Chapter 1

Getting started

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

Contained in this chapter

Why calibrate a probe?

In Chapter 6 of this manual you will find details of the subroutines that are used to calibrate your probe. But why is it so important that your probe is calibrated?

When you fit your probe into its machine shank/holder, it is not necessary for the probe's stylus to run true to the spindle centre line. A small amount of run-out can be tolerated, although 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 the 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 (subroutine L9802) provides the data to allow for this run-out.

As each probe system 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.
- 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 of a known diameter automatically stores one or more values for the radius of the stylus ball. The stored values are then automatically used by the measuring cycles to give the true size of the feature. The values are also used to give true positions of single surface features.

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. The stored value for length is different from the physical length of the probe assembly. Additionally, the operation can automatically compensate for machine and fixture height errors by adjusting the probe length value that is stored.

Calibration cycles

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

Subroutine L9801	This is used to establish the length of the probe in its tool shank.
Subroutine L9802	This is used to establish the off-centre values of the stylus.
Subroutine L9803	This is used to establish radius values of the stylus ball. It is suitable for all measuring cycles except L9821, L9822 and L9823.
Subroutine L9804	This is used to establish the vector radius values of the stylus ball. It is suitable for all measuring cycles, including L9821, L9822 and L9823.

For complete calibration of a probe system, you must use subroutines L9801, L9802, and either L9803 or L9804.

Subroutine L9800: Clear global ‘R’ parameters

Subroutine L9800 is called at the end of every measuring and calibration subroutine (9800-series) to reset to a default value those global ‘R’ parameters that are used as inputs.

If global ‘R’ parameters R00 to R26 are used for other programming purposes outside of this inspection software package, it is recommended that L9800 is called prior to setting them for the next probing cycle. All examples in this manual show this being done.

Chapter 2

Installing the software

This chapter describes how to load and customise the Inspection Plus software.

Contained in this chapter

Installing the software

NOTE: It is important that the software is installed correctly to suit the type of controller and options available. The type of processor and version of system software installed in the control will determine which software kit has been supplied and the cycle options that are available.

1. First, refer to Appendix B, "Features, cycles and limitations of the Inspection Plus software" to determine whether the Inspection Plus software is suitable for your needs.

2. Decide which cycles you require (see the section titled "Subroutine memory requirements" in the preliminary part of this manual titled "Before you begin").

3. Load the basic cycles from files 40140077 or 40140358. These files contain a complete basic package.

   Now do the following:

   (a) Delete all unwanted L98-- series cycles.

   (b) If the vector cycles will be used, delete subroutine L9803 (subroutine L9804 will be used instead).

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

   L9727, L9731 and L9804 (these subroutines are used only for vector cycles).

   (c) If neither of the print options will be used, delete subroutine L9730.

4. Choose which option 1 cycles from file 40140078 or 40140359 you require. If option 1 cycles are required, load the option 1 file.

   If you intend using one of the 4th axis routines then load only the cycle relevant to the axis to which the 4th axis is aligned (L9817 is the 4th axis subroutine used for X-axis measurement and L9818 is the 4th axis subroutine used for Y-axis measurement).

   If the machine has no 4th axis fitted, delete L9817 and L9818.

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

5. Choose which option 2 cycles from file 40140079 or 40140360 you require. If option 2 cycles are required, load the option 2 file.

   Delete all unwanted subroutines from the control.

Setting RENP[ ] global probe variables

Before using the cycles for the first time, certain RENP[ ] variables must be set.

RENP[0] and RENP[1] X and Y calibration radius

Nominal calibration data values must be set in RENP[0] and RENP[1].

For example, if a 6 mm diameter stylus is to be used, set both RENP[0] and RENP[1] to 3.0.

RENP[2] and RENP[3] X-axis and Y-axis stylus offsets

Set both RENP[2] and RENP[3] equal to zero.

RENP[5] digital input for monitoring probe status

For a description about setting global probe variable RENP[5], see Appendix F, “Use of subroutine variables”.

Note that this input is not used in the later set of probing software routines (Kit no. A-4014-0356). This is because version 4 of the Siemens system software made available a “Probe Status” flag and this is used in place of the digital input method.

RENP[6] back-off distance

For a description about setting global probe variable RENP[6], see Appendix F, “Use of subroutine variables”.

For small and medium size machines– that is, machines having an axis travel less than 1000 mm (40 in) – the standard feed rates as supplied are normally acceptable.

RENP[7] measuring input

For a description about setting global probe variable RENP[7], see Appendix F, “Use of subroutine variables”.

Settings subroutine L9724

If the default values are not suitable, you will need to change the settings subroutine (L9724). For a description of subroutine L9724, see Appendix B, “Settings subroutine details”.

Set the following settings subroutine options:

- Fast feed rates.
- Tolerance alarms or flag only (FMS type application).

The examples in this document 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.

Chapter 3

Optional inputs

This chapter describes the optional inputs that may be applied to some of the subroutines. 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.

R2 = b — Angle tolerance of the surface, e.g. 30 degrees ± 1 degree inputs R1 = 30. R2 = 1.

Example: R2 = 5 to set a tolerance of 5 degrees.

R4 =
R5 = — See the relevant measuring cycles and specific subroutine calls.
R6 =

R8 = e — Experience value.

Specify the number of an experience global parameter where an adjustment value to the measured size is stored (see Appendix D, “Experience value RENE [ ]”).

Example: R8 = 2. causes the experience value stored in global parameter RENE[2] to be applied to the measured size.

R9 = f — Percent feedback when updating a tool offset (see Appendix C, “Tolerances”).

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

Default: 1 (100%)

Also:

Feedrate in the protected positioning subroutine L9810 (see Chapter 5, “Protected positioning cycles”).

Example: R9 = 15 sets a feedrate of 15 mm/min.
(R9 = 0.6 sets a feedrate of 0.6 in/min.)

R11 = h — The tolerance value of a feature dimension being measured.

Example: For dimension 50.0 mm +0.4 mm –0 mm, the nominal tolerance is 50.2 mm with R11 = 0.2.
(For dimension 1.968 in +0.016 in –0 in, the nominal tolerance is 1.976 in with R11 = 0.008.)

R13 = m — The true position tolerance of a feature. This is a cylindrical zone about the theoretical position.

Example: R13 = 0.1 sets a true position tolerance of 0.1 mm.
(R13 = 0.004 sets a true position tolerance of 0.004 in.)

R17 = q — This is the probe overtravel distance for use when the default values are unsuitable. The probe will then travel beyond the expected position when it searches for a surface.

Default: 4 mm (0.16 in) in the Z-axis and 10 mm (0.394 in) in the X and Y axes.

Example: R17 = 8.0 sets an overtravel distance of 8 mm.
(R17 = 0.3 sets an overtravel distance of 0.3 in.)

R18 = r — This is an incremental dimension that is used in external features – for example, bosses and webs – to give a radial clearance from the nominal target surface prior to a Z-axis move.

Default: 5 mm (0.200 in).

Example: R18 = 10 sets a radial clearance of 10 mm.
(R18 = 0.4 sets a radial clearance of 0.4 in.)

R18 = –r — This is similar to R18 = r, except that the clearance is applied in the opposite direction to force an internal boss or web cycle.

Default: 5 mm (0.200 in).

Example: R18 = –10. sets a radial clearance of –10 mm.
(R18 = –0.4 sets a radial clearance of –0.4 in.)

R19 = s — This is the zero offset number that will be set.

The zero offset number will be updated.
R19 = 0 (G500)
R19 = 1 to R19 = 4 (G54 to G57)
R19 = 5 to R19 = 99 (G505 to G599)
R19 = 1000 (base zero offset)

Example: R19 = 3.

R20 = t — This is the tool offset number to be updated.

Example: R20 = 20 updates tool offset number 20 and edge D1 by default.
R20 = 20.2 updates tool offset number 20 and edge D2.

RENTL = "toolname"

For customers using the Tool Management / ShopMill option, a tool name rather than a tool number can be used. Note that the tool name must be enclosed in inverted commas and be exactly the same word format as the actual name.

Example: RENTL = "3D_Probe"

R21 = u Upper tolerance limit.

If this value is exceeded no tool offset or zero offset is updated and the cycle stops with an alarm. This tolerance is applied to both size and position where applicable.

Example: R21 = 2.0 to set the upper tolerance limit to 2 mm.
(R21 = 0.08 to set the upper tolerance limit to 0.08 in.)

R22 = v Null band.

This is the tolerance zone where no tool offset adjustment occurs.

Default: 0.

Example: R22 = 0.5 for a tolerance zone of ±0.5 mm.
(R22 = 0.02 for a tolerance zone of ±0.02 in.)

R23 = w Print data.

1. = Increment the feature number only.

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

Example: R23 = 1.

Chapter 4

Variable outputs

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

Contained in this chapter

Variable outputs – chart 1

	Single surface	Web/ pocket	Bore/boss	Internal corner	External corner	4th axis	X/Y angle measure
	L9811	L9812	L9814	L9815	L9816	L9817/18	L9843
RENC[35]	X position	X position	X position	X position	X position		
RENC[36]	Y position	Y position	Y position	Y position	Y position		
RENC[37]	Z position						
RENC[38]	Size	Size	Size				
RENC[39]				X surface angle	X surface angle	4th angle	Angle
RENC[40]	X error	X error	X error	X error	X error		
RENC[41]	Y error	Y error	Y error	Y error	Y error		
RENC[42]	Z error			Y surface angle	Y surface angle		
RENC[43]	Size error	Size error	Size error	Y angle error	Y angle error	Height error	Height error
RENC[44]				X angle error	X angle error	Angle error	Angle error
RENC[45]	True position error	True position error	True position error	True position error	True position error		
RENC[46]	Metal condition	Metal condition	Metal condition				
RENC[47]	Direction indicator						
RENC[48]	Out of tolerance flag (1 to 7)						
RENC[49]	Probe error flag (0 to 2)						

Variable outputs – chart 2

	PCD bore/boss	**Stock allowance**	**Angled single surface**	**Angled web/pocket**	**3-point bore/boss**	**Feature to feature**
	L9819	L9820	L9821	L9822	L9823	L9834
RENC[35]	X position		X position from start	X position	X position	X incremental distance
RENC[36]	Y position		Y position from start	Y position	Y position	Y incremental distance
RENC[37]	PCD					Z incremental distance
RENC[38]	Size		Size from start	Size	Size	Minimum distance
RENC[39]	Angle					Angle
RENC[40]	X error		X error	X error	X error	X error
RENC[41]	Y error		Y error	Y error	Y error	Y error
RENC[42]	PCD error					Z error
RENC[43]	Size error		Size error	Size error	Size error	Minimum distance error
RENC[44]	Angle error	Maximum value				Angle error
RENC[45]	True position error	Minimum value	True position error	True position error	True position error	True position error
RENC[46]	Metal condition	Variation (stock)	Metal condition	Metal condition	Metal condition	Metal condition
RENC[47]	Hole number		Direction indicator			
RENC[48]	Out of tolerance flag (1 to 7)					
RENC[49]	Probe error flag (0 to 2)					

Chapter 5

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 subroutine L9810 to set up the protected positioning of the probe. After it is correctly set, the probe will stop moving in the event of a collision.

Contained in this chapter

Protected positioning (probe trigger monitor) (L9810)

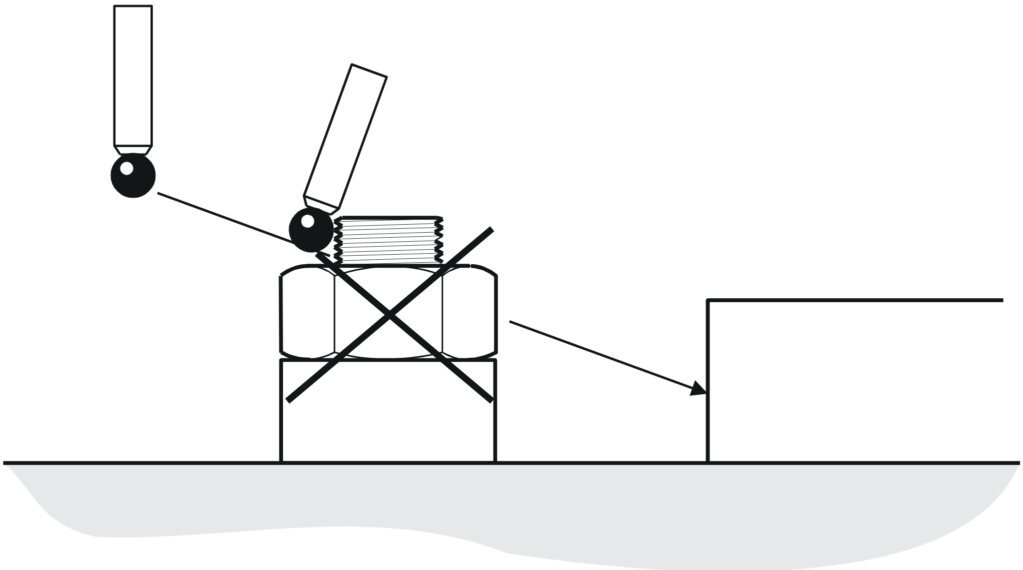

Figure 5.1 Probe protected positioning

Description

It is important to protect the stylus against collision as it 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 a measuring position using this subroutine call.

In the event of a collision the machine will stop. Either a PATH OBSTRUCTED alarm is generated or an error flag RENC[48] is set (see the R13 input).

Format

R24 = x R25 = y R26 = z [R9 = f R13 = m]
L9810
where [ ] denote optional inputs

Example: R26 = 10. R9 = 0.8 R13 = 0.2
L9810

Inputs

R24 = x x = R25 = y y = R26 = z z =	These are the target positions for the probe positioning move.
R9 = f	The modal feedrate for all protected positioning moves. The feedrate will be modal to this subroutine 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.
R13 = m = 1.0	This will set a probe trigger flag (no PATH OBSTRUCTED alarm). RENC[48] = 0 (no probe trigger) RENC[48] = 7 (probe triggered)

Example

G1G54X20.Y50.	
T20Z100.	Move to a safe plane.
L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
L9800	Clear the global 'R' parameters.
R26 = 10 R9 = 3000 L9810	Protected positioning move.
R26 = 0 R19 = 1 L9811	Single surface measure.

Chapter 6

Calibrating the probe

Before a probe is used it is important that it is calibrated correctly. This chapter describes how to use the four subroutines for calibrating a probe. If you need to know more about calibrating a probe, you will find helpful information in Chapter 1, “Getting started”.

Contained in this chapter

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 a probe. The purpose of each subroutine is summarised below.

Subroutine L9801	This is used to establish the length of the probe in its tool shank.
Subroutine L9802	This is used to establish the off-centre values of the stylus.
Subroutine L9803	This is used to establish the radius values of the stylus ball. It is suitable for all measuring cycles except for L9821, L9822 and L9823.
Subroutine L9804	This is used to establish the vector radius values of the stylus ball. It is suitable for all measuring cycles, including L9821, L9822 and L9823.

For complete calibration of a probe system, you must use subroutines L9801, L9802, and either L9803 or L9804. Examples of full calibration procedures are described in the sections titled “Example 1: Full calibration in an internal feature” and “Example 2: Full calibration on an external feature” at the end of this chapter.

Calibrating the probe length (L9801)

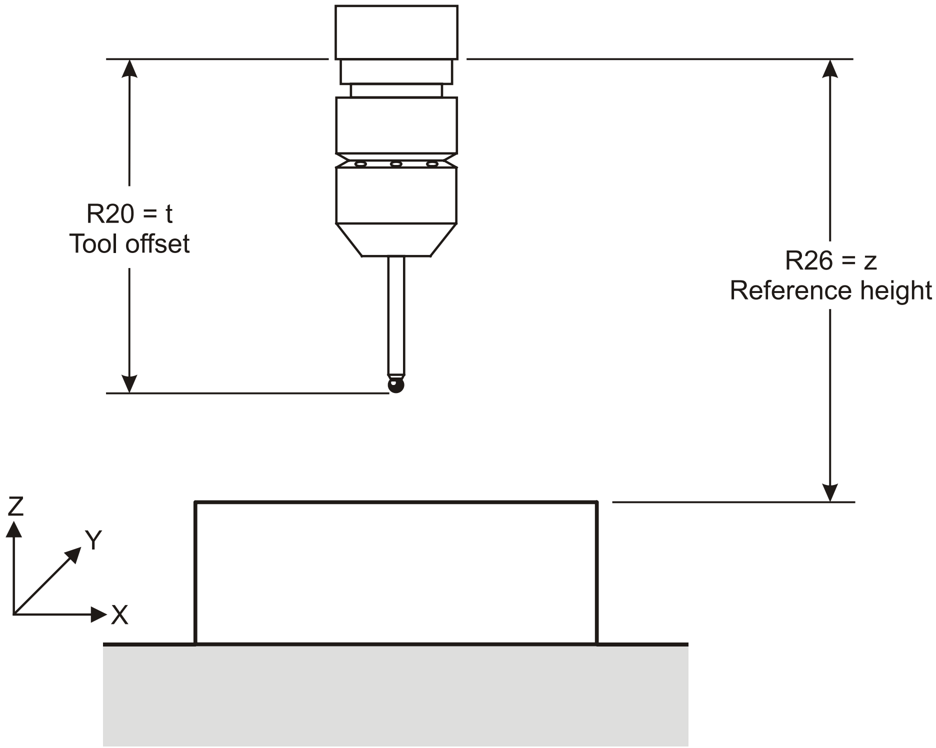

Figure 6.1 Calibrating the probe length

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

An approximate tool offset is loaded. The probe is positioned adjacent to the reference surface. When the cycle is run the surface is measured and the tool offset is reset to a new value. The probe then returns to the start position.

Format

R26 = z R20 = t or RENTL = "toolname"
L9801

Example: R26 = 50. R20 = 20
L9801

Compulsory inputs

R26 = Reference surface position.

Without the Tool Management / ShopMill option

R20 = The active tool number.

Example: R20 = 10

With the Tool Management / ShopMill option

RENTL = "toolname"

Note that the tool name must be enclosed in inverted commas and be exactly the same word format as the actual name.

Example: RENTL = “3D_Probe”

Outputs

The active tool offset and edge (D) will be set.

Example: Setting X, Y and Z values in work offset G54

%_N_????_MPF

G40G0	Preparatory codes for the machine.
G54X0Y0	Start position.
Z100.D01	Go to 100 mm (3.94 in) above and activate edge offset D1.
L9832	Turn on the probe (includes SPOS=0 for spindle orientation).
L9800	Clear the global ‘R’ parameters.
R26 = 10. R9 = 3000 L9810	Protected positioning move.
R26 = 0 R20 = 10 L9801	Datum Z direction.
R26 = 100. L9810	Protected positioning move.
L9833	Turn off the probe (when applicable).
G53Z100.	Reference return.
M30	End of the program.

NOTE: The tool offset must be active. The active tool offset T word number / tool name must be the same as the R20 / RENTL input (see above).
The current active edge number (D) is updated.

Calibrating the stylus X and Y offsets (L9802)

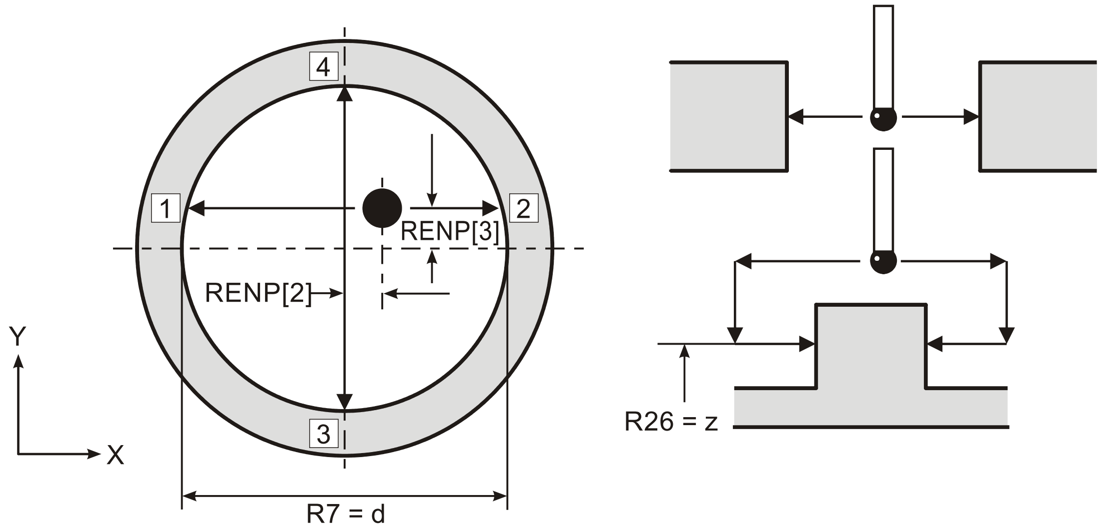

Figure 6.2 Calibrating the stylus X and Y offsets

Description

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

Application

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

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

Format

R7 = d [R26 = z]
L9802
where [ ] denote optional inputs.

Example: R7 = 50.005 R26 = 50.
L9802

Compulsory inputs

R7 = d Nominal size of the feature.

Optional input

R26 = z	The absolute Z-axis measuring position when calibrating on an external feature. If this is omitted, a bore cycle is assumed.

Outputs

The following data will be stored:

RENP[2] = X-axis stylus offset.
RENP[3] = 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 bored hole centre line.

%_N_????_MPF

G40G0	Preparatory codes for the machine.
L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
L9800	Clear the global 'R' parameters.
R7 = 50 L9802	Calibrate in a 50 mm (1.97 in) diameter bored hole.
L9833	Turn off the probe (when applicable).
M30	End of the program.

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

Run a complete positioning and calibration program as follows.

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

%_N_????_MPF

G40G0	Preparatory codes for the machine.
G54X0Y0	Move to the centre of the feature.
Z100.D01	Go to 100 mm (3.94 in) above and activate edge offset D1.
L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
L9800	Clear the global 'R' parameters.

R26 = –5. R9 = 3000 L9810	Protected positioning move into the hole.
R7 = 50. L9802	Calibrate in a 50 mm (1.97 in) diameter bored hole.
R26 = 100. R9 = 3000 L9810	Protected positioning move retract to 100 mm (3.94 in).
L9833	Turn off the probe (when applicable).
G53Z100.	Reference return.
M30	End of the program.

Calibrating the stylus ball radius (L9803)

NOTE: Do not use this cycle to calibrate the radius of the stylus ball if, subsequently, you intend using vector measuring subroutines L9821, L9822 or L9823. Instead, calibrate the radius of the stylus ball using subroutine L9804.

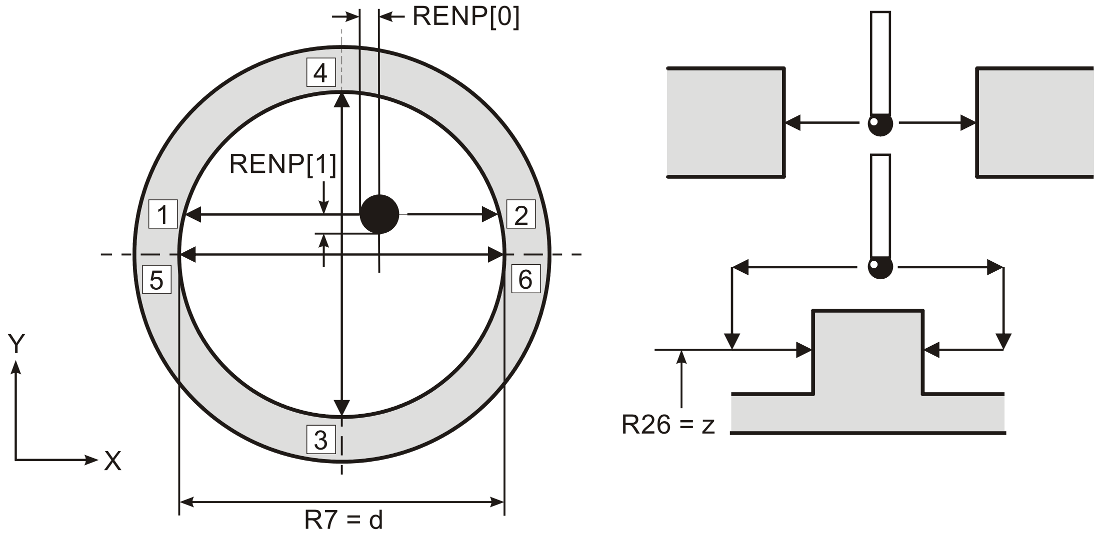

Figure 6.3 Calibrating the stylus ball radius

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. Position the probe to be calibrated inside the ring gauge on the approximate centre position, with spindle orientation active.

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

Format

R7 = d [R26 = z R19 = s]
L9803
where [ ] denote optional inputs.

Example: R7 = 50.005 R26 = 50. R19 = 1.
L9803

Compulsory inputs

R7 = d	Size of the reference ring gauge.

Optional inputs

R19 = s	The zero offset number that will be set. The zero offset number will be updated. R19 = 0 (G500) R19 =1 to R19 = 4 (G54 to G57) R19 = 5 to R19 = 99 (G505 to G599) R19 = 1000 (base zero offset). New zero offset = active zero offset + error.
R26 = z	The absolute Z-axis measuring position when calibrating on an external feature. If this is omitted, a ring gauge cycle is assumed.

Outputs

The following data will be stored.

RENP[0] = X+, X–, stylus ball radius	(XRAD)
RENP[1] = 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.

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

%_N_????_MPF

G40G0	Preparatory codes for the machine.
L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
L9800	Clear the global ‘R’ parameters.
R7 = 50.001 L9803	Calibrate in a 50.001 mm (1.9685 in) diameter ring gauge.
L9833	Turn off the probe (when applicable).
M30	End of the program.

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

Run a complete positioning and calibration program as follows.

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

%_N_???_MPF

G40G00	Preparatory codes for the machine.
G54X0Y0	Move to the centre of the feature.
Z100.D01	Go to 100 mm (3.94 in) above and activate edge offset D1.
L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
L9800	Clear the global 'R' parameters.
R26 = –5 R9 = 3000 L9810	Protected positioning move into the hole.
R7 = 50.001 L9803	Calibrate in a 50.001 mm (1.9685 in) ring gauge.
R26 = 100 R9 = 3000 L9810	Protected positioning move retract to 100 mm (3.94 in).
L9833	Turn off the probe (when applicable).
G53Z100.	Reference return.
M30	End of the program.

Calibrating the vector stylus ball radius (L9804)

NOTE: You must use this cycle to calibrate the radius of the stylus ball if you intend using vector measuring subroutines L9821, L9822 or L9823 (described in Chapter 8, "Vector measuring cycles"). Do not calibrate the stylus ball radius using subroutine L9803.

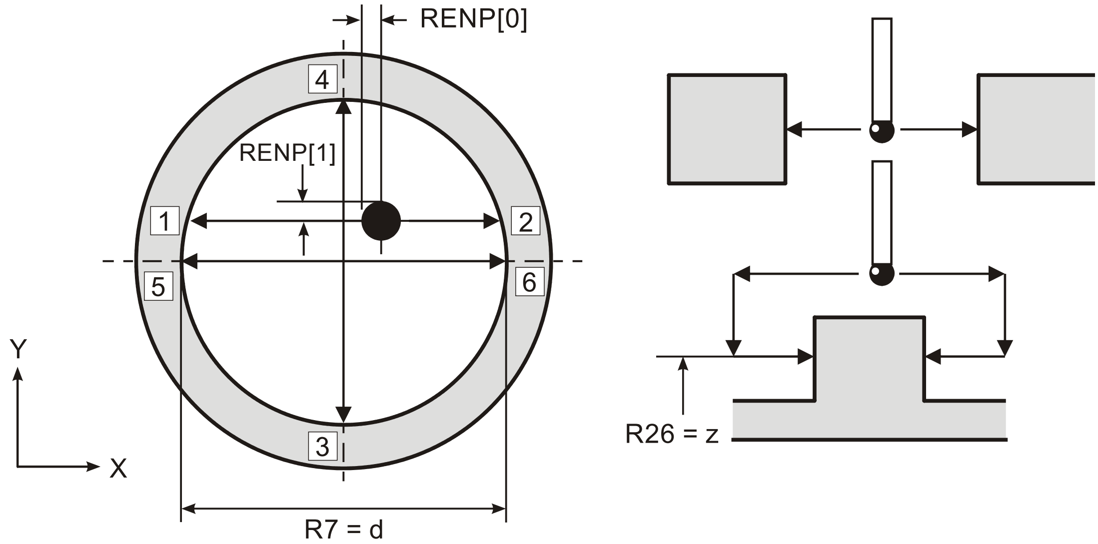

Figure 6.4 Calibrating the vector stylus ball radius

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. The probe to be calibrated is positioned inside the ring gauge on the approximate centre position with spindle orientation active.

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

Format

R7 = d [R26 = z R19 = s]
L9804
where [ ] denote optional inputs.

Example: R7 = 50.005 R26 = 50 R19 = 1.
L9804

Compulsory inputs

R7 = d Size of the reference ring gauge.

Optional inputs

R19 = s The zero offset number that will be set.

The zero offset number will be updated.
R19 = 0 (G500)
R19 =1 to R19 =4 (G54 to G57)
R19 = 5 to R19 = 99 (G505 to G599)
R19 = 1000 (base zero offset).
New zero offset = active zero offset + error.

R26 = z The absolute Z-axis measuring position when calibrating on an external feature. If this is omitted, a ring gauge cycle is assumed.

Outputs

The following data will be stored (same as for cycle L9803):

RENP[0] = X+, X–, stylus ball radius	(XRAD)
RENP[1] = Y+, Y–, stylus ball radius	(YRAD)

Additional vector calibration data:

RENP[10] = 30 degree stylus ball radius	(VRAD)
RENP[11] = 60 degree stylus ball radius	(VRAD)
RENP[12] = 120 degree stylus ball radius	(VRAD)
RENP[13] = 150 degree stylus ball radius	(VRAD)
RENP[14] = 210 degree stylus ball radius	(VRAD)
RENP[15] = 240 degree stylus ball radius	(VRAD)
RENP[16] = 300 degree stylus ball radius	(VRAD)
RENP[17] = 330 degree stylus ball radius	(VRAD)

Example 1: Vector stylus ball radius calibration

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

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

%_N_????_MPF

G40G0	Preparatory codes for the machine.
L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
L9800	Clear the global ‘R’ parameters.
R7 = 50.001 L9804	Calibrate in a 50.001 mm (1.9685 in) diameter ring gauge.
L9833	Turn off the probe (when applicable).
M30	End of the program.

Example 2: Vector stylus ball radius calibration (alternative method)

Run a complete positioning and calibration program as follows.

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

%_N_????_MPF

G40G0	Preparatory codes for the machine.
G54X0Y0	Move to the centre of the feature.
Z100.D01	Go to 100 mm (3.94 in) above and activate edge offset D1.
L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
L9800	Clear the global ‘R’ parameters.
R26 = –5. R9 = 3000 L9810	Protected positioning move into the hole.
R7 = 50.001 L9804	Calibrate in a 50.001 mm (1.9685 in) diameter ring gauge.
R26 = 100 R9 = 3000 L9810	Protected positioning move retract to 100 mm (3.94 in).
L9833	Turn off the probe off (when applicable).
G53Z100.	Reference return.
M30	End of the program.

Example 1: Full calibration in an internal feature

This example describes how to carry out full calibration of a probe in an internal feature using subroutines L9801, L9802 and L9804.

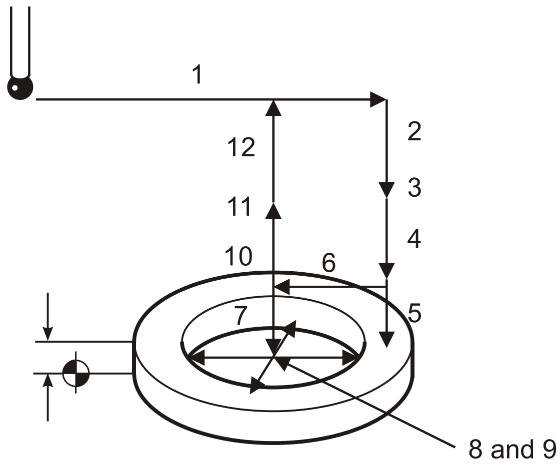

Figure 6.5 Full calibration in an internal feature

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 zero offset (example using G54).

	%_N_????_MPF	
	G40G0	Preparatory codes for the machine.
1.	G54X35.Y0	Move off the centre of the feature for height setting.
2.	Z100.D01	Go to 100 mm (3.94 in) above and activate edge offset D1.
3.	L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
3.1	L9800	Clear the global 'R' parameters.
4.0	R26 = 30 R9 = 3000	Protected positioning move above the reference
4.1	L9810	surface.
5.0	R26 = 20.006 R20 = 20.	Calibrate the probe length.
5.1	L9801	The surface is at 20.006 mm (7.876 in).

6.0	R24 = 0 R25 = 0	Protected positioning move to the centre.
6.1	L9810	
7.0	R26 = 5.	Protected positioning move into the hole.
7.1	L9810	
8.0	R7 = 50.	Calibrate in a 50 mm (1.97 in) diameter bored hole
8.1	L9802	to establish the X,Y stylus offset.
9.0	R7 = 50.001	Calibrate in a 50.001mm (1.9685in) diameter ring
9.1	L9804	gauge to establish the radius values of the stylus ball, including the vector directions.
10.0	R26 = 100 R9 = 3000	Protected positioning move retract to 100 mm
10.1	L9810	(3.94 in).
	L9833	Turn off the probe (when applicable).
	G53Z100.	Reference return.
	M30	End of the program.

Example 2: Full calibration on an external feature

This example describes how to carry out full calibration of a probe on an external feature using subroutines L9801, L9802 and L9804.

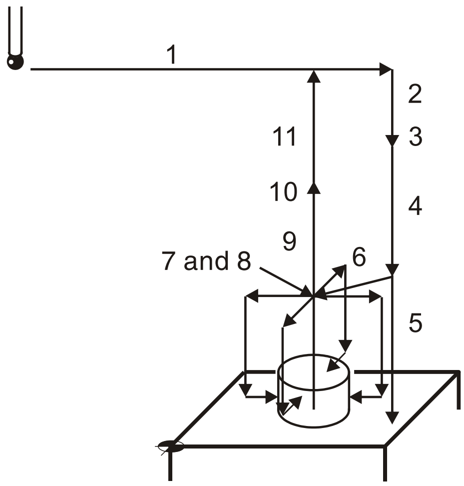

Figure 6.6 Full calibration on an external feature

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 the height of the Z surface in a zero offset (example using G54).

	%_N_????_MPF	
	G40G0	Preparatory codes for the machine.
1.0	G54X135Y100	Move to the centre of the feature for height setting.
2.0	Z100.D01	Go to 100 mm (3.94 in) above and activate edge offset D1.
3.0	L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
3.1	L9800	Clear the global ‘R’ parameters.
4.0	R26 = 30 R = 3000	Protected positioning move above the reference
4.1	L9810	surface.

5.0	R26 = 0 R20 = 20	Calibrate the probe length.
5.1	L9801	The Z surface is at zero.
6.0	R24 = 100 R25 = 100.	Protected positioning move to the centre.
6.1	L9810	
7.0	R7 = 50.001 R26 = 10.	Calibrate on a 50.001 mm (1.9685 in) diameter pin
7.1	L9802	gauge to establish the X,Y stylus offset.
8.0	R7 = 50.001R26 = 10.	Calibrate on a 50.001 mm (1.9685 in) diameter pin
8.1	L9804	gauge to establish the ball radius values, including the vector directions.
9.0	R26 = 100 R9 = 3000	Protected positioning move retract to 100 mm
9.1	L9810	(3.94 in).
10.0	L9833	Turn off the probe (when applicable).
11.0	G53Z100.	Reference return.
	M30	End of the program.

Chapter 7

Measuring cycles

This chapter describes how to use the non-vector measuring cycle subroutines. Before using these subroutines, the radius of the stylus ball must be calibrated using either subroutine L9803 or L9804 (see Chapter 6, “Calibrating the probe”).

Contained in this chapter

X Y Z single surface measurement (L9811)

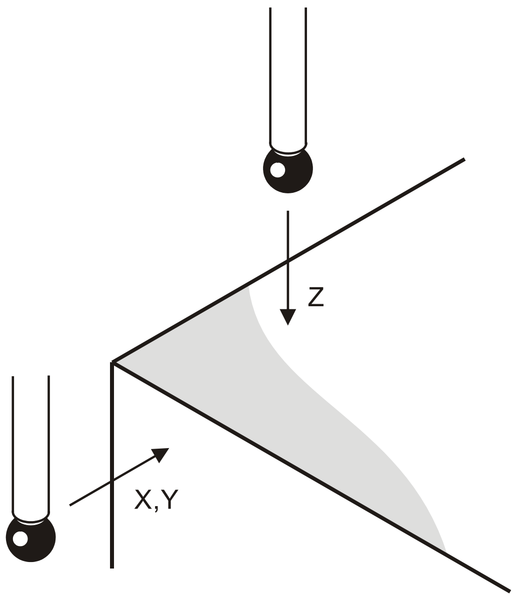

Figure 7.1 Measurement of a single surface

Description

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

Application

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

The measured surface can be treated in two ways:

1. As a size, where the tool offset is updated in conjunction with the R20 = t or RENTL = "toolname" and the R11 = h input.

2. As a reference position, for the purpose of adjusting a zero offset using the R19 = s and R13 = m inputs.

Format

R24 = x or R25 = y or R26 = z [R8 = e R9 = f R11 = h R13 = m R17 = q R19 = s
R20 = t or RENTL = "toolname" R21 = u R22 = v R23 = w]
L9811
where [ ] denotes optional inputs.

Example: R24 = 50 R8 = 0.005 R9 = 0.8 R11 = 0.2 R13 = 0.2 R17 = 10 R19 = 1
R20 = 20 R21 = 0.5 R22 = 0.5
L9811

Compulsory inputs

R24 = x
or
R25 = y x,y,z = The surface position or size.
or
R26 = z

Optional inputs

R11 = h The tolerance value of a feature dimension being measured.

R13 = m The true position tolerance of a feature. This is a cylindrical zone about the theoretical position.

R17 = 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.

R19 = s The zero offset number that will be set.

The zero offset number will be updated.
R19=0 (G500)
R19=1 to R19=4 (G54 to G57)
R19=5 to R19=99 (G505 to G599)
R19=1000 (base zero offset)
New zero offset = active zero offset + error.

Without the Tool Management / ShopMill option

R20 = Tool / edge number.

Examples:

R20 = 10 Tool T10 and edge D1 by default.

R20 = 10.2 Tool T10 and edge D2.

With the Tool Management / ShopMill option

RENTL = "Tool name".

Note that the tool name must be enclosed in inverted commas and be exactly the same word format as the actual name.

Example:

RENTL = "10MM DRILL"

R20 = Tool edge number.

Examples:

With no R20 input	Edge D1 by default.
R20 = 2	Edge D2.

R23 = w Print data.

1. = Increment the feature number only.

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

For details of optional inputs R8 = e, R9 = f, R21 = u, and R22 = v, see Chapter 3, “Optional inputs”.

Example: Measuring a single surface in X and Z

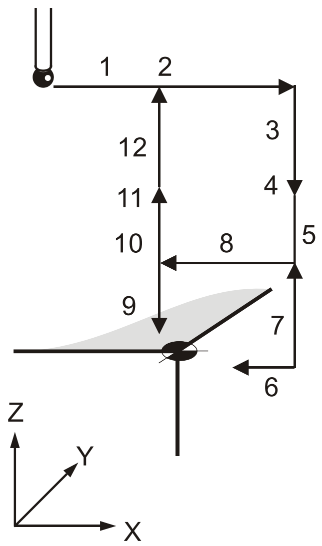

Figure 7.2
Probe movements

1.0	T1	Tool change tool 1.
1.1	M06	Select the probe.
2.	G54X–40.Y20.	Start position.
3.	Z100.D01	Go to 100 mm (3.94 in) above and activate edge offset D1.
4.	L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
4.1	L9800	Clear the global ‘R’ parameters.
5.0	R26 = –8. R9 = 3000	
5.1	L9810	Protected positioning move to the start position.
6.0	R25 = –50. R20 = 10.	
6.1	L9811	Single surface measurement.
7.0	R26 = 10.	
7.1	L9810	Protected positioning move.
8.0	R24 = –60.	
8.1	L9810	Protected positioning move.
9.0	R26 = 0 R20 = 10	
9.1	L9811	Single surface measurement.

10.0	R26 = 100.	
10.1	L9810	Protected positioning move.
11.	L9833	Turn off the probe (where applicable).
12.	G53Z100.	Reference return.
	continue	

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

Web/pocket measurement (L9812)

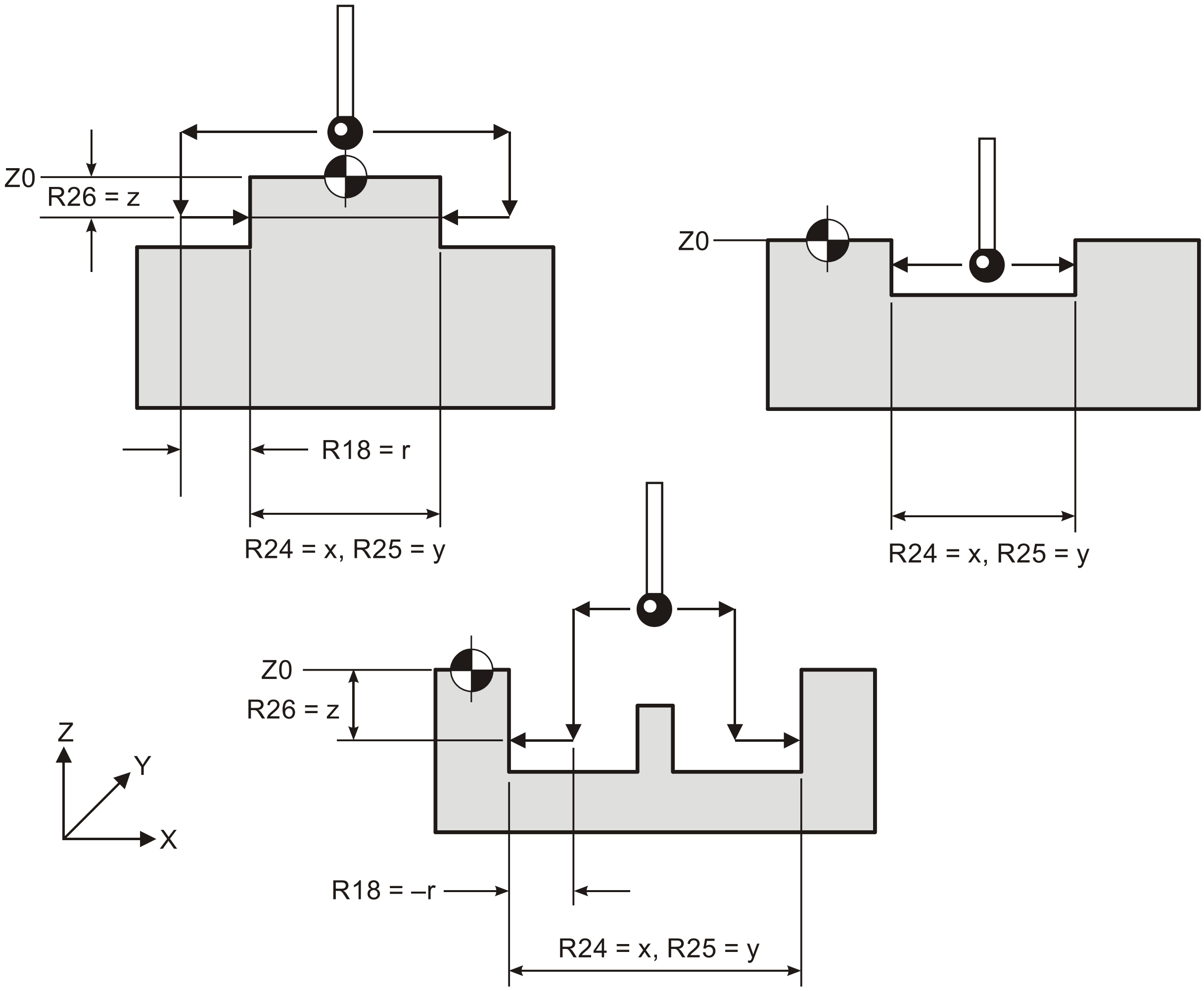

Figure 7.3 Measurement of a web or pocket feature

Description

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

Application

The probe is positioned to the expected centre line of the feature and at a suitable position in the Z-axis, with the probe and probe offset active. The cycle then runs with suitable inputs, as described.

Format

where [ ] denote optional inputs.

R24 = x [R8 = e R9 = f R11 = h R13 = m R17 = q R18 = r R19 = s R20 = t or
RENTL = "toolname" R21 = u R22 = v R23 = w]
L9812

or

R25 = y [R8 = e R9 = f R11 = h R13 = m R17 = q R18 = r R19 = s R20 = t or
RENTL = "toolname" R21 = u R22 = v R23 = w]
L9812

or

R24 = x R26 = z [R8 = e R9 = f R11 = h R13 = m R17 = q R18 = r R19 = s R20 = t
or RENTL = "toolname" R21 = u R22 = v R23 = w]
L9812

or

R25 = y R26 = z [R8 = e R9 = f R11 = h R13 = m R17 = q R18 = r R19 = s R20 = t
or RENTL = "toolname" R21 = u R22 = v R23 = w]
L9812

Example: R24 = 50. R26 = 100. R8 = 0.005 R9 = 0.8 R11 = 0.2 R13 = .2 R17 = 10.
R18 = 10.R19 = 1. RENTL = "20MM CUTTER" R21 = .5 R22 = .5
L9812

Compulsory inputs

R24 = x Nominal size of the feature when measured in the X-axis.
or
R25 = y Nominal size of the feature when measured in the Y-axis.

R26 = z The absolute Z-axis position when measuring a web feature. If this is omitted, a pocket cycle is assumed.

Optional inputs

R11 = h The tolerance value of a feature dimension being measured.

R13 = m The true position tolerance of a feature. This is a cylindrical zone about the theoretical position.

R17 = 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.

R18 = r	This is an incremental dimension that is used in external features – for example, 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).
R18 = –r	This is similar to R18 = r, except that the clearance is applied in the opposite direction to force an internal web cycle. **Default value:** 5 mm (0.200 in).
R19 = s	The zero offset number that will be set. The zero offset number will be updated. R19 = 0 (G500) R19 = 1 to R19 = 4 (G54 to G57) R19 = 5 to R19 = 99 (G505 to G599) R19 = 1000 (base zero offset) New zero offset = active zero offset + error.

Without the Tool Management / ShopMill option

R20 = Tool / edge number.

Examples:

R20 = 10	Tool T10 and edge D1 by default.
R20 = 10.2	Tool T10 and edge D2.

With the Tool Management / ShopMill option

RENTL = "Tool Name"

Note that the tool name must be enclosed in inverted commas and be exactly the same word format as the actual name.

Example:

RENTL = "10MM DRILL"

R20 = Tool edge number.

Examples:

With no R20 input	Edge D1 by default.
R20 = 2	Edge D2.

R23 = w Print data.

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

For details of optional inputs R8 = e, R9 = f, R21 = u, and R22 = v, see Chapter 3, “Optional inputs”.

Outputs

See Chapter 4, “Variable outputs”.

Example 1: Measuring a web

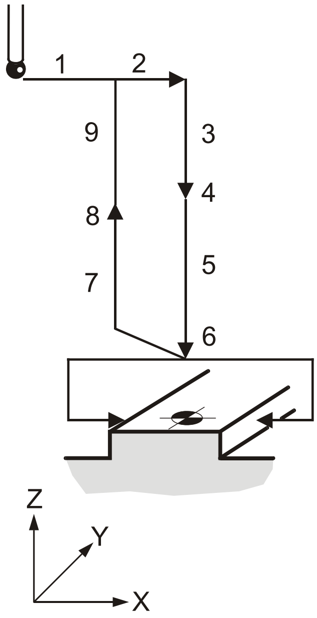

Figure 7.4
Probe movements

1.0	T1	Tool change tool 1.
1.1	M06	Select the probe.
2.	G54X0Y0	Start position.
3.	Z100. D01	Go to 100 mm (3.94 in) above and activate edge offset D1.
4.	L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
4.1	L9800	Clear the global ‘R’ parameters.
5.0	R26 = 10. R9 = 3000	
5.1	L9810	Protected positioning move.
6.0	R24 = 50. R26 = –10. R19 = 2	
6.1	L9812	Measure a 50.0 mm (1.968 in) wide web.
7.0	R26 = 100.	
7.1	L9810	Protected positioning move.
8.	L9833	Turn off the probe (where applicable).
9.	G53Z100.	Reference return.
	continue	

The feature centre line in the X-axis is stored in the zero offset G55 (R19 = 2).

Example 2: Measuring a pocket (referred datum)

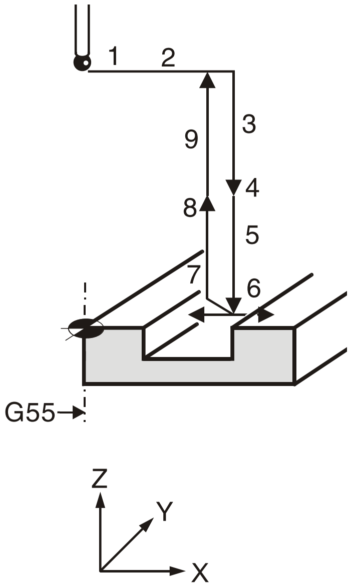

Figure 7.5
Probe movements

1.0	T1	Tool change tool 1.
1.1	M06	Select the probe.
2.	G54X100.Y50.	Start position.
3.	Z100. D01	Go to 100 mm (3.94 in) above and activate edge offset D1.
4.	L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
4.1	L9800	Clear the global ‘R’ parameters.
5.0	R26 = –10. R9 = 3000.	
5.1	L9810	Protected positioning move.
6.0	R24 = 30. R19 = 2	
6.1	L9812	Measure a 30.0 mm (1.181 in) wide pocket.
7.0	R26 = 100.	
7.1	L9810	Protected positioning move.
8.	L9833	Turn off the probe (where applicable).
9.	G53Z100.	Reference return.
	continue	

The error of the centre line is referred to the datum point X0 and the revised X0 position is set in zero offset G55 (R19 = 2).

Bore/boss measurement (L9814)

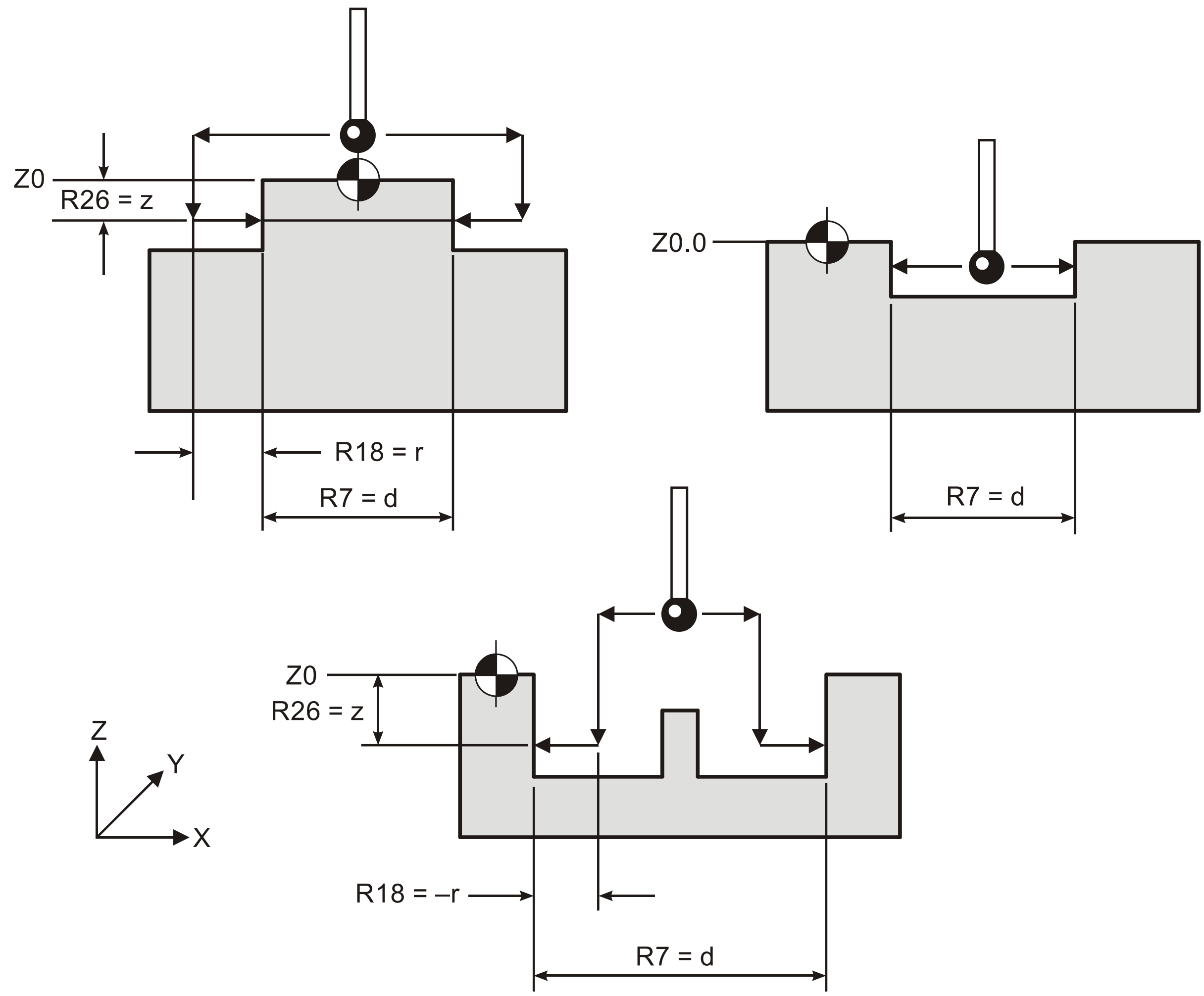

Figure 7.6 Measurement of a bore or boss feature

Description

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

Application

The probe is positioned to the expected centre line of the feature and at a suitable position in the Z-axis, with the probe and probe offset active. The cycle then runs with suitable inputs, as described.

Format

R7 = d [R8 = e R9 = f R11 = h R13 = m R17 = q R18 = r R19 = s R20 = t or RENTL = "toolname" R21 = u R22 = v R23 = w]
L9814

or

R7 = d R26 = z [R8 = e R9 = f R11 = h R13 = m R17 = q R18 = r R19 = s R20 = t or RENTL = "toolname" R21 = u R22 = v R23 = w]
L9814

where [ ] denotes optional inputs.

Example: R7 = 50.005 R26 = 100. R8 = 0.005 R9=0.8 R11 = 0.2 R13 = 0.2 R17 = 10. R18 = 10. R19 = 1. RENTL = "25MM CUTTER" R21 = 0.5 R22 = 0.5
L9814

Compulsory inputs

R7 = d Nominal size of the feature.

R26 = z The absolute Z-axis position when measuring a boss feature. If this is omitted, a bore cycle is assumed.

Optional inputs

R11 = h The tolerance value of a feature dimension being measured.

R13 = m The true position tolerance of a feature. This is a cylindrical zone about the theoretical position.

R17 = 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.

R18 = r This is an incremental dimension that is used in external features – for example, 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).

R18 = –r This is similar to R18 = r, except that the clearance is applied in the opposite direction to force an internal boss cycle.

Default value: 5 mm (0.200 in).

R19 = s The zero offset number that will be set.

The zero offset number will be updated.
R19 = 0 (G500)
R19 = 1 to R19 = 4 (G54 to G57)
R19 = 5 to R19 = 99 (G505 to G599)
R19 = 1000 (base zero offset)
New zero offset = active zero offset + error.

Without the Tool Management / ShopMill option

R20 = Tool / edge number.

Examples:

R20 = 10 Tool T10 and edge D1 by default.

R20 = 10.2 Tool T10 and edge D2.

With the Tool Management / ShopMill option

RENTL = "Tool name".

Note that the tool name must be enclosed in inverted commas and be exactly the same word format as the actual name.

Example:

RENTL = "10MM DRILL"

R20 = Tool edge number.

Examples:

With no R20 input Edge D1 by default.

R20 = 2 Edge D2.

R23 = w Print data.

1. = Increment the feature number only.

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

For details of optional inputs R8 = e, R9 = f, R21 = u, and R22 = v, see Chapter 3, “Optional inputs”.

Outputs

See Chapter 4, “Variable outputs”.

Example 1: Measuring a boss

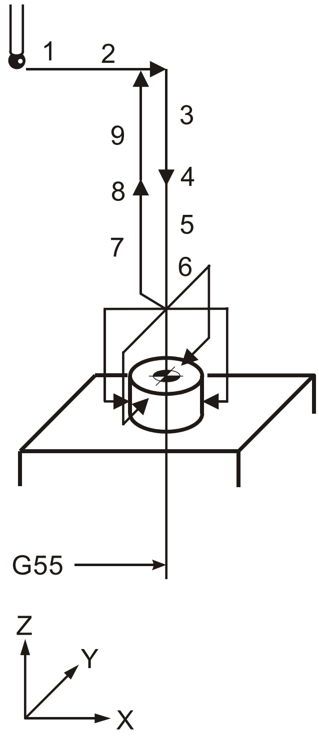

Figure 7.7
Probe movements

1.0	T1	Tool change tool 1.
1.1	M06	Select the probe.
2.	G54X0Y0	Start position.
3.	Z100.D01	Go to 100 mm (3.94 in) above and activate edge offset D1.
4.	L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
4.1	L9800	Clear the global 'R' parameters.
5.0	R26 = 10 R9 = 3000	
5.1	L9810	Protected positioning move.
6.0	R7 = 50. R26 = –10. R19 = 2.R18 = 10.	
6.1	L9814	Measure a 50.0 mm (1.968 in) diameter boss.
7.0	R26 = 100.	
7.1	L9810	Protected positioning move.
8.	L9833	Turn off the probe (when applicable).
9.	G53Z100.	Reference return.
	continue	

The feature centre line in the X and Y axis is stored in the zero offset G55 (R19=2).

Example 2: Measuring a bore (referred datum)

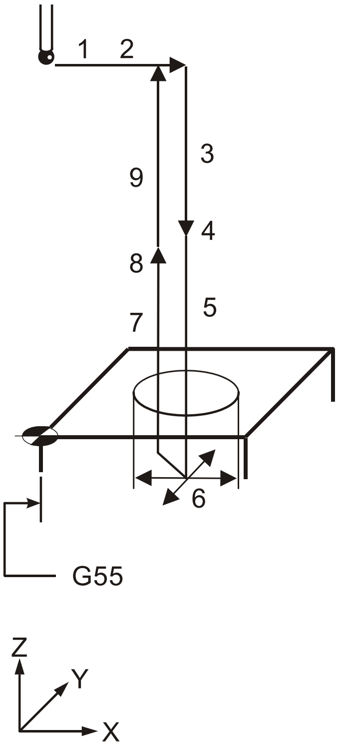

Figure 7.8
Probe movements

1.0	T1	Tool change tool 1.
1.1	M06	Select the probe.
2.	G54X100.0Y100.	Start position.
3.	Z100. D01	Go to 100 mm (3.94 in) above and activate edge offset D1.
4.	L9832	Turn on the probe (includes SPOS = 0 for spindle orientation).
4.1	L9800	Clear the global 'R' parameters.
5.0	R26 = –10. R9 = 3000	
5.1	L9810	Protected positioning move.
6.0	R7 = 30. R19 = 2	
6.1	L9814	Measure a 30.0 mm (1.181 in) diameter bore.
7.0	R26 = 100.	
7.1	L9810	Protected positioning move.
8.	L9833	Turn off the probe (when applicable).
9.	G53Z100.	Reference return.
	continue	

The error of the centre line is referred to the datum point X0, Y0 and the revised X0, Y0 position is set in zero offset G55 (R19=2).