Programming manual
H-2000-6031-0C-B

RENISHAW
apply innovation™

Inspection Plus software for machining centres

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EQUIPMENT REGISTRATION RECORD

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

MACHINE DETAILS

Machine description..

Machine type..

Controller..

Special control options..

....

....

RENISHAW HARDWARE	**RENISHAW SOFTWARE**
Inspection probe type	Inspection disk(s).................................
Interface type	....
	....
Tool setting probe type	Tool setting disk(s) ....
Interface type	....
	....

SPECIAL SWITCHING M CODES (OR OTHER) WHERE APPLICABLE

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

ADDITIONAL INFORMATION

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

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

Form 2

SOFTWARE DEVIATION RECORD

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

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

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

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

Caution – Software safety

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

Renishaw has no control over the exact program configuration of the controller with which the software is to be used, nor 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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About the Inspection Plus software

The Renishaw Inspection Plus software described in this manual is for use on machining centres that are fitted with Fanuc and Fanuc-compatible controllers.

For a comprehensive description of the features provided by the software and also the limitations of the software, see Appendix A, "Features, cycles and limitations of the Inspection Plus software".

About this manual

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

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

- Chapter 1, “Installing the software”, describes how to install and customise the Inspection Plus software on your machine.
- Chapter 2, “Optional inputs”, provides an explanation of the optional inputs that are required by some of the macro cycles.
- Chapter 3, “Variable outputs”, provides a complete list of the optional outputs that are produced by some of the macro cycles.
- Chapter 4, “Protected positioning cycle”, describes how to use the protected positioning macro (O9810). When used correctly, this macro prevents damage to the probe’s stylus if the probe collides with the workpiece.
- Chapter 5, “Calibrating the probe” explains why a probe’s stylus must be calibrated before you start using it then describes how to use the four macros that are provided for calibrating a probe.
- Chapter 6, “Measuring cycles”, describes how to use the non-vector measuring cycle macros.
- Chapter 7, “Vector measuring cycles”, describes how to use the three vector measuring cycle macros.
- Chapter 8, “Additional cycles”, describes how to use the macro cycles that are not described in previous chapters.
- Chapter 9, “Macro alarms and error messages”, describes the macro alarm numbers and 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 (in millimetres) are used in the examples. Where appropriate, the equivalent values in inches are shown in brackets.

Associated publication

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

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

Software kit part no. A-4012-0516

The kit comprises the following item:

- CD ROM assembly: part no. A-4012-0518

The CD ROM 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 file is set to multi-load all macros.

File 40120520 – Option 1 cycles

O9730	O9804	O9815	O9816	O9817	O9818	O9821	O9822
O9823	O9834	O9843					

The file is set to multi-load all macros.

File 40120521 – Option 2 cycles

O9819	O9820	O9830	O9831	O9832	O9833	O9835	O9836

The file is set to multi-load all macros.

File 40120727 – One-touch probe cycle

09726

Macro memory requirements

Before you load the Inspection Plus software, first calculate the total amount of memory required by the macros you wish to load. Next, check that the machine controller has sufficient memory capacity for these macros.

If memory capacity of the controller is stated in “metres of tape”, use the following data to convert from Kbytes to length or vice-versa.

Conversion: 1 Kb = 2.5 m (8.2 ft)
8 Kb = 20 m (65.6 ft)

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:

Macro number	Function	Memory (Kb)
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 (Kb)
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 (Kb)
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 requirement is as follows:

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

See Appendix K, “One-touch measuring” for installation and user information.

Using the software with multi-buffer options

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

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

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.	Measurement cycle.
G65P9810Z100.	Protected positioning move.
G5.1	Cancel the read ahead.

Renishaw customer services

Calling Renishaw

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 company that serves your country (for worldwide contact details, see our main web site at www.renishaw.com/contact).

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

- The software version you are using (see the Equipment registration record form).
- The type of hardware that you are using (see the Equipment registration record form).

- The error number and wording of any message that appears on your screen.
- A description of what happened and what you were doing when the problem occurred.
- A description of how you tried to solve the problem.

Chapter 1

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

Installing the software

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

1. First, refer to Appendix A, "Features, 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.

   Now do the following:

   (a) Delete all unwanted O98-- series cycles.

   (b) If vector cycles will be used, delete macro O9803 (macro O9804 will be used instead).

   If vector cycles will not be used, delete the following macros:

   O9727, O9731, and O9804 (these macros are used only for vector cycles).

   (c) If the print option will not be used, delete macro O9730.

4. Choose which of the Option 1 cycles from file 40120520 you require. If Option 1 cycles are required, load the Option 1 file.

   Before loading further macros, delete all unwanted macros from the control.

5. Choose which of the Option 2 cycles from file 40120521 you require. If Option 2 cycles are required, load the Option 2 file.

   Before loading further macros, delete all unwanted macros from the control.

6. If you intend using the one-touch probe cycle from file 40120727, load this file.

Setting the #506 back-off distance

For small and medium size machines; that is, machines that have less than 1000 mm (40 in) of axis travel; the standard feedrates as supplied are normally acceptable. However, if you need to set the #506 back-off distance and #119 fast feedrate, you must run the optimisation macro (O9836). After optimisation is completed, the optimisation macro (O9836) may be deleted.

For further details, see the following parts of this manual:

- Appendix H, "Use of macro variables", for a description of the use of macro variables.
- Chapter 8, "Additional cycles", for a description on using the optimisation macro O9836.

Editing the settings macro (O9724)

If the default values are not suitable, you will need to edit the settings macro (O9724). For a description of macro O9724, see Appendix B, "Settings macro O9724".

Set the following options:

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

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

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Chapter 2

Optional inputs

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

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

Contained in this chapter

Optional inputs

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

Bb	b =	Angle tolerance of the surface, e.g. 30 degrees ± 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 D, "Experience value Ee"). **Example:** E21. causes the experience value stored in tool offset 21 to be applied to the measured size.
Ff	f =	This can be either of the following: 1. The percentage feedback that is used when updating a tool offset (see Appendix C, "Tolerances"). Enter a value between 0 and 1 (0% and 100%). **Default value:** 1 (100%). 2. The feedrate that is used in the protected positioning macro (O9810) (see Chapter 4, "Protected positioning cycle"). **Example:** F15 sets a feedrate of 15 mm/min. (F0.6 sets a feedrate of 0.6 in/min.)
Hh	h =	The tolerance value of a feature dimension being measured. **Example:** For a dimension of 50.0 mm +0.4 mm –0 mm, the nominal tolerance is 50.2 mm with H0.2. (For a dimension of 1.968 in +0.016 in –0 in, the nominal tolerance is 1.976 in with H0.008.)
Ii Jj Kk	i = j = k =	See the relevant measuring cycles and specific macro calls.
Mm	m =	The true position tolerance of a feature. This is a cylindrical zone about the theoretical position. **Example:** M0.1 sets a true position tolerance of 0.1 mm. (M0.004 sets a true position tolerance of 0.004 in.)
Qq	q =	The probe overtravel distance for use when the default values are unsuitable. The probe will then travel beyond the expected position when it searches for a surface. **Default values:** 4 mm (0.16 in) in the Z-axis and 10 mm (0.394 in) in the X and Y axes.

Example: Q8. sets an overtravel distance of 8 mm.
(Q0.3 sets an overtravel distance of 0.3 in.)

The Qq input is also used in the optimisation macro (O9836) (see Chapter 8, "Additional cycles", for details).

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

Default value: 5 mm (0.200 in).

Example: R10. sets a radial clearance of 10 mm.
(R0.4 sets a radial clearance of 0.4 in.)

R-r –r = This is similar to Rr, except that the clearance is applied in the opposite direction to force an internal boss or web cycle.

Default value: 5 mm (0.200 in).

Example: R–10. sets a radial clearance of –10 mm.
(R–0.4 sets a radial clearance of –0.4 in.)

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

S1 to S6 (G54 to G59).
S0 (external work offset).
S101 to S148 (G54.1 P1 to G54.1 P48) additional offsets option.
New work offset = active work offset + error.
New external offset = external offset + error.

Example: S3.

Tt t = The tool offset number to be updated

Example: T20 updates tool offset number 20.

Uu u = Upper tolerance limit.

If this value is exceeded no tool offset or work offset is updated and the cycle stops with an alarm. Where applicable, this tolerance applies to both the size and position.

Example: U2. to set the upper tolerance limit to 2 mm.
(U0.08 to set the upper tolerance limit to 0.08 in.)

Vv v = Null band.

This is the tolerance zone in which no tool offset adjustment occurs.

Default value: 0

Example: V0.5 for a tolerance zone of ±0.5 mm.
(V0.02 for a tolerance zone of ±0.02 in.)

Ww w = Print the output data.

1 = Increment the feature number only.

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

Example: W1.

Chapter 3

Variable outputs

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

Contained in this chapter

Variable outputs (table 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 (table 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 4

Protected positioning cycle

As the probe moves around the workpiece, it is important that the stylus is protected against a collision with the workpiece. This chapter describes how to use 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 monitoring) (O9810)

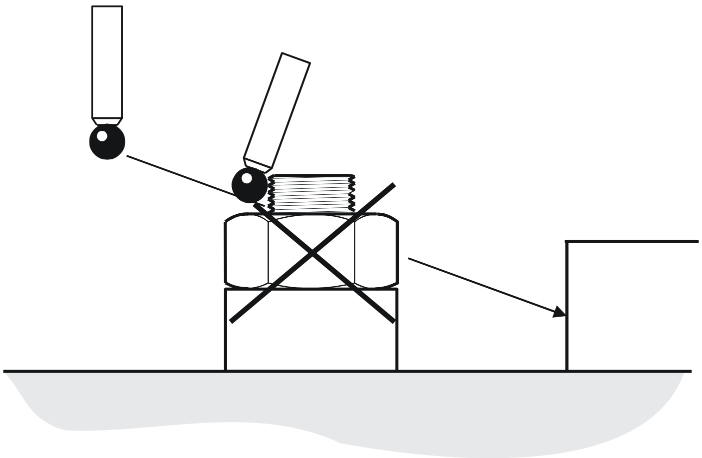

Figure 4.1 Probe protected positioning

Description

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

Application

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

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

Format

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

Example: G65P9810 Z10. F0.8 M0.2

Compulsory inputs

Xx	x =	
Yy	y =	These are 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 must not be exceeded.

Mm m = 1.0 This will set a probe trigger flag (no PATH OBSTRUCTED alarm)

#148 = 0 (No probe trigger).

#148 = 7 (Probe triggered).

Example

G1G54X20.Y50.	
G43H20Z100.	Move to a safe plane.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z10.F3000	Protected positioning move.
G65P9811Z0S1	Single surface measurement.

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Chapter 5

Calibrating the probe

Before a probe is used, it must be calibrated correctly. This chapter explains why it is so important that the probe is calibrated and then describes how to use the four macros to calibrate the probe.

Contained in this chapter

Why calibrate a probe?

When you fit your probe into the machine shank/holder, it is not necessary for the probe stylus to run true to the spindle centre line. A small amount of run-out can be tolerated, but it is good practice to get the stylus mechanically on-centre to reduce the effects of spindle and tool orientation errors. Without calibration of the probe, run-out will lead to inaccurate results. By calibrating the probe the run-out is automatically accounted for. The ‘calibration in a bored hole’ cycle (macro O9802) provides the data to allow for this run-out.

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

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

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

- Calibrating in a bored hole;
- Calibrating in a ring gauge; and
- Calibrating the probe length.

Calibrating in a bored hole

Calibrating a 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. Measured values are compensated by these values so that they are relative to the true spindle centre line.

Calibrating in a ring gauge

Calibrating a probe in a ring gauge that has a known diameter automatically stores one or more values for the radius of the stylus ball. These stored values are then automatically used by the measuring cycles to give the true size of the feature. The values are also used to give true positions of single surface features.

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

Calibrating the probe length

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

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

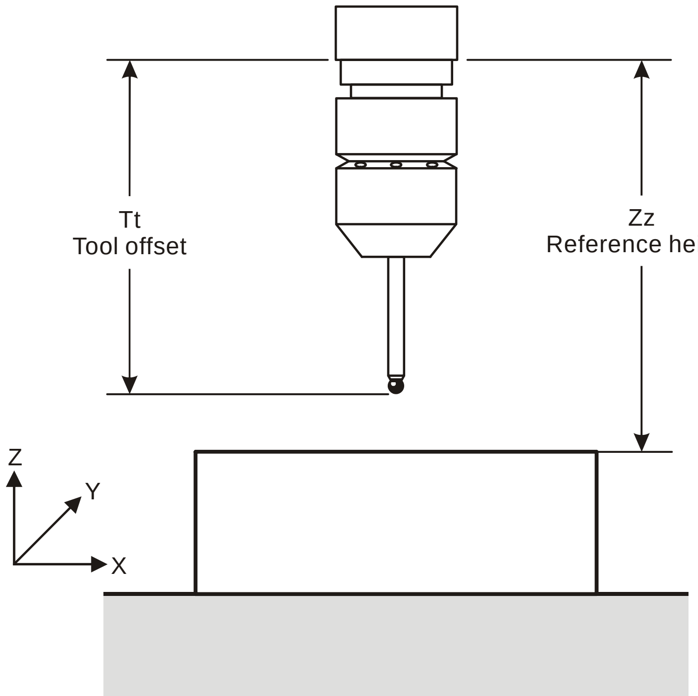

Figure 5.1 Calibrating the probe length

Description

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

Application

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

Format

G65 P9801 Zz Tt

Example: G65 P9801 Z50. T20

Compulsory inputs

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

Outputs

The active tool offset is set.

Example

Set the X, Y, Z values in a work offset (this example uses G54).

NOTE: The tool offset must be active. The active tool offset H word number must be the same as the T input number (shown underlined in this example).

O0001	
G90G80G40G0	Preparatory codes for the machine.
G54X0Y0	Start position.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z10.F3000	Protected positioning move.
G65P9801Z0T1.	Datum Z direction.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (when applicable).
G28Z100.	Reference return.
H00	Cancel the offset.
M30	End of the program.

Calibrating the stylus X and Y offsets (O9802)

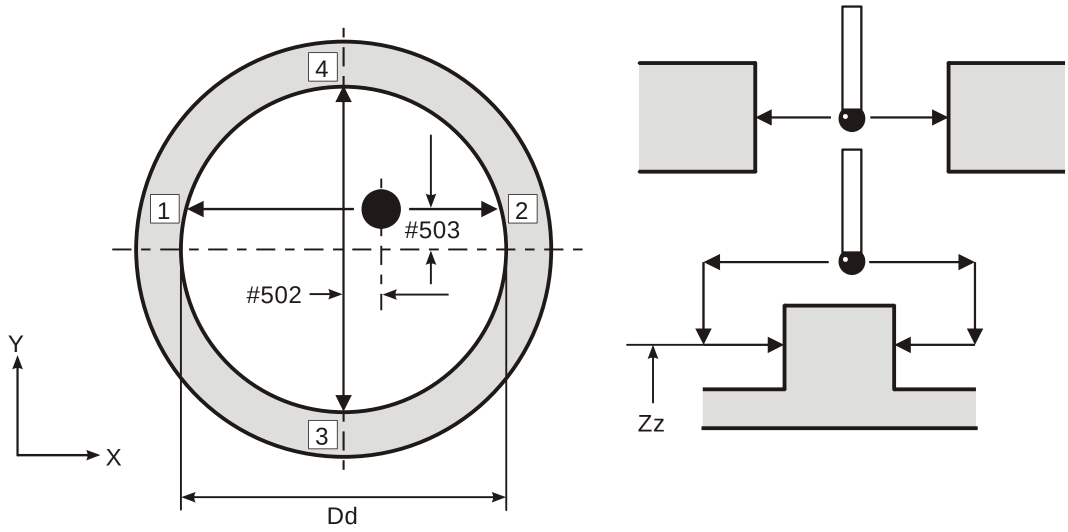

Figure 5.2 Calibrating the stylus X and Y offsets

Description

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

Application

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

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

Format

G65 P9802 Dd [Zz]
where [ ] denote optional inputs.

Example: G65 P9802 D50.005 Z50.

Compulsory input

Dd d = Nominal size of the feature.

Optional input

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

Outputs

The following data is stored:

#502 = X-axis stylus offset.

#503 = Y-axis stylus offset.

Example 1: Calibrating the stylus X, Y offset

A tool offset must be active before running this program.

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

O0002	
G90G80G40G0	Preparatory codes for the machine.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9802D50.	Calibrate in a 50 mm (1.97 in) diameter bored hole.
G65P9833	Switch the probe off (when applicable).
M30	End of the program.

Example 2: Calibrating the stylus X, Y offset (alternative method)

This example describes a complete positioning and calibration program.

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

O0002	
G90G80G40G0	Preparatory codes for the machine.
G54X0Y0	Move to the centre of the feature.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z-5.F3000	Protected positioning move into the 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	Switch the probe off (when applicable).
G28Z100.	Reference return.
H00	Cancel the offset (when applicable).
M30	End of the 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.

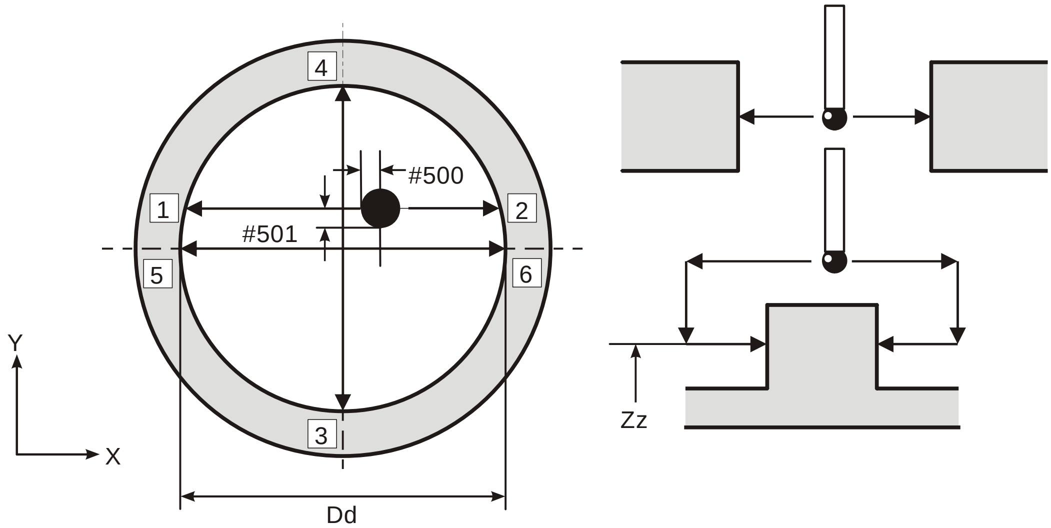

Figure 5.3 Calibrating the stylus ball radius

Description

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

Application

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

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

Format

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

Example: G65 P9803 D50.005 Z50. S1.

Compulsory input

Dd	d =	Size of the reference ring gauge.

Optional inputs

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

For optional input Ss, see Chapter 2, "Optional inputs".

Outputs

The following data is stored:

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

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

Example 1: Calibrating the radius of a stylus ball

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

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

O0003	
G90G80G40G0	Preparatory codes for the machine.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9803D50.001	Calibrate in a 50.001 mm (1.9685 in) diameter ring gauge.
G65P9833	Switch the probe off (when applicable).
M30	End of the program.

Example 2: Calibrating the radius of a stylus ball (alternative method)

This example describes a complete positioning and calibration program.

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

O0003	
G90G80G40G00	Preparatory codes for the machine.
G54X0Y0	Move to the centre of feature.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z-5.F3000	Protected positioning move into the 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	Switch the probe off (when applicable).
G28Z100.	Reference return.
H00	Cancel the offset (when applicable).
M30	End of the 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 7, "Vector measuring cycles"). Do not calibrate the stylus ball radius using macro O9803.

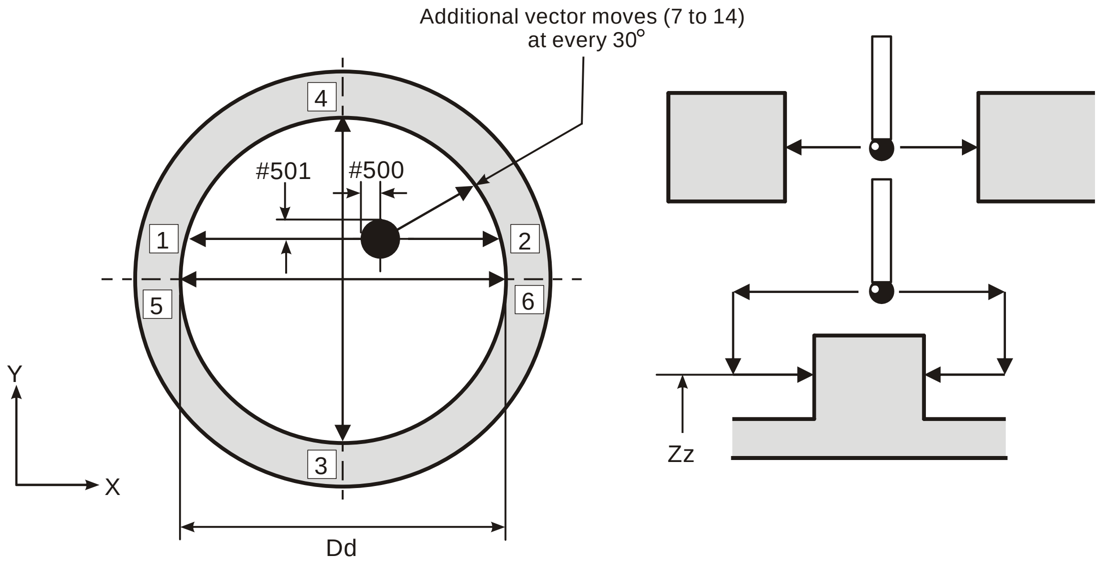

Figure 5.4 Calibrating the vector radius of a stylus ball

Description

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

Application

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

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

Format

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

Example: G65 P9804 D50.005 Z50. S1.

Compulsory inputs

Dd	d =	Size of the reference ring gauge.

Optional inputs

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

For optional input Ss, see Chapter 2, "Optional inputs".

Outputs

The following data is stored (as O9803):

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

Additional vector calibration data:

#510 = 30 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: Calibrating the vector stylus ball radius

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

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

O0004	
G90G80G40G0	Preparatory codes for the machine.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9804D50.001	Calibrate in a 50.001 mm (1.9685 in) diameter ring gauge.
G65P9833	Switch the probe off (when applicable).
M30	End of the program.

Example 2: Calibrating the vector stylus ball radius (alternative method)

This example describes a complete positioning and calibration program.

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

O0004	
G90G80G40G0	Preparatory codes for the machine.
G54X0Y0	Move to the centre of the feature.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
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	Switch the probe off (when applicable).
G28Z100.	Reference return.
H00	Cancel the offset (when applicable).
M30	End of the 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.

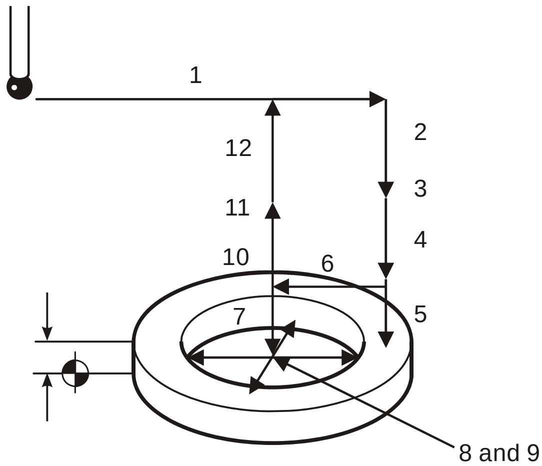

Figure 5.5 Full calibration in an internal feature

Assume the use of a 50.001 mm (1.9685 in) diameter ring gauge with a known centre position and top face height value.

Before running this program, do the following:

- Store the approximate length of the probe in the tool offset register.
- Set the exact X, Y, and Z feature positions in a work offset (this example uses G54).

	O0006	
	G90G80G40G0	Preparatory codes for the machine.
1.	G54X35.Y0	Move off the centre of the feature for height setting.
2.	G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
3.	G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
4.	G65P9810Z30.F3000	Protected positioning move above the reference surface.
5.	G65P9801Z20.006T1	Calibrate the probe length. The surface is at 20.006 mm (7.876 in).
6.	G65P9810X0Y0	Protected positioning move to the centre.
7.	G65P9810Z5.	Protected positioning move into the 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 radius values of the stylus ball, including the vector directions.
10.	G65P9810Z100.F3000	Protected positioning move retract to 100 mm (3.94 in).
11.	G65P9833	Switch the probe off (when applicable).
12.	G28Z100.	Reference return.
	H00	Cancel the offset (when applicable)
	M30	End of the 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.

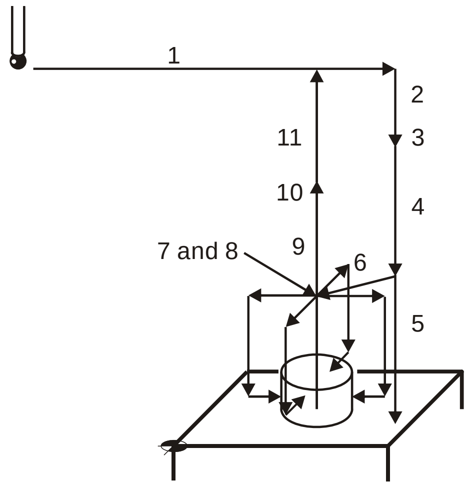

Figure 5.6 Full calibration on an external feature

Assume the use of a 50.001 mm (1.9685 in) diameter pin gauge, with a known centre position and a Z-reference surface.

Before running this program, do the following:

- Store the approximate length of the probe in the tool offset register.
- Set the exact X, Y pin feature positions and Z surface height in a work offset (this example uses G54).

	O0006	
	G90G80G40G0	Preparatory codes for the machine.
1.	G54X135.Y100.	Move to the centre of the feature for height setting.
2.	G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
3.	G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
4.	G65P9810Z30.F3000	Protected positioning move above the reference surface.
5.	G65P9801Z0.T1	Calibrate the probe length. The Z surface is at zero.
6.	G65P9810X100.Y100.	Protected positioning move to the 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	Switch the probe off (when applicable).
11.	G28Z100.	Reference return.
	H00	Cancel the offset (when applicable).
	M30	End of the program.

Chapter 6

Measuring cycles

This chapter describes how to use the non-vector measuring cycles. Before using these cycles, the radius of the stylus ball must be calibrated using either macro O9803 or O9804 (see Chapter 5, "Calibrating the probe").

Contained in this chapter

X Y Z single surface measurement (O9811)

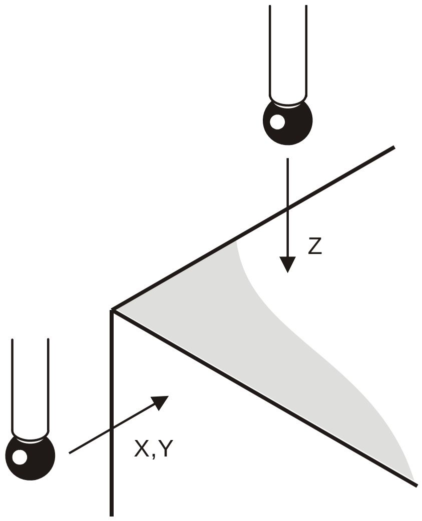

Figure 6.1 Measurement of a single surface

Description

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

Application

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

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

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

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

Format

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

Example: G65P9811X50.E21.F0.8H0.2M.2Q10.S1.T20. U.5V.5W2.

Compulsory inputs

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

Optional inputs

See Chapter 2, "Optional inputs".

Example: Measuring a single surface in X and Z

T01M06	Select the probe.
G54X-40.Y20.	Start position.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z-8.F3000	Protected positioning move to the start position.
G65P9811X-50.T10.	Single surface measurement.
G65P9810Z10.	Protected positioning move.
G65P9810X-60.	Protected positioning move.
G65P9811Z0T11	Single surface measurement.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (where applicable).
G28Z100.	Reference return.
continue	

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

Web/pocket measurement (O9812)

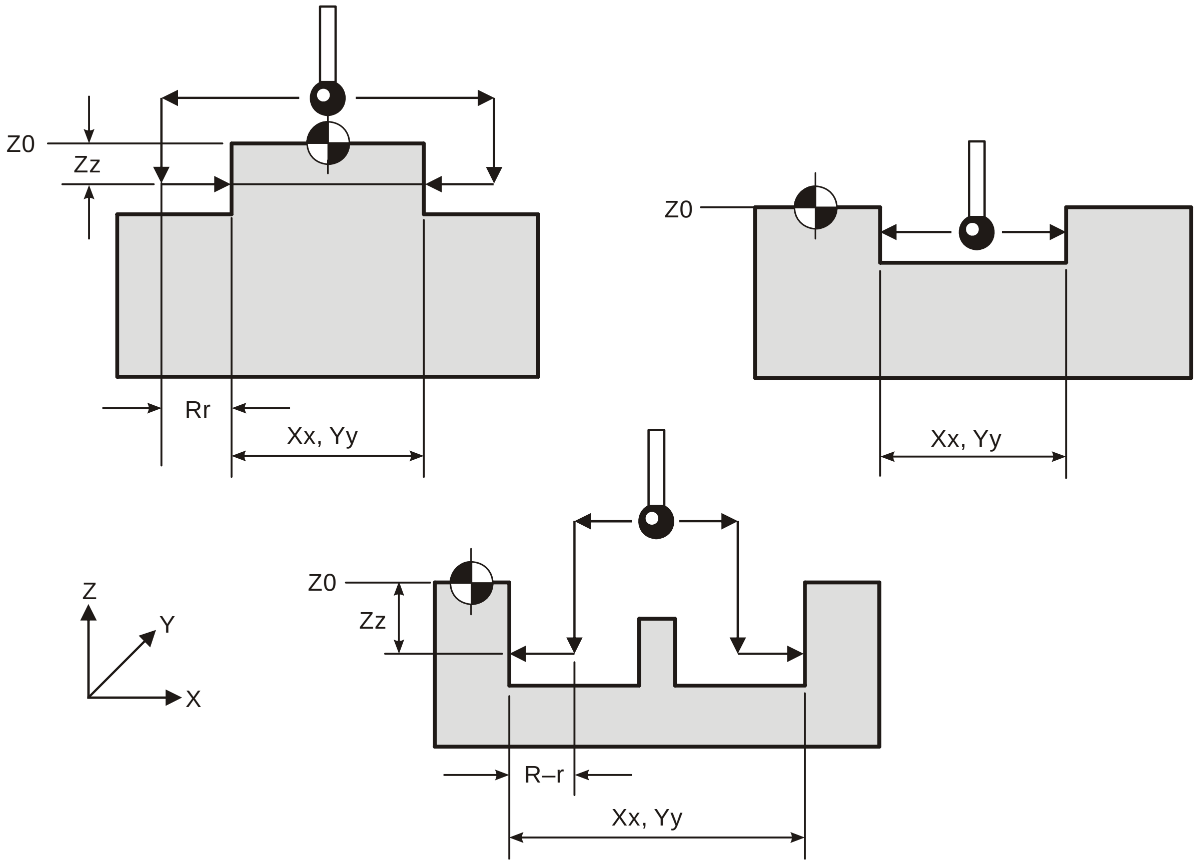

Figure 6.2 Measurement of a web or pocket feature

Description

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

Application

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

Format

G65 P9812 Xx [Ee Ff Hh Mm Qq Rr Ss Tt 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. E21. F0.8 H0.2 M.2 Q10. R10. S1. T20. U.5 V.5 W2.

Compulsory inputs

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

Optional inputs

See Chapter 2, "Optional inputs".

Outputs

See Chapter 3, "Variable outputs".

Example 1: Measuring a web

T01M06	Select the probe.
G54X0Y0	Start position.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z10.F3000	Protected positioning move.
G65P9812X50.Z-10.S2	Measure a 50.0 mm (1.968 in) wide web.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (where applicable).
G28Z100.	Reference return.
continue	

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

Example 2: Measuring a pocket (referred datum)

T01M06	Select the probe.
G54X100.Y50.	Start position.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z-10.F3000.	Protected positioning move.
G65P9812X30.S2	Measure a 30.0 mm (1.181 in) wide pocket.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (where applicable).
G28Z100.	Reference return.
continue	

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

Bore/boss measurement (O9814)

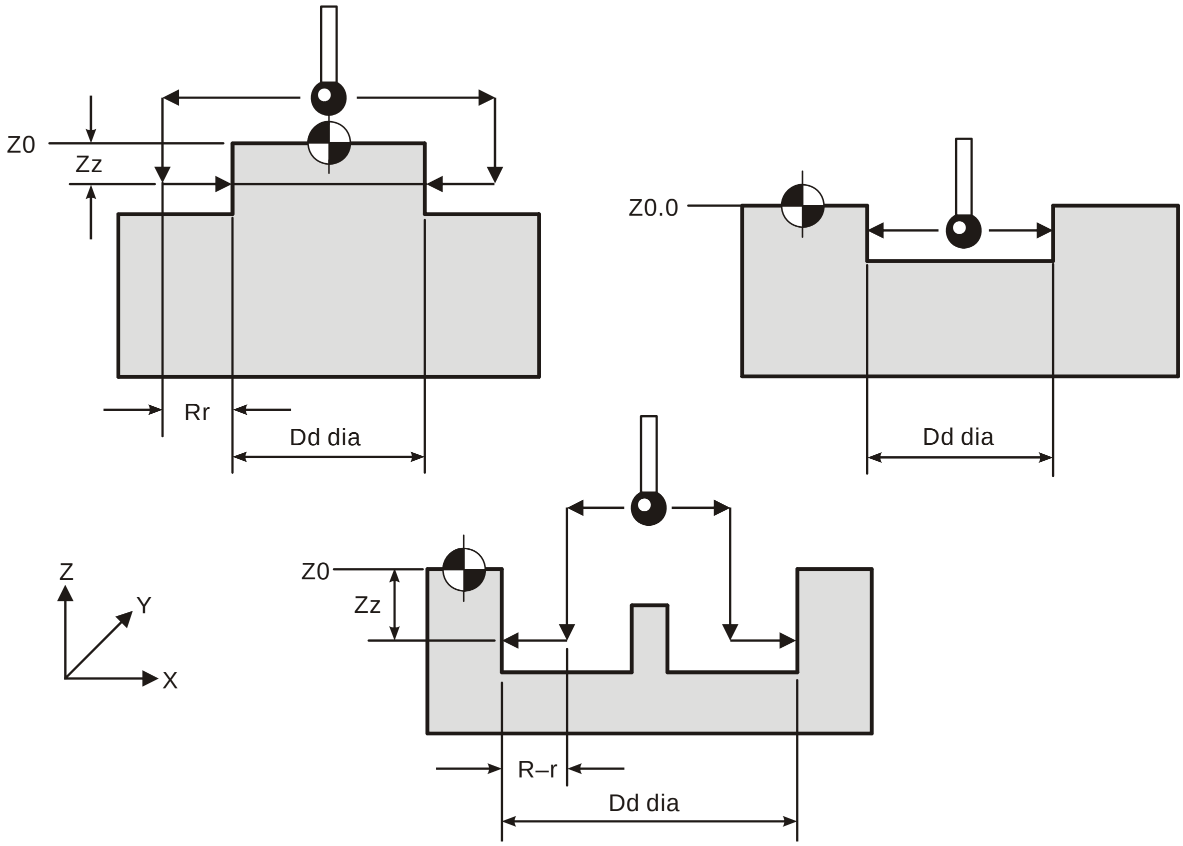

Figure 6.3 Measurement of a bore or boss feature

Description

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

Application

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

Format

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

or

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

where [ ] denote optional inputs.

Example: G65 P9814 D50.005 Z100. E21. 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

See Chapter 2, "Optional inputs".

Outputs

See Chapter 3, "Variable outputs".

Example 1: Measuring a boss

T01M06	Select the probe.
G54X0Y0	Start position.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z10.F3000	Protected positioning move.
G65P9814D50.Z-10.S2.R10.	Measure a 50.0 mm (1.968 in) diameter boss.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (when applicable).
G28Z100.	Reference return.
continue	

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

Example 2: Measuring a bore (referred datum)

T01M06	Select the probe.
G54X100.0Y100.	Start position.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z-10.F3000	Protected positioning move.
G65P9814D30.S2	Measure a 30.0 mm (1.181 in) diameter bore.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (when applicable)
G28Z100.	Reference return.
continue	

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

Finding an internal corner (O9815)

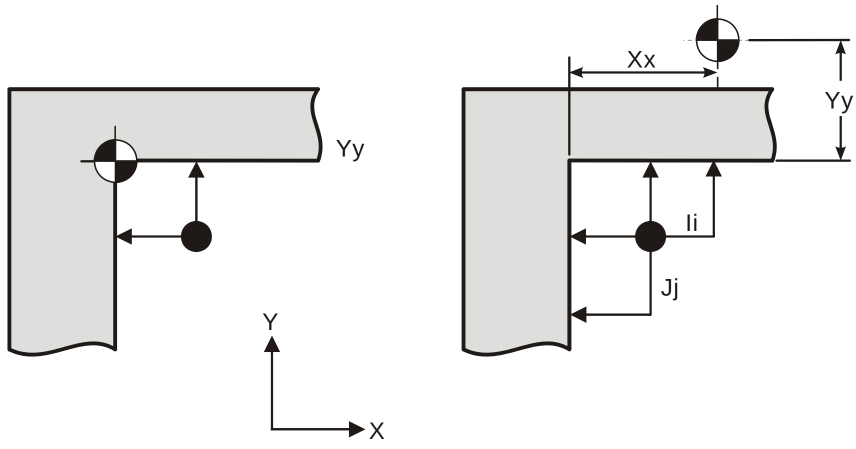

Figure 6.4 Finding an internal corner position

Description

This cycle is used to establish the corner position of a feature. A true corner intersection can be found when the corner is not 90 degrees.

Application

With the tool offset active, position the probe at the start position. The probe measures the Y-axis surface first then measures the X-axis surface. It then returns to the start position.

If an error occurs during the cycle, the probe returns to the start position.

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 the order shown above.

Compulsory inputs

Xx	x =	The nominal position of the corner in the X-axis.
Yy	y =	The nominal position of the corner in the Y-axis.

Optional inputs

A note about inputs I and J

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

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

Bb b = Angle tolerance. This applies to both X and Y surfaces. It is equal to half the total tolerance.

Example: ±0.25 degrees = B.25 tolerance.

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

Default value: no move.

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

Default value: no move.

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

Outputs

The measurement values of the feature are stored in variables #135 to #149 (for details, see Chapter 3, “Variable outputs”).

W2. Component number +1, feature number 1

W1 Feature number +1

The data listed below will be output:

1. The corner positions.
2. The tolerance if used.
3. The error in the X-axis.
4. The error in the Y-axis.
5. The work offset number if used.

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

Mm)
Uu) See Appendix G "Output flow (bore/boss and web/pocket cycles)" for the general output structure.

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.

T01M06	Select the probe.
G54X10.0Y10.	Start position.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z-5.F3000	Protected positioning move.
G65P9815X20.Y20.I10.J10.	Corner find.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (where applicable)
G28Z100.	Reference return.
G17	Select the plane.
G68X#135Y#136R#139	Set the rotational position and angle.
continue machining	
G69	Cancel the rotation mode.

Finding an external corner (O9816)

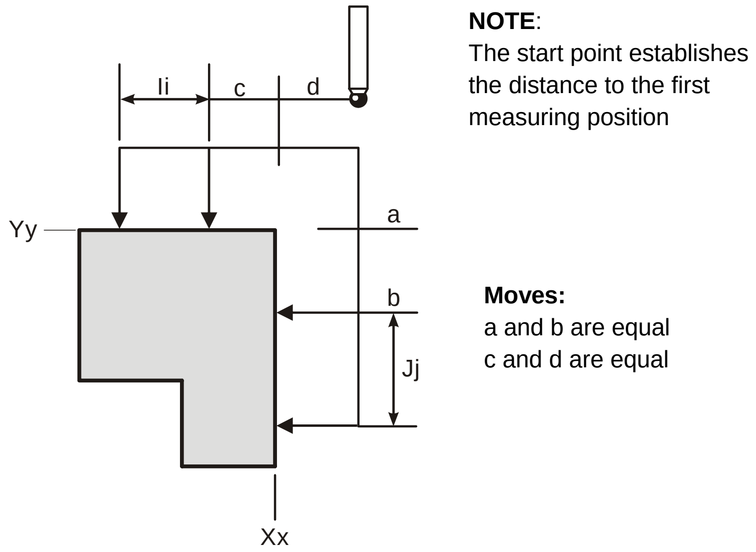

Figure 6.5 Finding an external corner

Description

This cycle is used to establish the corner position of a feature. A true corner intersection can be found when the corner is not 90 degrees.

Application

With the tool offset active, position the probe at the start position. The probe measures the Y-axis surface first then measures the X-axis surface. It then returns to the start position.

If an error occurs during the cycle, the probe returns to the start position.

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 the order shown above.

Compulsory inputs

Xx x = The nominal position of the corner in the X-axis.

Yy y = The nominal position of the corner in the Y-axis.

Optional inputs

A note about inputs I and J

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

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

Bb b = Angle tolerance. This applies to both X and Y surfaces. It is equal to half the total tolerance.

Example: ±0.25 degrees = B.25 tolerance.

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

Default value: no move.

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

Default value: no move.

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

Outputs

The measurement values of the feature are stored in variables #135 to #149 (for details, see Chapter 3, “Variable outputs”).

W2. Component number +1, feature number 1

W1 Feature number +1

The data listed below will be output:

1. The corner positions.
2. The tolerance if used.
3. The error in the X-axis.
4. The error in the Y-axis.
5. The work offset number if used.

Ss	The work offset stated will be set such that the nominal X Y positions will be corrected.
Mm) Uu)	See Appendix G "Output flow (bore/boss and web/pocket cycles)" for the general output structure.

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.

T01M06	Select the probe.
G54X-10.Y-10.	Start position.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z-5.F3000	Protected positioning move.
G65P9816X0Y0I10.J10.	Corner find.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (where applicable).
G28Z100.	Reference return.
G17	Select the plane.
G68X#135Y#136R#139	Set the corner position and angle.
continue machining	
G69	Cancel the co-ordinate rotation mode.

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Chapter 7

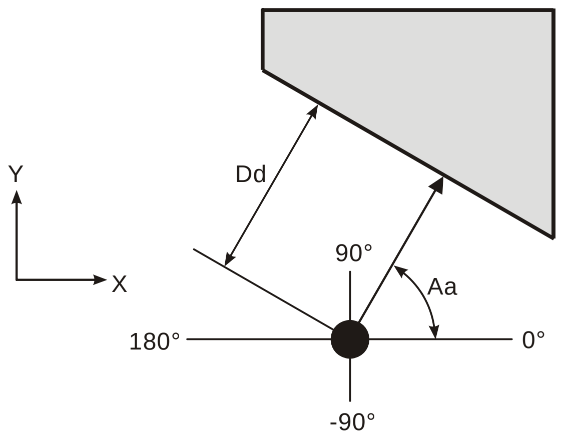
Vector measuring cycles

This chapter describes how to use the vector measuring cycles. Before using these cycles, the radius of the stylus ball must be calibrated using macro O9804 (see Chapter 5, "Calibrating the probe"). Do **not** use macro O9803 to calibrate the probe stylus.

Contained in this chapter

Single angled surface measurement (O9821)

NOTE: Before using this cycle the probe must have been calibrated recently using the vector stylus ball radius cycle (O9804) (described in Chapter 5, "Calibrating the probe"). Do **not** use macro O9803 to calibrate the probe.



NOTE:
Angles are in the range ±180 degrees.
Positive (+) angle: Counter-clockwise direction.
Negative (–) angle: Clockwise direction.

Figure 7.1 Measuring a single angled surface

Description

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

Application

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

Format

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

Example: G65 P9821 A45.005 D50.005 E21. F0.8 H0.2 M0.2 Q10. S1. T20. U.5 V.5 W2.

Compulsory inputs

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

Optional inputs

See Chapter 2, "Optional inputs".

Outputs

See Chapter 3, "Variable outputs".

Example: Measuring a single angled surface

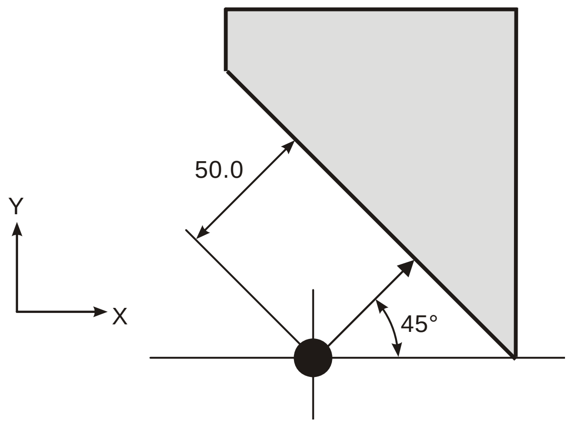


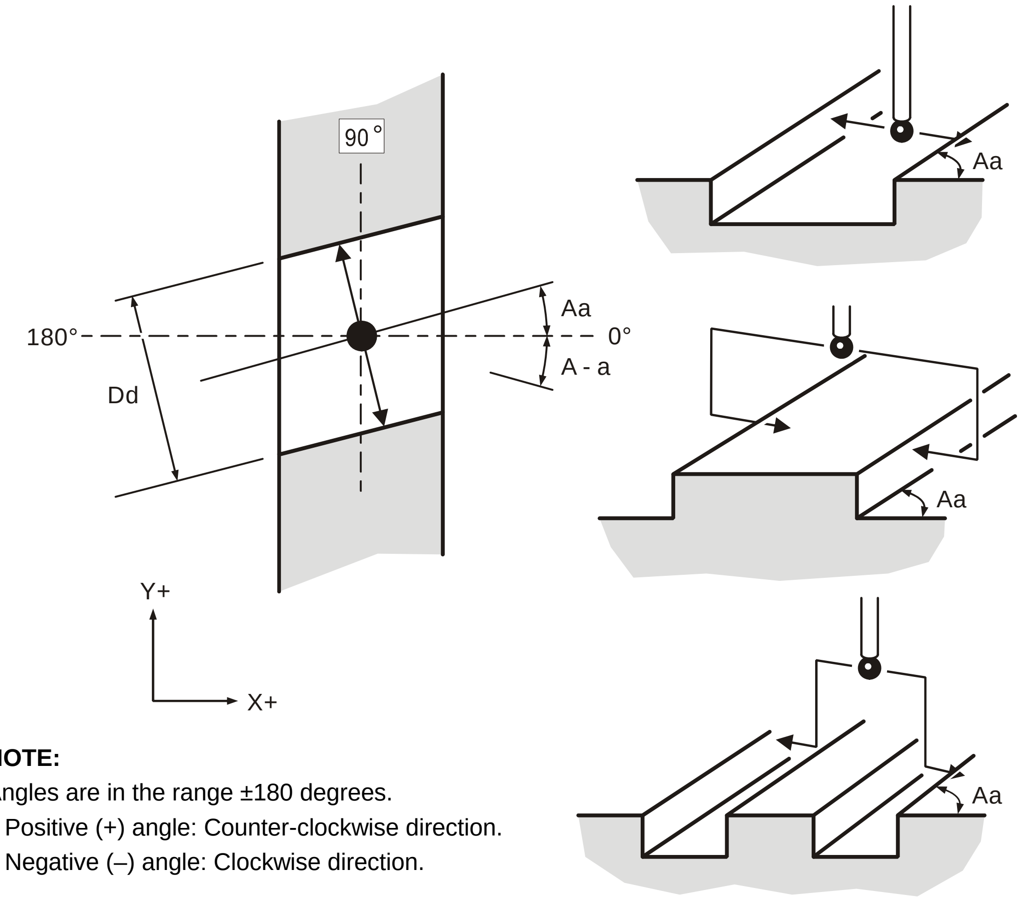
Figure 7.2 Measuring a single angled surface

T01M06	Select the probe.
G54X-40.Y20.	Start position.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z-8.F3000	Protected positioning move to the start position.
G65P9821A45.D50.T10	Single surface measurement.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (when applicable).
G28Z100.	Reference return.

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

Angled web or pocket measurement (O9822)

NOTE: Before using this cycle the probe must have been calibrated recently using the vector stylus ball radius cycle (O9804) (described in Chapter 5, "Calibrating the probe"). Do **not** use macro O9803 to calibrate the probe.



NOTE:
Angles are in the range ±180 degrees.
Positive (+) angle: Counter-clockwise direction.
Negative (–) angle: Clockwise direction.

Figure 7.3 Measuring an angled web or pocket

Description

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

Application

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

Format

G65 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 [ ] denote optional inputs.

Example: G65 P9822 A45.005 D50.005 Z50. E21. 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

See Chapter 2, "Optional inputs".

Outputs

See Chapter 3, "Variable outputs".

Example: Measuring an angled web

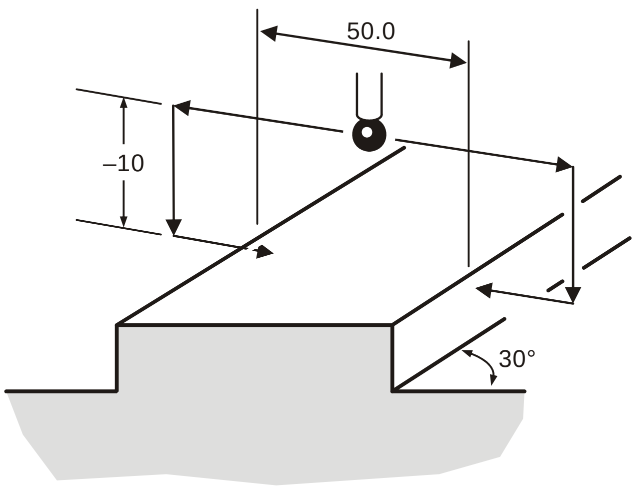


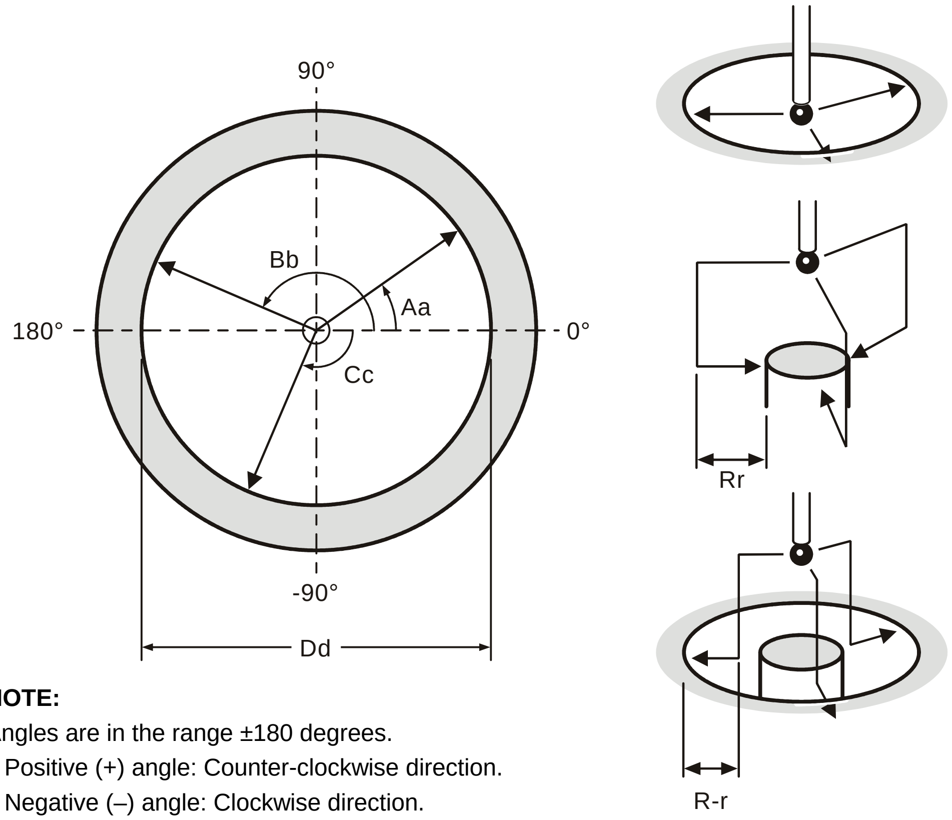
Figure 7.4 Measuring an angled web

T01M06	Select the probe.
G54X0Y0	Start position.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65 P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z10.F3000	Protected positioning move.
G65P9822A30.D50.Z-10.S2	Measure a 50.0 mm (1.9685 in) wide web at 30 degrees.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (when applicable).
G28Z100.	Reference return.
continue	

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

3-point bore or boss measurement (O9823)

NOTE: Before using this cycle the probe must have been calibrated recently using the vector stylus ball radius macro (O9804) (described in Chapter 5, "Calibrating the probe"). Do not use macro O9803 to calibrate the probe.



NOTE:
Angles are in the range ±180 degrees.
Positive (+) angle: Counter-clockwise direction.
Negative (–) angle: Clockwise direction.

Figure 7.5 3-point bore or boss measurement

Description

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

Application

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

Format

G65 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 Vv Ww]

where [ ] denote optional inputs.

Example: G65 P9823 A45.005 B150.0 C35.005 D50.005 Z50. E21. F0.8 H0.2 M0.2 Q10. R10. S1. T20. U.5 V.5 W2.

Compulsory inputs

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

Optional inputs

See Chapter 2, "Optional inputs".

Outputs

See Chapter 3, "Variable outputs".

Example: 3-point bore measurement (referred datum)

T01M06	Select the probe.
G54X100.Y100.	Start position.
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65 P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z-10.F3000	Protected positioning move.
G65P9823D30.A30.B150.C-90.S2	Measure a 30.0 mm (1.181 in) diameter bore.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (when applicable).
G28Z100.	Reference return.
continue	

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

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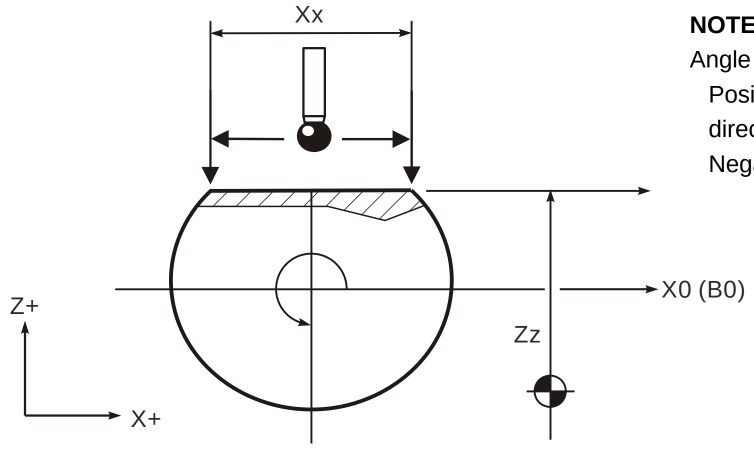
Chapter 8

Additional cycles

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

Contained in this chapter

4th axis X measurement (O9817)



NOTE:
Angle correction to the 4th axis:
Positive (+) angle: Counter-clockwise direction.
Negative (–) angle: Clockwise direction.

Figure 8.1 4th axis X measurement

Description

This macro is used to find the slope of a surface between two points (Z1 and Z2). The 4th axis can then be rotated to compensate for the surface error.

Application

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

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

Format

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

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

Compulsory inputs

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

Optional inputs

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

Example: With a component dimension of 45 degrees (±0.25 degrees), the 4th axis will be positioned to 45 degrees and B.25 tolerance.

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

Outputs

#139 will show the measured position of the 4th axis.

#143 will show the (Z1 - Z2) value.

#144 will show the angle correction value.

NOTE: Different machines and applications may require the 4th axis system variable number to be changed. This is done by editing macro O9817 to suit your machine when the macro is installed.

4th axis address setting edits

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

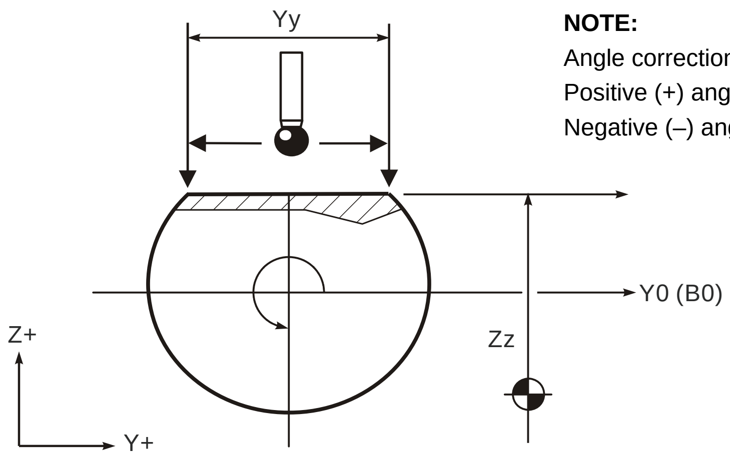
Axis direction change edits

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

Example: Setting the 4th axis to a milled flat

T01M06	Select the probe.
G43H1Z200.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G0B45.	Position the 4th axis to 45 degrees.
G65P9810X0Y0Z20.F3000	Position 10 mm (0.394 in) above the surface.
G65P9817X50.Z10.B5.	Measure at 50 mm (1.9685 in) centres, update G54 and set a tolerance of 5 degrees.
G65P9810Z200.	Protected positioning move.
G65P99833	Switch the probe off (when applicable).
G28Z200.	Reference return.
continue	

4th axis Y measurement (O9818)



NOTE:
Angle correction to the 4th axis:
Positive (+) angle: Counter-clockwise direction.
Negative (–) angle: Clockwise direction.

Figure 8.2 4th axis Y measurement

Description

This macro is used to find the slope of a surface between two points (Z1 and Z2). The 4th axis can then be rotated to compensate for the surface error.

Application

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

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

Format

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

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

Compulsory inputs

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

Optional inputs

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

Example: With a component dimension of 45 degrees (±0.25 degrees), the 4th axis will be positioned to 45 degrees and B.25 tolerance.

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

Outputs

#139 will show the measured position of the 4th axis.

#143 will show the (Z1 - Z2) value.

#144 will show the angle correction value.

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

4th axis address setting edits

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

Axis direction change edits

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

Example: Setting the 4th axis to a milled flat

T01M06	Select the probe.
G43H1Z200.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G0A45.	Position the 4th axis to 45 degrees.
G65P9810X0Y0Z20.F3000	Position 10 mm (0.394 in) above the surface.
G65P9818Y50.Z10.S1.B5.	Measure at 50 mm (1.9685 in) centres, update G54 and set a tolerance of 5 degrees.
G65P9810Z200.	Protected positioning move.
G65P9833	Switch the probe off (when applicable).
G28Z200.	Reference return.
continue	

Bore/boss on PCD measurement (O9819)

NOTE:
Angles are in the range ±180 degrees.
Positive (+) angle: Counter-clockwise direction.
Negative (–) angle: Clockwise direction.

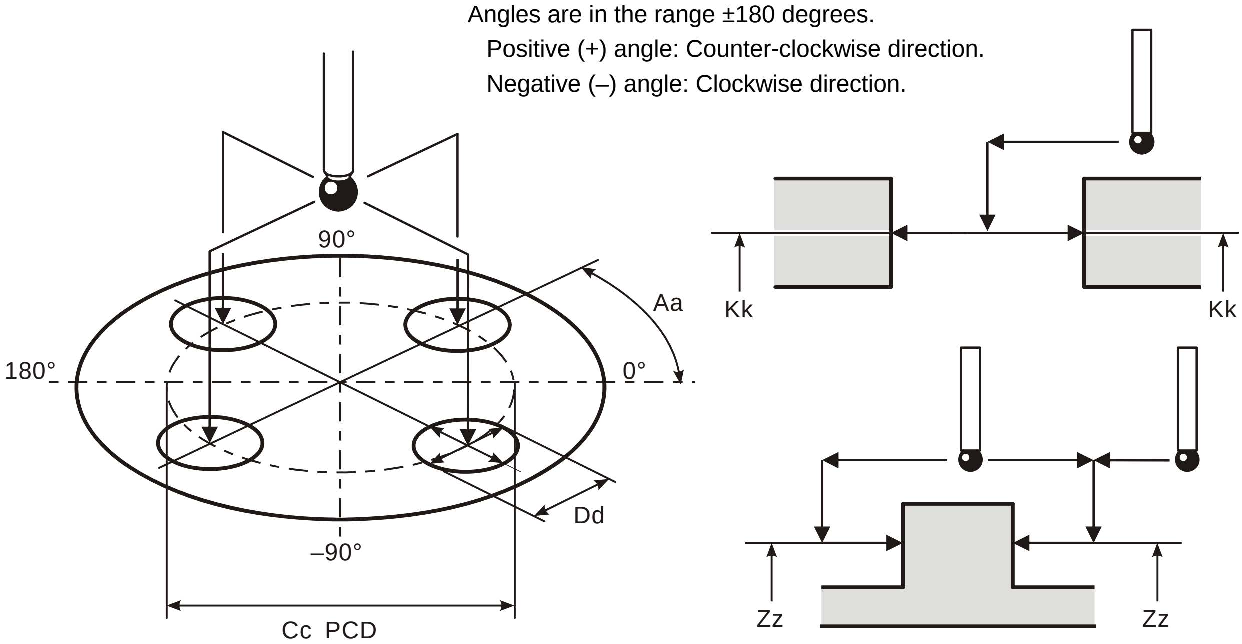


Figure 8.3 Bore/boss on PCD measurement

Description

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

Application

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

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

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

Format

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

or

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

where [ ] denote optional inputs.

Example: G65 P9819 C28.003 D50.005 K11. A45.005 B2. E21. H0.2 M0.2 Q10. R10. 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 at which the bore is to be measured.

Zz z = Absolute Z axis position at which the boss is to be measured.

Optional inputs

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

Default value: 0.

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

Default value: 1.

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

Outputs

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

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

W1. Feature number (incremented by 1).

The data listed below is output to the online device (printer). For details of the print macro output format, see Appendix F, “Printing a macro output”.

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

- The feature number.
- The error of the size and position.

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

If #120 is set, the UPPER TOLERANCE EXCEEDED alarm occurs and #119 = 2 is set. Otherwise, only the flag #119 = 2 is set.

The program continues.

Stock allowance (O9820)

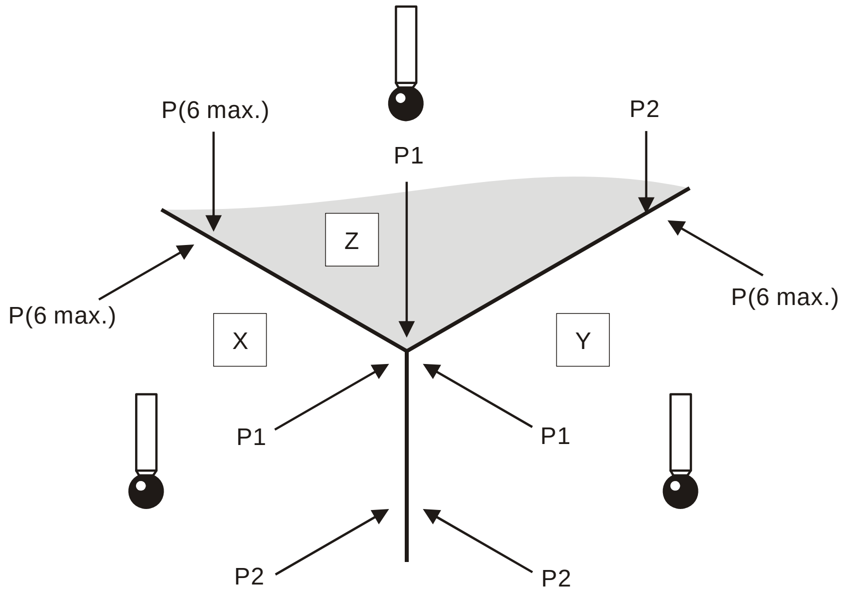


Figure 8.4 Measuring the stock allowance

Description

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

Application

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

NOTES:

1. When a work offset is set, the surface position is at the minimum measured position and the stock value is seen in #146.
2. When a work offset is **not** set, the nominal position is assumed and the maximum and minimum values are seen in #144 and #145 respectively.

Format

X-surface measure

G65 P9820 Xx Jj Kk [Ss Uu]

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

or

Y-surface measure

G65 P9820 Yy Ii Kk [Ss Uu]

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

or

Z-surface measure

G65 P9820 Zz Ii Jj [Ss Uu]

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

where [ ] denote optional inputs.

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

Compulsory inputs

Xx
or
Yy x, y, z = The nominal surface position for checking the stock allowance.
or
Zz

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

or

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

or

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

Optional inputs

Ss s = The work offset number that will be set. It will be set to the minimum metal position #145.

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.

Uu u = The maximum stock allowance or upper tolerance (metal condition).

1. Uu input only.
   The upper tolerance metal condition. For example, the surface is at 30.00 +2.0/-0.0
   G65P9820Z30.0U2.0IiJj
2. Uu and Ss inputs.
   The maximum stock allowance.

Outputs

With the Uu input only	The upper tolerance exceeded flag #148 is set to 3.
With the Uu and Ss inputs	The excess stock flag #148 is set to 6.
#144	The maximum value (metal condition).
#145	The minimum value (metal condition).
#146	Variation (stock allowance).

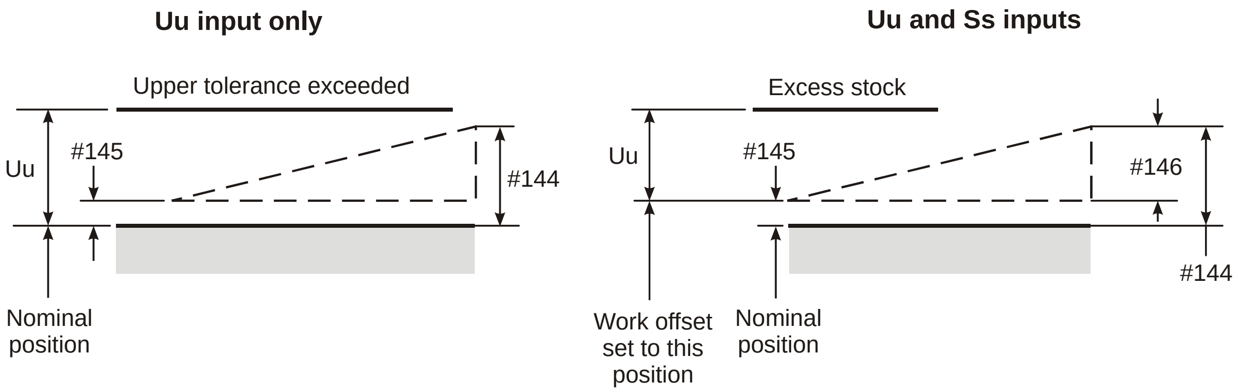


Figure 8.5 Outputs for the stock allowance cycle

Example 1: Checking a Z surface for stock variation

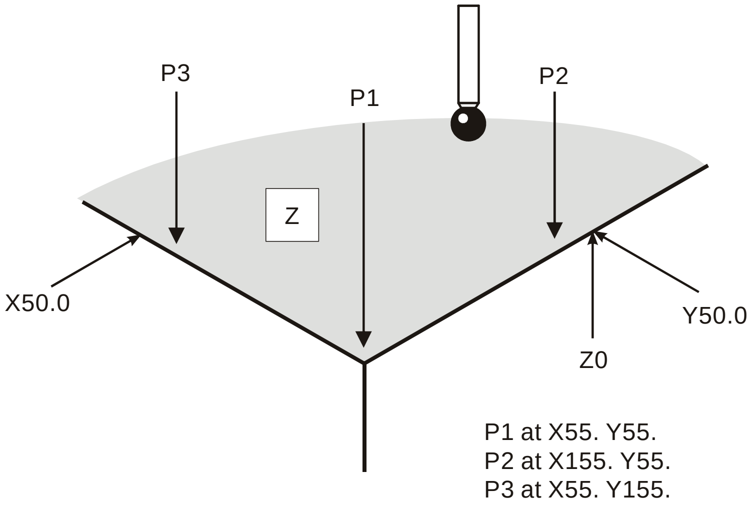


Figure 8.6 Checking a Z surface for stock variation

Select the probe.

G65P9810X55.Y55.Z20.F3000	Protected positioning move to P1.
G65P9820Z0I155.J55.I55.J155.U2.	Measure at P1, P2, P3 and set a 2 mm (0.0 39 in) tolerance.

continue machining

Example 2: Checking an X surface and updating a work offset

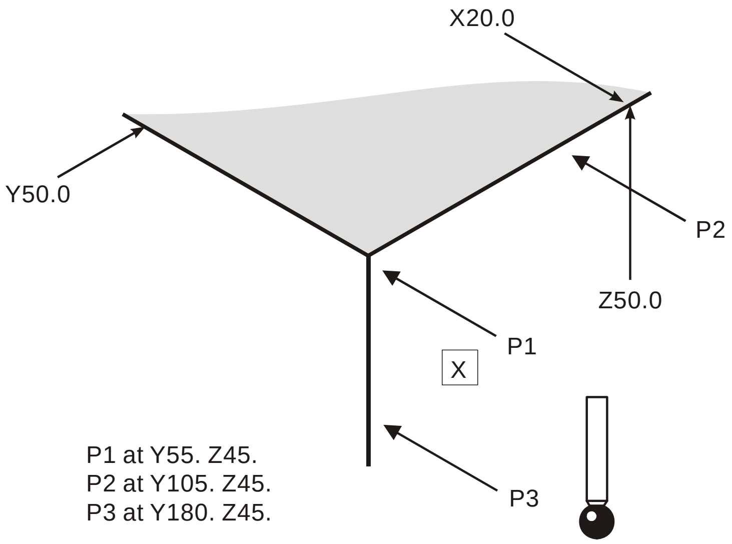


Figure 8.7 Checking an X surface and updating a work offset

Select the probe.

G65P9810X40.Y55.Z45.F3000	Protected positioning 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 the tool and offset G55 for machining the X surface at the new X20. surface position.

Storing multi-stylus data (O9830)

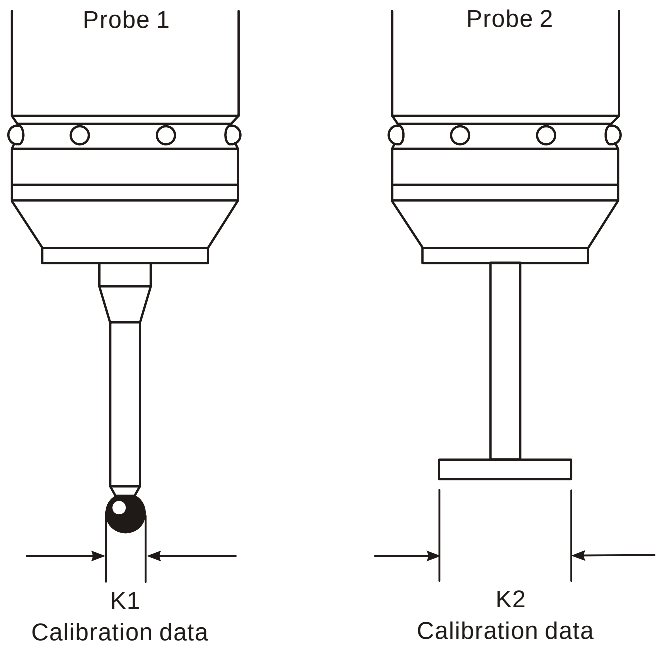


Figure 8.8 Storing multi-stylus data

Description

The macro is used to store the stylus calibration data that is established during the calibration cycles. Data is stored in a spare set of macro variables.

Use this macro in conjunction with macro O9831 to recall relevant calibration data for each probe.

Application

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

Format

G65 P9830 Kk

Example: G65P9830K11.

Compulsory input

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

	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 (K11 to K14)

#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, in which 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 (the X, Y, Z values must be set in the work offset).
G43H1Z100.	Activate offset 1 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z-5.F3000	Protected positioning move for Z.
G65P9803D50.001	Calibrate in a reference feature (ring gauge).
G65P9830K1	Store the calibration values for multi-stylus K1.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (when applicable).
G28Z100.	Reference return.
H00	Cancel the offset.
M30	End of the program.

Loading multi-stylus data (O9831)

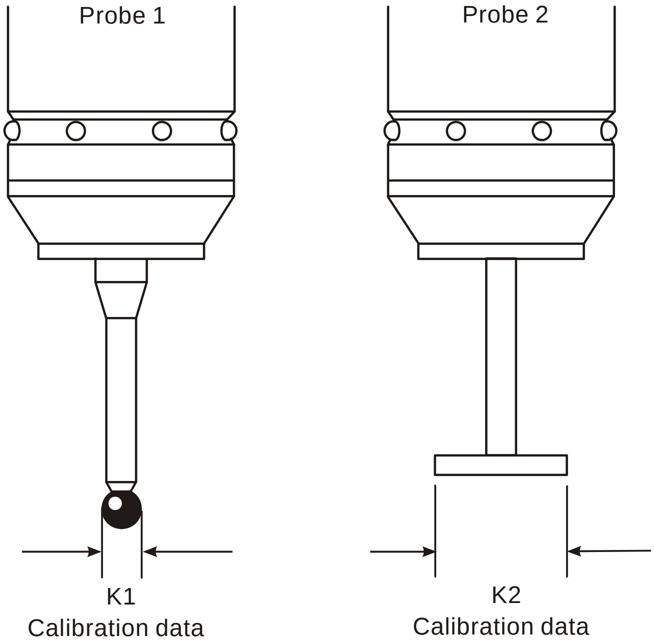


Figure 8.9 Recalling multi-stylus data

Description

This macro is used, in conjunction with O9830, 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 a 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 that is used for recalling data.

For a given stylus the Kk input number must always be the same as that used to store the calibration data when using O9830.

	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 loaded 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, in which data may 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 and go to 100 mm (3.94 in) above.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810Z-10.F3000	Protected positioning move.
G65P9831K1	Load the 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 the calibration values for multi-stylus K2.
G65P9814D130.S2	Measure a 130.0 mm (5.12 in) diameter bore.
G65P9810Z100.	Protected positioning move.
G65P9833	Switch the probe off (when applicable).
G28Z100.	Reference return.
continue	

Switching the probe on (O9832)

Description

This macro is used to switch the probe on before it is used. With a probe tool offset active, the probe is loaded into the spindle and moved to a safe start plane before it is activated.

In the event of a startup failure, a loop in the software tries to activate the probe up to four times. If the probe does not activate, an alarm results.

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

Format

M98P9832

Example

G43H20Z100.	Apply a tool offset and move to a safe plane.
G65P9832	Switch the probe on (this includes M19). Alternatively, use M19 to orientate the spindle.
G65P9810X- - --Y- - -F- - -	Move to a gauging position.

Switching the probe off (O9833)

Description

This macro is used to switch the probe off after it has been used. With a probe tool offset active, the probe is retracted to a safe start plane and switched off before a tool change.

A loop in the software 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 that the probe is active. This means that the G28 reference return must be done after this macro, otherwise the G28 position is not effective.

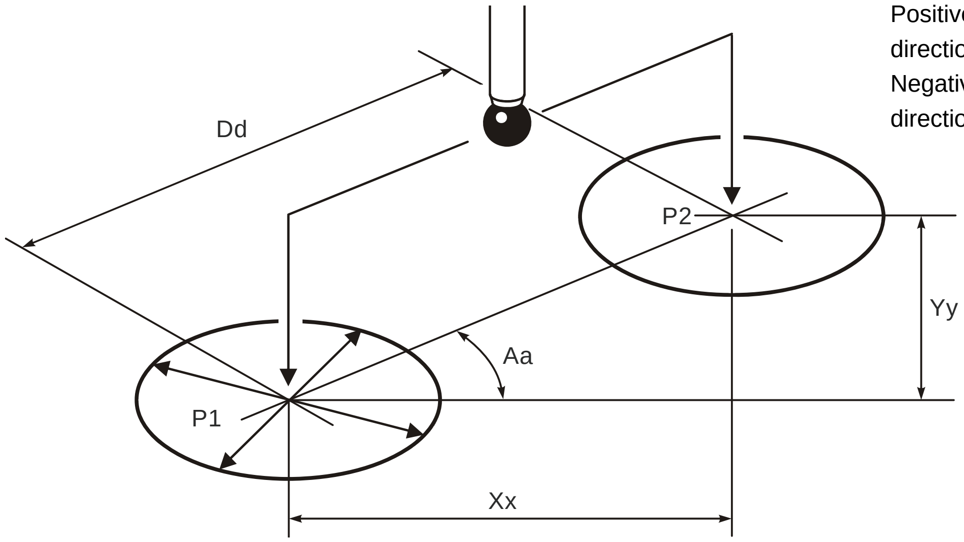
Format

M98P9833

Example

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

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



NOTE:
Angles are in the range ±180 degrees.
Positive (+) angle: Counter-clockwise direction.
Negative (–) angle: Clockwise direction.

Figure 8.10 Determining feature-to-feature data in the XY plane

Description

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

Application

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

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

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

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

Format

G65 P9834 Xx [Ee Ff Hh Mm Ss Tt 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 [ ] denote optional inputs.

Examples: G65P9834X100.E21.F0.8H0.2M0.2S1.T20.U.5V.5W2.
or
G65P9834Y100.E21.F0.8H0.2M0.2S1.T20. U.5V.5W2.
or
G65P9834X100.Y100.B2.E21.H0.2M0.2S1. U.5W2.
or
G65P9834A45.005D50.005B2.E21.H0.2 M0.2S1.U.5W2.

NOTES:

1. Updating a tool offset with the T input is possible only if either O9811 or O9821 is used for the P2 data. Otherwise a T INPUT NOT ALLOWED alarm results.
2. This cycle cannot be used in conjunction with the web/pocket cycle macro O9812.
3. Angles. The XY plane is with respect to the X+ axis direction. Use angles in the range ±180 degrees.
4. When G65P9834 (without any inputs) is used, the following data is then stored:

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

Compulsory inputs

Aa	a =	The angle of P2 with respect to P1 when measured from the X+ axis (angles are between ±180 degrees).
Dd	d =	The minimum distance between P1 and P2.
Xx	x =	The nominal incremental distance in the X axis.

Yy	y =	The nominal incremental distance in the Y axis.
(no inputs)		This is used to store output data of the last cycle for P1 data.

Optional inputs

See Chapter 2, "Optional inputs".

Outputs

See Chapter 3, "Variable outputs".

Example 1: Measuring the incremental distance between two holes

G65P9810X30.Y50.F3000	Protected positioning move.
G65P9810Z-10.	Protected positioning move.
G65P9814D20.	P1 20 mm (0.787 in) bore.
G65P9834	Store the data.
G65P9810Z10.	Protected positioning move.
G65P9810X80.Y78.867	Move to the new position.
G65P9810Z-10.	Protected positioning move.
G65P9814D30.	P2 30 mm (1.181 in) bore.

And either this

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

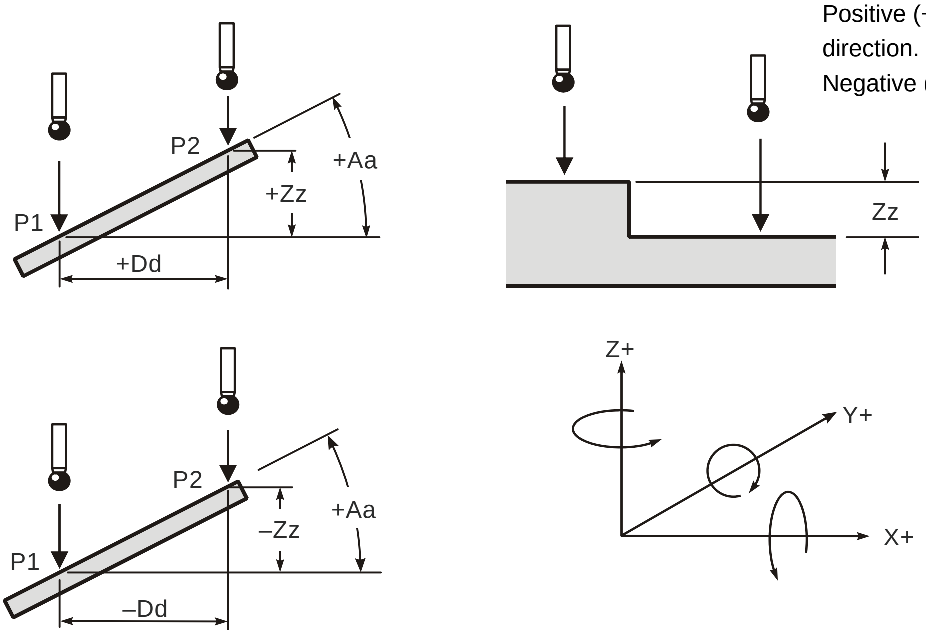
or this

G65P9834A30.D57.735M.1

Example 2: Measuring a surface to bore

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

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



NOTE:
Angles are in the range ±180 degrees.
Positive (+) angle: Counter-clockwise direction.
Negative (–) angle: Clockwise direction.

Figure 8.11 Determining feature-to-feature data in the Z plane

Description

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

Application

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

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

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

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

Format

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

or

G65 P9834 Aa Zz [Bb Ww]

or

G65 P9834 Dd Zz [Bb Ww]

or

G65 P9834 (with no inputs)

where [ ] denote optional inputs.

Examples: G65P9834Z50.E21.F0.8H0.2M0.2S1.T20. U.5V.5W2.

or

G65P9834A45.005Z50.B2.W2.

or

G65P9834D50.005Z50.B2.W2.

or

G65P9834 (with no inputs)

NOTES:

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

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

Inputs

Aa and Zz, or Dd and Zz inputs

1. The +Dd / –Dd values should be used to indicate the direction of P2 with respect to P1.
2. Angles are between ±180 degrees.
3. A positive Aa (+Aa) angle is in the counter-clockwise direction.

Zz input only

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

Compulsory inputs

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

See Chapter 2, "Optional inputs".

Outputs

See Chapter 3, "Variable outputs".

Example 1: Measuring the incremental distance between two surfaces

G65P9810X30.Y50.F3000	Protected positioning move.
G65P9810Z30.	Protected positioning move.
G65P9811Z20.	P1 20 mm (0.787 in) surface.
G65P9834	Store the data.
G65P9810X50.	Move to the new position.
G65P9811Z15.	P2 15 mm (0.591 in) surface.
G65P9834Z-5.H.1	The feature to feature is at –5.0 mm (–0.197 in).

Example 2: Measuring an angled surface

G65P9810X30.Y50.F3000	Protected positioning move.
G65P9810Z30.	Protected positioning move.
G65P9811Z20.	P1 at the 20 mm (0.787 in) position.
G65P9834	Store the data.
G65P9810X77.474	Move to the new position.
G65P9811Z10.	P2 at the 10 mm (0.394 in) position.

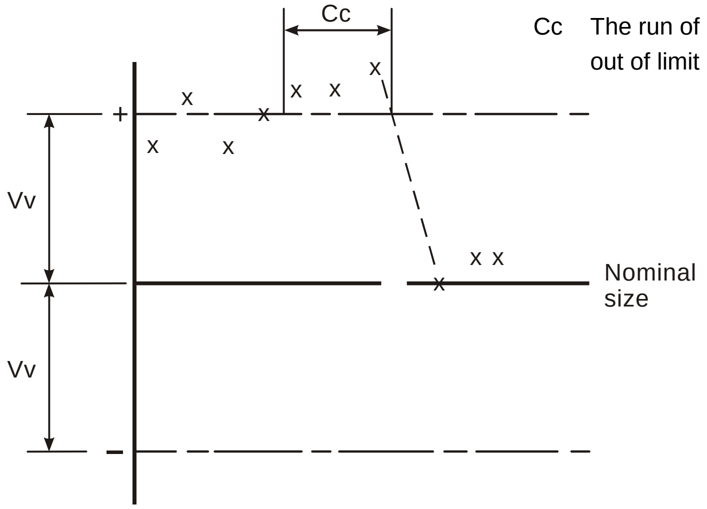
and either this

G65P9834D27.474Z-10.B.5	Measure the slope –20 degrees (clockwise), angle tolerance ±5 degrees.

or this

G65P9834A-20.Z-10.B.5

Updating the statistical process control (SPC) tool offset (O9835)



Cc The run of measurements that are out of limit prior to correction.

Figure 8.12 Updating the SPC tool offset

Description

This macro can be used in conjunction with measuring cycles to control the updating of tool offsets. An update is based on the average value of a sample of measurements.

Application

A measuring cycle should be run 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: Before using this macro, set the Mm store tool offsets to 0 on the offset page.

Format

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

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

Compulsory inputs

Tt	t =	The tool offset number to be updated.
Mm	m =	The spare tool offset pair that are used for storing the average value and counter. m = Accumulated average value store location. m+1 = Counter store location.

Optional inputs

Cc	c =	The number of measurements that are out of tolerance before corrective action is taken **Default value:** 3.
Zz	z =	The flag for Z length offset updating. 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 necessary only when using the type 'C' tool offset option.

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

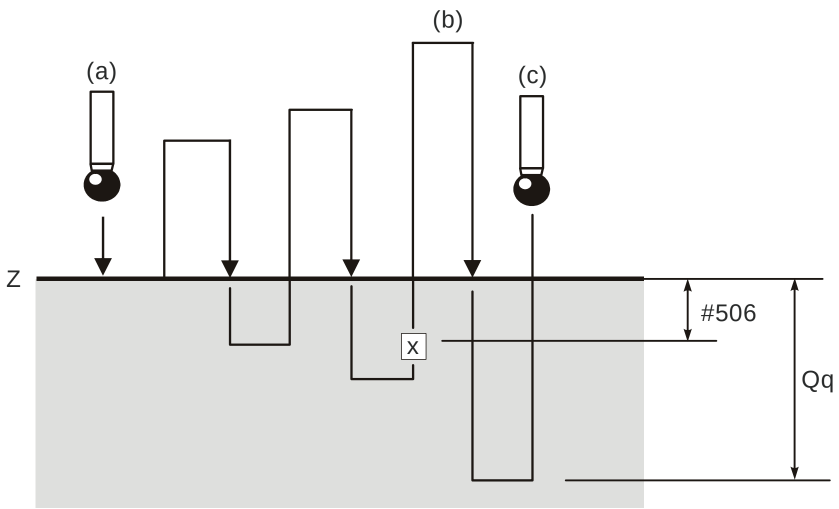
Example: Updating an SPC tool offset

From previous

G65P9814D50.H.5	Measure a bore to 0.5 mm (0.0197 in) tolerance.
G65P9835T30.M31.V.1C4.	T30 = The tool offset number for updating. M31. = Spare tool offsets pair (31 and 32). V.1 = Control limit. C4. = Run of measurements that are 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 8.13 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 that you run this macro in every case.

Description

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

Application

1. The probe should be made active. At this stage the switch-on macro for the optical probe may not be functioning. Therefore, use the MDI (manual data input) mode and spin the probe at S500, then stop the spindle.

2. Position the probe stylus to 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/min) and then retracts. It continues to find the surface several times to establish the optimum values.

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

NOTE: The repeat surface finding moves get progressively faster until the maximum overtravel is reached. The retract position off the surface also 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.

Installing values

1. The fast feedrate value in #119 must be loaded into the setting macro O9724. See Appendix B, "Settings macro O9724", for details.
2. The back-off distance in #118 must be transferred into variable #506. This is possible in MDI mode. This variable is located on the common retained variable page.

Format

G65 P9836 [Qq]
where [ ] denote optional input.

Example: G65P9836 Q10.

Optional input

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

Diagnostic alarms

For details of the macro alarms, see Chapter 9, "Macro alarms and error messages".

Feedrates

All feedrates within the software, except for the gauging move, are related and are dependent on the fast feedrate #119 value. The gauging move is always at 30 mm/min (1.2 in/min).

You should note that the back-off distance #506 can be affected by changing the feedrate #119. Running this macro will establish compatible setting data.

Feedrates are calculated internally as described:

Basic move macro (O9726) feedrate

Z-axis fast approach	#119*.6 (3000 mm/min [120 in/min] as standard).
XY-axis fast approach	#119*.6 (3000 mm/min [120 in/min] as 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] as standard).
XY-axis positioning	#119 (5000 mm/min [200 in/min] as standard).

Example

Write a small program to run this macro.

With the probe active, position the probe approximately 2 mm (0.08 in) above the surface.

```
%
O5036
G40G80G90          Preparatory codes for the machine.
H00                Make the tool offset zero.
G65P9836Q6.0       Optimise for an overtravel of 6 mm (0.24 in).
M30
%
```

Angle measurement in the X or Y plane (O9843)

NOTE:
Angles are in the range ±180 degrees.
Positive (+) angle: Counter-clockwise direction.
Negative (–) angle: Clockwise direction.

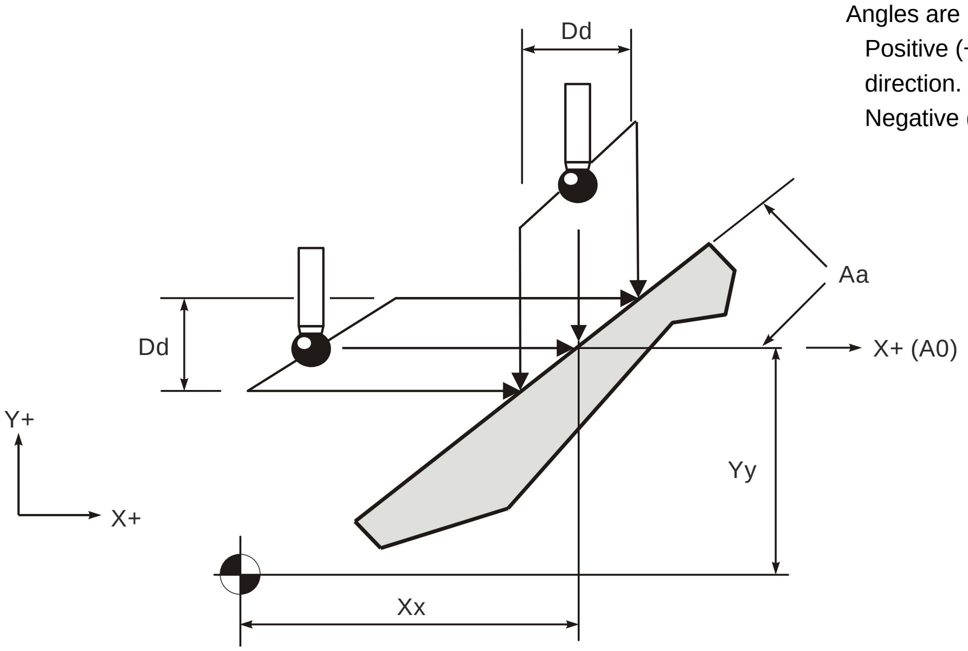


Figure 8.14 Measuring an angled surface in the X or Y plane

Description

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

Application

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

Format

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

where [ ] denote optional inputs.

Example: 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 position of the surface. An Xx input results in a cycle measuring in the X-axis direction.
Yy	y =	The mid-point position of the surface. A Yy input results in a cycle measuring in the Y-axis direction.

NOTE: Do not mix the Xx and Yy inputs.

Optional inputs

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

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

Outputs

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

#143 The measured height difference.

#144 The surface angle error.

Alarms

For details of the macro alarms, see Chapter 9, "Macro alarms and error messages".

Example: Measuring an angled surface

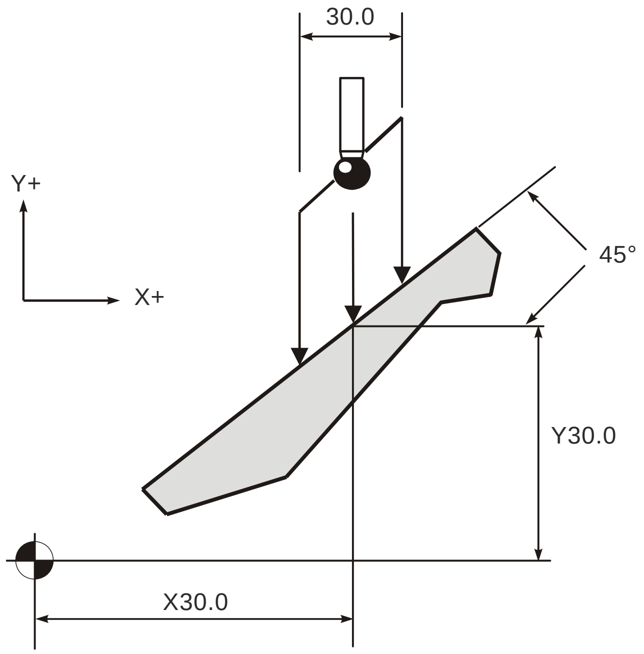


Figure 8.15 Example of an angled surface measurement

G65P9810 X30.Y50.Z100.F3000	Protected positioning move.
G65P9810 Z-15.	Protected move to the start position.
G65P9843Y30.D30.A45.	Angle measurement.
G65P9810 Z100.	Retract to a safe position.
continue	
G17	
G68G90X0Y0 R[#139]	Rotate the co-ordinate system by the angle.
continue the machining program	

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

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Chapter 9

Macro alarms and error messages

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

This chapter describes:

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

Contained in this chapter

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 alarms

Format

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

Format: 30006 = 1 (PROBE SWITCH OFF FAILURE)

Cause: The switch-off cycle (macro O9833) may have failed if a spindle speed of S500 was not achieved.

Action: Check that the spindle speed override is not active.

Check that the probe is not faulty.

Press cycle start to continue

NOTE: On Fanuc 0M or 6M controls, the 3006 alarms described above indicate a reset condition. Restart the program from a safe position.

Format: #3000 = 101 (PROBE START UP FAILURE)

Cause: The switch-on cycle (macro O9832) may have failed if a spindle speed of S500 was not achieved.

Action: Check that the spindle speed override is not active.

Check that the probe is not faulty.

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

This is a reset condition.

Format: #3000 = 91 (MESSAGE)

91 (FORMAT ERROR)

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

91 (DATA #130 TO #139 MISSING)

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

91 (IJK INPUTS 5 MAX)

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

91 (K INPUT OUT OF RANGE)

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

This is a reset condition.

Format: #3000 = 86 (PATH OBSTRUCTED)

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

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

This is a reset condition.

Format: #3000 = 88 (NO FEED RATE)

Cause: This occurs only during a protected positioning cycle.

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

This is a reset condition.

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

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

Action: Edit and start again from a safe position.

This is a reset condition.

Format: #3000 = 92 (PROBE OPEN)

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

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

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

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

This is a reset condition.

Format: #3000 = 93 (PROBE FAIL)

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

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

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

This is a reset condition.

Optimisation macro only (O9836) alarms

Format: #3000 = 72 (SKIP SIGNAL ALREADY ACTIVE)

Cause: This indicates that the machine skip signal is high prior to the probe move.

Action Check that the probe is active and that the interface is not in error.

Check the wiring.

Check that the interface output relay is configured correctly, i.e. N/C or N/O.

Check whether the stylus is in contact with a surface (a possible reseating problem).

Clear the fault.

Format: #3000 = 73 (NO SKIP SIGNAL DURING MOVE)

Cause: This indicates that the skip signal was not activated during the move.

Action: Check the wiring.

Check probe operation.

Check the interface LED outputs to confirm operation when the stylus is manually deflected. Also check the relay output voltage to skip when the probe is triggered.

Edit the program.

Format: #3000 = 74 (H00 CODE TOOL LENGTH NOT ACTIVE)

Cause: 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)

Cause: This denotes the end of the optimisation cycle.

The values in #118 and #119 can be installed (see "Optimising a probing cycle (O9836)" in Chapter 8, "Additional cycles" for details).

Action: Install the setting values.

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Appendix A

Features, cycles and limitations of the Inspection Plus software

Contained in this appendix

Features of the Inspection Plus software

- Protected positioning.
- Measurement of internal and external features to determine both size and position. This includes:
  - Obtaining a 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

General

- 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.
- The Inspection Plus software can be used with the machine controllers described below.

Mazak M32 controllers

The standard variables are sufficient.

Limitations

- None – ISO/EIA programming only.

Fanuc 10, 11, 12 and 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 to 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 the 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 controllers work 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 co-ordinate values of ±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 B

Settings macro O9724

Contained in this appendix

Macro G65P9724

Macro G65P9724 is called at the beginning of all top level macros to establish the necessary modal information.

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

#119 values

#119 = 5000 (FAST FEED MM) #119 = 200 (FAST FEED INCH)	The fast feedrate of the cycles can be adjusted by this variable to suit the machine characteristics and should be optimised.

- The fast feedrate of the Z-axis P9726 basic move macro is at the #119*.6 value (3 metres/min as standard).
- The fast feedrate of all Z-axis positioning moves is also at the #119*.6 value (3 metres/min as standard).
- The fast feedrate of all XY axis positioning moves is at the #119 value (5 metres/min as standard).

#123 values

#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 a PROBE OPEN or PROBE FAIL alarm.

#120 values

#120 = 1 (SELECT OPTIONS)	See the table below.

Tool offset type	Tolerance alarm condition	Work offset type	
		FS9 type 10/11/12/15/M	**FS6 type 0/6/16/18M**
A type B type C type	Flag and alarms Flag and alarms Flag and alarms	# 120 = 1 # 120 = 2 # 120 = 3	# 120 = 9 # 120 = 10 # 120 = 11
A type B type C type	Flag Flag Flag	# 120 = 5 # 120 = 6 # 120 = 7	# 120 = 13 # 120 = 14 # 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 I, "Tool offset macros 09732 and 09723").

Example

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

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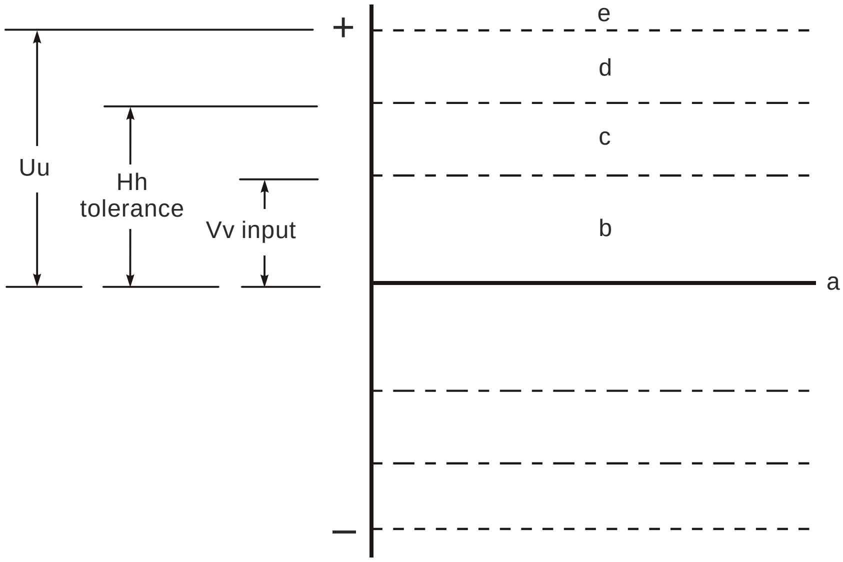
Appendix C

Tolerances

Contained in this appendix

Tolerances

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



a = Nominal size.

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

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

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

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

Figure C.1 Size and tool offset update tolerances

Also see the SPC macro O9835 (see Chapter 8, "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 C.2 below.

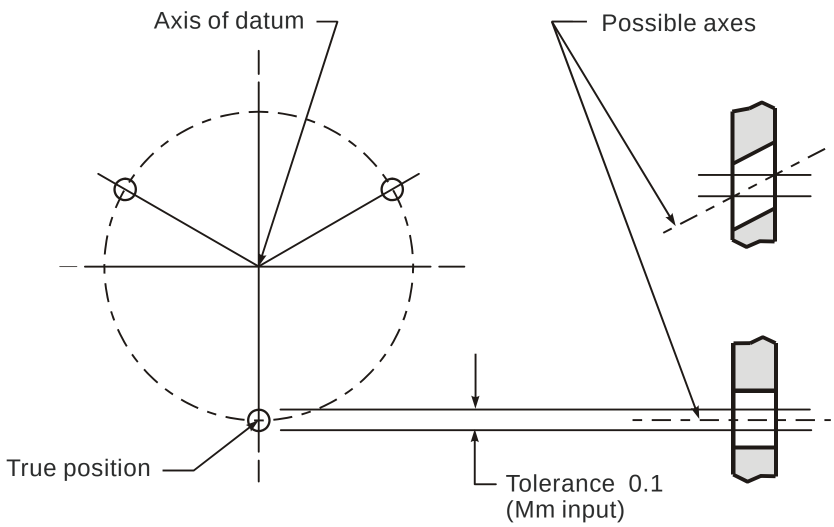


Figure C.2 Cylinders centred on true positions

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Appendix D

Experience values Ee

Contained in this appendix

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 E, "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 E

Additional spare tool offsets

Contained in this appendix

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 E.1 shows the extra tool store locations.

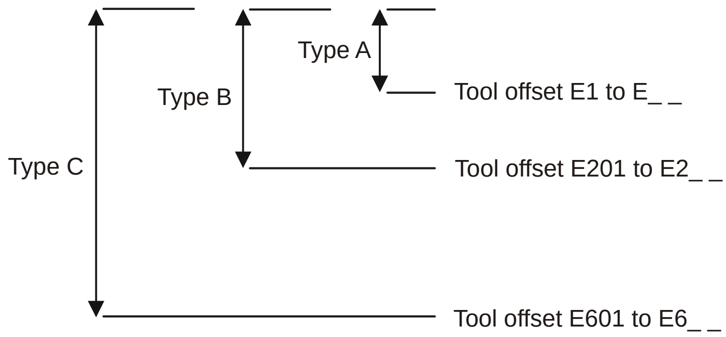


Figure E.1 Spare tool offset location details

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 F

Printing a macro output

Contained in this appendix

Example of printing a macro output

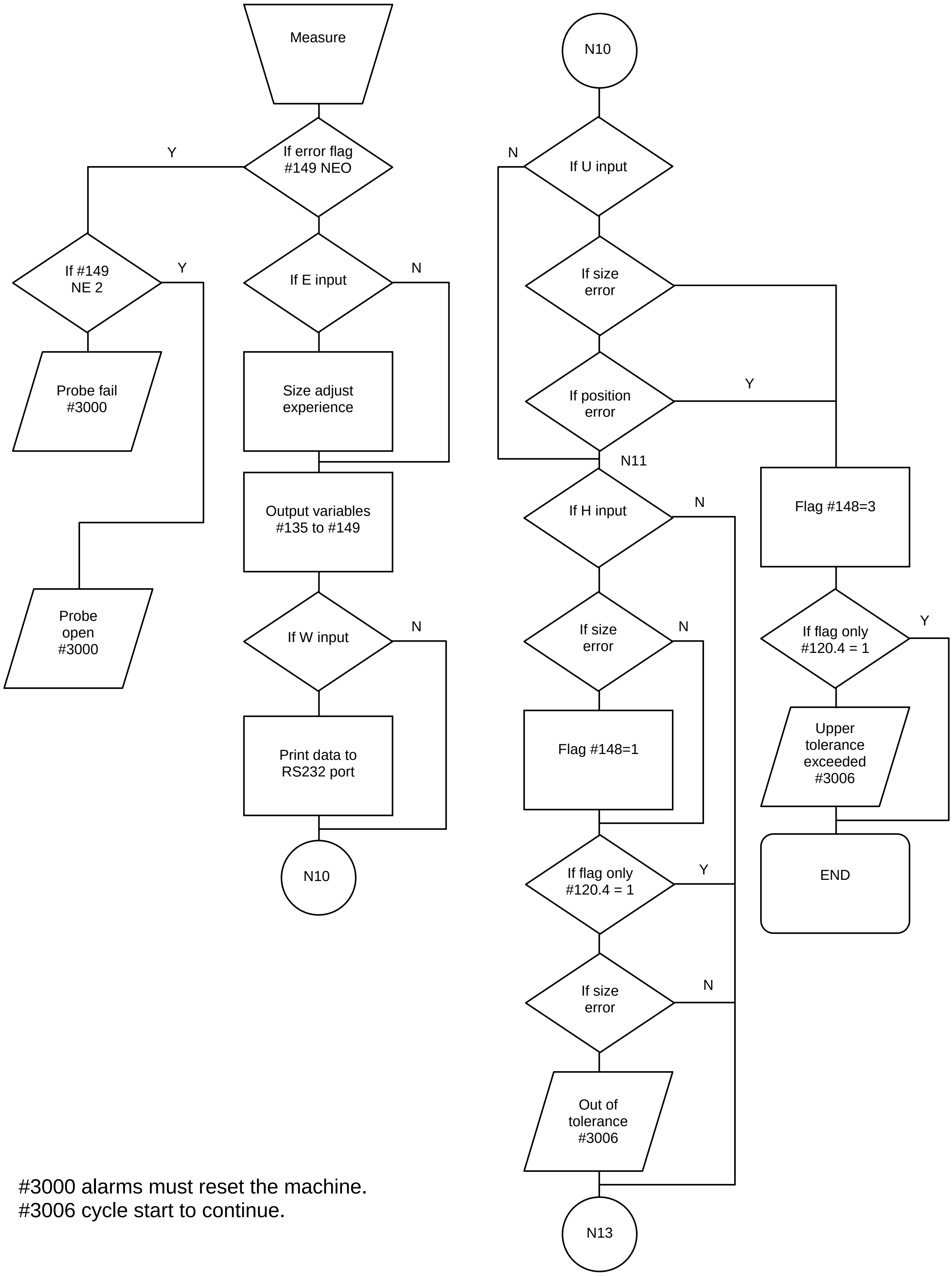
```
-------------------------------------------------------------------------
COMPONENT NO 31               FEATURE NO 1
-------------------------------------------------------------------------

POSN R79.0569  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 G

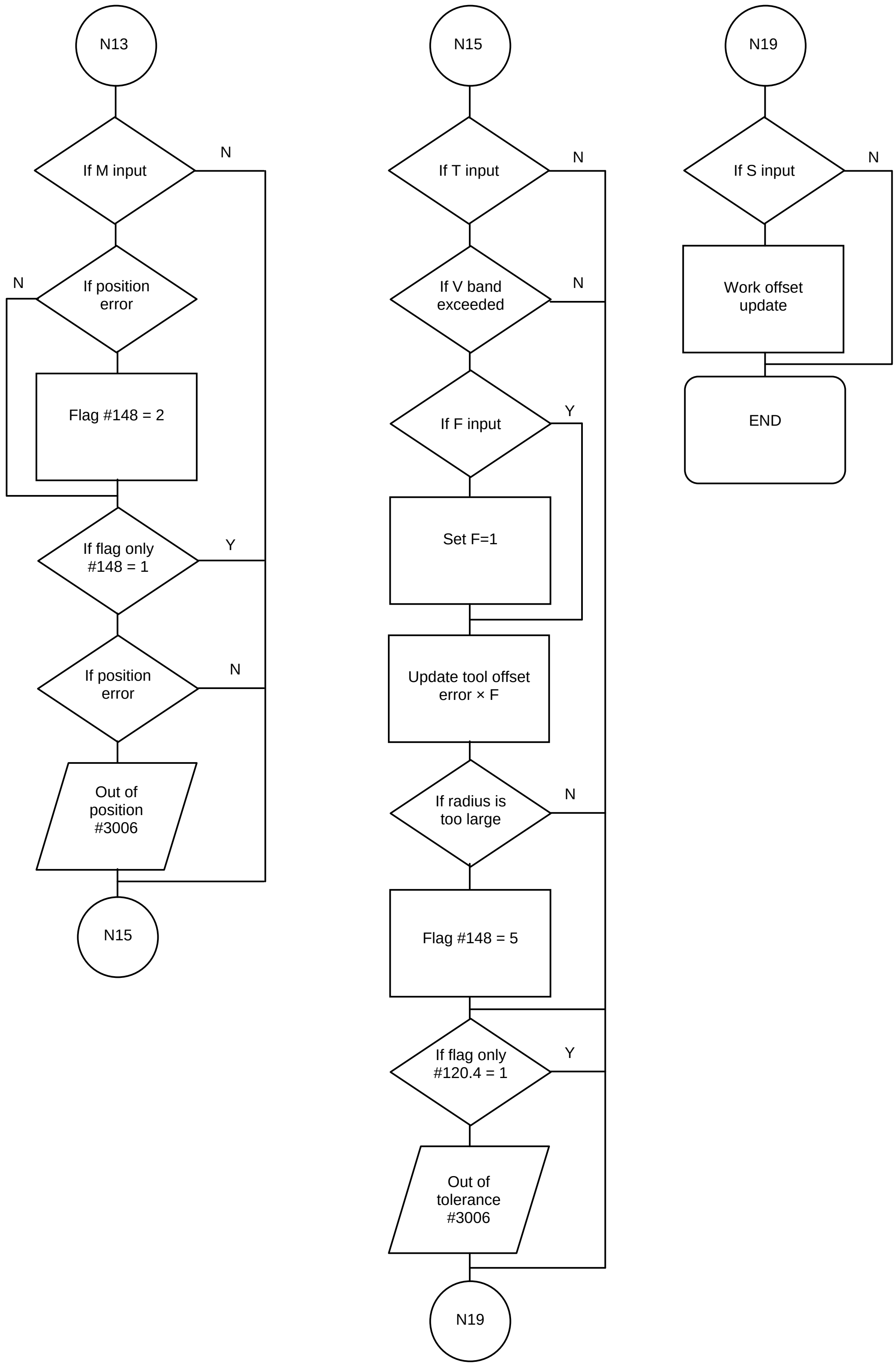
Output flow (bore/boss and web/pocket cycles)

Contained in this appendix

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



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



N13
If M input
N
N
If position error
Flag #148 = 2
If flag only #148 = 1
Y
If position error
N
Out of position #3006
N15
N15
If T input
N
If V band exceeded
N
If F input
Y
Set F=1
Update tool offset error × F
If radius is too large
N
Flag #148 = 5
If flag only #120.4 = 1
Y
Out of tolerance #3006
N19
N19
If S input
N
Work offset update
END

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Appendix H

Use of macro variables

Contained in this appendix

Local variables

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

Common variables

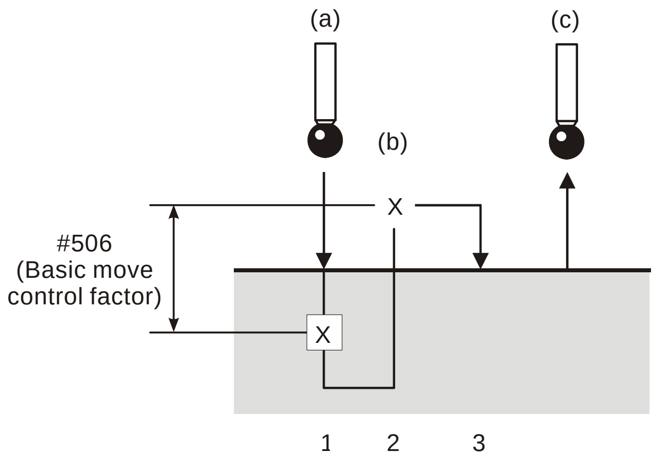
#100 to #115	These are not used by this software.
#116	Active tool length, which is calculated in macro O9723.
#117	Modal feedrate value used in the protected positioning macro (O9810).
#118	Radius too large flag macro O9812, O9814, O9822, O9823 (also used for the temporary ATAN store in macro O9731).
#119	Fast feedrate value. This is set in macro O9724 at 5000 mm/min (200 in/min) default value.
#120	Setting variable used in macro O9724.
#121	Print option. The component number is incremented by 1 with each heading. To reset, state #121 = 0.
#122	Print option. The feature number is incremented by 1 with each print macro call. To reset, state #122 = 0.
#123	Start and end of block position zone normal setting 0.05 mm (0.002 in). If the skip position is within this zone, the cycle aborts, with either a PROBE OPEN or PROBE FAIL alarm.
#124	Stored X skip position at the end of the basic move macro (O9726).
#125	Stored Y skip position at the end of the basic move macro (O9726).
#126	Stored Z skip position at the end of the basic move macro (O9726).
#127	X average skip position at the end of the X diameter move macro (O9721).
#128	Y average skip position at the end of the Y diameter move macro (O9722).
#129	Inch/metric multiplier (0.04/1.0)
#130 to #134	Output data. Data is also stored in common variables #135 to #139 when the feature-to-feature macro (O9834) is used.
#135 to #149	See Chapter 3, "Variable outputs", for an output reference chart.
#150 onwards	These 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 (see Figure H.1). 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.

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.
Move 2: Recover off the surface.
Move 3: Gauge feed at 30 mm/min (1.2 in/min).

a = Fast feed.
b = Gauge feed (30 mm/min).
c = Return.

Figure H.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 and O9823.
#510 to #565	These are reserved for vector calibration data and multi-stylus storage as shown below:

#510 (30 degrees)	Vector
#511 (60 degrees)	calibration
#512 (120 degrees)	data
#513 (150 degrees)	
#514 (210 degrees)	
#515 (240 degrees)	
#516 (300 degrees)	
#517 (330 degrees)	

#518	Multi-stylus
#519	data
#520	K1 and K11
#521	
#522	Multi-stylus
#523	data
#524	K2 and K12
#525	
#526	Multi-stylus
#527	data
#528	K3 and K13
#529	
#530	Multi-stylus
#531	data
#532	K4 and K14
#533	
#534	Vector
#535	multi-stylus
#536	data K11
#537	
#538	
#539	
#540	
#541	
#542	Vector
#543	multi-stylus
#544	data K12
#545	
#546	
#547	
#548	
#549	
#550	Vector
#551	multi-stylus
#552	data K13
#553	
#554	
#555	
#556	
#557	
#558	Vector
#559	multi-stylus
#560	data K14
#561	
#562	
#563	
#564	
#565	

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

Appendix I

Tool offset macros O9732 and O9723

Contained in this appendix

Introduction

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

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

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

Editing macro O9732

Edit macro O9732 as follows:

O9732 (REN OFFSET TYPE)

#27 = 2000 (L WEAR 10000)	
#28 = 2200 (L G-W 11000)	Numbers in brackets are the alternative
#29 = 2600 (R WEAR 12000)	system variable numbers.
#30 = 2400 (R GEOM 13000)	

macro continued

Editing macro O9723

Edit macro 09723 as follows:

O9723 (REN ACT OFFSET)

#27 = 2000 (L wear 10000)	Numbers in brackets are the alternative
#28 = 2200 (L G-W 11000)	system variable numbers.

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

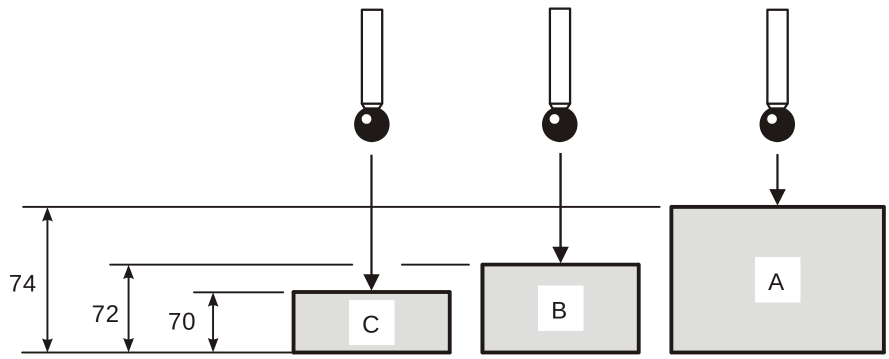
Appendix J

General probing applications

Contained in this appendix

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 ± 0.5

Figure J.1 Part identification

G65 P9810Z84.F3000	Protected positioning move to the start position.
G65P9811Z70.	Single surface measurement (target C surface).
IF[#137GT73.]GOTO100	If the result is greater than 73.0, go to N100.
IF[#137GT71.]GOTO200	If the result is greater than 71.0, go to N200.
IF[#137GT69.]GOTO300	If the result is greater than 69.0, go to 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)

continue 'C' component

N400

M30

%

Example 2: Probe measure every nth component

It is often a requirement to probe every nth component in the interests of reducing the overall cycle time. To do this, the following programming method can be employed:

O5000(PART PROGRAM)	
#100 = 0	Reset the counter.
#101 = 5	Count limit.
N1	
(START OF MACHINING)	
conventional part programming	
N32	
(START OF PROBE ROUTINES)	
IF[#100LT#105]GOTO33	If the counter is less than 5, jump to N33.
T01M06 (PART INSPECTION)	Select the inspection probe.
probing routines	
#100=0	Reset the counter to zero.
N33	
(CONTINUE MACHINING OR END)	
#100=#100+1	Increment the counter.
rest of machining program	
M99P1	Return to N1.
M30	
%	

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Appendix K

One-touch measuring

Contained in this appendix

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:

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

Table K.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 (i.e. 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 option makes it possible to probe at a high feedrate, 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 points must be considered.

Machine distortion

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

Servo delays

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

Examples:

Fanuc 15 controller

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

Fanuc 16/18 controllers

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

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

Fanuc 0 controller

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 measurement on top of the ring gauge.
- Retract to 50 mm and return to the centre.

Table K.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
Two-touch cycles		-	-	-	27.6
One-touch cycle:					
Stand-off distance	0.5	18.0	18.5	20.0	22.4
	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 K.2 Cycle time comparison

Installing the one-touch cycles

NOTE: The new one-touch basic move macro (O9726) is compatible only 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

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

:9726(REN BASIC MEASURE - 1T)	
#9=500*****#129(EDIT MEAS FEED)	***** Feedrate – edit the 500 value.
#28=#9/1000(EDIT ZONE)	Acceleration / deceleration zone.
#31=0	
IF[#17NE#0]GOTO2	
#17=3*#129(EDIT)	* Standoff – edit the 3 value.
N2	

NOTE: * denotes that 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, when not using the high speed skip function or when the servo delays are included in the results.

Standoff 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 K-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 K.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 standoff 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 reseated, 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 K-2), 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:

zone dimension = measuring feedrate / 1000
(ie zone factor = 1000)

NOTE: See Macro edits on page K-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 K.4 Example of zone allowance using default zone factor 1000

NOTE: The allowance measuring range is the Q standoff 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 (i.e. the middle of the measuring move). 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 = absolute (Q value - total STEP value)

   Calculate the zone factor (see the descriptions above):

   Zone factor = measuring feedrate / A

Q input

Qq q = Overtravel and standoff 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 standoff position for the one-touch cycles (see also Acceleration and deceleration allowance on page K-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 K-6).

Measuring move detail

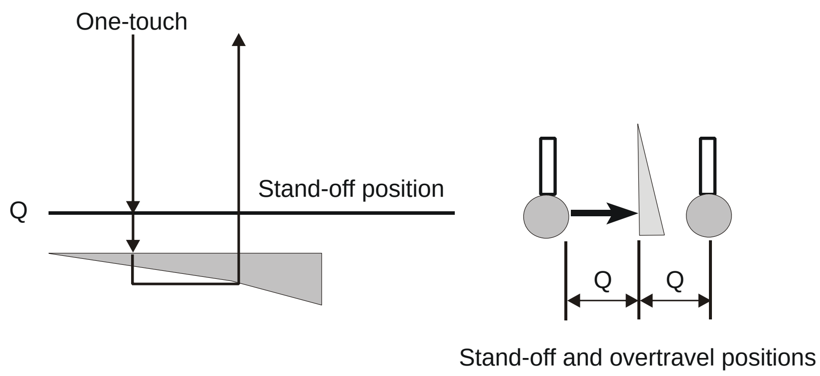
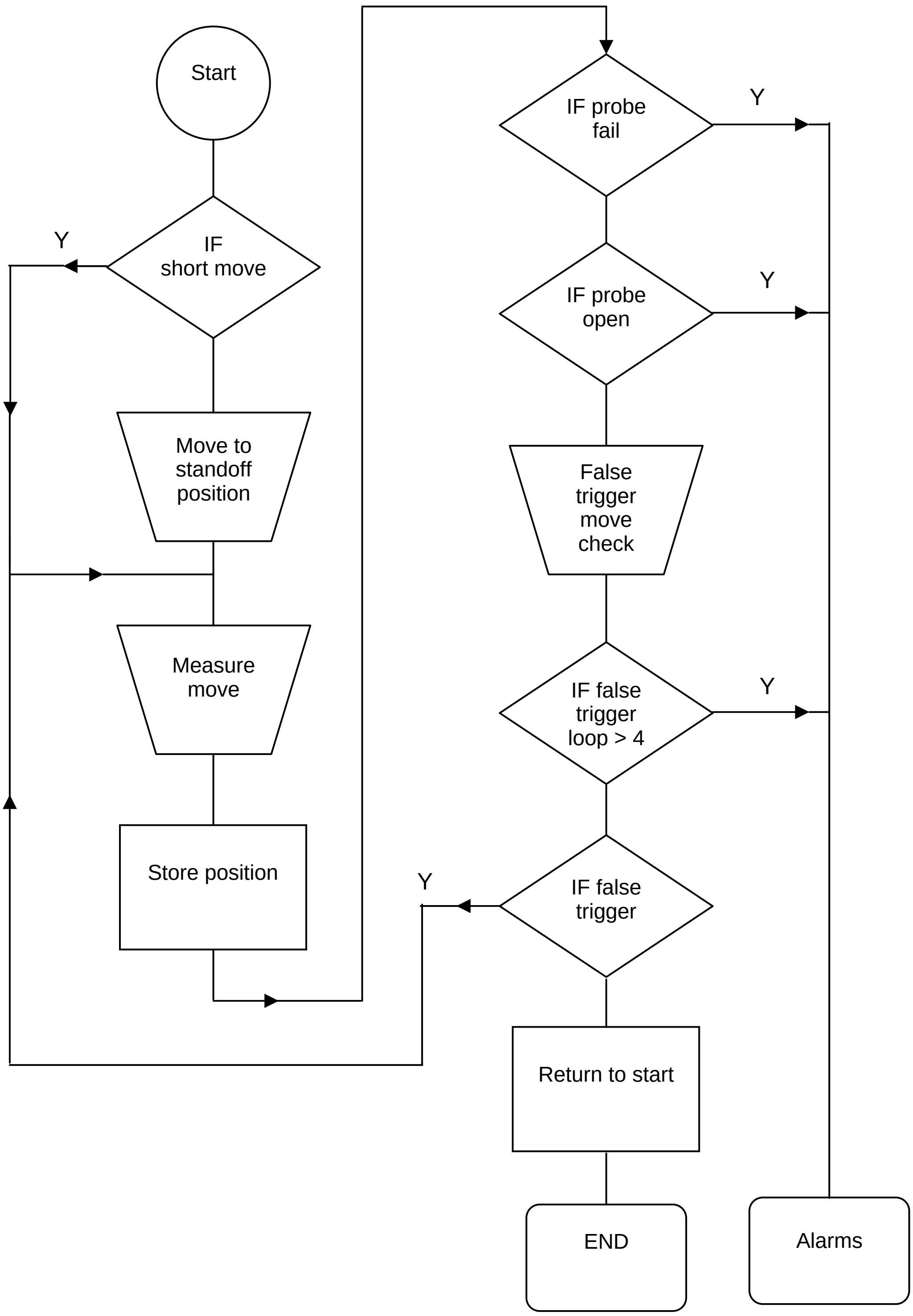


Figure K.1 Measuring move detail

One-touch measuring move logic



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Renishaw plc

New Mills, Wotton-under-Edge,
Gloucestershire, GL12 8JR
United Kingdom

T +44 (0)1453 524524
F +44 (0)1453 524901
E uk@renishaw.com

www.renishaw.com

RENISHAW
apply innovation™

**For worldwide contact details,
please visit our main web site at
www.renishaw.com/contact**

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