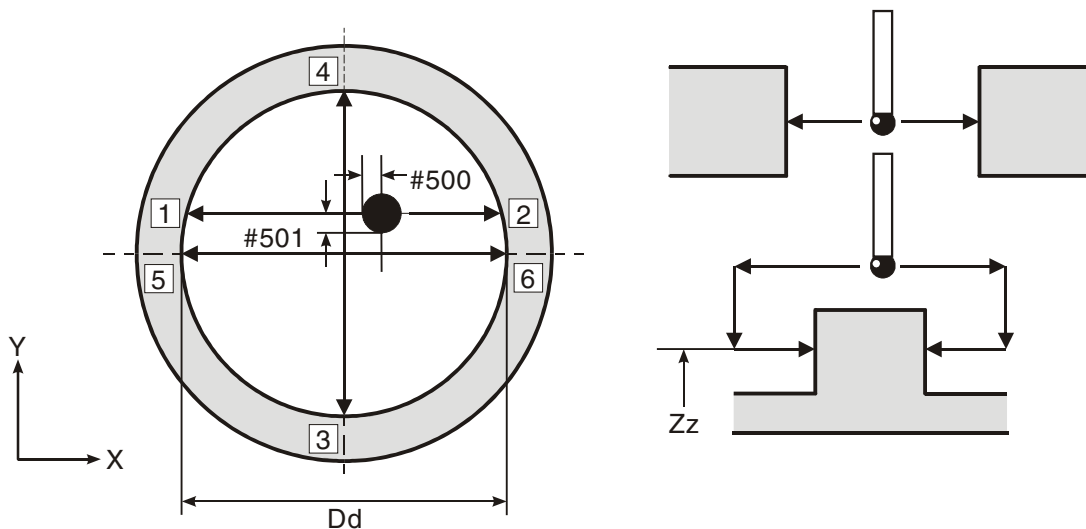


Figure 6.3 Calibrating the stylus ball radius

### Description

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

### Application

Clamp a calibrated ring gauge on the machine table at an approximately known position. Position the probe to be calibrated inside the ring gauge on the approximate centre position, with spindle orientation active. When the cycle is run, six moves are made in order to determine the stylus ball radius values. 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=    Reference ring gauge size

## Optional inputs

Ss    s=    The work offset number which will be set.  
 The work offset number will be updated.  
 S1 to S6 (G54 to G59)  
 S0 (external work offset).  
 S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option.  
 New work offset = active work offset + error.  
 New external offset = external offset + error.

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

## Outputs

The following data will be stored as shown:

#500 = X+, X-, stylus ball radius    (XRAD)

#501 = Y+, Y-, stylus ball radius    (YRAD)

## Example 1: Stylus ball radius calibration

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

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

O0003

G90G80G40G0                      Preparatory codes for the machine.

G65P9832                              Spin the probe on (includes M19) or M19 for spindle orientation.

G65P9803D50.001                      Calibrate in a 50.001 mm (1.9685 in) diameter ring gauge.

G65P9833                              Spin the probe off (when applicable).

M30                                      End of program.

**Example 2: Alternative stylus ball radius calibration**

Run a complete positioning and calibration program as follows.

Set the approximate X, Y, Z feature positions in a work offset (example using G54).

O0003

G90G80G40G00                      Preparatory codes for the machine.

G54X0Y0                              Move to centre of feature.

G43H1Z100.                          Activate offset 1, go to 100 mm (3.94 in) above.

G65P9832                              Spin the probe on (includes M19), or M19 for spindle orientation.

G65P9810Z-5.F3000                  Protected positioning move into hole.

G65P9803D50.001                    Calibrate in a 50.001 mm (1.9685 in) ring gauge.

G65P9810Z100.F3000                Protected positioning move retract to 100 mm (3.94 in).

G65P9833                              Spin the probe off (when applicable).

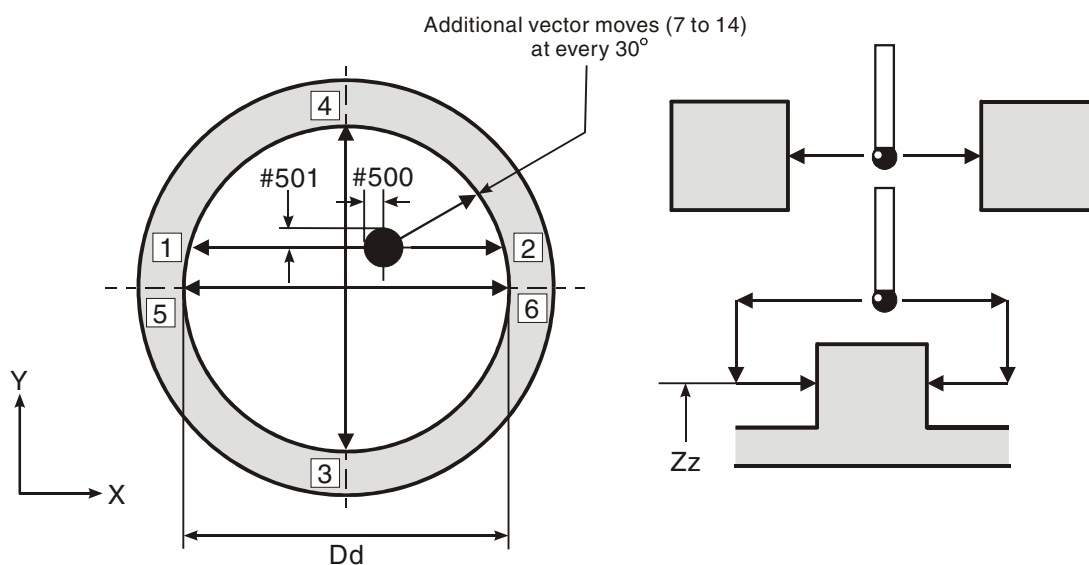
G28Z100.                              Reference return.

H00                                      Cancel offset (when applicable).

M30                                      End of program.

## Calibrating the vector stylus ball radius (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 8, "Vector measuring cycles"). Do not calibrate the stylus ball radius using macro O9803.



**Figure 6.4** Calibrating the vector stylus ball radius

### Description

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

### Application

Clamp a calibrated ring gauge on the machine table at an approximately known position. The probe to be calibrated is positioned inside the ring gauge on the approximate centre position, with spindle orientation active. When the cycle is run, 14 moves are made in order to determine the stylus ball radius values. 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= Reference ring gauge size.

### Optional inputs

Ss s= The work offset number which will be set.  
The work offset number will be updated.  
S1 to S6 (G54 to G59)  
S0 (external work offset).  
S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option.  
New work offset = active work offset + error.  
New external offset = external offset + error.

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

### Outputs

The following data will be stored as shown (as O9803):

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

Additional vector calibration data:

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

**Example 1: Vector stylus ball radius calibration**

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

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

O0004

G90G80G40G0

Preparatory codes for the machine.

G65P9832

Spin the probe on (includes M19), or M19 for spindle orientation.

G65P9804D50.001

Calibrate in a 50.001 mm (1.9685 in) diameter ring gauge.

G65P9833

Spin the probe off (when applicable).

M30

End of program.

**Example 2: Alternative vector stylus ball radius calibration**

Run a complete positioning and calibration program as follows.

Set the approximate X, Y, Z feature positions in a work offset (example using G54).

O0004

G90G80G40G0

Preparatory codes for the machine.

G54X0Y0

Move to centre of feature.

G43H1Z100.

Activate offset 1, go to 100 mm (3.94 in) above.

G65P9832

Spin the probe on (includes M19), or M19 for spindle orientation.

G65P9810Z-5.F3000

Protected positioning move into the hole.

G65P9804D50.001

Calibrate in a 50.001 mm (1.9685 in) diameter ring gauge.

G65P9810Z100.F3000

Protected positioning move retract to 100 mm (3.94 in).

G65P9833

Spin the probe off (when applicable).

G28Z100.

Reference return.

H00

Cancel offset (when applicable).

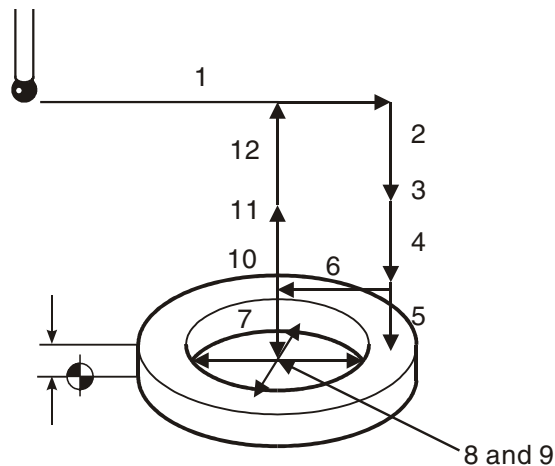
M30

End of program.

## Example 1 – Full calibration in an internal feature

This example describes how to carry out full calibration of the probe in an internal feature using macros O9801, O9802 and O9804, using a 50.001 mm (1.9685 in) diameter ring gauge, with a known centre position and top face height value.

The approximate probe length must be stored in the tool offset register before running this program. Set the exact X, Y, and Z feature positions in a work offset (example using G54).



**Figure 6.5 Full calibration in an internal feature**

O0006

G90G80G40G0

Preparatory codes for the machine.

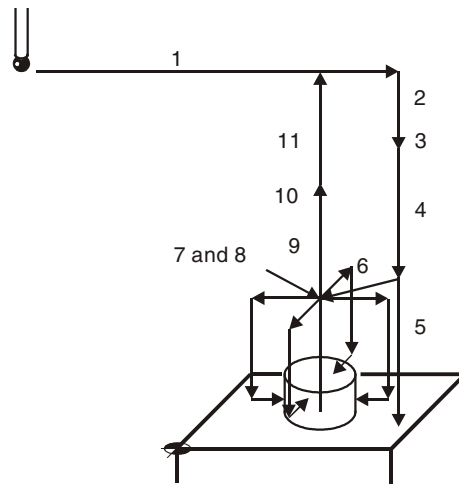
- |    |                   |  |
|----|-------------------|--|
| 1. | G54X35.Y0         | Move off centre of feature for height setting.   |
| 2. | G43H1Z100.        | Activate offset 1, go to 100 mm (3.94 in) above.                                       |
| 3. | G65P9832          | Spin the probe on (includes M19), or M19 for spindle orientation.                      |
| 4. | G65P9810Z30.F3000 | Protected positioning move above reference surface.                                    |
| 5. | G65P9801Z20.006T1 | Calibrate the probe length. Surface at 20.006 mm (7.876 in)                            |
| 6. | G65P9810X0Y0      | Protected positioning move to centre.  |
| 7. | G65P9810Z5.       | Protected positioning move into hole.  |
| 8. | G65P9802D50.      | Calibrate in a 50 mm (1.97 in) diameter bored hole to establish the X,Y stylus offset. |

- |                        |  |
|------------------------|--|
| 9. G65P9804D50.001     | Calibrate in a 50.001 mm (1.9685 in) diameter ring gauge to establish the ball radius values, including the vector directions. |
| 10. G65P9810Z100.F3000 | Protected positioning move retract to 100 mm (3.94 in).  |
| 11. G65P9833           | Spin the probe off (when applicable).  |
| 12. G28Z100.           | Reference return.  |
| H00                    | Cancel offset (when applicable)  |
| M30                    | End of program   |

## Example 2 – Full calibration on an external feature

This example describes how to carry out full calibration of the probe on an external feature using macros O9801, O9802 and O9804, using a 50.001 mm (1.9685 in) diameter pin gauge, with a known centre position and a Z-reference surface.

The approximate probe length must be stored in the tool offset register before running this program. Set the exact X, Y pin feature positions and Z surface height in a work offset (example using G54).



**Figure 6.6 Full calibration on an external feature**

O0006

G90G80G40G0

Preparatory codes for the machine.

- |    |                     |   |
|----|---------------------|---|
| 1. | G54X135.Y100.       | Move to centre of feature for height setting.   |
| 2. | G43H1Z100.          | Activate offset 1, go to 100 mm (3.94 in) above.  |
| 3. | G65P9832            | Spin the probe on (includes M19), or M19 for spindle orientation.                           |
| 4. | G65P9810Z30.F3000   | Protected positioning move above reference surface.   |
| 5. | G65P9801Z0.T1       | Calibrate the probe length. Z surface at zero.  |
| 6. | G65P9810X100.Y100.  | Protected positioning move to centre.   |
| 7. | G65P9802D50.001Z10. | Calibrate on a 50.001 mm (1.9685 in) diameter pin gauge to establish the X,Y stylus offset. |

- |                        |   |
|------------------------|---|
| 8. G65P9804D50.001Z10. | Calibrate on a 50.001 mm (1.9685 in) diameter pin gauge to establish the ball radius values, including the vector directions. |
| 9. G65P9810Z100.F3000  | Protected positioning move retract to 100 mm (3.94 in).   |
| 10. G65P9833           | Spin the probe off (when applicable).   |
| 11. G28Z100.           | Reference return.   |
| H00                    | Cancel offset (when applicable)   |
| M30                    | End of program  |

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# Chapter 7

## Measuring cycles

This chapter describes how to use the non-vector measuring cycles. The probe stylus ball radius must be calibrated using either macro O9803 or O9804 (see Chapter 6, "Calibrating the probe") before using the macros described here.

### Contained in this chapter

X Y Z single surface measurement (O9811).....	7-2
Web/pocket measurement (O9812).....	7-5
Bore/boss measurement (O9814).....	7-9
Finding an internal corner (O9815).....	7-13
Finding an external corner (O9816).....	7-17

## X Y Z single surface measurement (O9811)

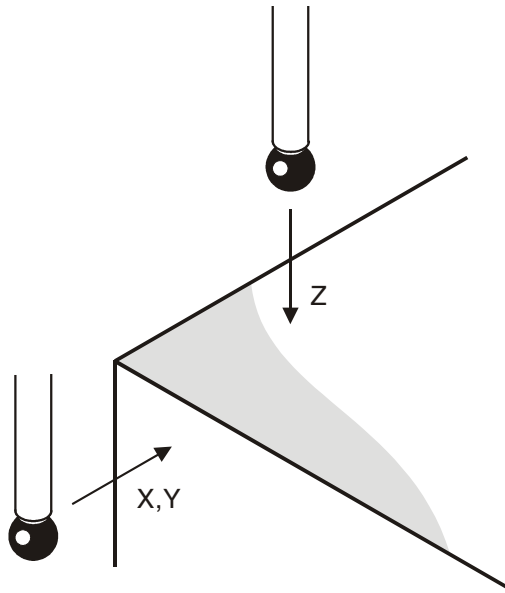


Figure 7.1 Measurement of a single surface

### Description

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

### Application

The probe should be positioned with its tool offset active adjacent to the surface. The cycle measures the surface and returns to the start position.

There are two possibilities as follows:

1. The surface can be treated as a size, where the tool offset is updated in conjunction with the Tt and the Hh input.
2. The surface can be treated 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 Uu Vv Ww]  
 where [ ] denotes optional inputs

**Example:** G65P9811X50.E0.005F0.8H0.2M.2Q10.S1.T20. U.5V.5W2.

---

## Compulsory inputs

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

## Optional inputs

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

Mm     m=     The true position tolerance of a feature. A cylindrical zone about the theoretical position.

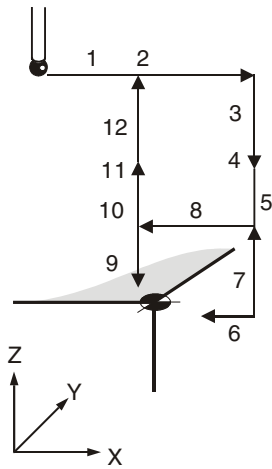
Qq     q=     The probe overtravel distance for use when the default values are unsuitable. The probe will then travel beyond the expected position when it searches for a surface.  
**Default** = 4 mm (0.16 in) in the Z-axis and 10 mm (0.394 in) in the X and Y axes.

Ss     s=     The work offset number which will be set.  
The work offset number will be updated.  
S1 to S6 (G54 to G59)  
S0 (external work offset).  
S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option.  
New work offset = active work offset + error.  
New external offset = external offset + error.

Tt     t=     The tool offset number to be updated.

Ww     w=     Print data  
  
1. = Increment the feature number only.  
2. = Increment the component number, and reset the feature number.

For optional inputs Ee, Ff, Uu, and Vv, see Chapter 3, "Optional inputs".

**Example: X and Z single surface measurement**

**Figure 7.2**  
**Probe movements**

- |     |                   |   |
|-----|-------------------|---|
| 1.  | T01M06            | Select the probe.   |
| 2.  | G54X-40.Y20.      | Start position.   |
| 3.  | G43H1Z100.        | Activate offset 1, go to 100 mm (3.94 in).                        |
| 4.  | G65P9832          | Spin the probe on (includes M19), or M19 for spindle orientation. |
| 5.  | G65P9810Z-8.F3000 | Protected positioning move to start position.                     |
| 6.  | G65P9811X-50.T10. | Single surface measure.   |
| 7.  | G65P9810Z10.      | Protected positioning move.                                       |
| 8.  | G65P9810X-60.     | Protected positioning move.                                       |
| 9.  | G65P9811Z0T11     | Single surface measure.   |
| 10. | G65P9810Z100.     | Protected positioning move.                                       |
| 11. | G65P9833          | Spin the probe off (where applicable).                            |
| 12. | G28Z100.          | Reference return.   |

continue

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

## Web/pocket measurement (O9812)

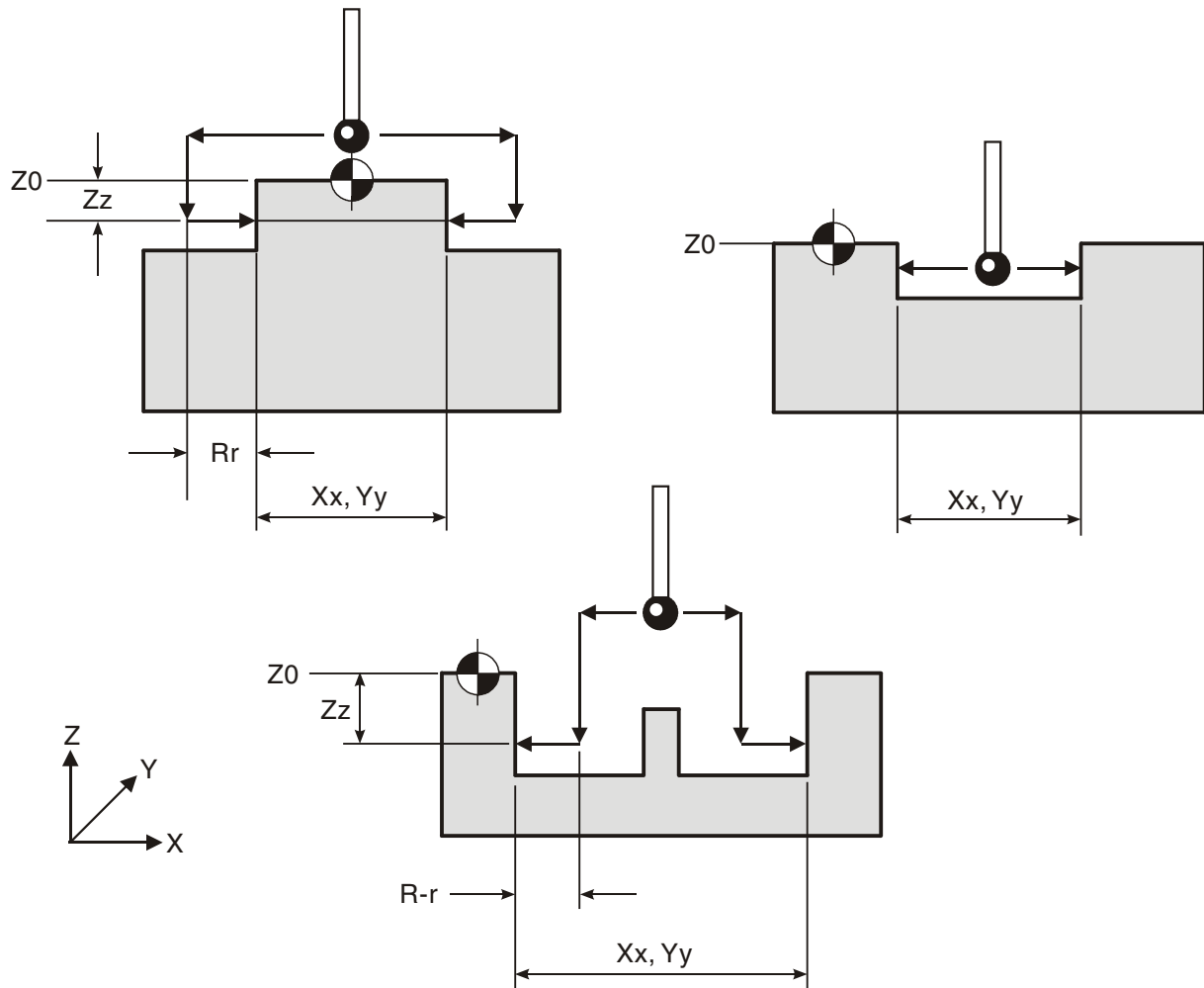


Figure 7.3 Measurement of a web or pocket feature

### Description

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

### Application

Position the probe to the expected centre-line of the feature and a suitable position in the Z-axis with the probe and probe offset active. Run the cycle with suitable inputs as described.

**Format**

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

or

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

or

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

or

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

where [ ] denote optional inputs.

**Example:** G65P9812 X50. Z100. E0.005 F0.8 H0.2 M.2 Q10. R10. S1. T20. U.5 V.5 W2.

**Compulsory inputs**

Xx    x=    Nominal size of feature when measured in the X-axis.

or

Yy    y=    Nominal size of 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**

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

Mm    m=    The true position tolerance of a feature. A cylindrical zone about the theoretical position.

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** = 4 mm (0.16 in) in the Z-axis, and 10 mm (0.394 in) in the X and Y axes.

Rr    r=    An incremental dimension that is used in external features, e.g. bosses and webs, to give a radial clearance from the nominal target surface prior to a Z-axis move.

**Default** = 5 mm (0.200 in).

R-r    -r=    Similar to Rr, except that the clearance is applied in the opposite direction to force an internal web cycle.

**Default** = 5 mm (0.200 in).

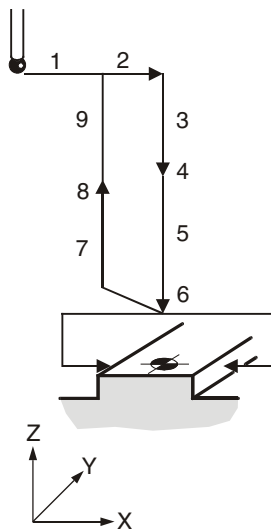
- Ss s= The work offset number which will be set.  
The work offset number will be updated.  
S1 to S6 (G54 to G59)  
S0 (external work offset).  
S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option.  
New work offset = active work offset + error.  
New external offset = external offset + error.
- Tt t= The tool offset number to be updated.
- Ww w= Print data  
1. = Increment the feature number only.  
2. = Increment the component number, and reset the feature number.

For optional inputs Ee, Ff, Uu, and Vv, see Chapter 3, "Optional inputs".

## Outputs

See Chapter 4, "Variable outputs".

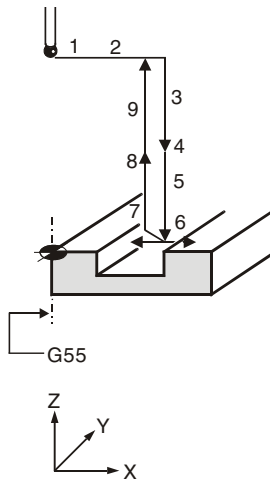
### Example 1: Measuring a web



**Figure 7.4**  
**Probe movements**

1. T01M06 Select the probe.
  2. G54X0Y0 Start position.
  3. G43H1Z100. Activate offset 1, go to 100 mm (3.94 in) above.
  4. G65P9832 Spin the probe on (includes M19), or M19 for spindle orientation.
  5. G65P9810Z10.F3000 Protected positioning move.
  6. G65P9812X50.Z-10.S2 Measure a 50.0 mm (1.968 in) wide web.
  7. G65P9810Z100. Protected positioning move.
  8. G65P9833 Spin the probe off (where applicable).
  9. G28Z100. Reference return.
- continue

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

**Example 2: Measuring a pocket (referred datum)**

**Figure 7.5**  
**Probe movements**

- |    |                     |   |
|----|---------------------|---|
| 1. | T01M06              | Select the probe.   |
| 2. | G54X100.Y50.        | Start position.   |
| 3. | G43H1Z100.          | Activate offset 1, go to 100 mm (3.94 in).                        |
| 4. | G65P9832            | Spin the probe on (includes M19), or M19 for spindle orientation. |
| 5. | G65P9810Z-10.F3000. | Protected positioning move.                                       |
| 6. | G65P9812X30.S2      | Measure a 30.0 mm (1.181 in) wide pocket.                         |
| 7. | G65P9810Z100.       | Protected positioning move.                                       |
| 8. | G65P9833            | Spin the probe off (where applicable).                            |
| 9. | G28Z100.            | Reference return.   |
- continue

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

## Bore/boss measurement (O9814)

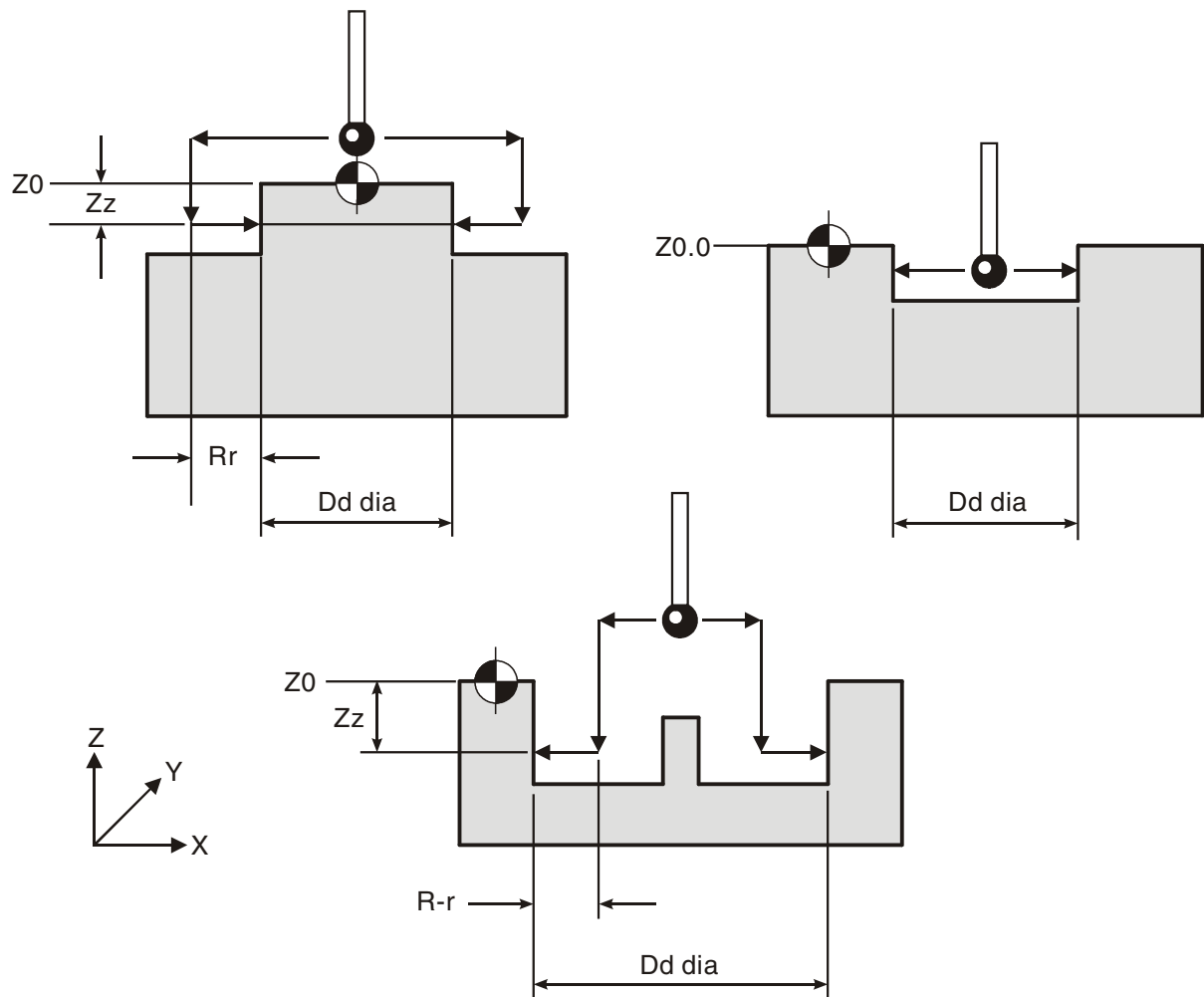


Figure 7.6 Measurement of a bore or boss feature

### Description

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

### Application

Position the probe to the expected centre-line of the feature and a suitable position in the Z-axis with the probe and probe offset active. Run the cycle with suitable inputs as described.

## Format

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

or

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

where [ ] denotes optional inputs

**Example:** G65 P9814 D50.005 Z100. E0.005 F0.8 H0.2 M.2 Q10. R10. S1. T20.  
U.5 V.5 W2.

## Compulsory inputs

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

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

Mm m= The true position tolerance of a feature. A cylindrical zone about the theoretical position.

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** = 4 mm (0.16 in) in the Z-axis, and 10 mm (0.394 in) in the X and Y axes.

Rr r= This is an incremental dimension that is used in external features, e.g. bosses and webs, to give a radial clearance from the nominal target surface prior to a Z-axis move.  
**Default** = 5 mm (0.200 in).

R-r -r= This is similar to Rr, except that the clearance is applied in the opposite direction to force an internal boss cycle.  
**Default** = 5 mm (0.200 in).

Ss s= The work offset number which will be set.  
The work offset number will be updated.  
S1 to S6 (G54 to G59)  
S0 (external work offset).  
S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option.  
New work offset = active work offset + error.  
New external offset = external offset + error.

Tt t= The tool offset number to be updated.

Ww w= Print data

1. = Increment the feature number only.

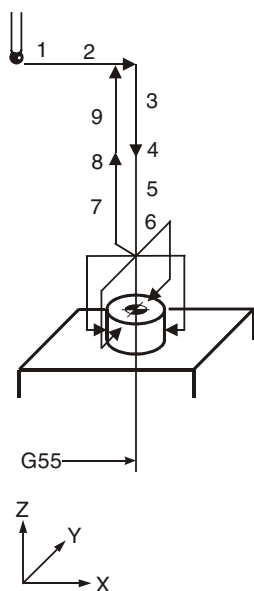
2. = Increment the component number, and reset the feature number.

For optional inputs Ee, Ff, Uu, and Vv, see Chapter 3, "Optional inputs".

## Outputs

See Chapter 4, "Variable outputs".

### Example 1: Measuring a boss



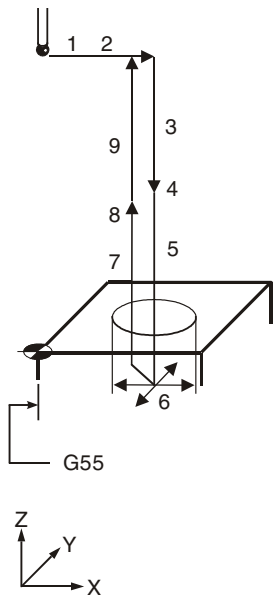
- |    |                          |   |
|----|--------------------------|---|
| 1. | T01M06                   | Select the probe.   |
| 2. | G54X0Y0                  | Start position.   |
| 3. | G43H1Z100.               | Activate offset 1, go to 100 mm (3.94 in).                        |
| 4. | G65P9832                 | Spin the probe on (includes M19), or M19 for spindle orientation. |
| 5. | G65P9810Z10.F3000        | Protected positioning move.                                       |
| 6. | G65P9814D50.Z-10.S2.R10. | Measure a 50.0 mm (1.968 in) diameter boss.                       |
| 7. | G65P9810Z100.            | Protected positioning move.                                       |
| 8. | G65P9833                 | Spin the probe off (when applicable).                             |
| 9. | G28Z100.                 | Reference return.   |

**Figure 7.7**  
**Probe movements**

continue

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

**Example 2: Measuring a bore (referred datum)**



- |    |                    |   |
|----|--------------------|---|
| 1. | T01M06             | Select the probe.   |
| 2. | G54X100.0Y100.     | Start position.   |
| 3. | G43H1Z100.         | Activate offset 1, go to 100 mm (3.94 in).                        |
| 4. | G65P9832           | Spin the probe on (includes M19), or M19 for spindle orientation. |
| 5. | G65P9810Z-10.F3000 | Protected positioning move.                                       |
| 6. | G65P9814D30.S2     | Measure a 30.0 mm (1.181 in) diameter bore.                       |
| 7. | G65P9810Z100.      | Protected positioning move.                                       |
| 8. | G65P9833           | Spin the probe off (when applicable)                              |
| 9. | G28Z100.           | Reference return  |

**Figure 7.8**  
**Probe movements**

continue

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

## Finding an internal corner (O9815)

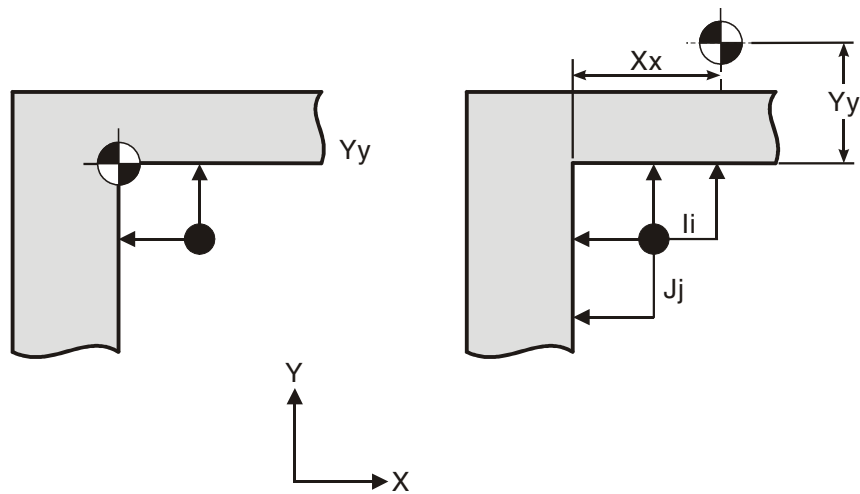


Figure 7.9 Finding an internal corner position

### Description

This cycle is used to establish the corner position of a feature.

**NOTE:** A true corner intersection can be found, even if the corner is not 90 degrees

### Application

The probe must be positioned with its tool offset active at a start position as shown in the figure above. The probe measures the Y-axis surface first and then measures the X-axis surface. The probe then returns to the start position.

Errors occurring during the cycle return the probe to the start position.

**NOTE:** If the I and J inputs are missing, only two gauging moves occur. The corner feature is assumed to be parallel to the axes.

If either I or J is missing, then three gauging moves occur and the corner feature is assumed to be 90 degrees.

## Format

G65 P9815 Xx Yy [Bb Ii Jj Mm Qq Ss Uu Ww]

where [ ] denote optional inputs

**Example:** G65 P9815 X100. Y100. B2. I10. J10. M.2 Q10. S1. U.5 W2.

---

**NOTE:** If inputs I and J are used, they **must** be stated in this order.

---

## Compulsory inputs

Xx x= Nominal corner position X-axis.

Yy y= Nominal corner position Y-axis.

## Optional inputs

Bb b= Angle tolerance.

This applies to both X and Y surfaces. It is equal to half the total tolerance, e.g.  $\pm 0.25$  degrees = B.25 tolerance.

Ii i= Incremental distance to the second probe position along the X-axis (positive value is assumed).

**Default** = no move.

Jj j= Incremental distance to the second probe position along the Y-axis (positive value is assumed).

**Default** = no move.

Mm m= The true position tolerance of a feature. A cylindrical zone about the theoretical position.

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** = 4 mm (0.16 in) in the Z-axis, and 10 mm (0.394 in) in the X and Y axes.

Ss s= The work offset number which will be set.

The work offset number will be updated.

S1 to S6 (G54 to G59)

S0 (external work offset).

S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option.

New work offset = active work offset + error.

New external offset = external offset + error.

Ww    w=    Print data

1. = Increment the feature number only.

2. = Increment the component number, and reset the feature number.

For optional input Uu, see Chapter 3, "Optional inputs".

## Outputs

The feature measurements will be stored in variables #135 to #149 (see variable chart).

W2.    Component number +1, feature number 1

W1    Feature number +1

The following will be output:

1.    Corner positions
2.    Tolerance if used
3.    Error in the X-axis
4.    Error in the Y-axis
5.    Work offset number if used

Ss    The work offset stated will be set such that the nominal X Y positions will be corrected.

Mm)    See Appendix H, "Output flow", for the general output structure.

Uu )

---

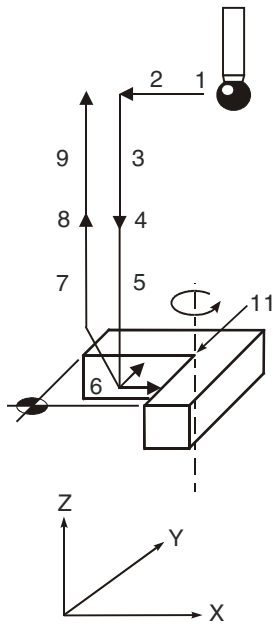
**NOTE:** #139 is the angle of the X surface and is measured from the X+ axis direction.

#142 is the angle of the Y surface and is also measured from the X+ axis direction.

---

### Example: Finding an internal corner

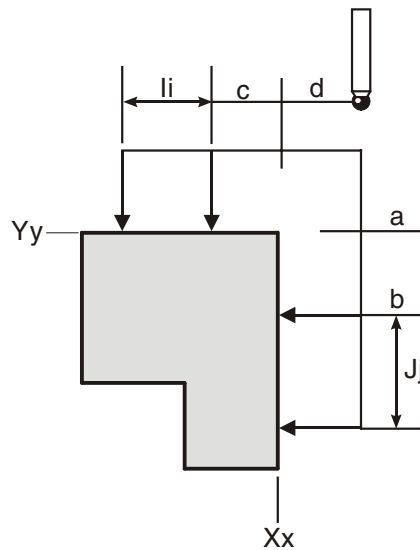
**NOTE:** Co-ordinate rotation. It is possible to implement rotation using G68/G69 when the control option is available.



**Figure 7.10**  
**Probe movements**

- |                             |   |
|-----------------------------|---|
| 1. T01M06                   | Select the probe.   |
| 2. G54X10.0Y10.             | Start position.   |
| 3. G43H1Z100.               | Activate offset 1, go to 100 mm (3.94 in).                        |
| 4. G65P9832                 | Spin the probe on (includes M19), or M19 for spindle orientation. |
| 5. G65P9810Z-5.F3000        | Protected positioning move.                                       |
| 6. G65P9815X20.Y20.I10.J10. | Corner find.  |
| 7. G65P9810Z100.            | Protected positioning move.                                       |
| 8. G65P9833                 | Spin the probe off (where applicable)                             |
| 9. G28Z100.                 | Reference return.   |
| 10. G17                     | Select plane.   |
| 11. G68X#135Y#136R#139      | Set rotational position and angle.                                |
|                             | continue machining  |
| 12. G69                     | Cancel rotation mode.   |

## Finding an external corner (O9816)



**NOTE:**

The start point establishes the distance to the first measuring position

**Moves:**

a and b are equal  
c and d are equal

**Figure 7.11 Finding an external corner**

### Description

This cycle is used to establish the corner position of a feature.

**NOTE:** A true corner intersection can be found, even if the corner is not 90 degrees.

### Application

The probe must be positioned with its tool offset active at a start position as shown in the diagram. The probe measures the Y-axis surface first and then measures the X-axis surface. The probe then returns to the start position.

Errors occurring during the cycle return the probe to the start position.

**NOTE:** If the I and J inputs are missing, only two gauging moves occur. The corner feature is assumed to be parallel to the axes.

If either I or J is missing, then three gauging moves occur and the corner feature is assumed to be 90 degrees.

## Format

G65 P9816 Xx Yy [Bb Ii Jj Mm Qq Ss Uu Ww]

where [ ] denote optional inputs

**Example:** G65 P9816 X100. Y100. B2. I10. J10. M.2 Q10. S1. U.5 W2.

---

**NOTE:** If inputs I and J are used, they **must** be stated in this order.

---

## Compulsory inputs

Xx     x=     Nominal corner position X-axis.

Yy     y=     Nominal corner position Y-axis.

## Optional inputs

Bb     b=     Angle tolerance.

This applies to both X and Y surfaces. It is equal to half the total tolerance, e.g.  $\pm 0.25$  degrees = B.25 tolerance.

Ii     i=     Incremental distance to the second probe position along the X-axis (a positive value is assumed).

**Default** = no move.

Jj     j=     Incremental distance to the second probe position along the Y-axis (a positive value is assumed).

**Default** = no move.

Mm     m=     The true position tolerance of a feature. A cylindrical zone about the theoretical position.

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** = 4 mm (0.16 in) in the Z-axis, and 10 mm (0.394 in) in the X and Y axes.

Ss     s=     The work offset number which will be set.

The work offset number will be updated.

S1 to S6 (G54 to G59)

S0 (external work offset).

S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option.

New work offset = active work offset + error.

New external offset = external offset + error.

Ww w= Print data

1. = Increment the feature number only.
2. = Increment the component number, and reset the feature number.

For optional inputs Uu, see Chapter 3, "Optional inputs".

## Outputs

The feature measurements will be stored in variables #135 to #149 (see Chapter 4, "Variable outputs").

W2. Component number + 1, feature number set to 1.

W1. Feature number +1

The following will be output:

1. Corner positions
2. Tolerance if used
3. Error in the X-axis
4. Error in the Y-axis
5. Work offset number if used

Ss The work offset stated will be set such that the nominal X Y positions will be corrected.

Mm) See Appendix H, "Output flow" for the general output structure.

Uu )

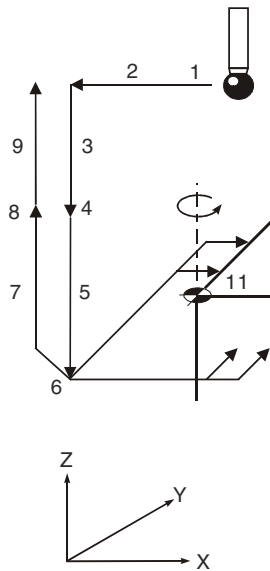
---

**NOTE:** #139 is the angle of the X surface and is measured from the X+ axis direction.  
#142 is the angle of the Y surface and is also measured from the X+ axis direction.

---

### Example: Finding an external corner

**NOTE:** Co-ordinate rotation. It is possible to implement rotation using G68/G69 when the control option is available.



**Figure 7.12**  
**Probe movements**

- |     |                      |   |
|-----|----------------------|---|
| 1.  | T01M06               | Select the probe.   |
| 2.  | G54X-10.Y-10.        | Start position.   |
| 3.  | G43H1Z100.           | Activate offset 1, go to 100 mm (3.94 in).                        |
| 4.  | G65P9832             | Spin the probe on (includes M19), or M19 for spindle orientation. |
| 5.  | G65P9810Z-5.F3000    | Protected positioning move.                                       |
| 6.  | G65P9816X0Y0I10.J10. | Corner find.  |
| 7.  | G65P9810Z100.        | Protected positioning move.                                       |
| 8.  | G65P9833             | Spin the probe off (where applicable).                            |
| 9.  | G28Z100.             | Reference return.   |
| 10. | G17                  | Select plane.   |
| 11. | G68X#135Y#136R#139   | Set corner position and angle.                                    |
|     | continue machining   |   |
| 12. | G69                  | Cancel co-ordinate rotation mode.                                 |

## Chapter 8

# Vector measuring cycles

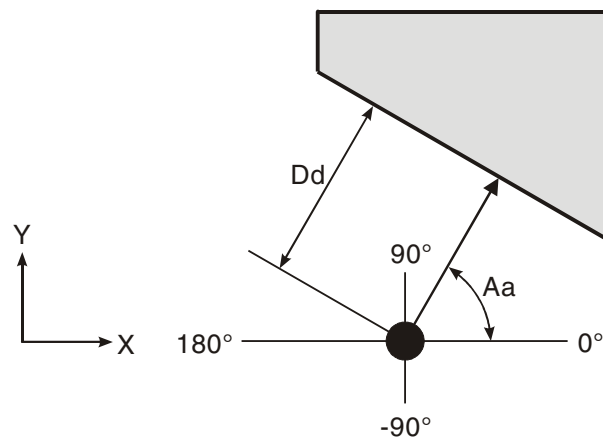
This chapter describes how to use the vector measuring cycles. The probe stylus ball radius must be calibrated using macro O9804 (see Chapter 6, "Calibrating the probe") before using the macros described here. Do **not** use macro O9803 to calibrate the probe stylus.

### Contained in this chapter

Angled single surface measurement (O9821) .....	8-2
Angled web or pocket measurement (O9822) .....	8-5
3-point bore or boss measurement (O9823) .....	8-9

## Angled single surface measurement (O9821)

**NOTE:** The probe must have recently been calibrated using the vector stylus ball radius cycle (O9804) (described in Chapter 6, "Calibrating the probe") before using this cycle. Do **not** use macro O9803 to calibrate the probe.



**NOTE:**

Angles in the range  $\pm 180$  degrees  
+Aa angles (counter-clockwise)

**Figure 8.1** Measuring an angled surface

### Description

This cycle measures a surface feature using one vectored measuring move along the X Y axis.

### Application

Position the probe to the expected reference point of the feature and a suitable position in the Z-axis with the probe and probe offset active. Run the cycle with suitable inputs as described.

### Format

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

**Example:** G65 P9821 A45.005 D50.005 E0.005 F0.8 H0.2 M0.2 Q10. S1.  
T20. U.5 V.5 W2.

---

## Compulsory inputs

Aa a= Direction of probe measurement measured from the X+ axis direction.

Dd d= Nominal distance to the surface (radial).

## Optional inputs

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

Mm m= The true position tolerance of a feature. A cylindrical zone about the theoretical position.

Qq q= The probe overtravel distance for use when the default values are unsuitable. The probe then travels beyond the expected position when it searches for a surface.

**Default** = 4 mm (0.16 in) in the Z-axis, and 10 mm (0.4 in) in the X and Y axes.

Ss s= The work offset number which will be set.  
The work offset number will be updated.  
S1 to S6 (G54 to G59)  
S0 (external work offset).  
S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option.  
New work offset = active work offset + error.  
New external offset = external offset + error.

Tt t= The tool offset number to be updated

Ww w= Print data

1. = Increment the feature number only.

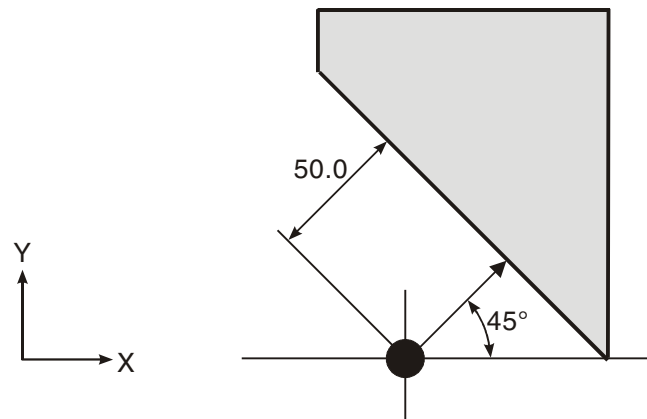
2. = Increment the component number, and reset the feature number.

For optional inputs Ee, Ff, Uu, and Vv, see Chapter 3, "Optional inputs".

## Outputs

See Chapter 4, "Variable outputs".

### Example: Angled single surface measurement



**Figure 8.2 Measuring a single angled surface**

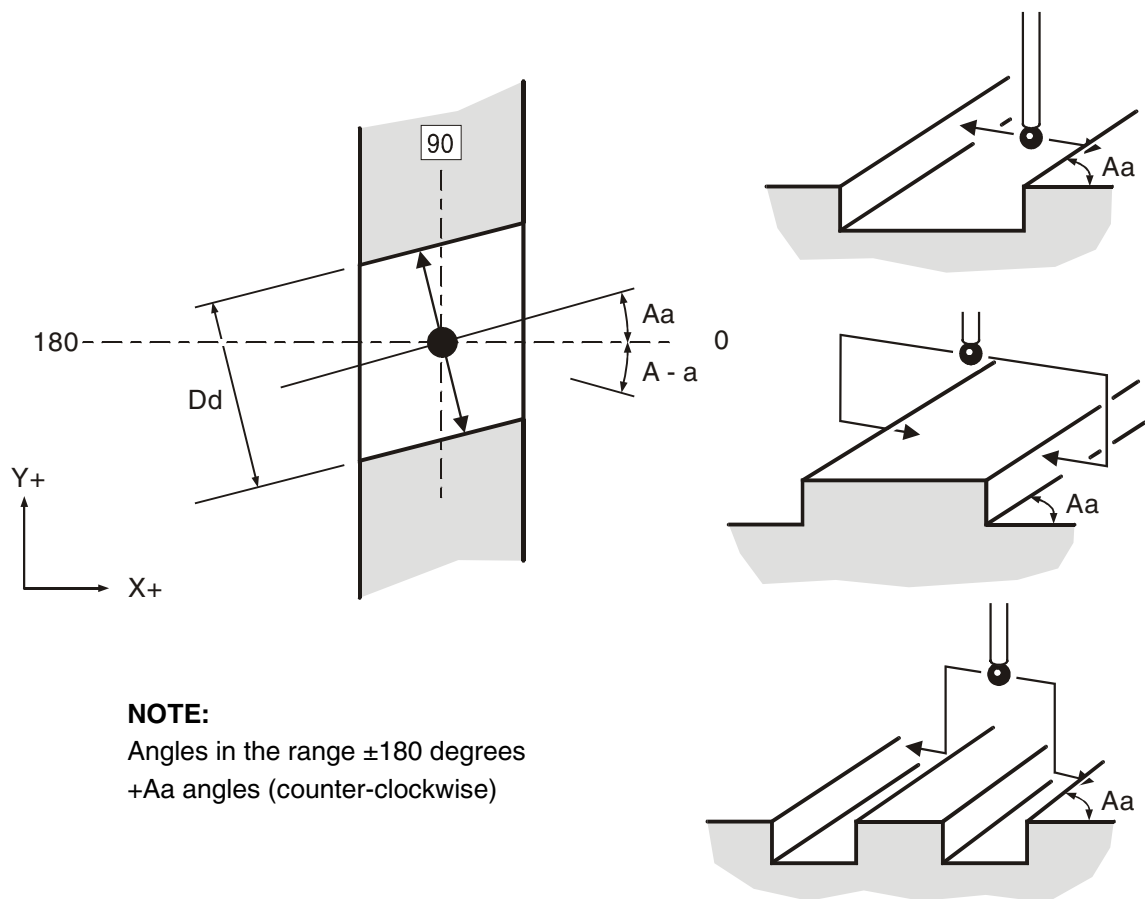
	1. T01M06	Select the probe.
	2. G54X-40.Y20.	Start position.
	3. G43H1Z100.	Activate offset 1, go to 100 mm (3.94 in).
	4. G65P9832	Spin the probe on (includes M19), or M19 for spindle orientation.
	5. G65P9810Z-8.F3000	Protected positioning move to start position.
	6. G65P9821A45.D50.T10	Single surface measure.
	7. G65P9810Z100.	Protected positioning move.
	8. G65P9833	Spin the probe off (when applicable).
	9. G28Z100.	Reference return.

**Figure 8.3  
Probe movements**

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

## Angled web or pocket measurement (O9822)

**NOTE:** The probe must have recently been calibrated using the vector stylus ball radius cycle (O9804) (described in Chapter 6, "Calibrating the probe") before using this cycle. Do **not** use macro O9803 to calibrate the probe.



**NOTE:**  
Angles in the range  $\pm 180$  degrees  
+Aa angles (counter-clockwise)

**Figure 8.4** Measuring an angled web or pocket

### Description

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

### Application

Position the probe to the expected centre line of the feature and a suitable position in the Z-axis with the probe and probe offset active. Run the cycle with suitable inputs as described.

**Format**

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

or

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

where [ ] denotes optional inputs

**Example:** G65 P9822 A45.005 D50.005 Z50. E0.005 F0.8 H0.2 M0.2 Q10. R10. S1.  
T20. U.5 V.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**

Hh	h=	The tolerance value of a feature dimension being measured.
Mm	m=	The true position tolerance of a feature. A cylindrical zone about the theoretical position.
Qq	q=	The probe overtravel distance for use when the default values are unsuitable. The probe then travels beyond the expected position when it searches for a surface. <b>Default</b> = 4 mm (0.16 in) in the Z-axis, and 10 mm (0.394 in) in the X and Y axes.
Rr	r=	This is an incremental dimension that is used in external features, e.g. bosses and webs, to give a radial clearance from the nominal target surface prior to a Z-axis move. <b>Default</b> = 5 mm (0.200 in).
R-r	-r=	This is similar to Rr, except that the clearance is applied in the opposite direction to force an internal web cycle. <b>Default</b> = 5 mm (0.200 in).

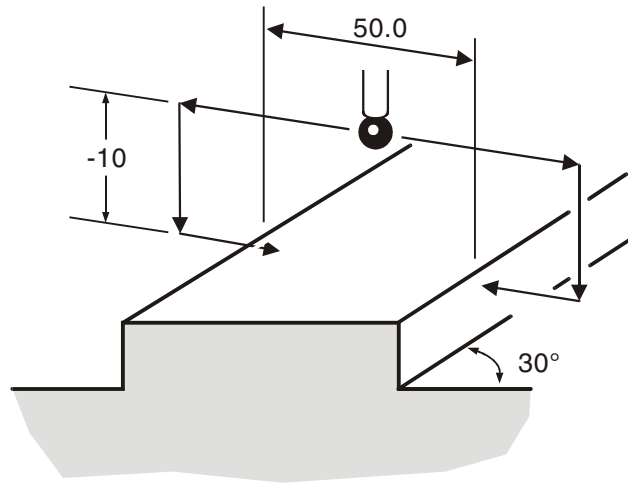
Ss	s=	The work offset number which will be set. The work offset number will be updated. S1 to S6 (G54 to G59) S0 (external work offset). S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option. New work offset = active work offset + error. New external offset = external offset + error.
Tt	t=	The tool offset number to be updated
Ww	w=	Print data  1. = Increment the feature number only.  2. = Increment the component number, and reset the feature number.

For optional inputs Ee, Ff, Uu, and Vv, see Chapter 3, "Optional inputs".

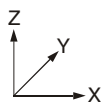
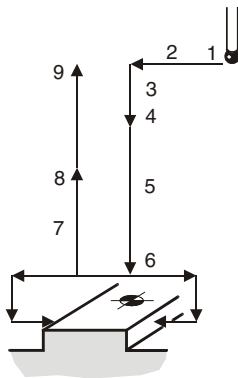
## Outputs

See Chapter 4, "Variable outputs".

**Example: Angled web measurement**



**Figure 8.5 Measuring an angled web**



**Figure 8.6 Probe movements**

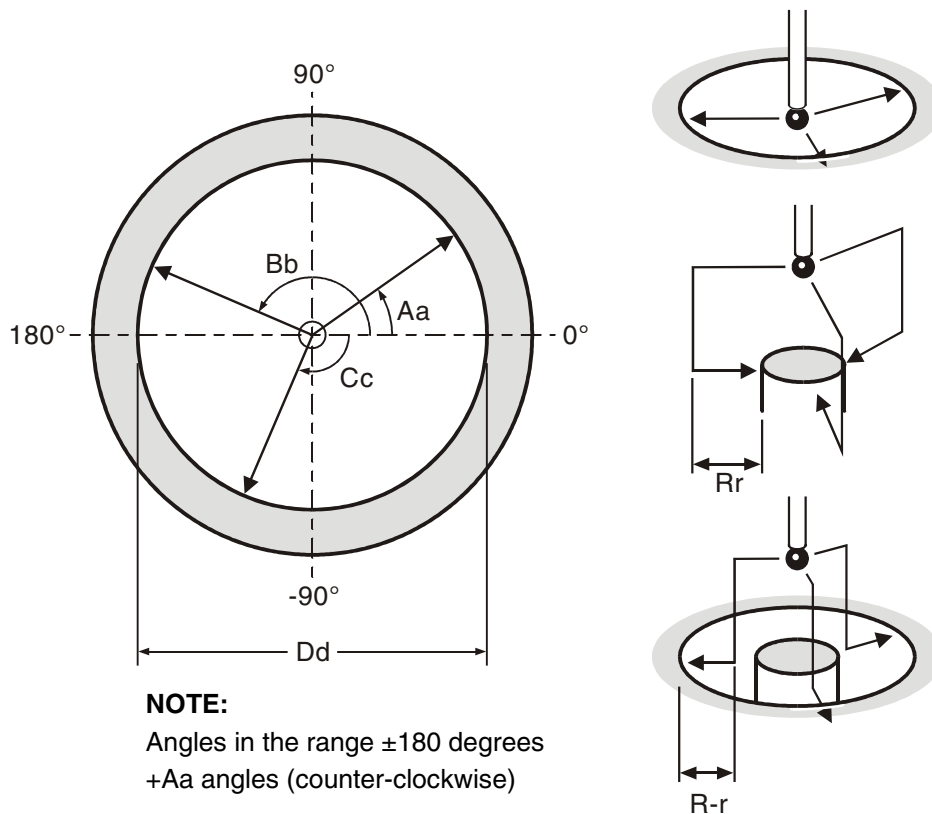
- |    |                         |   |
|----|-------------------------|---|
| 1. | T01M06                  | Select the probe.   |
| 2. | G54X0Y0                 | Start position.   |
| 3. | G43H1Z100.0             | Activate offset 1, go to 100 mm (3.94 in).                        |
| 4. | G65 P9832               | Spin the probe on (includes M19), or M19 for spindle orientation. |
| 5. | G65P9810Z10.F3000       | Protected positioning move.                                       |
| 6. | G65P9822A30.D50.Z-10.S2 | Measure a 50.0 mm (1.9685 in) wide web at 30 degrees.             |
| 7. | G65P9810Z100.           | Protected positioning move.                                       |
| 8. | G65P9833                | Spin the probe off (when applicable).                             |
| 9. | G28Z100.                | Reference return  |

continue

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

## 3-point bore or boss measurement (O9823)

**NOTE:** The probe must have recently been calibrated using the vector stylus ball radius macro (O9804) (described in Chapter 6, "Calibration cycles") before using this cycle. Do not use macro O9803 to calibrate the probe.



**Figure 8.7 3-point bore or boss measurement**

### Description

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

### Application

Position the probe to the expected centre line of the feature and a suitable position in the Z-axis with the probe and probe offset active. Run the cycle with suitable inputs as described.

**Format**

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

or

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

where [ ] denotes optional inputs

**Example:** G65 P9823 A45.005 B150.0 C35.005 D50.005 Z50. E.005 F0.8 H0.2 M0.2  
Q10. R10. S1. T20. U.5 V.5W2.

**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 feature.
Zz	z=	The absolute Z axis position when measuring a boss feature. If this is omitted, a bore cycle is assumed.

**Optional inputs**

Hh	h=	The tolerance value of a feature dimension being measured.
Mm	m=	The true position tolerance of a feature. A cylindrical zone about the theoretical position.
Qq	q=	The probe overtravel distance for use when the default values are unsuitable. The probe then travels beyond the expected position when it searches for a surface. <b>Default</b> = 4 mm (0.16 in) in the Z-axis, and 10 mm (0.394 in) in the X and Y axes.
Rr	r=	This is an incremental dimension that is used in external features, e.g. bosses and webs, to give a radial clearance from the nominal target surface prior to a Z-axis move. <b>Default</b> = 5 mm (0.200 in).

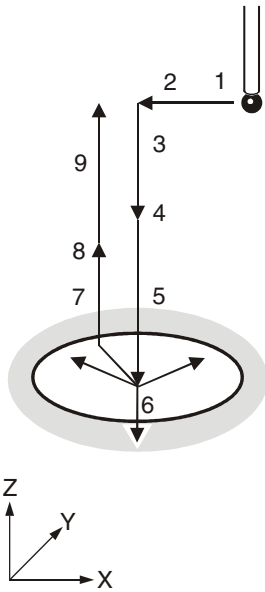
R-r	-r=	This is similar to Rr, except that the clearance is applied in the opposite direction to force an internal boss cycle. <b>Default</b> = 5 mm (0.200 in).
Ss	s=	The work offset number which will be set. The work offset number will be updated. S1 to S6 (G54 to G59) S0 (external work offset). S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option. New work offset = active work offset + error. New external offset = external offset + error.
Tt	t=	The tool offset number to be updated.
Ww	w=	Print data  1. = Increment the feature number only. 2. = Increment the component number, and reset the feature number.

For optional inputs Ee, Ff, Uu, and Vv, see Chapter 3, "Optional inputs".

## Outputs

See Chapter 4, "Variable outputs".

**Example: 3-point bore measurement (referred datum)**



**Figure 8.8**  
**Probe movements**

- |    |                              |   |
|----|------------------------------|---|
| 1. | T01M06                       | Select the probe  |
| 2. | G54X100.Y100.                | Start position  |
| 3. | G43H1Z100.                   | Activate offset 1 go to 100 mm (3.94 in)                          |
| 4. | G65 P9832                    | Spin the probe on (includes M19), or M19 for spindle orientation. |
| 5. | G65P9810Z-10.F3000           | Protected positioning.  |
| 6. | G65P9823D30.A30.B150.C-90.S2 | Measure a 30.0 mm (1.181 in) diameter bore.                       |
| 7. | G65P9810Z100.                | Protected positioning move.                                       |
| 8. | G65P9833                     | Spin the probe off (when applicable).                             |
| 9. | G28Z100.                     | Reference return  |

continue

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

# Chapter 9

## Additional cycles

The Inspection Plus software contains a number of macro cycles that cannot be categorised under the headings used in previous chapters of this manual (Chapters 5 to 8 inclusive). This chapter describes how to use these cycles.

### Contained in this chapter

4th axis X measurement (O9817) .....	9-2
4th axis Y measurement (O9818) .....	9-5
Bore/boss on PCD measurement (O9819) .....	9-8
Stock allowance (O9820) .....	9-11
Storing multi-stylus data (O9830) .....	9-16
Loading multi-stylus data (O9831) .....	9-20
Spinning the probe on (O9832) .....	9-23
Spinning the probe off (O9833) .....	9-24
Determining feature-to-feature data in the XY plane (O9834) .....	9-25
Determining feature-to-feature data in the Z plane (O9834) .....	9-29
Updating the SPC tool offset (O9835) .....	9-33
Optimising a probing cycle (O9836) .....	9-35
Angle measurement in the X or Y plane (O9843) .....	9-38

## 4th axis X measurement (O9817)

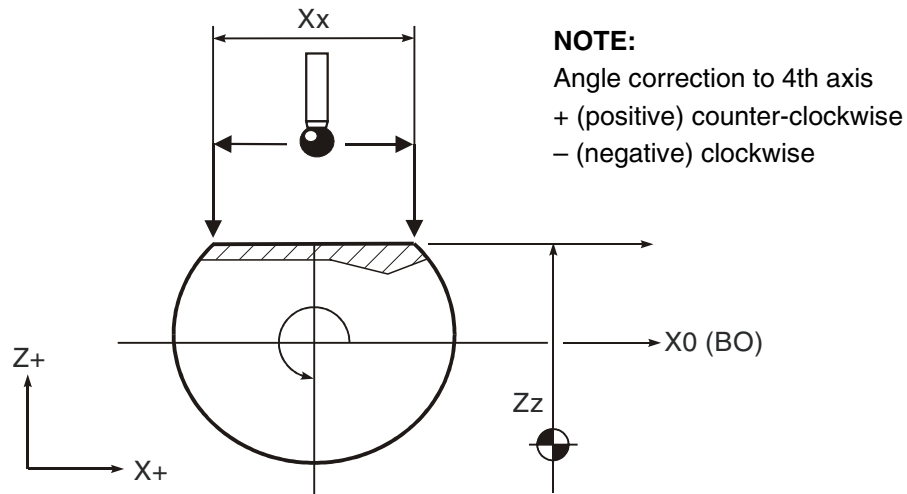


Figure 9.1 4th axis X measurement

### Description

The purpose of this macro is to find the slope of a surface between two points Z1 and Z2 to allow the 4th axis to be rotated to compensate for the surface error.

### Application

The 4th axis must be positioned to the expected angular position of the feature (i.e. surface normal to the Z axis). If the Ss input is used, the work offset register is adjusted by the error amount.

**NOTE:** It is normally necessary on most machines to re-state the work offset and move to the angular position after the cycle to make the new work offset active.

### Format

G65 P9817 Xx Zz [Qq Bb Ss Ww]  
 where [ ] denotes optional inputs.

**Example:** G65 P9817 X100. Z50. Q10. B2. S1. W2.

---

## Compulsory inputs

- Xx    x=    The X-axis distance between Z1 and Z2 measurement positions.
- Zz    z=    The Z-axis expected surface position.

## Optional inputs

- Bb    b=    Set a tolerance on the angular position of the feature. It is equal to half the total tolerances, e.g. component dimension 45 degrees ( $\pm 0.25$  degrees) the 4th axis would be positioned to 45 degrees and B.25 tolerance.
- Qq    q=    The probe overtravel distance for use when the default values are unsuitable. The probe then travels beyond the expected position when it searches for a surface.  
**Default = 10 mm (0.4 in).**
- Ss    s=    The work offset number which will be set.  
The work offset number will be updated.  
S1 to S6 (G54 to G59)  
S0 (external work offset).  
S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option.  
New work offset = active work offset + error.  
New external offset = external offset + error.
- Ww    w=    Print data  
  
1. = Increment the feature number only.  
2. = Increment the component number, and reset the feature number.

## Outputs

- #143    will show (Z1 - Z2) value
- #144    will show angle correction value
- #139    will show 4th axis measured position.

---

**NOTE:** Different machines and application may require the 4th axis system variable number to be changed. It will be achieved by editing macro O9817 when the macro is installed to suit your machine.

---

Edit as follows:

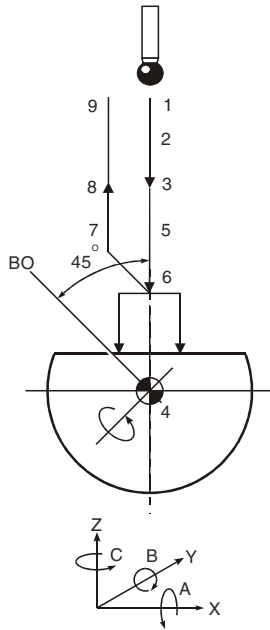
#3 = 4 (4th axis number) change axis number as required (see the Fanuc macro section for axis numbers)

Axis direction change

Edit as follows:

#4 = 1(1 = clockwise, and -1 = counter-clockwise) change as required.

**Example: Set the 4th axis to a milled flat**



- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. T01M06</li> <li>2. G43H1Z200.</li> <li>3. G65P9832</li> <li>4. G0B45.</li> <li>5. G65P9810X0Y0Z20.F3000</li> <li>6. G65P9817X50.Z10.B5.</li> <li>7. G65P9810Z200.</li> <li>8. G65P99833</li> <li>9. G28Z200.</li> </ol> | <p>Select the probe.</p> <p>Activate offset 1, go to 100 mm (3.94 in).</p> <p>Spin the probe on (includes M19), or M19 for spindle orientation.</p> <p>Position 4th axis to 45 degrees.</p> <p>Position 10 mm (0.394 in) above the surface.</p> <p>Measure at 50 mm (1.9685 in) centres, update G54 and set a tolerance of 5 degrees.</p> <p>Protected positioning move.</p> <p>Spin the probe off (when applicable).</p> <p>Reference return.</p> |
|---|--|

**Figure 9.2**  
**Probe movements**

continue

## 4th axis Y measurement (O9818)

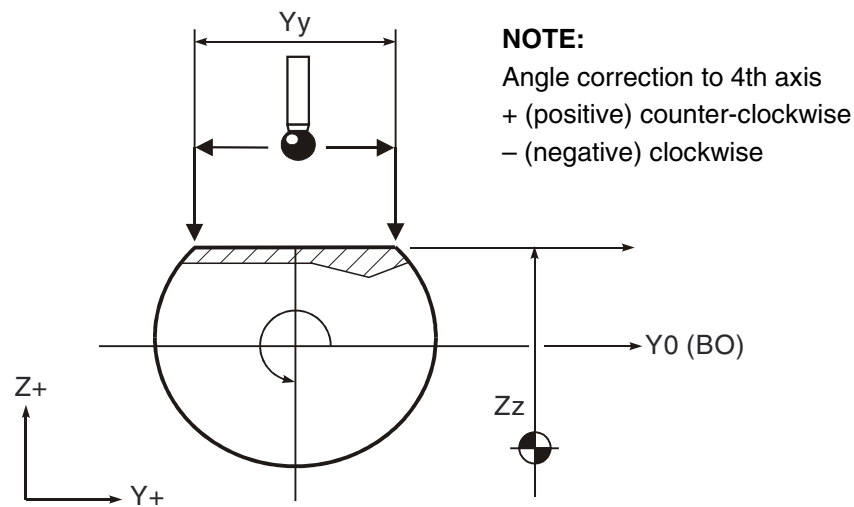


Figure 9.3 4th axis Y measurement

### Description

The purpose of this macro is to find the slope of a surface between two points Z1 and Z2 to allow the 4th axis to be rotated to compensate for the surface error.

### Application

The 4th axis must be positioned to the expected angular position of the feature (i.e. surface normal to the Z axis). If the Ss input is used, the work offset register is adjusted by the error amount.

**NOTE:** It is normally necessary on most machines to re-state the work offset and move to the angular position after the cycle to make the new work offset active.

### Format

G65 P9818 Yy Zz [Qq Bb Ss Ww]  
 where [ ] denotes optional inputs

**Example:** G65 P9818 Y100. Z50. Q10. B2. S1. W2.

**Compulsory inputs**

- Yy    y=    The Y axis distance between Z1 and Z2 measurement positions.
- Zz    z=    The Z axis expected surface position.

**Optional inputs**

- Bb    b=    Set a tolerance on the angular position of the feature. It is equal to half the total tolerances, e.g. component dimension 45 degrees  $\pm$ .25 degrees the 4th axis would be positioned to 45 degrees and B.25 tolerance.
- Qq    q=    The probe overtravel distance for use when the default values are unsuitable. The probe then travels beyond the expected position when it searches for a surface.  
**Default** = 10 mm (0.4 in).
- Ss    s=    The work offset number which will be set.  
The work offset number will be updated.  
S1 to S6 (G54 to G59)  
S0 (external work offset).  
S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option.  
New work offset = active work offset + error.  
New external offset = external offset + error.
- Ww    w=    Print data  
  
1. = Increment the feature number only.  
2. = Increment the component number, and reset the feature number.

**Outputs**

- #143    will show (Z1 - Z2) value
- #144    will show angle correction value
- #139    will show 4th axis measured position

---

**NOTE:** Different machines and application may require the 4th axis system variable number to be changed. It is achieved by editing macro O9818 when the macro is installed to suit your machine.

---

Edit as follows:

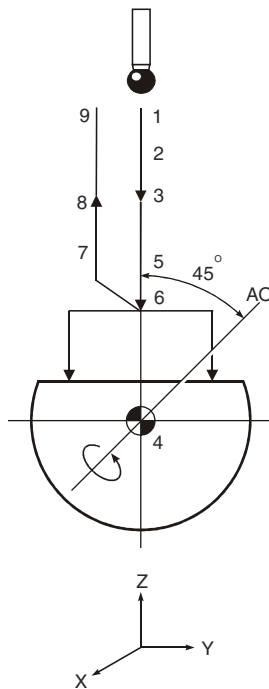
#3 = 4 (4th axis number) change axis number as required (see Fanuc macro section for axis numbers)

Axis direction change

Edit as follows:

#4 = 1 (1 = clockwise, and -1 = counter-clockwise) change as required.

### Example: Set the 4th axis to a milled flat



- |                           |  |
|---------------------------|--|
| 1. T01M06                 | Select the probe.  |
| 2. G43H1Z200.             | Activate offset 1, go to 100 mm (3.94 in).   |
| 3. G65P9832               | Spin the probe on (includes M19), or M19 for spindle orientation.                  |
| 4. G0A45.                 | Position 4th axis to 45 degrees.   |
| 5. G65P9810X0Y0Z20.F3000  | Position 10 mm (0.394 in) above the surface.                                       |
| 6. G65P9818Y50.Z10.S1.B5. | Measure at 50 mm (1.9685 in) centres, update G54 and set a tolerance of 5 degrees. |
| 7. G65P9810Z200.          | Protected positioning move.  |
| 8. G65P9833               | Spin the probe off (when applicable).  |
| 9. G28Z200.               | Reference return.  |
- continue

**Figure 9.4**  
**Probe movements**

## Bore/boss on PCD measurement (O9819)

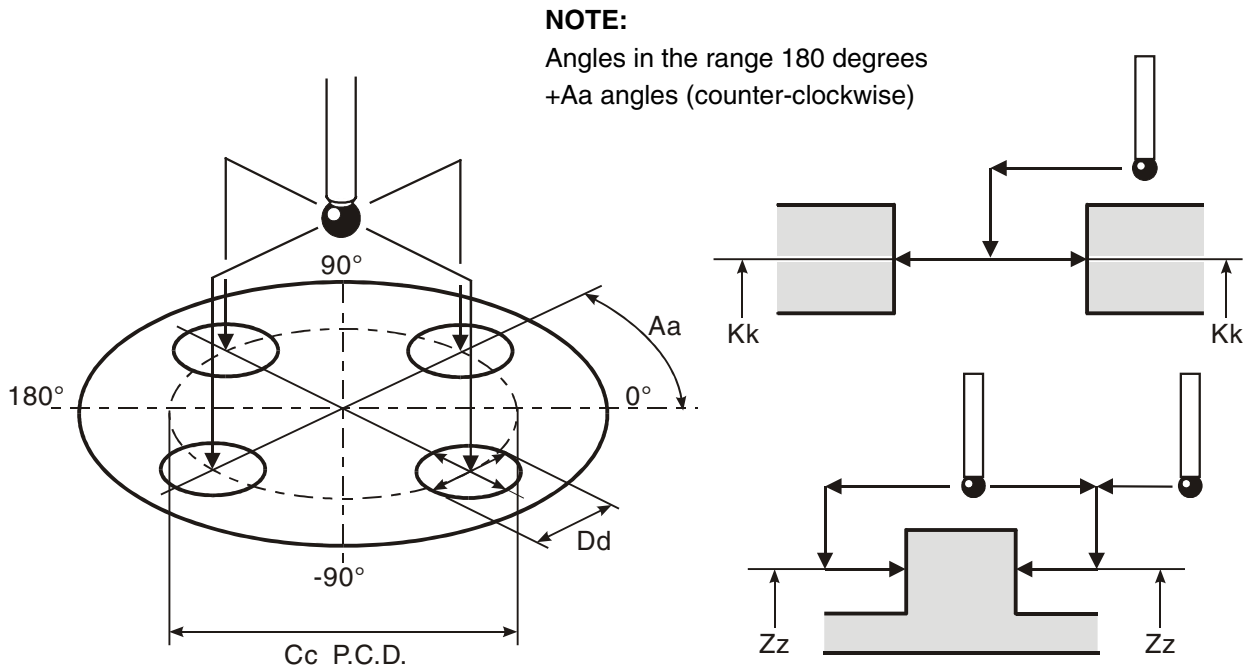


Figure 9.5 Bore/boss on PCD measurement

### Description

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

### Application

1. The probe is positioned at the centre of the PCD above the component. The probe moves to all bore/boss features and measures each feature automatically. The probe then returns to the PCD centre at the end of the cycle.
2. The macro makes use of the bore/boss macro which is nested within the moves. This means that 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 and the probe stays in position instead of returning to the start position as is usual. This is done for safety reasons because the return path to 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 [ ] denotes optional inputs.

**Example:** G65 P9819 C28.003 D50.005 K11. A45.005 B2. E0.005 H0.2 M0.2  
Q10. R10. U.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 where the bore is to be measured.
Zz	z=	Absolute Z axis position where the boss is to be measured.

## Optional inputs

Aa	a=	Angle measured from the X axis to the first bore/boss feature. <b>Default = 0.</b>
Bb	b=	The number of bore/boss features on the PCD. <b>Default = 1.</b>
Hh	h=	The tolerance value of the bore/ boss dimension being measured.
Mm	m=	The true position tolerance of the bore or boss. A cylindrical zone about the theoretical position.
Qq	q=	The probe overtravel distance for use when the default values are unsuitable. The probe then travels beyond the expected position when it searches for a surface. <b>Default = 4 mm (0.16 in) in the Z-axis, and 10 mm (0.394 in) in the X,Y axis.</b>
Rr	r=	This is an incremental dimension that is used in an external bore or boss to give a radial clearance from the nominal target surface prior to a Z-axis move. <b>Default = 5 mm (0.200 in).</b>

R-r    -r=    This is an incremental dimension that is used in an internal boss or web to give a radial clearance from the nominal target surface prior to a Z-axis move.

**Default** = 5 mm (0.200 in).

Ww    w=    Print data

1. = Increment the feature number only.

2. = Increment the component number, and reset the feature number.

For optional inputs Ee and Uu, see Chapter 3, "Optional inputs".

## Outputs

The feature measurements will be stored in variables #135 to #149 (see Chapter 4, "Variable outputs").

W2.0    Component number (incremented by 1). Feature number (set to 1).

W1.    Feature number (incremented by 1).

The following data is output to the on-line device (printer):

- Diameter of each bore/boss
- XY absolute position, angle position and pitch circle diameter of each feature.
- Feature number.
- Error of size and position.

Refer to the print macro details for the output format.

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 #119 = 2 is set. Otherwise the flag #119 = 2 is set only. The program continues.

## Stock allowance (O9820)

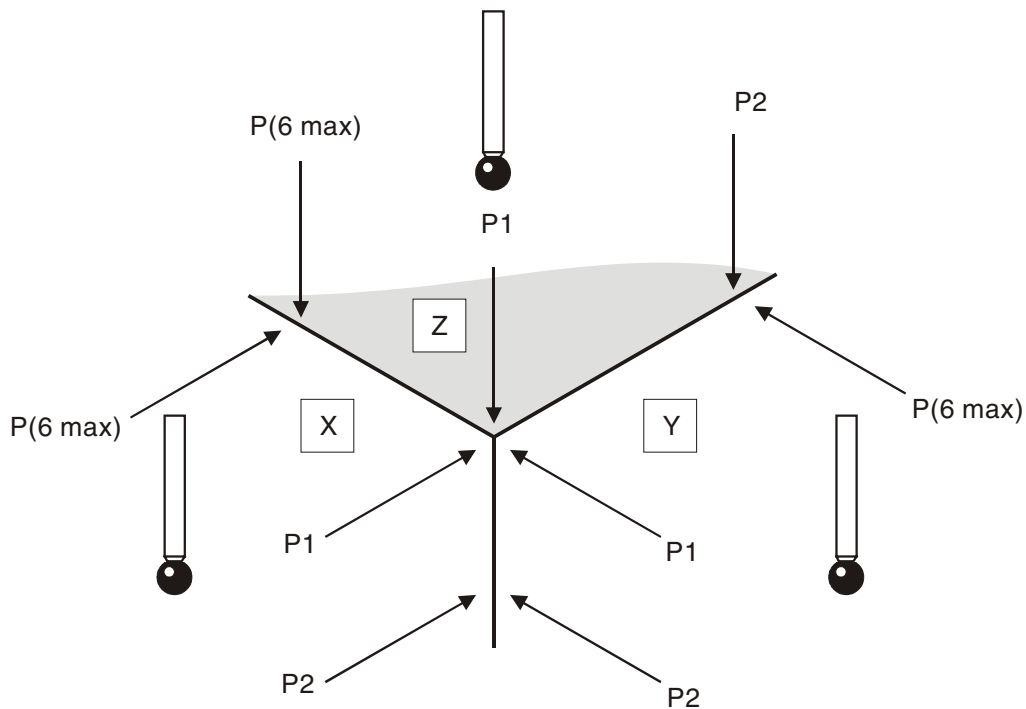


Figure 9.6 Measuring the stock allowance

### Description

The cycle measures either an X or Y or Z surface at defined positions to establish the maximum and minimum stock condition of the surface.

### Application

The probe should be positioned above the surface at the first measuring position. The cycle measures the surface at this position (P1). Additional points P2 to P6 maximum are measured as defined, depending on the number of sets of I, J, or K inputs.

### NOTES:

1. If setting a work offset, the surface position will be at the minimum measured position and the stock value is seen in #146.
2. If **NOT** setting a work offset, the nominal position is assumed and the maximum and minimum values are seen in #144 and #145.

**Format****X-surface measure**

G65 P9820 Xx Jj Kk [Ss Uu]

or

---

**NOTE:** Successive pairs of Jj, Kk values must be in order for P2 to P6.
 

---

**Y-surface measure**

G65 P9820 Yy li Kk [Ss Uu]

or

---

**NOTE:** Successive pairs of li, Kk values must be in order for P2 to P6.
 

---

**Z-surface measure**

G65 P9820 Zz li Jj [Ss Uu]

where [ ] denotes optional inputs

---

**NOTE:** Successive pairs of li, Jj values must be in order for P2 to P6.
 

---

**Example:** G65 P9820 X100. J10. K11. S1. U.5  
 (this shows one additional [JK] pair of values, i.e. P2)

**Compulsory inputs**

Xx

or

Yy      x, y, z =      The nominal surface position for stock allowance check

or

Zz

I1 (P2) to      i=      X surface positions for P2 to P6 (maximum five additional  
I5 (P6)

or

J1 (P2) to      j=      Y surface positions for P2 to P6 (maximum five additional  
J5 (P6)

or

K1 (P2) to      k=      Z surface positions for P2 to P6 (maximum five additional  
K5 (P6)

## Optional inputs

- Uu    u=    The maximum stock allowance or upper tolerance (metal condition).
- Uu input only  
The upper tolerance metal condition, e.g., surface at 30.00 +2.0/-0.0  
G65P9820Z30.0U2.0liJ
  - Uu and Ss input.  
The maximum stock allowance.
- Ss    s=    The work offset number which will be set. This will be set to the minimum metal position #145.  
The work offset number will be updated.  
S1 to S6 (G54 to G59)  
S0 (external work offset).  
S101 to S148 (G54.1 P1 to G54.1P48) additional offsets option.  
New work offset = active work offset + error.  
New external offset = external offset + error.

## Outputs

- Uu input only    Upper tolerance exceeded flag #148 will be set to 3
  - Uu and Ss input    Excess stock flag #148 will be set to 6
- #144                    Maximum value (metal condition)
- #145                    Minimum value (metal condition)
- #146                    Variation (stock allowance)

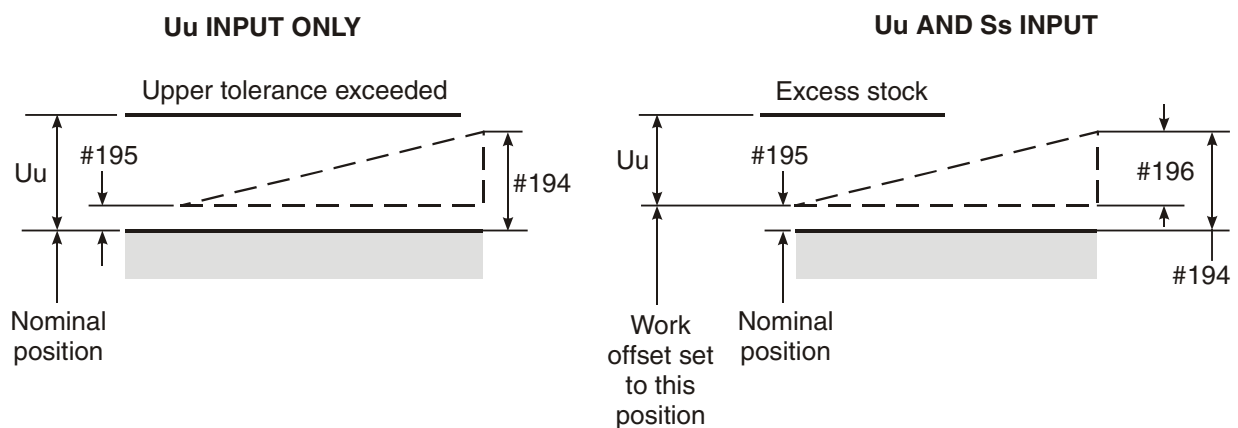
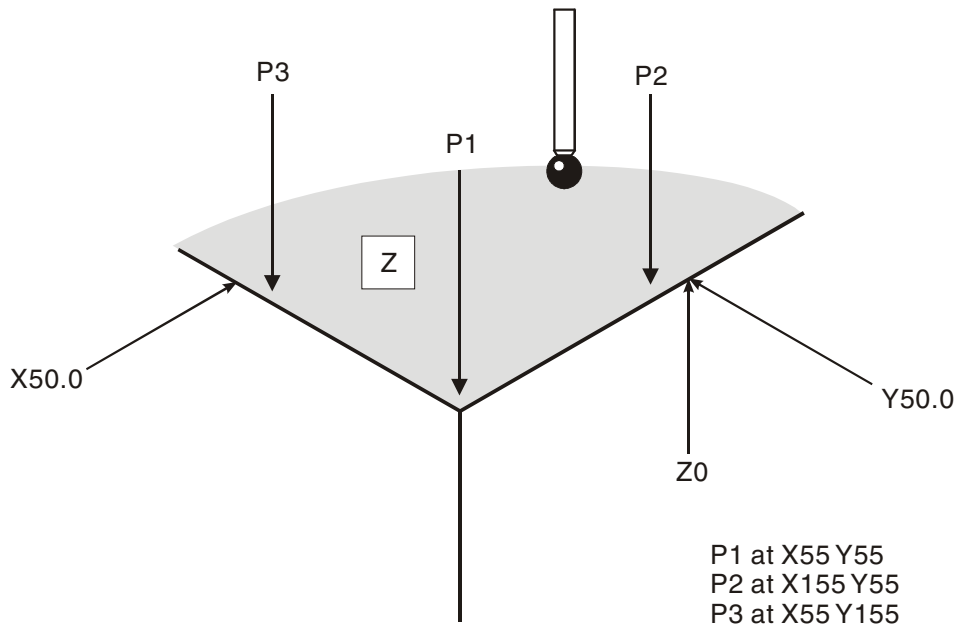


Figure 9.7 Outputs for the stock allowance cycle

### Example 1 Checking a Z surface for stock variation



**Figure 9.8 Checking a Z surface for stock variation**

Select the probe.

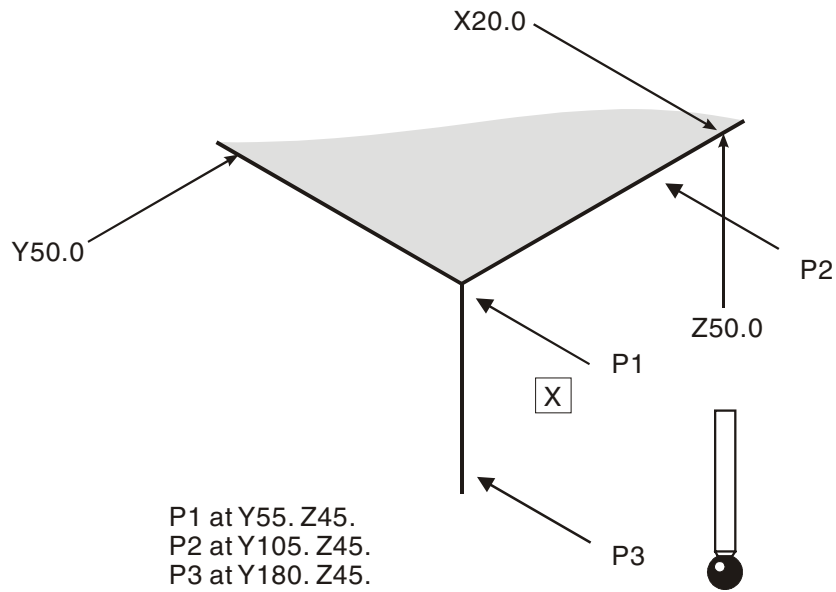
G65P9810X55.Y55.Z20.F3000

Protected move to P1.

G65P9820Z0I155.J55.I55.J155.U2.

Measure at P1, P2, P3 and set a 2 mm  
(0.039 in) tolerance.

continue machining

**Example 2 Checking an X surface and updating a work offset****Figure 9.9 Checking an X surface and updating a work offset**

Select the probe.

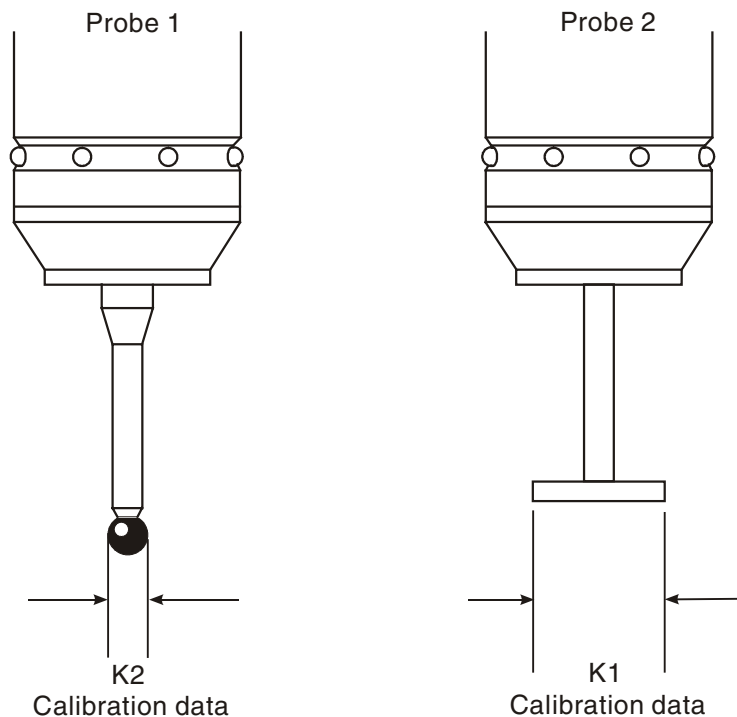
G65P9810X40.Y55.Z45.F3000

Protected move to P1.

G65P9820 X20.J105.K45.J180.K45.S2

Measure at P1, P2, P3 and set the X-axis work offset G55 to the minimum stock position at program position X20. Retract, select tool and offset G55 for machining X surface at the new X20. surface position.

## Storing multi-stylus data (O9830)



**Figure 9.10 Storing multi-stylus data**

### Description

The macro is used to store probe stylus calibration data that has been established during the calibration cycles. It is stored in a spare set of macro variables. This macro must be used in conjunction with macro O9831 to recall relevant calibration data for each probe.

### Application

Calibrate the stylus using macro O9802 and O9803. Run macro O9830 to store the calibration data #500 to #503. The values are recalled when macro O9831 is run.

It is also possible to store calibration data for vector cycles, by the use of the optional input.

**Format**

G65 P9830 Kk

**Example:** G65P9830K11.**Compulsory input**

Kk k= The multi-stylus probe number for data storage.

	<b>Active calibration data</b>				<b>Store location</b>			
	XRAD	YRAD	XOFF	YOFF	XRAD	YRAD	XOFF	YOFF
K1	#500	#501	#502	#503	#518	#519	#520	#521
K2	#500	#501	#502	#503	#522	#523	#524	#525
K3	#500	#501	#502	#503	#526	#527	#528	#529
K4	#500	#501	#502	#503	#530	#531	#532	#533

### For vector calibration data storage

#500 to #503 are stored as shown above, plus all the vector radii as shown below.

	Buffer calibration data				Store location			
	RAD	RAD	RAD	RAD				
K11	#510	#511	#512	#513	#534	#535	#536	#537
	#514	#515	#516	#517	#538	#539	#540	#541
K12	#510	#511	#512	#513	#542	#543	#544	#545
	#514	#515	#516	#517	#546	#547	#548	#549

When the additional macro option is installed, K13 and K14 can be used.

K13	#510	#511	#512	#513	#550	#551	#552	#553
	#514	#515	#516	#517	#554	#555	#556	#557
K14	#510	#511	#512	#513	#558	#559	#560	#561
	#514	#515	#516	#517	#562	#563	#564	#565

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

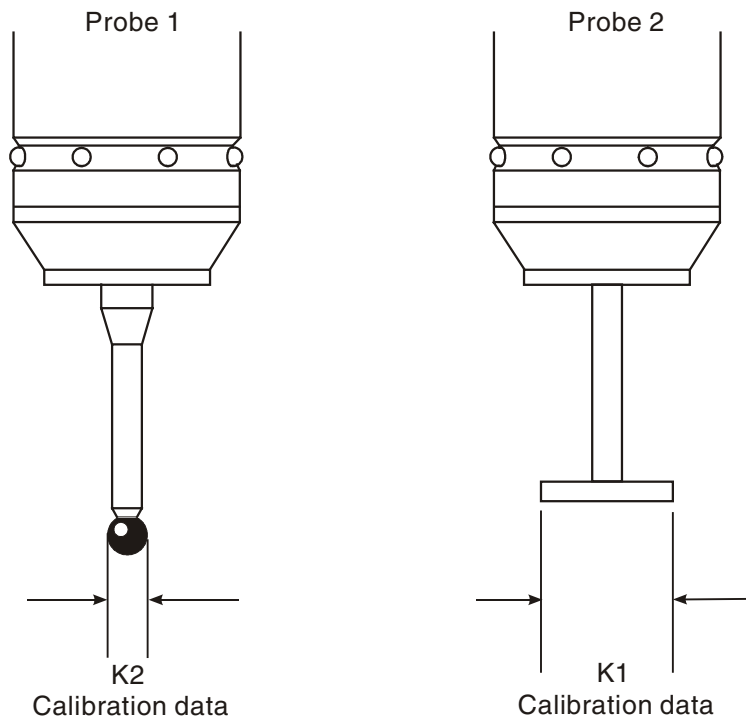
### Example: Multi-stylus store K1

O0003

G90G80G40G0	Preparatory codes for the machine.
G54X0Y0	Start position (X, Y, Z values must be set in the work offset)
G43H1Z100.	Activate offset 1, go to 100 mm (3.94 in).
G65P9832	Spin the probe on (includes M19), or M19 for spindle orientation.
G65P9810Z-5.F3000	Protected positioning move for Z.
G65P9803D50.001	Calibrate in a reference feature (ring gauge).
G65P9830K1	Store calibration values for multi-stylus K1.
G65P9810Z100.	Protected positioning move.
G65P9833	Spin the probe off (when applicable)
G28Z100.	Reference return.

H00	Cancel offset.
M30	End of program

## Loading multi-stylus data (O9831)



**Figure 9.11 Recalling multi-stylus data**

### Description

This macro is used in conjunction with O9830. It is used to recall stored calibration data to the active calibration variable range prior to using a particular probe stylus configuration.

### Application

The program must be run immediately before any measuring cycle to select the correct probe calibration data. The Kk input determines the data to be recalled.

### Format

G65 P9831 Kk

**Example:** G65P9831K11.

## Compulsory input

Kk k= The multi-stylus probe number for data recall. The Kk input number should always be the same as that used to store the data using O9830 for a given stylus.

	Active calibration data				Store location			
	XRAD	YRAD	XOFF	YOFF	XRAD	YRAD	XOFF	YOFF
K1	#500	#501	#502	#503	#518	#519	#520	#521
K2	#500	#501	#502	#503	#522	#523	#524	#525
K3	#500	#501	#502	#503	#526	#527	#528	#529
K4	#500	#501	#502	#503	#530	#531	#532	#533

## For vector calibration data storage

#500 to #503 are stored as shown above, plus all the vector radii as shown below.

	Buffer calibration data				Store location			
	RAD	RAD	RAD	RAD				
K11	#510	#511	#512	#513	#534	#535	#536	#537
	#514	#515	#516	#517	#538	#539	#540	#541
K12	#510	#511	#512	#513	#542	#543	#544	#545
	#514	#515	#516	#517	#546	#547	#548	#549

When the additional macro option is installed, K13 and K14 can be used.

K13	#510	#511	#512	#513	#550	#551	#552	#553
	#514	#515	#516	#517	#554	#555	#556	#557
K14	#510	#511	#512	#513	#558	#559	#560	#561
	#514	#515	#516	#517	#562	#563	#564	#565

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

**Example: Multi-stylus load K1 and K2**

T01M06	Select the probe.
G54X100.Y100.	Start position.
G43H1Z100.	Activate offset 1, go to 100 mm (3.94 in).
G65P9832	Spin the probe on (includes M19), or M19 for spindle orientation.
G65P9810Z-10.F3000	Protected positioning move.
G65P9831K1	Load calibration values for multi-stylus K1.
G65P9814D30.S2	Measure a 30.0 mm (1.181 in) diameter bore.
G65P9810Z10.	Protected positioning move.
G65P9810X350.	Protected positioning move.
G43H2Z-10.	Activate offset 2.
G65P9831K2	Load calibration values for multi-stylus K2.
G65P9814D130.S2	Measure a 130.0mm (5.12in) diameter bore.
G65P9810Z100.	Protected positioning move.
G65P9833	Spin the probe off (when applicable).
G28Z100.	Reference return.
continue	

---

## Spinning the probe on (O9832)

### Description

This macro is used to spin the probe on prior to it being used. The probe is loaded into the spindle and moved to a safe start plane, where the above format is used to activate the probe.

In the event of a startup failure, there is a loop in the software which tries to activate the probe up to four times. An alarm results if the probe does not activate.

It should be noted that a small automatic Z axis movement takes place within the macro to test if the probe is active.

---

**NOTE:** The probe tool offset must be active.

---

### Format

M98P9832

### Example

G43H20Z100.	Apply a tool offset and move to a safe plane.
G65P9832	Spin the probe on (includes M19), or M19 for spindle orientation.
G65P9810X- ---Y- - -F- - -	Move to a gauging position.

## Spinning the probe off (O9833)

### Description

This macro is used to spin the probe off prior to it being used. The probe is retracted to a safe start plane, where the above format is used to switch the probe off prior to a tool change.

There is a loop in the software, which will tries to de-activate the probe up to four times. An alarm results if the probe does not switch off.

It should be noted that a small automatic Z-axis movement takes place within the macro to test if the probe is active. This means that the G28 reference return must be done following this macro, otherwise the G28 position is not effective.

---

**NOTE:** The probe tool offset must be active.

---

### Format

M98P9833

### Example:

G65P9810Z100.	Retract to a safe plane with the tool offset still active.
G65P9833	Spin the probe off.
G91	
G28Z0	Retract
continue	

## Determining feature-to-feature data in the XY plane (O9834)

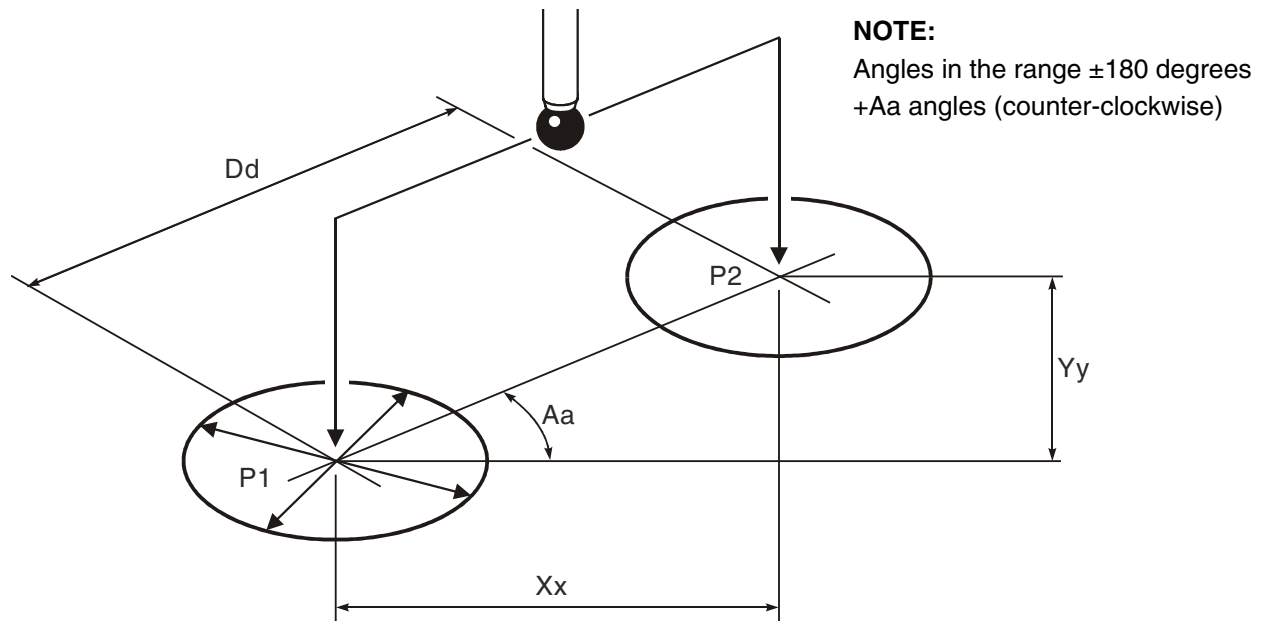


Figure 9.12 Determining feature-to-feature data in the XY plane

### 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 and #135 to #147 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 Uu Vv Ww]

or

G65 P9834 Yy [Ee Ff Hh Mm Ss Tt 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 [ ] denotes optional inputs

**Examples:** G65P9834X100.E0.005F0.8H0.2M0.2S1.T20.U.5V.5W2.

or

G65P9834Y100.E0.005F0.8H0.2M0.2S1.T20. U.5V.5W2.

or

G65P9834X100.Y100.B2.E0.005H0.2M0.2S1. U.5W2.

or

G65P9834A45.005D50.005B2.E0.005H0.2 M0.2S1.U.5W2.

**NOTES:** 1. Updating a tool offset with T input is only possible if either O9811 or O9821 is used for P2 data. Otherwise an alarm (T INPUT NOT ALLOWED) 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  $\pm 180$  degrees.

4. When G65P9834 (without any inputs) is used, then the following data is stored:

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

### Compulsory inputs

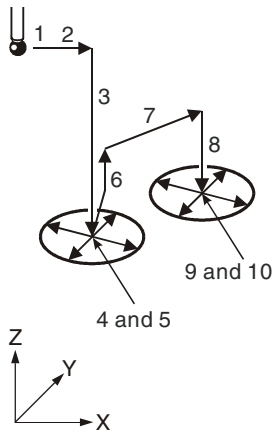
Xx	x=	The nominal incremental distance in the X axis.
Yy	y=	The nominal incremental distance in the Y axis.
Aa	a=	The angle of P2 with respect to P1 measured from the X+ axis (angles between $\pm 180$ degrees).
Dd	d=	The minimum distance between P1 and P2.
(No inputs)		This is used to store output data of the last cycle for P1 data.

### Optional inputs

Bb	b=	The angle tolerance of the surface, e.g. 30 degrees $\pm 1$ degree.
Hh	h=	The tolerance value of the feature dimension being measured.
Mm	m=	The true position tolerance of a feature. A cylindrical zone about the theoretical position.
Ss	s=	The work offset number which will be set. The work offset number will be updated. S1 to S6 (G54 to G59) S0 (external work offset). S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option. New work offset = active work offset + error. New external offset = external offset + error.
Tt	t=	The tool offset number to be updated.
Ww	w=	Print data  1. = Increment the feature number only.  2. = Increment the component number, and reset the feature number.

For optional inputs Ee, Ff, Uu and Vv, see Chapter 3, "Optional inputs".

**Example 1 Measuring the incremental distance between two holes**



**Figure 9.13**  
**Probe movements**

1. G65P9810X30.Y50.F3000 Protected positioning move.
2. G65P9810Z-10. Protected positioning move.
3. G65P9814D20. P1 20 mm (0.787 in) bore.
4. G65P9834 Store data.
5. G65P9810Z10. Protected positioning move.
6. G65P9810X80.Y78.867 Move to new position.
7. G65P9810Z-10. Protected positioning move.
8. G65P9814D30. P2 30 mm (1.181 in) bore.

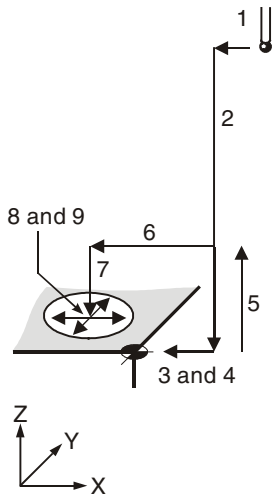
**And either this**

9. G65P9834X50.Y28.867M.1 Incremental distance measure with 0.1 mm (0.0039 in) true position tolerance.

**or this**

9. G65P9834A30.D57.735M.1

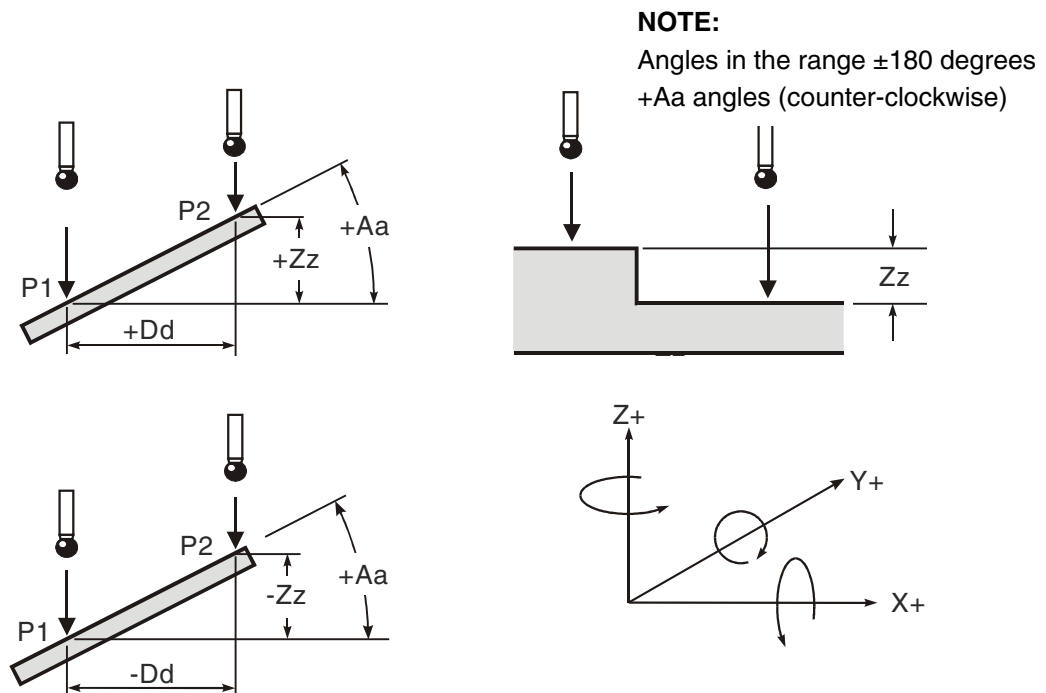
**Example 2: Surface to bore measurement**



**Figure 9.14**  
**Probe movements**

1. G65P9810X10.Y50.F3000 Protected positioning move.
2. G65P9810Z-10. Protected positioning move.
3. G65P9811X0. P1 at X0 mm (0 in) position.
4. G65P9834 Store data.
5. G65P9810Z10. Protected positioning move.
6. G65P9810X-50. Move to new position.
7. G65P9810Z-10. Protected positioning move.
8. G65P9814D20.5 P2 20.5 mm (0.807 in) bore.
9. G65P9834X-50.H.2 Measure distance -50 mm (-1.97 in)

## Determining feature-to-feature data in the Z plane (O9834)



**Figure 9.15** 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 and #135 to #147 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, and 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 Uu Vv Ww]

or

G65 P9834 Aa Zz [Bb Ww]

or

G65 P9834 Dd Zz [Bb Ww]

or

G65 P9834 (with no inputs)

where [ ] denotes optional inputs

**Examples:** G65P9834Z50.E0.005F0.8H0.2M0.2S1.T20. U.5V.5W2.

or

G65P9834A45.005Z50.B2.W2.

or

G65P9834D50.005Z50.B2.W2.

or

G65P9834 (with no inputs)

- 
- NOTES:**
- Updating a tool offset with T input is only possible if O9811 is used for P2 data. Otherwise an alarm (T INPUT NOT ALLOWED) results.
  - Angles. These are with respect to the XY. Use angles in the range  $\pm 180$  degrees.
  - When G65P9834 (without any inputs) is used, then the following data is stored:
 

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

## Inputs

### Aa Zz or Dd Zz inputs

- +Dd/-Dd values should be used to indicate the direction of P2 with respect to P1.
- +Aa angles (counter-clockwise).
- Angles between  $\pm 180$  degrees.

### Zz only input

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

### Compulsory inputs

Aa a= The angle of P2 with respect to P1 measured from the XY plane (angles between  $\pm 180$  degrees).

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

Bb b= The angle tolerance of the surface, e.g. 30 degrees  $\pm 1$  degree.

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

Mm m= The true position tolerance of a feature. A cylindrical zone about the theoretical position.

Ss s= The work offset number which will be set.  
The work offset number will be updated.  
S1 to S6 (G54 to G59)  
S0 (external work offset).  
S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option.  
New work offset = active work offset + error.  
New external offset = external offset + error.

Tt t= The tool offset number to be updated.

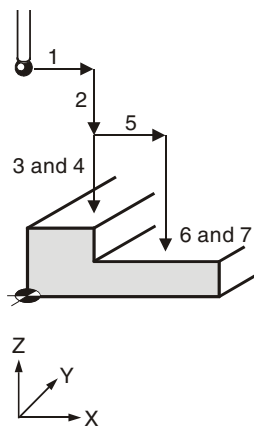
Ww w= Print data

1. = Increment the feature number only.

2. = Increment the component number, and reset the feature number.

For optional inputs Ee, Ff, Uu and Vv, see Chapter 3, "Optional inputs".

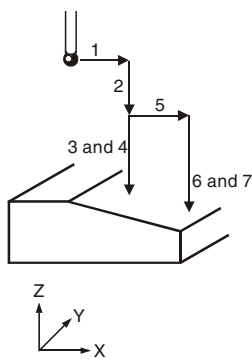
### Example 1: Measuring the incremental distance between two surfaces



- |    |                       |  |
|----|-----------------------|--|
| 1. | G65P9810X30.Y50.F3000 | Protected positioning move.                |
| 2. | G65P9810Z30.          | Protected positioning move.                |
| 3. | G65P9811Z20.          | P1 20 mm (0.787 in) surface.               |
| 4. | G65P9834              | Store data.                                |
| 5. | G65P9810X50.          | Move to new position.                      |
| 6. | G65P9811Z15.          | P2 15 mm (0.591 in) surface.               |
| 7. | G65P9834Z-5.H.1       | Feature to feature at -5.0 mm (-0.197 in). |

**Figure 9.16**  
Probe movements

### Example 2: Measuring an angled surface



- |                        |                         |   |
|------------------------|-------------------------|---|
| 1.                     | G65P9810X30.Y50.F3000   | Protected positioning move.   |
| 2.                     | G65P9810Z30.            | Protected positioning move.   |
| 3.                     | G65P9811Z20.            | P1 at 20 mm (0.787 in) position.  |
| 4.                     | G65P9834                | Store data.   |
| 5.                     | G65P9810X77.474         | Move to new position.   |
| 6.                     | G65P9811Z10.            | P2 at 10 mm (0.394 in) position.  |
| <b>and either this</b> |                         |   |
| 7.                     | G65P9834D27.474Z-10.B.5 | Measure slope -20 degrees (clockwise)<br>angle tolerance $\pm 5$ degrees. |

**Figure 9.17**  
Probe movements

**or this**

- |    |                       |
|----|-----------------------|
| 7. | G65P9834A-20.Z-10.B.5 |
|----|-----------------------|

## Updating the SPC tool offset (O9835)

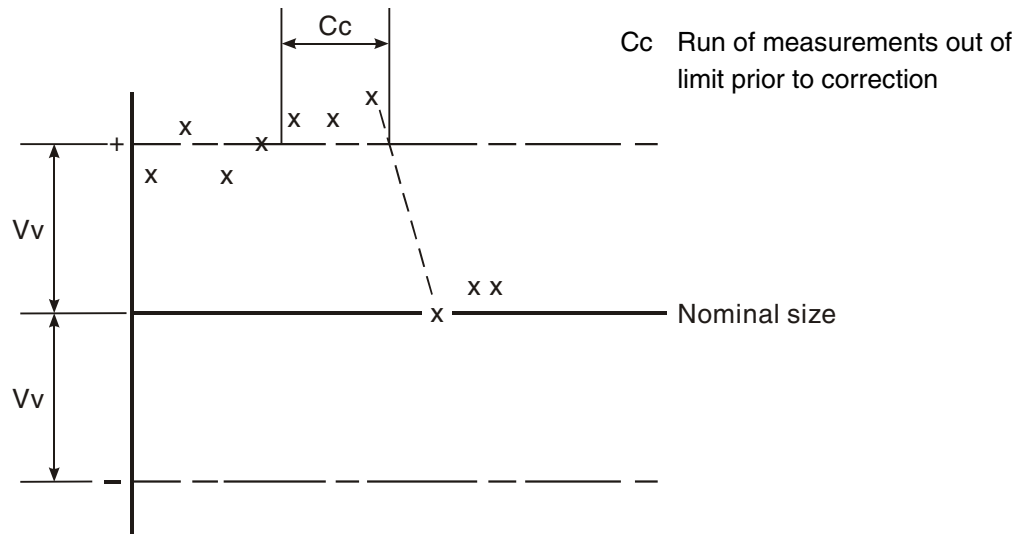


Figure 9.18 Updating the SPC tool offset

### Description

This macro can be used in conjunction with measuring cycles to control tool offset updates. It offers the possibility of providing an update based on the average value of a sample of measurements.

### Application

A measuring cycle should be run, but with no tool offset update (Tt input). A component tolerance (Hh input) can be used if required. The SPC macro should follow. An average value is accumulated until a specified continuous run of values are outside the control limit. At this point the tool offset is updated, based on the average value.

---

**IMPORTANT:** Set the Mm store tool offsets to 0 on the offset page prior to use.

---

### Format

G65P9835 Tt Mm [Vv Cc Ff Zz]  
 where [ ] denotes optional inputs

**Example:** G65P9835T20.M0.2V0.25C4F0.8Z1.

**Compulsory inputs**

Tt	t=	Tool offset number for updating.
Mm	m=	Spare tool offset pair for storing average value and counter.
	m	= Accumulated average value store location.
	m+1	= Counter store location.

**Optional inputs**

Cc	c=	Number of measurements out of tolerance before corrective action is taken <b>Default = 3.</b>
Ff	f=	See Chapter 3, "Optional inputs".
Vv	v=	See Chapter 3, "Optional inputs".
Zz	z=	Flag for Z length offset update. A Z value needs to be input to force the length offset register to be updated, otherwise the radius register will be updated.

---

**NOTE:** This input is only necessary when using type 'C' tool offset option.

---

**Example: SPC tool offset updating**

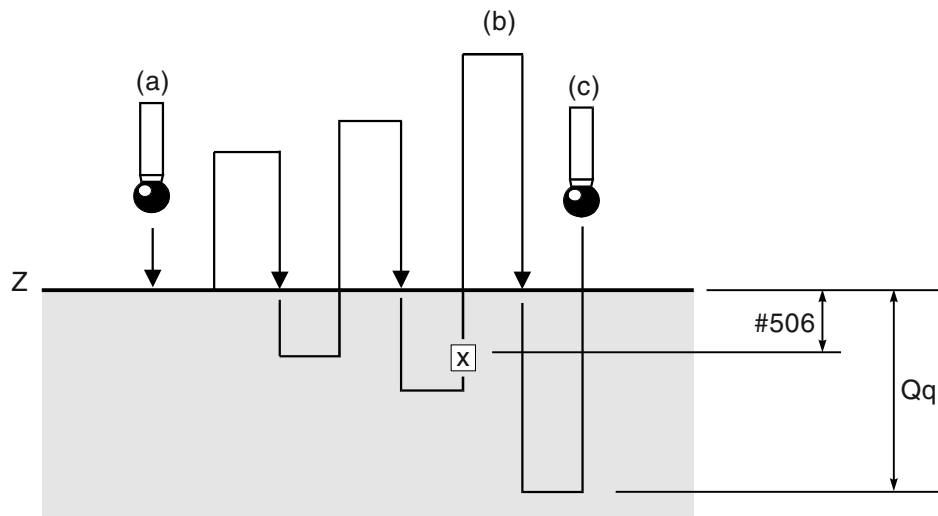
From previous

G65P9814D50.H.5            Measure bore to 0.5 mm (0.0197 in) tolerance.

G65P9835T30.M31.V.1C4.    T30 = Tool offset number for updating.  
    M31. = Spare tool offsets pair (31 and 32).  
    V.1 = Control limit.  
    C4. = Run of measurements out of limit.

continues

## Optimising a probing cycle (O9836)



a = Start at 30 mm/min (1.181 in/min)

b = #119\*.6 feedrate

c = Maximum feedrate

**Figure 9.19 Optimising a probing cycle**

**NOTE:** For small and medium machines the default values for feedrate and back-off distance are adequate. Therefore it is not essential to run this macro in every case.

### Description

This macro is used to establish the optimum maximum feedrate and back-off distance values for the probing cycles.

### Application

1. The probe should be made active. At this stage the spin-on macro for the optical probe may not be functioning. Therefore, use the MDI mode and spin the probe at S500, then stop the spindle.
2. Position the probe stylus within 2 mm (0.08 in) of the surface. Call this macro within a small program, and run the cycle.

The probe moves towards the Z surface at 30 mm/min. (1.2 in). The cycle continues to retract and find the surface several times to establish the optimum values.

At the end, the cycle returns to the start position.

---

**NOTE:** The repeat surface finding moves get progressively faster until the maximum overtravel is reached. Also, the retract position off the surface increases. It is important, therefore, that you allow for adequate Z axis movement, e.g., 60 mm (2.4 in).

---

The macro ends with a macro alarm message:

MESSAGE 75 (#118=BMCF DIST AND #119=FAST FEED)

These values are recommended values. They are not automatically installed into the active variables.

#### Install values

1. The fast feed value in #119 must be loaded into the setting macro O9724. See Appendix C, "Settings macro details", for details.
2. The back-off distance in #118 must be transferred into variable #506. This is possible in 'manual data input mode'. The variable is to be found on the common retained variable page.

#### Format

G65 P9836 Qq

**Example:** G65P9836Q10.

#### Optional input

Qq    q=    The maximum overtravel for the probe.  
          **Default** = 4 mm (0.16 in).

#### Diagnostic alarms

See Chapter 10, "Macro alarms", for details.

---

**NOTE:** Feedrates. All the feedrates within the software are related, and are dependent on the fast feedrate #119 value, with the exception of the gauging move. This is always at 30 mm/min (1.2 in/min). It should also be noted that the back-off distance #506 can be affected by changing the feedrate #119. Running this macro will establish compatible setting data.

---

## Feedrates

Feedrates are internally calculated as shown:

### Basic move macro O9726

Z axis fast approach #119\*.6 (3000 mm/min [120 in/min.] standard).

XY axis fast approach #119\*.6 (3000 mm/min [120 in/min.] standard).

Gauge move 30 mm/min. (1.2 in/min) all axes.

### All other feedrates

Z axis positioning #119\*.6 (3000 mm/min. [120 in/min.] standard).

XY axis positioning #119 (5000 mm/min. [200 in/min.] standard).

## Example

Write a small program to run this macro.

Position the probe at approx. 2 mm (0.08 in) above a surface, with the probe active.

%

O5036

G40G80G90 Preparatory codes for the machine.

H00 Make tool offset zero

G65P9836Q6.0 Optimise for 6 mm (0.24 in) overtravel

M30

%

## Angle measurement in the X or Y plane (O9843)

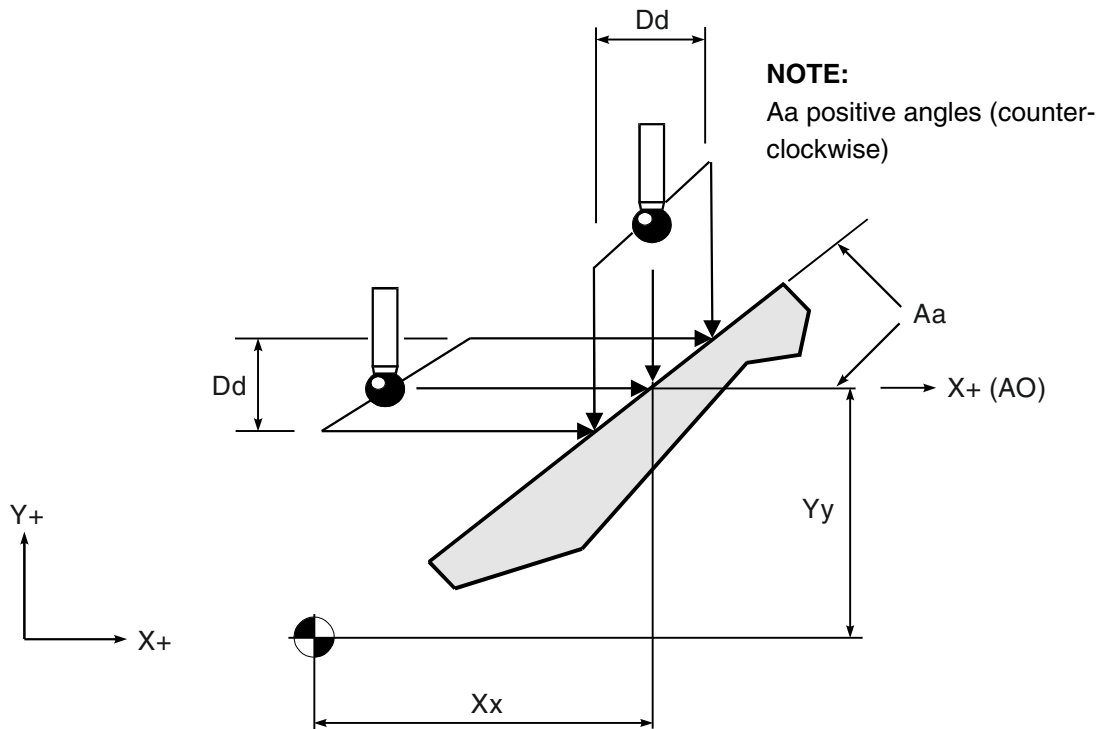


Figure 9.20 Measuring an angled surface in the X or Y plane

### Description

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

### Application

The probe stylus must be positioned adjacent to the surface and at the required Z axis position to provide a suitable start 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 [ ] denotes optional inputs

**Example:** G65P9843 X50.D30.A45.H.2Q15.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 surface position of the surface. An Xx input results in a cycle measuring in the X axis direction.
Yy	y=	The mid-point surface 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

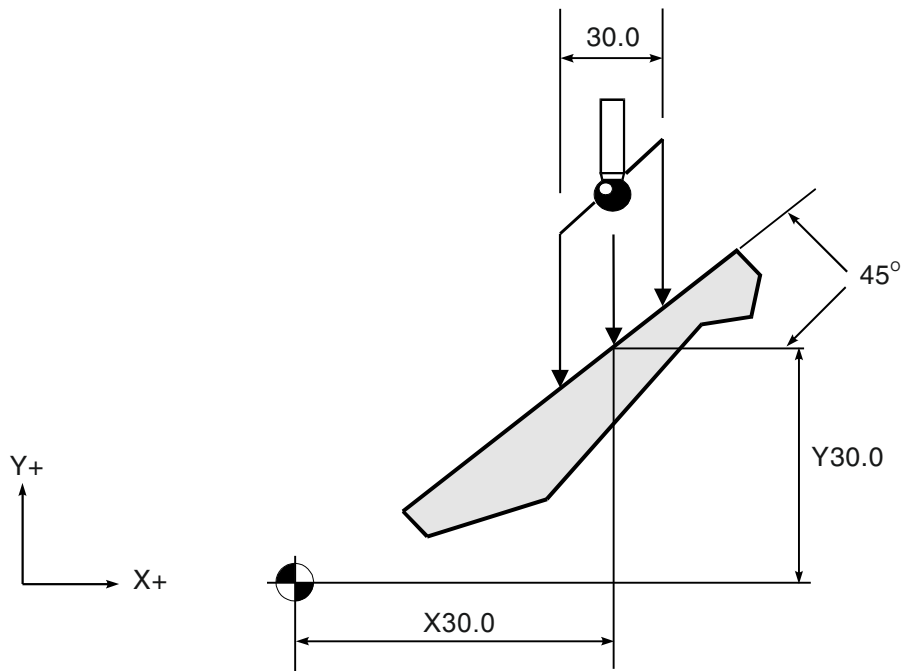
Aa	a=	The nominal angle of the surface measured from the X+ axis direction positive angles (counter-clockwise). Specify angles between $\pm 90$ degrees of the default value. <b>Defaults:</b> X axis measuring 90 degrees. Y axis measuring 0 degrees.
Bb	b=	The angle tolerance of the surface, e.g., 30 degrees $\pm 1$ degrees. Inputs A30.B1.
Qq	q=	The probe move overtravel distance. Default value is 10 mm (0.394 in).
Ww	w=	Print data  1. = Increment the feature number only.  2. = Increment the component number, and reset the feature number.

## Outputs

#139	The surface angle measured from the X+ direction.
#143	The measured height difference.
#144	The surface angle error.

## Alarms

Refer to Chapter 10, "Macro alarm list", for details of the macro alarms.

**Example****Figure 9.21 Example of an angled surface measurement**

G65P9810 X30.Y50.Z100.F3000    Protected positioning move.

G65P9810 Z-15.    Protected move to start position.

G65P9843Y30.D30.A45.    Angle measure.

G65P9810 Z100.    Retract to a safe position.

continue

G17

G68G90X0Y0 R[#139]    Rotate co-ordinate system by the angle.

continue machining program

---

**NOTE:** The Renishaw probe cycles cannot be used while co-ordinate rotation is in force, i.e. cancel code G69.

---

# Chapter 10

## Macro alarm list

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:

- How to identify an alarm number that may be displayed on a Fanuc 0M controller.
- The meaning and likely cause of each alarm message that may be displayed on the screen of a Mazak M32 controller. It then describes typical actions that you should take to clear the fault.
- The meaning and likely cause of each alarm message that is associated with the optimisation macro (O9836). It then describes typical actions that you should take to clear the fault.

### Contained in this chapter

Fanuc 0M controller alarms .....	10-2
Mazak M32 controller alarms.....	10-2
General alarm list.....	10-2
Optimisation macro only (O9836) alarms .....	10-5

## Fanuc 0M controller alarms

Alarm messages are not displayed on the screen, only the alarm number. The alarm numbers displayed are (500 + n), where n is the alarm number.

**Example:** 92(PROBE OPEN) is alarm 592

## Mazak M32 controller alarms

Alarms are not automatically displayed. The message can be seen on the screen by pressing the MNT button.

## General alarm list

### Format

		#148 flag
3006=	1 (OUT OF TOL) 1 (OUT OF POS) 1 (ANGLE OUT OF TOL) 1 DIA OFFSET TOO LARGE	Updates the offset if the cycle start button is pressed to continue 1 2 4 5
	1 (UPPER TOL EXCEEDED) 1 (EXCESS STOCK)	No offset update if the cycle start button is pressed to continue 3 6
	1 (PROBE SWITCH OFF FAILURE)	Spin-off macro O9833

### Action

Check the following:

The spin-off cycle may fail if the spindle speed of S500 is not achieved. Check that the spindle speed override is not active.

Possible faulty probe.

Press cycle start to continue

---

**NOTE:** Fanuc 0M or 6M – Alarms will be a reset condition. Restart the program from a safe position.

---

**Format**

#3000 = 101(PROBE START UP FAILURE) Spin-on macro O9832

**Action**

Check the following:

The spin-on cycle may fail if the spindle speed of S500 is not achieved. Check that the spindle speed override is not active.

Possible faulty probe.

This is a reset condition. Edit the program and start again from a safe start 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 (Y	INPUT MISSING)
	91 (Z	INPUT MISSING)
	91 (XYZ	INPUT MISSING)
	91 (DATA	#130 TO #139 MISSING)
	91 (X0	INPUT NOT ALLOWED)
	91 (Y0	INPUT NOT ALLOWED)
	91 (H	INPUT NOT ALLOWED)
	91 (T	INPUT NOT ALLOWED)
	91 (IJK	INPUTS 5 MAX)
	91 (XY	INPUT MIXED)
	91 (XY	INPUT MIXED)
	91 (ZK	INPUT MIXED)
	91 (SH	INPUT MIXED)
	91 (ST	INPUT MIXED)
	91 (TM	INPUT MIXED)
	91 (XYZ	INPUT MIXED)
	91 (K	INPUT OUT OF RANGE)

**Action**

Edit the program. This is a reset condition. Edit the program and start again from a safe start position.

**Format**

#3000 = 86(PATH OBSTRUCTED) protected positioning cycle only.

**Action**

Edit the program. This is a reset condition. Clear the obstruction and start again from a safe position.

**Format**

#3000 = 88(NO FEED RATE) protected positioning cycle only

**Action**

Edit the program. This is a reset condition. Insert the F\_\_\_ code input, and start again from a safe position.

**Format**

#3000 = 89(NO TOOL LENGTH ACTIVE)

**Action**

Edit the program. This is a reset condition. G43 or G44 must be active before the cycle is called. Edit and start again from a safe position.

**Format**

#3000 = 92(PROBE OPEN) This alarm occurs if the probe is already triggered before a move.

**Action**

Clear the fault. This is a reset condition. Clear the fault and start again from a safe start position. 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.

**Format**

#3000 = 93(PROBE FAIL) This alarm occurs if the probe did not trigger during the move.

**Action**

Edit the program. This is a reset condition. Edit the program and start again from a safe start position. The surface was not found or the probe has failed.

## Optimisation macro only (O9836) alarms

**Format**

#3000 = 72(SKIP SIGNAL ALREADY ACTIVE) optimisation macro only.

This indicates that the machine skip signal is high prior to the probe move. Check that the probe is active and that the interface is not in error. Check wiring. Check that the interface output relay is configured correctly, i.e. N/C or N/O. Is the stylus in contact with a surface? A possible reseal problem.

**Action**

Clear the fault

**Format**

#3000 = 73(NO SKIP SIGNAL DURING MOVE) optimisation macro only

The skip signal was not activated during the move. Check the wiring. Check probe operation and interface LED outputs to confirm operation when the stylus is manually deflected. Also relay output voltage to skip when the probe is triggered.

**Action**

Edit the program

**Format**

#3000 = 74(H00 CODE TOOL LENGTH NOT ACTIVE) optimisation macro only.

The tool length offset must be set to zero by programming 'H00' prior to calling the macro. This permits the safe operation of jogging the stylus into a start position before running the macro.

**Action**

Edit the program

**Format**

#3000 = 75(#118=BMCF DIST AND #119=FAST FEED) optimisation macro only.

This is the end of the optimisation cycle. The values in #118 and #119 can be installed (see "Optimising a probing cycle (O9836)" in Chapter 9, "Additional cycles" for details).

**Action**

Install setting values

# Appendix A

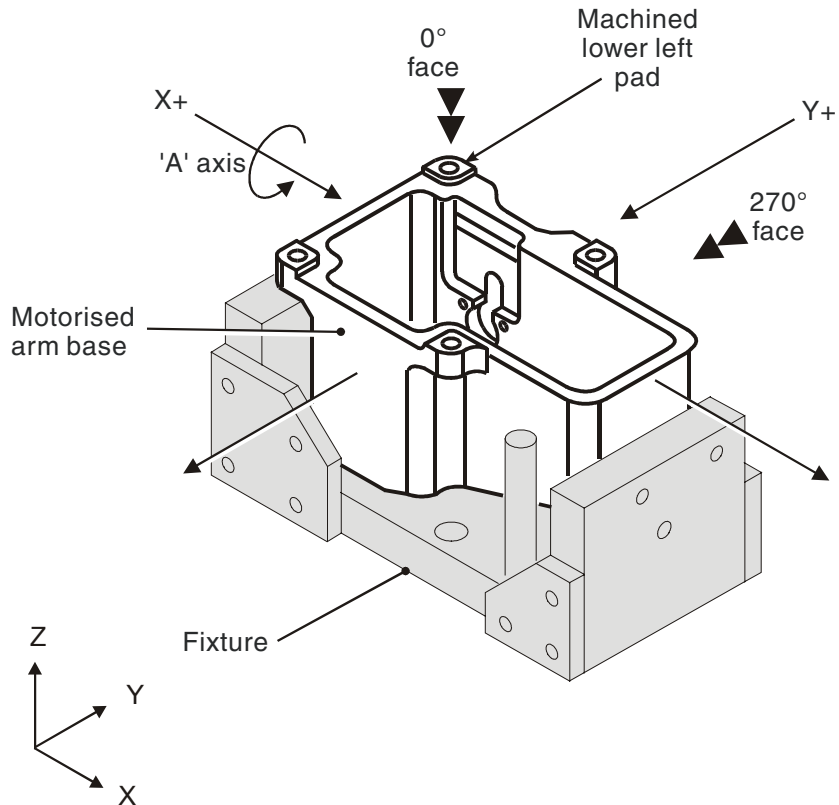
## Example job

### Contained in this appendix

Introduction .....	A-2
Probe operations.....	A-3

## Introduction

The component shown in Figure A.1 is to be machined on two faces by rotating the component about the machine A axis on the 4th axis unit.



**Figure A.1 Motorised arm base – General view**

The following probe operations are carried out:

- The probe is used initially on the 0 degree face to level up the component using an A axis work offset shift.
- The component datum is then set in the X, Y, and Z axis for machining.

During machining of this face, the side face of the lower left pad is machined as a datum for the 270 degree face machining (Ref. Y axis datum).

- The probe is also used on the 270 degree face to set the Y, Z axis component datum.
- Nominal work offset data is entered in G54 and G55 before the machining operation.



1. /G00G54X90.Y0. Rapid positioning
2. /G43G1H30Z100.F3000 Go to Z 100 mm (3.94 in), apply tool offset.
3. /G65P9832 Spin the probe on.
4. /G65P9810Z10.F3000 Protected move to start position.
5. /G65P9818Y79.Z0S1. Set G54 A axis on the top face.
6. /G0A0 Level to new A axis position.
7. /#2802=#2801 Transfer G54 A axis to G55 A axis work offset.
8. /G65P9810Z-28.F3000. Protected move to position.
9. /G65P9812Y69.S1. Set G54 Y centre.
10. /G65P9810X-35.Y0 Protected move to position.
11. /G65P9811X-44.S1. Set G54 X position.
12. /#2502=#2501 Transfer G54 X axis to G55 X axis work offset.
13. /G65P9810X0 Protected move to position.
14. /G65P9810Z-84. Protected move to position.
15. /G65P9811Z-94.S1. Set G54 Z position.
16. /G65P9810Z100. Protected move retract.
17. /G65P9833 Spin the probe off.
18. /G91G28Z0  
/G90  
/M01

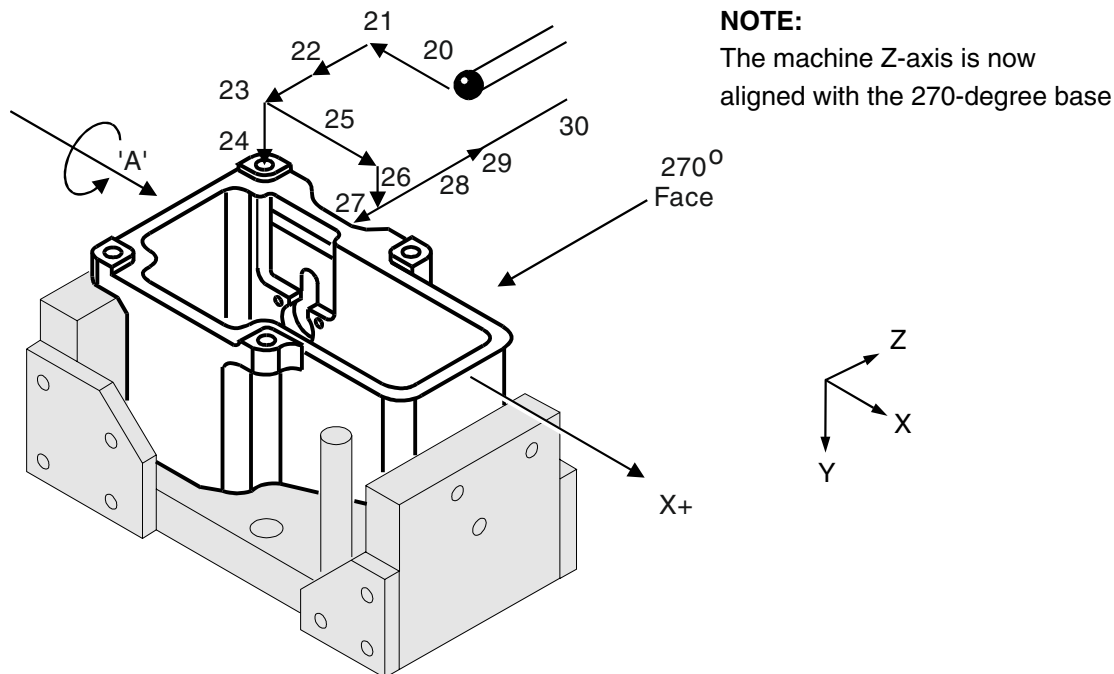
***Continue machining 0-degree face***

- G0A-90. Index to 270 degree face.
- N210  
(PROBE TO SET G55 Y Z)
- /M01
- /T30 Select probe.
- /M09

/G91G28Z0

/G90

**Refer to Figure A.3 for probe movements 20 to 30**



**Figure A.3 Probing operations on the 270-degree face**

20.	/G0G55X-38.0Y-74.0	Rapid positioning move
21.	/G43G1H30Z100.F3000	Go to Z 100 mm (3.94 in), apply tool offset.
22.	/G65P9832	Spin the probe on.
23.	/G65P9810Z-5.F3000.	Protected move to position.
24.	/G65P9811Y-66.S2.	Set G55 Y axis work offset.
25.	/G65P9810X0Z10.	Protected move to position.
26.	/G65P9810Y-60.	Protected moves to position.
27.	/G65P9811Z0S2.	Set G55 Z axis work offset.
28.	/G65P9810Z100.	Protected move retract.
29.	/G65P9833	Spin the probe off.
30.	/G91G28Z0	Retract

/G90

/M01

***Continue machining 270-degree face***

G91G28Z0                                Z return

G28X0Y0A0                              X, Y, A return to start position.

G90

N420

M01

M30

%

## Appendix B

# Features, cycles and limitations of the Inspection Plus software

### Contained in this appendix

Features of the Inspection Plus software.....	B-2
Cycles .....	B-2
Limitations.....	B-3
Mazak M32 controller .....	B-3
Fanuc 10/11/12/15M controllers .....	B-4
Fanuc 6M controller .....	B-4
Fanuc 0M controller .....	B-4
Fanuc 16M – 18M controllers .....	B-4
Limitations when using vector cycles O9821, O9822 and O9823 .....	B-4
Use of 3-point bore/boss macro O9823.....	B-5
Mathematical precision .....	B-5
Effect of vector calibration data on results .....	B-5

## Features of the Inspection Plus software

- Protected positioning
- Measurement of internal and external features to determine both size and position.  
This includes:
  - Obtaining a hardcopy 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
  - SPC (statistical process control) feedback based on average value
- Calculation of feature-to-feature data
- Measurement of external and internal corners for corner surfaces which may not be parallel to an axis
- Calibration of multiple styli
- 4th axis datum setting and tolerancing
- Angular measurement of features
- 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)
- Internal and external corner find
- Vectored measurement:
  - 3-point bore/boss
  - Web/pocket
  - Single surface
- Additional macros:
  - 4th axis measurement
  - Bore/boss on a PCD
  - Stock allowance
  - Multi-stylus calibration
  - XY plane angle measurement

## Limitations

- The probe cycles will not run if 'mirror image' is active.
- The probe cycles will not run if 'co-ordinate rotation' is active.
- Consider macro variable availability.
- This software package can be used in the following controls.

### **Mazak M32 controller**

The standard variables are sufficient.

#### **Limitations**

- None – ISO/EIA programming only.

## **Fanuc 10/11/12/15M controllers**

### **Limitations**

- #500 to #549 standard variable option.
- The use of multi-stylus data storage for vector calibration is not possible, unless the option for extra variables is installed.

## **Fanuc 6M controller**

### **Limitations**

- #500 to #511 standard variables (no option).
- It not possible to use the multi-stylus macro option or the vector cycles.

## **Fanuc 0M controller**

### **Limitations**

- #500 to #531 standard variables (no option).
- It is not possible to use the multi-stylus macro to store vector calibration data (K11 to K14).

## **Fanuc 16M – 18M controllers**

### **Limitations**

- None.

## **Limitations when using vector cycles O9821, O9822 and O9823**

Vectored cycles involve the mathematical operation of squared values. This can lead to precision errors if large values are used. The following factors must be considered:

## Use of 3-point bore/boss macro O9823

The macro may be used to establish the centre and diameter of a bore or external feature. There is however a practical limitation to the use of the macro. It is advisable to use the largest distance between contacts, that is practical. The minimum conditions to give reliable data are as follows:

- 168 degrees total span.  
48 degrees between any two points.
- The software does not check the minimum condition inputs.
- The accuracy of the result deteriorates if the minimum conditions are not followed.

## Mathematical precision

The mathematical precision of the controller is a limiting factor if large values are used. The Fanuc controller works within an accuracy of eight significant figures. Because of the mathematical operations concerned, an error may accumulate if large values for probing positions about the centre are used for calculation. It is suggested that, at this moment, X Y coordinate values of  $\pm 300.00$  mm (30.000 in) from the feature centre are not exceeded for any position around a bore, to retain a resultant resolution of better than 0.01 mm (0.001 in).

## Effect of vector calibration data on results

The vector calibration cycle establishes true calibration data at each 30 degree increment. A small error due to the probe trigger characteristics may occur at intermediate angles between the 30 degree calibration points. However this error is small for standard machine tool probes with standard styli.

---

**NOTE:** For better accuracy, always use the standard bore/boss cycle (O9814) where possible.

---

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# Appendix C

## Settings macro details

### Contained in this appendix

Macro G65P9724.....	C-2
---------------------	-----

## Macro G65P9724

This macro 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 following values are supplied as standard:

- #120 = 1 (SELECT OPTIONS) (see table below)
- #123 = .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 Probe Open or Probe Fail.
- #119 = 5000 (FAST FEED MM) The fast feed rate of the cycles can be adjusted by this variable to suit the machine characteristics and should be optimised.
- #119 = 200 (FAST FEED INCH)

---

### NOTES:

1. The Z axis P9726 basic move macro fast feedrate is #119\*.6, i.e. 3 metres/min as standard.
  2. All Z axis positioning moves are also #119\*.6, i.e. 3 metres/min as standard.
  3. All XY axis positioning moves are #119 value i.e. 5 metres/min as standard.
- 

Select value for #120			
		Work offset type	
Tool offset	Tolerance alarm condition	FS9 type 10/11/12/15/M	FS6 type 0/6/16/18M
A type	Flag and alarms	# 120=1	# 120=9
B type	Flag and alarms	# 120=2	# 120=10
C type	Flag and alarms	# 120=3	# 120=11
A type	Flag	# 120=5	# 120=13
B type	Flag	# 120=6	# 120=14
C type	Flag	# 120=7	# 120=15

It is expected that the settings to enable 'Flag only alarms' will suit FMS machining cells where the requirement is to run unmanned. The process error flag #148 will be set and it should be monitored after relevant probe cycles for corrective action (for use of extended tool offsets, see Appendix J, "Tool offset macro 09732 and 09723").

### Example

G65 P9812 X30.H.2	Set tolerance on measured size
IF[#148EQ1] GOTO999	Test for out of tolerance
continue part program	
GOTO1000	
N999 G65P5001	Pallet change. This changes the pallet to select the next component for machining (details are machine-dependent)
GOTO1	Go to start of program
N1000	
M30	

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# Appendix D

## Tolerances

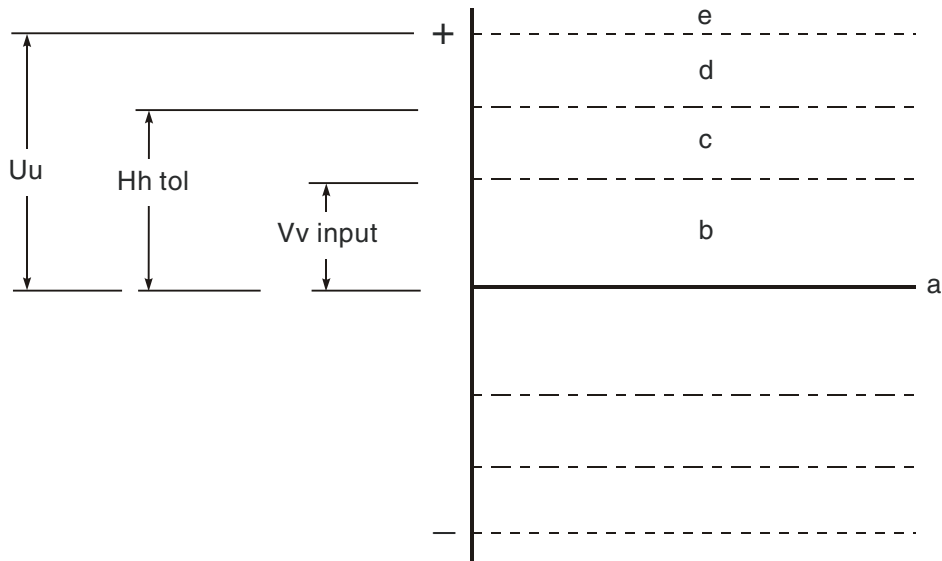
### Contained in this appendix

Tolerances .....D-2

True position tolerances.....D-3

# Tolerances

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 = Hh 'Out of tolerance' alarm occurs. The tolerance value is that which is applied to the size of the feature
- e = Uu upper size. If this value is exceeded there is no tool offset or work offset updated and the cycle is stopped with an alarm. This tolerance applies to both size and position where applicable.

**Figure D.1 Size and tool offset update tolerances**

Also see SPC macro O9835 (see Chapter 9, "Additional cycles") which can be used as a modified method for the feedback of tool offset corrections. Use this instead of Ff.

## True position tolerances

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

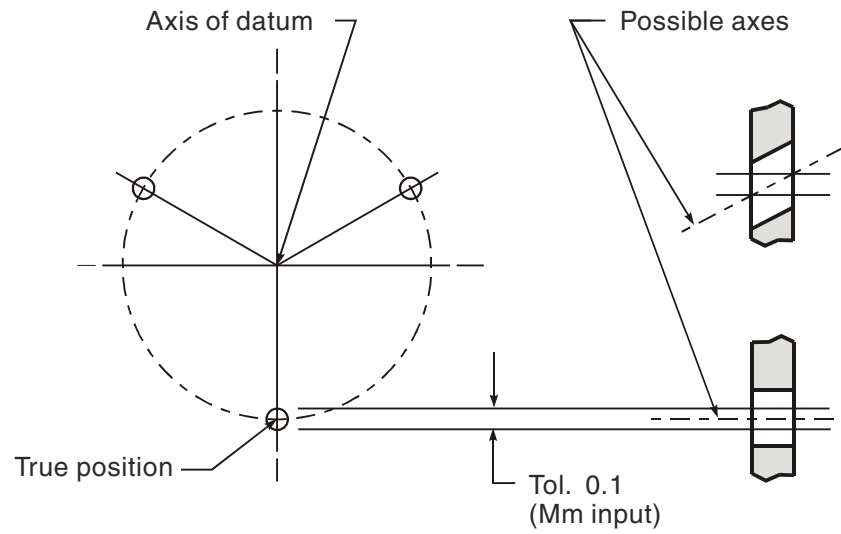


Figure D.2 Cylinders centred on true positions

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# Appendix E

## Experience values Ee

### Contained in this appendix

Experience values Ee ..... E-2

Reason for using this option ..... E-2

## 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

G65P9814 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.

---

Also refer to Appendix F, "Additional spare tool offsets".

## 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 by this means.

# Appendix F

## Additional spare tool offsets

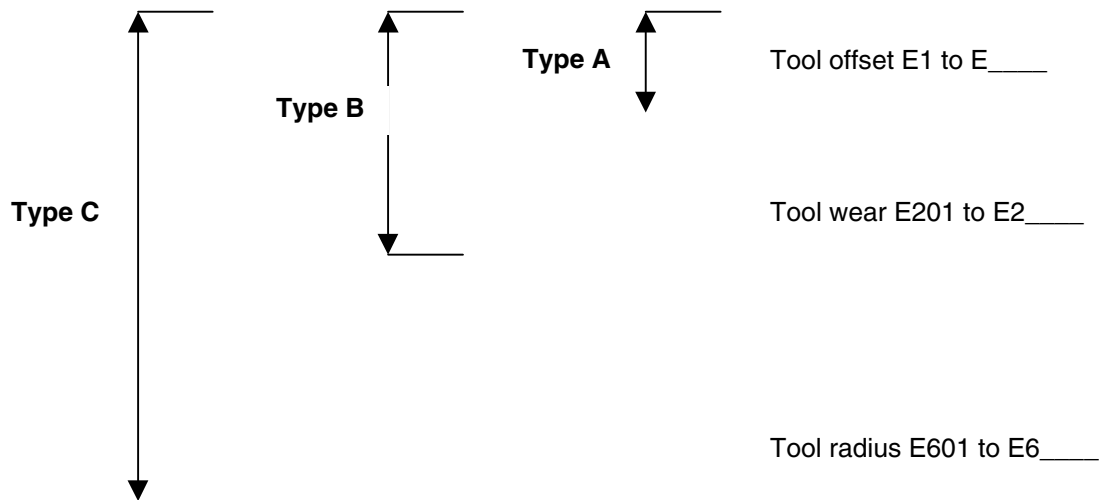
### Contained in this appendix

Additional spare tool offsets .....	F-2
-------------------------------------	-----

## Additional spare tool offsets

The range of spare tool offsets can be extended when either a Type B or Type C tool offset option is installed on the machine.

Figure F.1 shows the extra tool store locations.



**Figure F.1 Spare tool offset location details**

From the figure, you can see that you should add either 200 or 600 to the tool offset number.

These additional tool offset registers can safely be used for both 'Ee' experience values and also with the SPC macro O9835 'Mm' input provided. The tool offset number is not used as a normal tool offset location.

# Appendix G

## Printing a macro output

### Contained in this appendix

Example of printing a macro output .....	G-2
--	-----

## Example of printing a macro output

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

POSNR79.0569 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

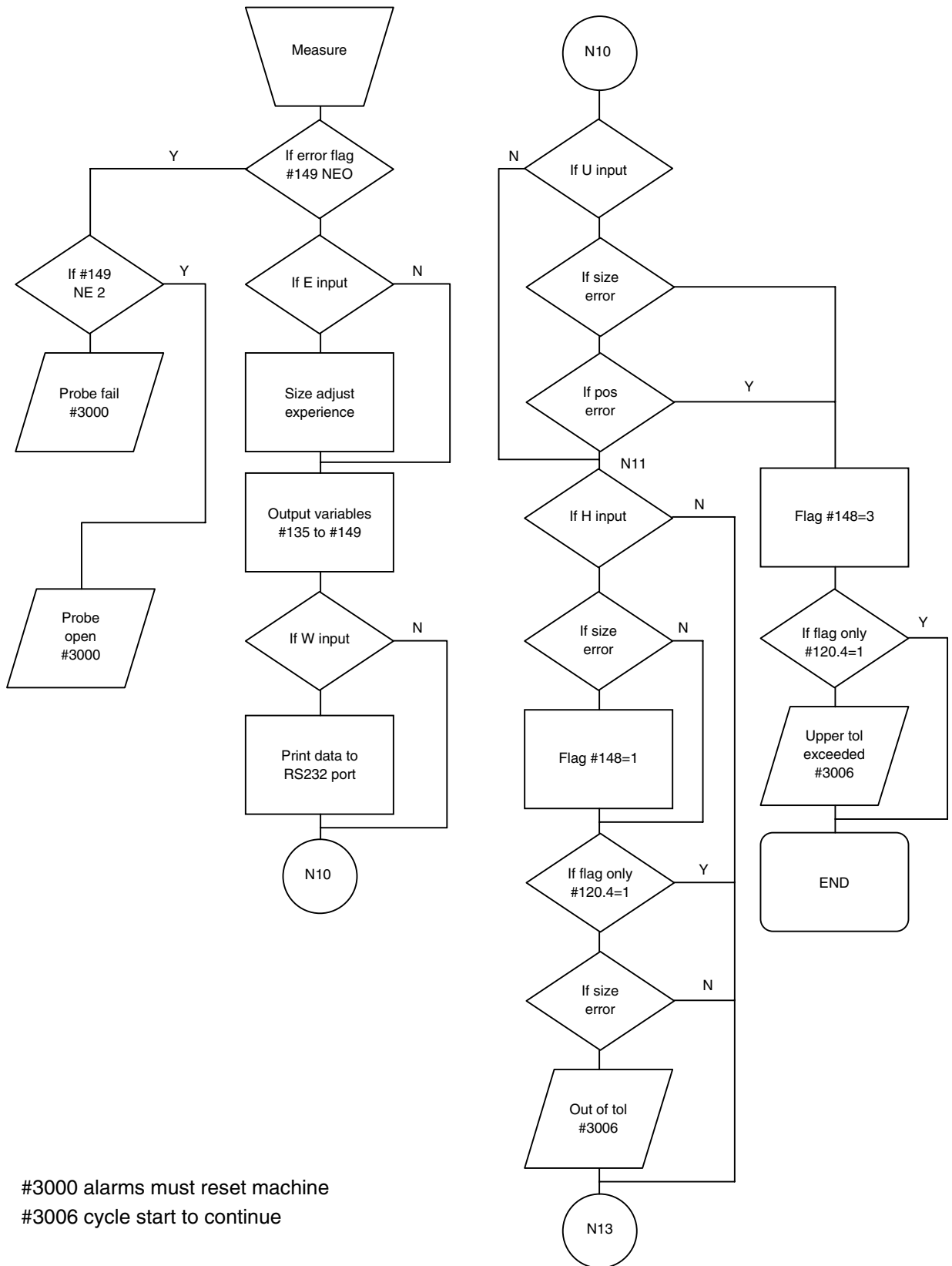
## Appendix H

### Output flow (bore/boss and web/pocket cycles)

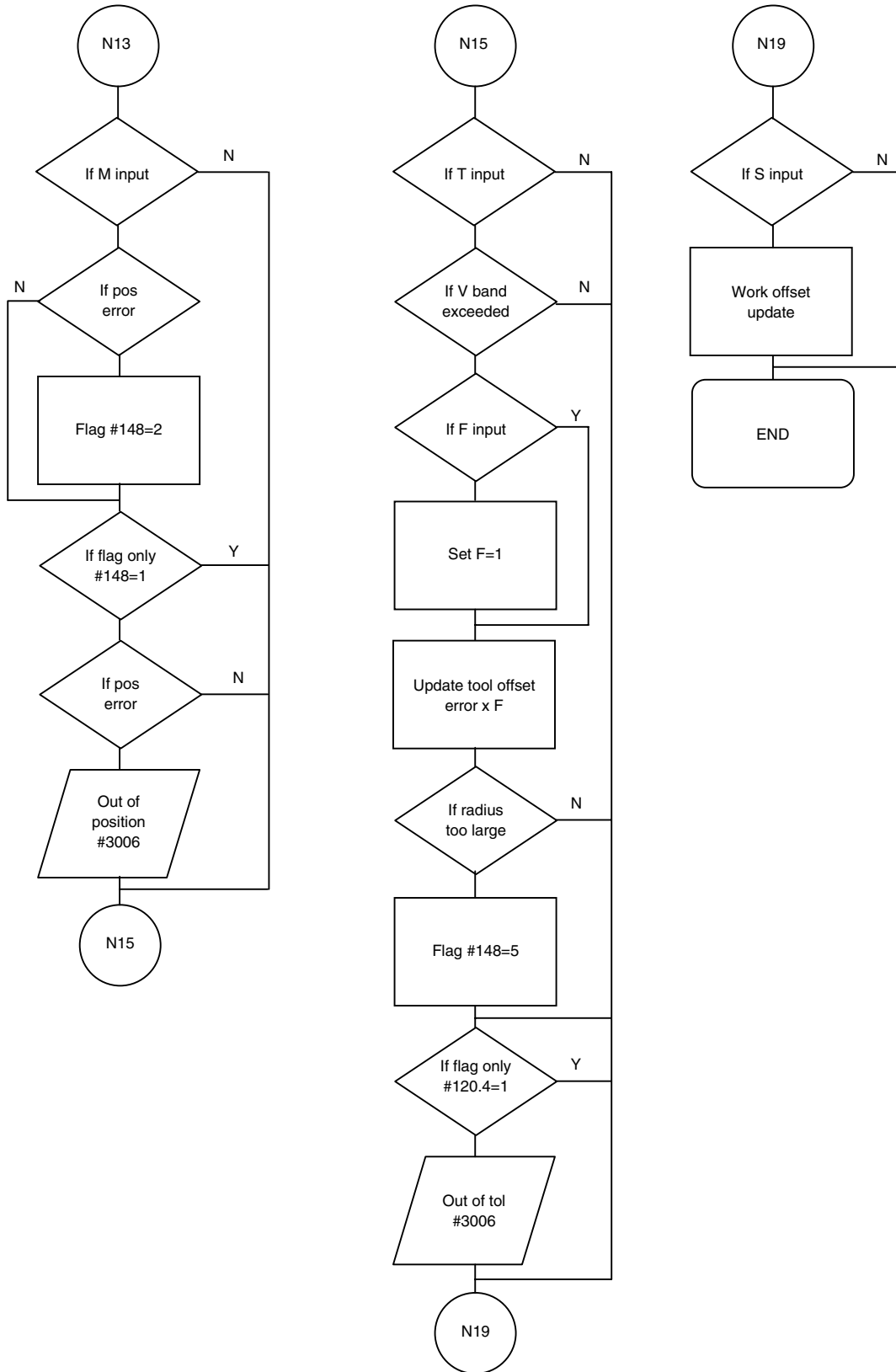
#### Contained in this appendix

Output flow (bore/boss and web/pocket cycles) .....	H-2
---	-----

### Output flow (bore/boss and web/pocket cycles)



#3000 alarms must reset machine  
 #3006 cycle start to continue



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# Appendix I

## Use of macro variables

### Contained in this appendix

Local variables .....	I-2
Common variables .....	I-2
Common retained variables .....	I-3

## Local variables

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

## Common variables

#100 to #115    Are NOT used by this software.

#116            Active tool length - calculated in macro O9723.

#117            Modal feedrate value is used in the protected positioning macro (O9810).

#118            Radius too large flag macro O9812, O9814, O9822, O9823 (also used for temporary ATAN store in macro O9731).

#119            Fast feed rate 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, component number (6-digit) increment by 1, with each heading program #121 = 0 to reset.

#122            Feature number (4-digit) increment by 1, with each print macro call program #122 = 0 to reset.

#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 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 #139 is stored when the feature-to-feature macro O9834 is used.

#135 to #149    See Chapter 4, "Variable outputs", for an output reference chart.

#150 onwards Are NOT used by the software.

## Common retained variables

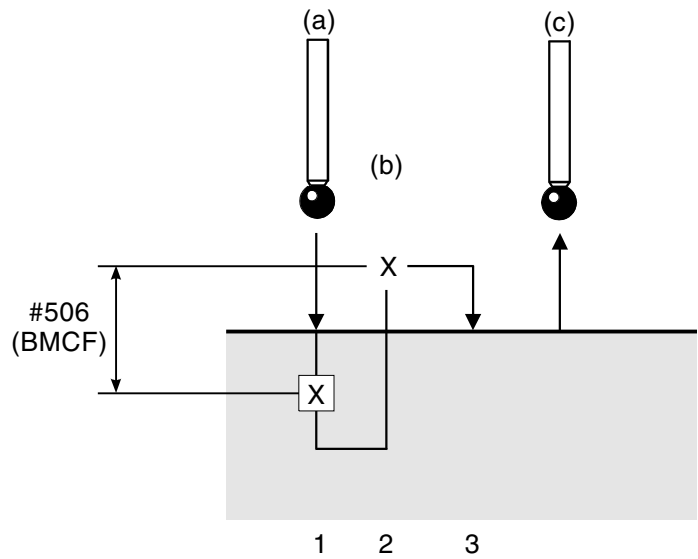
#500	(XRAD) X calibration radius
#501	(YRAD) Y calibration radius
#502	(XOFF) X axis stylus offset
#503	(YOFF) Y axis stylus offset
#504	(Reserved for other software packages)
#505	(Reserved for other software packages)
#506	Basic move control factor. This is used to control the back-off distance in the basic move before the final gauge move. It should be fine tuned on installation to suit the machine. Refer to Figure I.1 for a diagrammatic representation.

A default value of 0.5 is installed by the software. The actual factor should normally be between 0 and 1.0. Reduce the value to reduce the back-off distance.

---

**NOTE:** This value can be found by using the optimisation macro O9836. The value must be set in the settings macro O9724.

---



Move 1 fast feed to find the surface                      a = Fast feed  
 Move 2 recover off the surface                              b = Gauge feed (30 mm/min)  
 Move 3 gauge feed 30 mm/min (1.2 in/min)              c = Return

**Figure I.1 Basic move control factor**

- #507                      (Reserved for other software packages)
- #508                      (Reserved for other software packages)
- #509                      Active vector radius used in macros O9821, O9822, O9823
- #510 to #565          These are reserved for vector calibration data and multi-stylus storage as shown below:
- #510 (30 degree)              Vector calibration data
- #511 (60 degrees)
- #512 (120 degrees)
- #513 (150 degrees)
- #514 (210 degrees)
- #515 (240 degrees)
- #516 (300 degrees)
- #517 (330 degrees)
- #518                      Multi-stylus data K1 and K11
- #519
- #520
- #521

#522	Multi-stylus data K2 and K12
#523	
#524	
#525	
#526	Multi-stylus data K3 and K13
#527	
#528	
#529	
#530	Multi-stylus data K4 and K14
#531	
#532	
#533	
#534	Vector multi-stylus data K11
#535	
#536	
#537	
#538	
#539	
#540	
#541	
#542	Vector multi-stylus data K12
#543	
#544	
#545	
#546	
#547	
#548	
#549	
#550	Vector multi-stylus data K13
#551	
#552	
#553	
#554	
#555	
#556	
#557	

#558            Vector multi-stylus data K14  
#559  
#560  
#561  
#562  
#563  
#564  
#565

The actual variables available are the limiting factor and depend on the control options available.

# Appendix J

## Tool offset macros O9732 and O9723

### Contained in this appendix

Introduction .....	J-2
Editing macro O9732 .....	J-2
Editing macro O9723 .....	J-2

## Introduction

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

The macro uses 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 = 2200 (L G-W 11000)

#29 = 2600 (R WEAR 12000)

#30 = 2400 (R GEOM 13000)

Numbers in brackets are the alternative system variable numbers

macro continued

## Editing macro O9723

Edit macro O9723 as follows:

O9723 (REN ACT OFFSET)

#27 = 2000 (L wear 10000)

#28 = 2200 (L G-W 11000)

Numbers in brackets are the alternative system variable numbers.

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

# Appendix K

## General probing applications

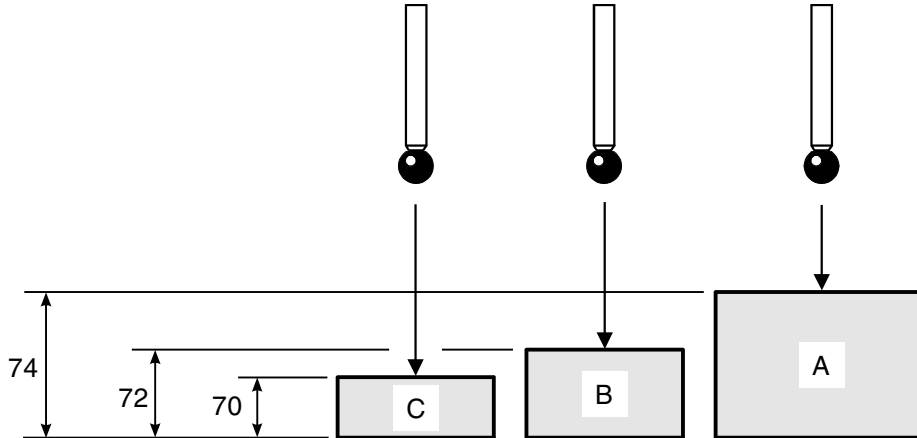
### Contained in this appendix

Example 1 – Part identification.....K-2

Example 2 – Probe measure every *n*th component.....K-3

## Example 1 – Part identification

If a group of components can be identified by a single feature a probe can be used to inspect that feature and decide which component is present. This is done by using data from the output chart following a measuring program.



Each part surface is known to be within  $\pm 0.5$

**Figure K.1 Part identification**

```

G65 P9810Z84.F3000      Protected move to start position
G65P9811Z70.           Single surface measure (target C surface)
IF[#137GT73.]GOTO100   If error greater than 73.0 goto N100
IF[#137GT71.]GOTO100   If error greater than 71.0 goto N200
IF[#137GT69.]GOTO100   If error greater than 69.0 goto N300

GOTO400

N100(PROGRAM TO MACHINE A)

continue 'A' component

GOTO400

N200(PROGRAM TO MACHINE B)

continue 'B' component

GOTO400

N300(PROGRAM TO MACHINE C)
    
```



M30

%

# Appendix L

## One-touch measuring

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## Introduction

The Inspection Plus software package provides an optional one-touch measuring capability to supplement the standard two-touch cycles. The one-touch cycles are intended for use on machines with a fast probe trigger detection ability so that high measuring feedrates can be used.

The Inspection Plus software (Renishaw part no A-4012-0516) comprises the following:

<b>Disk assembly</b>	A-4012-0518	
<b>Files</b>	Two-touch probe cycles	40120519 40120520 40120521
	Additional one-touch probe cycles (macro O9726 only)	40120727

**Table L-1 Inspection Plus software kit**

### Why use a one-touch probe cycle?

A one-touch cycle offers the benefit of reduced cycle times and fewer probe triggers per cycle. It can be used in the following circumstances:

- On machines fitted with fast probe trigger signal detection (ie the high speed skip option - see below)
- When the nominal surface position is known to within a small window of uncertainty

### Using the high speed skip option

This makes it possible to probe at high feedrates of typically 1 m/min without any loss of measuring accuracy, provided the surface is hit at a constant velocity. When this cannot be relied on, the following must be considered:

#### Machine distortion

The machine is under stress during acceleration and deceleration and therefore the recorded trigger values may have errors depending on machine tool condition.

## Servo delays

Normally the axis servo delays are included in the result unless steps are taken to account for it. Refer to your machine parameter manual for setting information so that these errors are considered and compensated for.

### Examples:

#### Fanuc 15

Setting parameter 7300.7=1 (SEB) will enable this function

#### Fanuc 16/18

Setting parameter 6201.1=1 (SEB) will enable this function

---

**NOTE:** When not fitted as standard, the high speed skip option may not be easily retrofitted to a machine because of hardware and configuration requirements.

---

#### Fanuc 0

Setting parameter - none available

## Comparing cycle times

A program was prepared to perform five surface measurements as follows:

- Start 50 mm above the ring gauge
- Measure a 50 mm bore at 5 mm deep (four cardinal points)
- Retract to 5 mm above, move over and make a Z measure on top of the ring gauge.
- Retract to 50 mm and return to the centre

Table L-2 below shows cycle time comparisons only. Check for suitable measuring feedrates on your machine.

		Time in seconds @ 500 mm/min	Time in seconds @ 120 mm/min	Time in seconds @ 60 mm/min	Time in seconds @ 30 mm/min
<b>Two-touch cycles</b>		-	-	-	27.6
<b>One-touch cycle:</b>					
Stand-off	0.5	18.0	18.5	20.0	22.4
distance	1.0	18.2	19.8	22.2	27.3
	2.0	18.7	22.4	27.4	37.1
	3.0	19.1	24.4	32.2	47.0

Table L-2 Cycle time comparison

## Installing the one-touch cycles

---

**NOTE:** The new one-touch basic move macro O9726 is only compatible with the software supplied with this package. Previous versions are not compatible.

---

Before installing the one-touch cycles, the standard two-touch cycles must already have been installed.

The one-touch cycles file (40120727.\*\*\*) contains a new one-touch macro O9726. This should be loaded once the existing two-touch macro O9726 has been deleted from memory.

### Macro edits

The macro O9726, shown below, may be edited for measuring feedrate and stand-off/overtravel distance values:

```
:9726(REN BASIC MEASURE - 1T)
#9=500*#129(EDIT MEAS FEED) .... * Feed - edit 500 value
#28=#9/1000(EDIT ZONE) .... accel / deceleration zone
#31=0
IF[#17NE#0]GOTO2
#17=3*#129(EDIT) ..... * stand off - edit 3 value
N2
```

---

**NOTE:** \* denotes this value must be in millimetres

---

### Measuring the feedrate

The default value is 500 mm/min (20 in/min). This may be changed by editing the macro, for example if not using the high speed skip function or if the servo delays are included in the results.

### Stand-off and overtravel distance

The default value is 3 mm (0.12 in) in the X, Y and Z axes. Edit the macro to set a new default or, alternatively, use the Q input to override the default value (see page L.8).

## System operation

Refer to the relevant chapters of this manual for a description of the cycles and their use.

### Using standard skip

Based on a typical 4 millisecond scan time of the PLC, the standard two-touch method uses a feedrate of 30 mm/min (1.18 in/min). This gives a measuring uncertainty of 0.002 mm (0.0001 in).

Generally, the two-touch method is well suited to this situation because the back-off distance can be optimised to provide a short measuring move; for example less than 0.5 mm (0.020 in). If the one-touch cycles are chosen, the stand-off distance should be kept small and higher feedrates used if accuracy of measuring is not critical.

---

**NOTE:** Measuring uncertainty is related to the feedrate.

---

Feedrate	Measuring uncertainty
30 mm/min	0.002 mm
60 mm/min	0.004 mm
120 mm/min	0.008 mm
500 mm/min	0.033 mm

**Table L-3 Example using the 4 millisecond scan time allowance**

## Additional variables used

The following additional variables are used by this software:

- #124 This is used to store the X axis measured skip position. The value is set in macro O9726.
- #125 This is used to store the Y axis measured skip position. The value is set in macro O9726.
- #126 This is used to store the Z axis measured skip position. The value is set in macro O9726.

## Approach feedrates

The feedrate for the approach to the stand-off position in macro O9726 is set at 3000 mm/min (120 in/min) in the X, Y and Z axes.

## Back-off distance #506

This variable is not used in the one-touch cycles.

## False trigger loop

At the end of the measuring move a false trigger test is made to see if the probe is triggered against a surface. If the probe has resealed, the measuring move continues. Four attempts are made before a PROBE OPEN alarm occurs.

## Acceleration and deceleration allowance

To avoid the possibility of capturing bad data (see Machine distortion and Servo delays on page L-2 and L-3), the one-touch basic move sets a checking zone dimension at the start and end of the measuring move. If the data captured is within these zones, a PROBE OPEN or PROBE FAIL alarm is generated.

The zone dimension is related to the feedrate and is currently set as follows:

$$\begin{aligned} \text{zone dimension} &= \text{measuring feedrate} / 1000 \\ &(\text{ie zone factor} = 1000) \end{aligned}$$

---

**NOTE:** See Macro edits on page L-4 for details of setting the measuring feedrate.

---

Feedrate	Acceleration and deceleration allowance
30 mm/min	0.03 mm
60 mm/min	0.06 mm
120 mm/min	0.12 mm
500 mm/min	0.50 mm

**Table L-4 Example of zone allowance using default zone factor 1000**

**NOTE:** The allowance measuring range is the Q stand-off distance + twice this zone value.

These values will be suitable in most cases, but optimisation or adjustment may be required on some machines. A test program can be prepared to test the measuring accuracy as follows:

1. Set the measuring feedrate in macro O9726.
2. Set a large Q value, for example 3 mm (0.12 mm) or greater.
3. Prepare a test program to measure a surface.
4. Measure the surface, ensuring the trigger is in the constant velocity zone (ie middle of measuring move) and record the first measured value.
5. Make a small STEP adjustment to the programmed surface position (for example 0.5 mm) and repeat the test, recording the total STEP dimension and the measured value.
6. Repeat step 5, making several STEP changes (in the same direction). You will see when the measured result deviates from the first recorded value. This is the point where measurement becomes affected by acceleration/deceleration.

Calculate the acceleration/deceleration value:

$$A = \text{absolute (Q value - total STEP value)}$$

Calculate the zone factor (see descriptions above):

$$\text{Zone factor} = \text{measuring feedrate} / A$$

## Q input

Qq    q=    Overtravel and stand-off position

The programming input and format is the same whether using one- or two-touch cycles. The exception is that the Q input, which with two-touch cycles controls the overtravel distance, also controls the stand-off position for the one-touch cycles (see also Acceleration and deceleration allowance on page L-6).

**NOTE:** The Q value represents the allowable measuring range. The actual overtravel and stand-off distance is automatically increased by the acceleration and deceleration distance (see Acceleration and deceleration allowance on page L-6).

## Measuring move detail

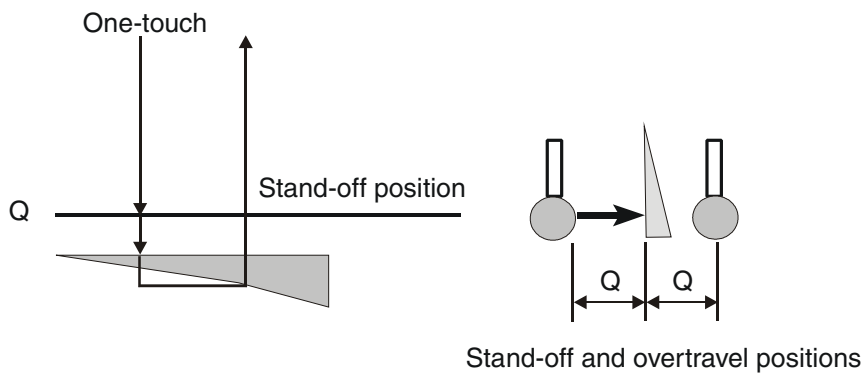
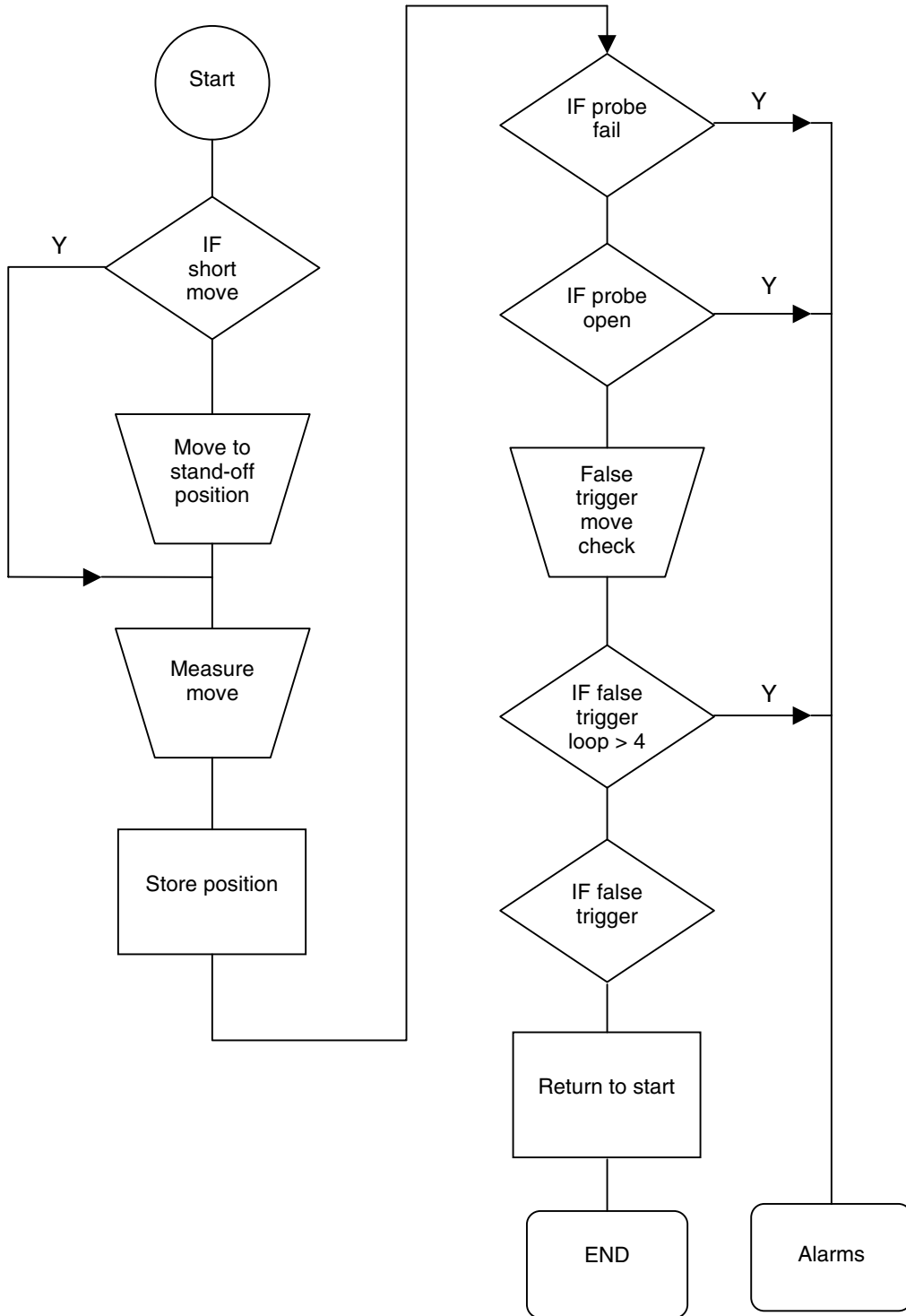


Figure L-1 Measuring move detail

### One-touch measuring move logic



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# Glossary of terms - abbreviations and definitions

Definitions of many of the terms used are provided here to assist your understanding of the Inspection Plus software.

---

**NOTE:** This glossary also includes terms that are associated with probing but which have not been used in this publication.

---

## **ATAN calculation**

This describes a user transparent macro written by Renishaw to handle the ATAN function in mathematical calculations.

## **User transparent**

Macros which are used by the software but which do not get called directly by the user, i.e. they are for internal use by the software only.

## **BRDO**

Ball radius directional offsets. This is a term that is used to describe the stored software compensations for the stylus ball radius. They are determined during calibration of the probe.

## **Bore/boss measure**

This is a Renishaw measuring cycle type definition.

**Bore** – is an internal-width feature measurement on a circle. Feature types consist of holes or bores.

**Boss** – this is an external-width feature measurement on a circle. Feature types consist of shafts, bosses, and spigots.

## **Calibration**

This is the method of establishing the probe trigger point compensations. They include the probe and machine effects which the software must use to correct the results.

## **C.W.**

Clockwise

**C.C.W.**

Counter-clockwise.

**Datum, datuming**

This is the method used to establish a part feature reference point which is subsequently used for other measurement or machining operations. A datum defines any co-ordinate value as a reference position.

**DPRNT**

This is a Fanuc control command. It outputs ASCII data to the RS-232 port of the controller. It is used to output a part inspection report that is based on probe results.

**DTI**

**Dial test indicator.** This instrument is traditionally used for aligning vices and fixtures with respect to the machine axis.

**Gauging move**

This describes the movement of the probe onto the surface with data capture active, i.e. it is a measurement move.

**IMM**

**Inductive module machine.** Together with the IMP, it forms part of the inductive transmission system that is used to transmit signals back to the machine tool controller. The IMM is part of the inductive coupling and is mounted on the machine. See also IMP.

**IMP**

**Inductive module probe.** Together with the IMM, it forms part of the inductive transmission system that is used to transmit signals back to the machine tool controller. The IMP is part of the inductive coupling and is mounted on the probe. See also IMM.

**INHIBIT**

This is a Renishaw interface input signal. It is used to either stop or inhibit the transmission of the probe signal to the machine controller.

**MDI**

**Manual data input.** This is a commonly used term on Fanuc controllers (and controllers that emulate the Fanuc). It means that operation of the machine is determined by data that is entered through the keyboard.

**MMS menu cycles**

**Mazatrol monitoring system.** This is a standard Mazak probe option unit that is normally fitted as original equipment.

**MI5 interface**

This is the Renishaw probe interface that is used to condition and control the probe signal to the machine tool.

**M19 spindle orientation**

This is the machine manufacturer's M-code function that instructs the machine spindle to rotate and orientate to a fixed position.

**Nominal surface position**

This is the expected surface position, or theoretical position. When used in relation to tolerances, it refers to the mid-position of the upper and lower limit of the surface.

**OMI**

**Optical module interface.** This is a combined optical receiver and machine interface unit that forms part of the Renishaw optical probe transmission system. The unit is mounted either on the guarding or some other suitable position where it is within the transmission envelope and range of the probe.

**OMM**

**Optical module machine.** This is part of the Renishaw optical probe transmission system. The unit is mounted either on the guarding or some other suitable position where it is within the transmission envelope and range of the probe.

**OMP**

**Optical module probe.** This is part of the Renishaw optical probe transmission system. The unit is mounted on the probe unit.

**Optimisation macro**

This is part of the Renishaw software package. It is used to establish the optimum fast feed rates for probing and the optimum back-off distance.

**PCD**

**Pitch circle diameter.** This is a commonly used British term to mean a set of features placed in a circular pattern.

**Probe trigger flag**

This is a variable or diagnostic register which is set to a value when the probe is triggered.

**Protected positioning**

This is a means of moving the probe from place to place while the probe trigger signal is monitored. In the event of an unexpected triggering signal, the machine axis is halted to prevent damage to the probe stylus.

**PTR**

**Paper tape reader.** This is the machine's interface which is used to load the stored part programs. It is now largely superseded by the use of floppy disk drives, external PCs, and the RS-232 serial interface.

**RMM**

**Receiver module machine.** This is part of the Renishaw radio probe transmission system. The unit is mounted either on the guarding or some other suitable position where it is within the transmission envelope and range of the probe.

**RMP**

**Radio module probe.** This is part of the Renishaw radio probe transmission system. The unit is mounted on the probe.

**SPC**

**Statistical process control.** Some Renishaw software packages contain a macro which uses a simple form of SPC to control tool offset update corrections in closed loop machining.

**Stylus**

This is the probe tip assembly that is used to trigger the probe on the tool during measurement.

**SSR**

**Solid state relay.** The SSR converter terminal block is a Renishaw hardware unit which is used to convert the signal from a signal conditioning module into an SSR output signal.

**Tolerance limits**

These are the extreme upper and lower metal condition values from the nominal surface position.

**Vector cycle, vector measure/calibration**

This is a probe move, which move one or more machine axes simultaneously to approach the surface from the normal direction.

**Vector stylus ball radius calibration**

This is an extra set of probe stylus ball radius calibration values which must be determined when using vector cycles. They are the probe software compensation values required for probing in different directions.

**Web/pocket measure**

This describes a Renishaw measuring cycle type definition.

**Pocket** – is an internal-width feature measurement. Feature types consist of slots, pockets, and internal recesses.

**Web** – is an external-width feature measurement. Feature types consist of blocks, plate widths, and upstanding keys.

**Work zero point**

This is a similar concept to Datum. It defines where the work co-ordinate system is set to zero. A datum can define any co-ordinate value as a reference position.

**Workpiece datum**

This can be any workpiece feature or co-ordinate, which is chosen as a reference position.

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