Installation, integration and user's guide
H-1000-5051-02-A

RENISHAW
apply innovation™

SP80 ultra-high accuracy scanning probe system

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SP80

Ultra-high accuracy scanning probe system

Installation, integration and user's guide

CE

About this user's guide
This document is intended as a guide to initial installation, integration and subsequent use of the Renishaw SP80 scanning probe system.

Care of equipment
Renishaw probes and associated equipment are precision tools used for obtaining precise measurements and must therefore be treated with care.

Changes to Renishaw products
Renishaw reserves the right to improve, change or modify its hardware or software without incurring any obligations to make changes to Renishaw equipment previously sold.

Warranty
Renishaw plc warrants its equipment for a limited period (as set out in our Standard Terms and Conditions of Sale) provided that it is installed exactly as defined in the associated Renishaw documentation.

Prior consent must be obtained from Renishaw if non-Renishaw equipment (e.g. interfaces and/or cabling) is used or substituted. Failure to comply with this will invalidate the Renishaw warranty.

Claims under warranty must be made from authorised service centres only, which may be advised by the supplier or distributor.

Patents
Features of Renishaw's SP80 scanning probe system, and associated equipment, are the subjects of the patents and patent applications. Full details are available on request.

EP 0207121	JP 1549396	US 4959542	WO 03/062738
EP 0470234	JP 3,004,050	US 5,327,657	WO 03/083407
EP 0568120	JP 3,279,317	US 5,390,424	WO 03/087708
EP 566719 B		US 5,323,540	

Information to the user

FCC Section 15.21

The user is cautioned that any changes or modifications not expressly approved by Renishaw plc or authorised representative could void the user's authority to operate the equipment.

FCC Section 15.105

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with this instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Section 15.19

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference.

(2) This device must accept any interference received, including interference that may cause undesired operation.

Electrical requirements

UCC1/UCC2 controller

The UCC1/UCC2 is powered from the a.c. mains supply via an IEC 320 connector. Please refer to the UCC1 installation guide (Renishaw part number H-1000-5056) or the UCC2 installation guide (Renishaw part number H-1000-5223) for safety instructions and documentation relevant to the use of the UCC1/UCC2 CMM controller and its subsystems.

CC6 counter card

Please refer to the CC6 Installation and programmer's guide (H-1000-6008) for safety instructions and documentation relevant to the use of the CC6 counter card.

NOTE: The SP80 can be powered by either a connection to a Renishaw UCC1, UCC2, a CC6 counter card via a PC or an OEM specifically designed system.

Environmental requirements

SP80 system

The IU80 complies (or exceeds) with the following environmental conditions stated in BS EN 61010-1:1993:

Indoor use	IP30
Altitude	Up to 2000 m
Operating temperature	+0 °C to +50 °C
Storage temperature	-10 °C to +70 °C
Relative humidity	80% maximum (non-condensing) for temperatures up to +31 °C Linear decrease to 50% at +40 °C
Transient overvoltages	Installation category II
Pollution degree	2

Safety

EN - Safety

There is no overtravel protection in the +Z axis other than an endstop. Your control system must therefore be able to stop the motion of the machine in the +Z axis of the probe before the endstop is reached. If this is not the case, safety glasses must be worn when operating or observing the operation of the SP80 system to avoid injury in the case of stylus breakage.

Machine operators must be trained in the use and application of the SP80 in the context of the machine it is fitted to before being allowed to operate that machine.

CAUTION: Permanent magnets are used in some components of the SP80 system. It is important to keep them away from items which may be affected by magnetic fields, e.g. data storage systems, pacemakers and watches etc.

International safety instructions

GB **WARNING:** You must now turn to appendix 1 and read the safety instructions in your own language before unpacking and installing this product.

DE **SICHERHEITSANWEISUNGEN:** Lesen Sie die Sicherheitsanweisungen in Ihrer Sprache im Anhang 1 vor dem Auspacken und Installieren des Produktes.

DK **SIKKEREDHED:** Læs sikkerhedsinstrukserne i Appendix 1 FØR udpakning og installation af dette produkt!

EL **ΑΣΦΑΛΕΙΑ:** Πρέπει τώρα να γυρίσετε στο Κεφάλαιο 1 και να διαβάσετε τις οδηγίες ασφαλείας στη δική σας γλώσσα προτού ανοίξετε αυτό το προϊόν για να το εγκαταστήσετε.

ES **SEGURIDAD:** Debe volver al Apéndice 1 y leer las instrucciones de seguridad en su propio idioma antes de abrir e instalar este producto.

FIN **TURVALLISUUTTA:** Ennen tämän tuotteen pakkauksen avaamista ja asentamista lue liitteessä 1 olevat omalla kielelläsi kirjoitetut turvaohjeet.

FR **SECURITE:** Vous devez à présent consulter l'annexe 1 et les instructions de sécurité dans votre propre langue avant de déballer et d'installer ce produit.

IT **SICUREZZA:** Prima di aprire ed installare questo prodotto dovete leggere le istruzioni di sicurezza nella Vostra Lingua riportate nell'Appendice 1.

NL **VELIGHEID:** Ga nu naar Appendix 1 en lees de veiligheidsinstructies, in uw eigen taal, voordat u dit product uitpakt en installeert.

PT **SEGURANÇA:** Você deve retornar ao Apêndice 1 e ler as instruções de segurança em seu idioma antes de desembalar e instalar este produto.

SV **SÄKERHETSFÖRESKRIFTER:** Du måste nu gå till bilaga 1 och läsa säkerhetsinstruktionerna på ditt eget språk innan du packar upp och installerar denna produkt.

Contents

1 Introduction

This installation and integration guide is intended to help OEM personnel in the initial installation, integration and use of the Renishaw SP80 ultra-high accuracy scanning probe. The SP80 is a quadrature measurement probe which provides class-leading performance, as well as the most flexible use of styli for maximum productivity.

The guide provides information on mechanical and electrical probe installation, system connections and interface options. The installation options are explained as the SP80 can be integrated via the UCC1/UCC2 controller (by using a dedicated SP80 daughtercard), or by using the CC6 counter card (which requires the IU80 interpolator unit). If you intend to handle probe interfacing yourself then details of probe signals, power requirements etc. can be found in section 5, 'system interconnection and electrical integration', although this will significantly increase the complexity of the integration process.

Figure 1 - Renishaw's SP80 ultra-high accuracy scanning probe

2 System overview

The SP80 system comprises the SP80 ultra-high accuracy scanning probe, the probe interface (see options listed in section 3.1) and a rack system for stylus changing.

The SP80 is a fixed type scanning probe that uses digital scale and readhead technology (with 0.02 µm measuring resolution), and features Renishaw's innovative isolated optical metrology principles, to provide exceptional scanning performance, even with long styli. Simple and robust passive design, with no internal motors to generate heat or reliability issues, unnecessary system complexity is avoided.

The probe is able to access deep into parts by carrying styli up to 500 mm long* and 500 g weight, including star configurations which do not require counterbalancing. Renishaw's range of M5 styli products are designed to complement SP80 and ensure peak performance.

Detachable stylus holders (SH80) permit rapid and repeatable interchange between stylus configurations thus eliminating re-calibration, maximising productivity and permitting optimum solutions to match the application.

The stylus holders also provide crash protection in the X Y direction and a bump stop prevents damage to the probe in the Z axis.

The SP80 has a kinematic mount that offers a repeatable connection to the quill mounting plate (KM80), allowing the probe to be easily removed from the co-ordinate measuring machine (CMM). The KM80 is designed for a 80 mm square quill. Alternative mounting plates are provided to suit a 60 mm quill (KM6080) or shank mounted installations (SM80).

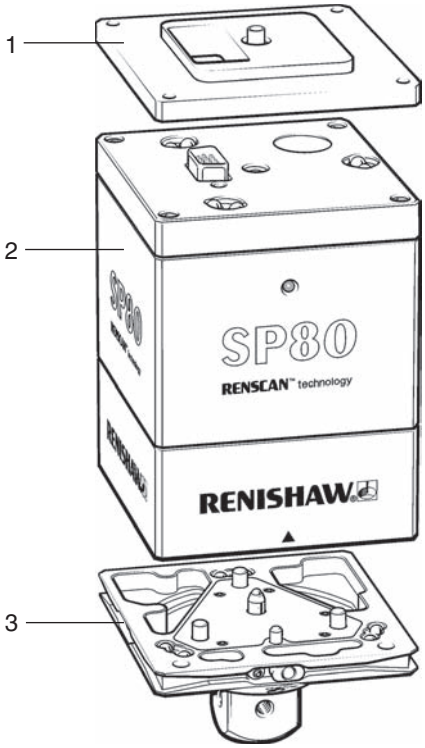
Stylus change ports (SCP80) are mounted to Renishaw's modular rack system (MRS) to provide rapid automatic interchange between stylus holders.

NOTE: The MRS mounts on the CMM table and comprises a length selectable horizontal rail, with height selectable legs. It carries stylus changer units for several Renishaw probe systems as well as the ACR3 autochange rack.

* longer stylus lengths may be carried subject to operating conditions - consult Renishaw for application assistance.

2.1 SP80 probe kit (KM80 + SP80 probe + SH80)

The SP80 probe kit contains the main components detailed below (figure 2), together with a probe cable, tools and a stylus.



1. KM80 kinematic quill mount plate (to suit 80 mm^2 CMM quills)
2. SP80 probe body
3. SH80 stylus holder

Figure 2 - The SP80 probe kit

2.1.1 KM80 kinematic quill mount plate

The SP80 is mounted on the quill of a CMM using the KM80 kinematic quill mount plate (figure 2). The KM80 is attached to the bottom of the quill, and the probe is subsequently mounted to the KM80 via a kinematic joint and quick release autojoint locking mechanism. The KM80 suits 80 mm^2 CMM quills.

2.1.2 KM6080 quill mount adaptor plate

The KM6080 is an adaptor plate that attaches to a 60 x 60 mm quill, but converts the 'footprint' to 80 x 80 mm to allow acceptance of the SP80. It is not supplied with the standard SP80 probe kit and must be ordered separately.

2.1.3 SM80 shank mount adaptor plate

The SM80 shank adaptor plate (SM80) is an option when the KM80 or KM6080 cannot be used, e.g. retrofit of a CMM. It is not supplied with the standard SP80 probe kit and must be ordered separately. The SM80 accepts any standard Renishaw shank and converts the output connector of the SP80 to a Touchel (as PH10 connector) on the rear of the mount.

CAUTION: Poor shank mounting can impair measuring accuracy and therefore this mounting method should be avoided wherever possible.

2.1.4 SP80 probe body

The SP80 scanning probe body (figure 2) is designed for use on direct computer controlled (DCC) CMMs. Direct fitting of the probe to the quill using the KM80 is beneficial for ultimate metrology performance, and for simple fitment to the CMM. The probe uses standard probe head cabling (so there is no requirement for new or extra cabling within the CMM).

The SP80 builds on the passive scanning technology of the SP600 family, but features digital scale and readheads. The design enables exceptional high-accuracy scanning performance, even with long styli and extensions up to 500 mm long* and 500 g weight. Star styli do not need to be balanced, and travel in each axis is ±2.5 mm.

* longer stylus lengths may be carried subject to operating conditions - consult Renishaw for application assistance.

The sensor mechanism comprises an arrangement of three sets of parallel springs, one for each body axis, set in a cube - hence the body shape. The motion of the stylus is coupled to a ‘moving cube’ holding graduated reflective scales - again one for each axis. The readheads are mounted on the wall of the probe and the light projected from them is reflected from the moving cube. This arrangement is known as the 'isolated optical metrology' principle, which is described in more detail in section 2.8. The motion detection system does not require any form of moving wire.

Interchangeable stylus holders (SH80) feature a repeatable mount to the probe body and permit use of the optimised measuring solution to suit the application. Automatic stylus changing of SH80s is provided by stylus changing ports (SCP80) which mount to the MRS.

An LED on the front face of the probe provides a visual indication of the probe status. The LED will illuminate green when power is supplied to the probe. This LED may be switched off by the user if not required and the LED colour and mode is also user configurable (the options being green, red, or both together resulting in orange).

2.1.5 SH80 stylus holder

The SH80 stylus holder (figure 2/3/4) is located onto the probe body using a repeatable magnetic kinematic joint. It provides rapid interchange between stylus configurations thus enabling optimisation of measuring solutions to suit the application whilst achieving improved accuracy.

The SH80 features a 5-way cube for attachment of M5 styli, and for additional flexibility, this cube may be rotationally adjusted for infinite angle position of the stylus. It is locked in the desired position by a single grubscrew and does not need to be removed from the probe body to make the adjustment.

The SH80 can be automatically removed and replaced on the probe body by using a SCP80 mounted on a MRS.

SH80s supplied from November 2004 onwards feature a revised design that makes it possible to dock into a SCP80 port which is aligned with any of the four sides of the SP80 probe (previously docking was only possible from the rear side of the probe body).

This will enable the MRS/SCP80 system to be positioned to the rear, front, left or right of the CMM, or any combination of these.

The revised SH80 design (figure 3) has docking slots on all four sides, together with a new magnet keeper plate assembly which the user must fit to the side of the SH80 that will enter into the SCP80 port.

Engraved graduations (figure 4) assist visual orientation of the stylus cube, and four engraved alignment marks (▼ ◗ ● ■) are positioned on the SH80 and the corresponding sides of the SP80 body. The triangular mark indicates the front of the probe body (as previously).

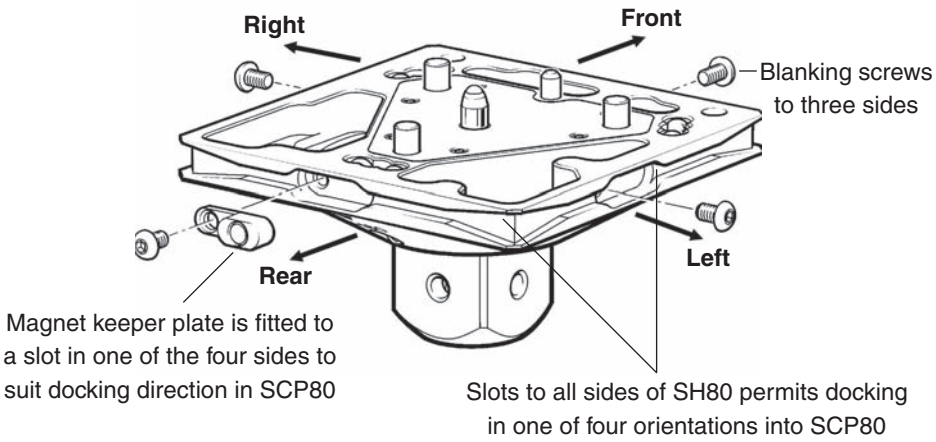


Figure 3 - SH80 docking arrangements (November 2004 onwards)

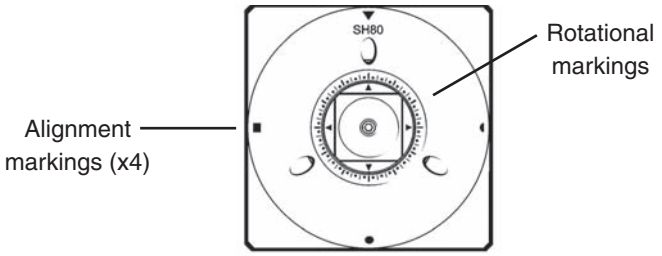
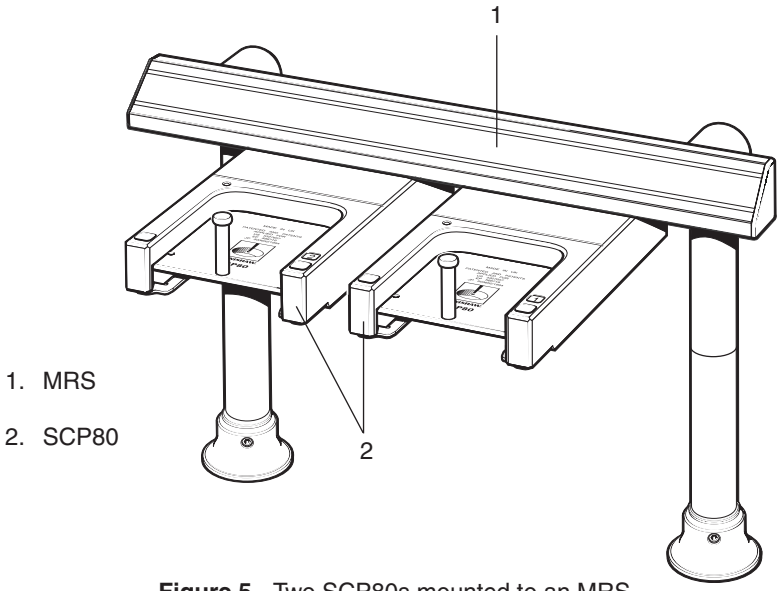


Figure 4 - SH80 markings (November 2004 onwards)

Stylus changing offers crash protection by either the module becoming detached on collision or by setting a high deflection to alert the CMM of an unexpected collision. As with the SP600, the robustness of the probe means that a simple re-qualification of the probe and stylus arrangement should allow work to continue immediately.

2.2 SCP80 stylus changing port

The SCP80 stylus changing port (figure 5) enables automation of SH80 interchange onto the probe. It does not require any electrical connection for operation, and it fits to the MRS. This provides simple flexibility to incorporate as many ports as required, whilst optimising working volume. The SCP80 has a spring-loaded mechanism that is designed to ease the stylus holder away from the probe body thus reducing the pull-off force to less than 20 N during the change cycle.



1. MRS
2. SCP80

Figure 5 - Two SCP80s mounted to an MRS

2.3 IU80 interpolator unit

The IU80 interpolator unit (figure 6) is a free-standing interface for the SP80. It is required for installations where the UCC1/UCC2 daughtercard is not used. The IU80 is connected to the probe by the machine cable. The output of the IU80 is then transferred either to the CC6, or alternatively to an OEM controller via an unterminated cable.

Figure 6 - IU80 interpolator unit

2.4 CC6 PCI counter card

The Renishaw CC6 counter card (figure 7) is a 5 V 32 bit PCI card. The card can be used to integrate the Renishaw SP80 probe when used in conjunction with the Renishaw IU80 interpolator unit.

The CC6 monitors the output of the SP80 probe via the IU80 and supplies the host PC with this information on request, via the PCI bus. The CC6 is small enough to fit neatly into a 5 V switching standard PCI slot inside the host PC without precluding the insertion of any other cards or impairing any required access to other components.

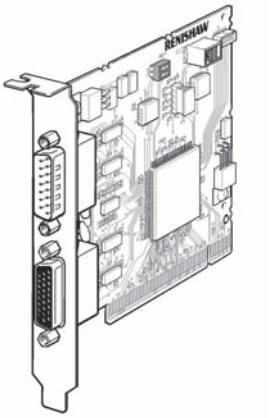


Figure 7 - CC6 PCI counter card

2.5 UCC1/UCC2 SP80 daughtercard

The SP80 daughtercard (figure 8) is one of a range of plug-in daughtercards for the Renishaw UCC1/UCC2 universal CMM controllers and permits use with the SP80. It consists of two printed circuit boards mounted together with a metal end plate for fixing within the UCC controller. The board itself has a single connector to suit the UCC1/UCC2 controllers internal bus sockets and a single connector accessible from the back panel of the UCC1/UCC2 for system connection (figure 6).

1. UCC1/UCC2 controller
2. Optical link to host computer
3. Probe cable
4. SP80 daughtercard

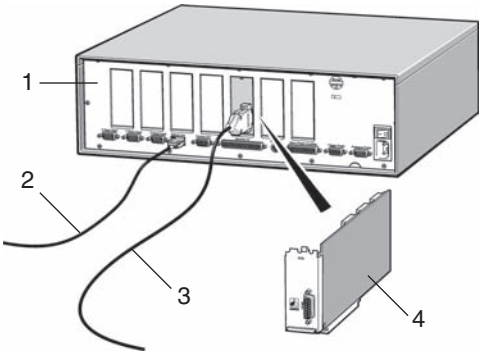


Figure 8 - UCC1/UCC2 and SP80 daughtercard

2.8 Isolated optical metrology principle

Using an isolated optical metrology principle (figure 9), SP80 directly measures the deflection of the whole mechanism, thus providing outstandingly accurate position sensing.

The isolated optical metrology system can detect sources of variable error such as thermal and dynamic effects. By contrast, probes with displacement sensors mounted to stacked axes suffer from latency under changing inertial loads, and cannot detect thermal growth in their mechanisms.

Isolated optical metrology can be explained as a feature of the transducer system. The readheads for each axis are fixed to the body of the probe, and measure the deflection in each direction. Any inter-axis errors caused by the arc motion of each pair of parallel-acting springs are directly measured by the sensor system. Isolated optical metrology systems have no moving wire connections.

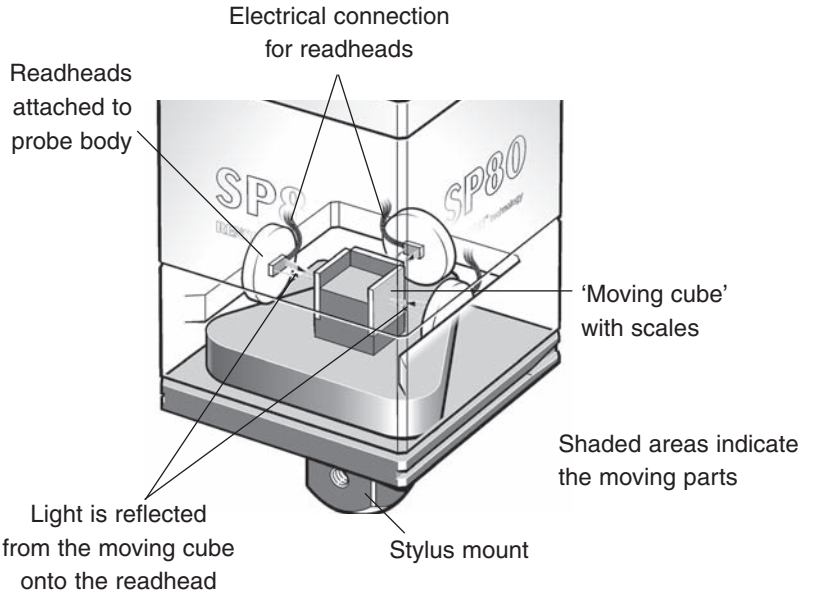


Figure 9 - Isolated optical metrology principle

3 Product specification

3.1 SP80

Table 1 - SP80 probe system specification	
Probe attributes	Ultra-high accuracy scanning probe with three axis measurement (±X, ±Y, ±Z)
Orientation	Vertical
Size	80 mm square body, 150 mm long including SH80 stylus holder
Quill mounting	KM80 - 80 mm quill to kinematic SP80 quill mount (standard) KM6080 - 60 mm quill to 80 mm kinematic SP80 probe mount (option) SM80 - shank mount and other custom made adaptor plates available - contact your Renishaw supplier for details
Measurement range	3 axis measurement: ±2.5 mm (±0.12 in) (X, Y, Z)
Overtravel range	X and Y protected by breakout of the kinematic joint to the SH80 Z has a mechanical 'bump-stop'
Resolution of digital scales	0.02 µm
Measurement capability test to ISO10360-2 *	Typically <1.0 µm with a 50 mm stylus Time for typical test = 70 s
Scanning capability test to ISO10360-4 *	Typically <1.5 µm Tij with a 50 mm stylus Time for typical scan = 74 s
Return to zero	Approximately 1% of working deflection
Spring rate	Approximately 1.8 N/mm (X, Y, Z)

* Tested on a CMM with specification of 0.48 µm +L/1000

Table 1 - SP80 probe system specification continued	
Stylus carrying capability	Renishaw M5 stylus range Maximum 500 g mass (unbalanced) Maximum 500 mm protection [#]
Mass	SP80 probe body only 860 g SH80 stylus holder 185 g KM80 quill mount 110 g
Pull off force of SH80	<20 N when using SCP80 - otherwise approximately 80 N
Probe power supply	+9 V to +18 V @ 300 mA maximum dc
System power supply (including IU80)	+5 V ±0.25 V @ 1 A maximum dc
SP80 probe outputs (X, Y, Z)	1.5 V ±0.25 V p-p. analogue quadrature signal (2.5 V zero crossing reference)
Interfacing options	• Using a UCC1/UCC2 SP80 daughtercard for direct integration • Using a Renishaw PCI counter card (CC6) and the Renishaw interpolator unit (IU80) • Other interface card designed by the OEM and used in conjunction with an IU80 • Using a counter card and interpolator units designed by the machine builder
Change rack system	SCP80 units mounted to MRS

[#] Longer stylus lengths may be carried subject to operating conditions - consult Renishaw for application assistance.

3.2 SCP80

Table 2 - SCP80 stylus change port specification	
Type of rack	Passive, individual port for interchanging SH80
Mounting	Mounts to the MRS modular rack system Spaced and user definable positions along the length of the MRS
Labels	User applied port number labels
Collision protection	No collision protection in the SCP80 or MRS
Operating orientation	The SH80 is contained horizontal to the probe axis
Maximum stylus length	The MRS can be configured to accommodate an SH80 with the 500 mm maximum (vertical) stylus length Additional MRS legs may be required.
Port entry tolerances	CMM positional accuracy of ±0.25 mm
Port lid opening force	2.6 N
Force to detatch SH80	<20 N

3.3 System dimensions

Dimensions in mm

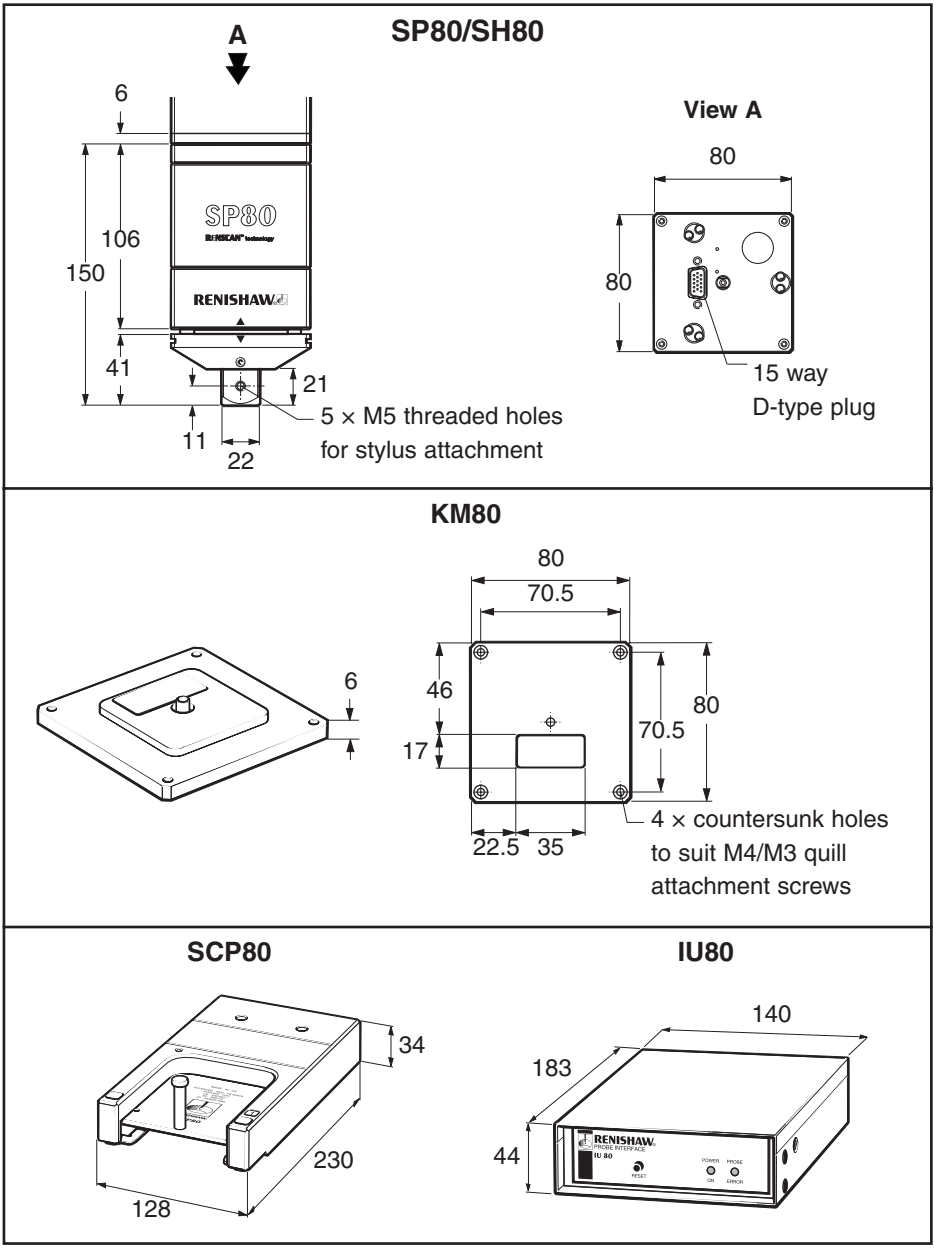


Figure 10 - System dimensions

4 Mechanical integration

4.1 Attaching the KM80 quill adaptor plate

Mounting the SP80 on the CMM via the KM80 is the recommended method due to its inherent stiffness, as well as the reduced overall Z length when compared to the alternative mounting options (KM6080 or SM80) detailed below. The KM80 has the same mechanical footprint as the PH10MQ (80 mm × 80 mm), and is attached to the CMM quill using 4 × M3 or M4 screws in the corners of the plate. Orientate the KM80 to the CMM axis as shown in figure 11 below, such that the front of the SP80 probe (as indicated by the LED) faces forward.

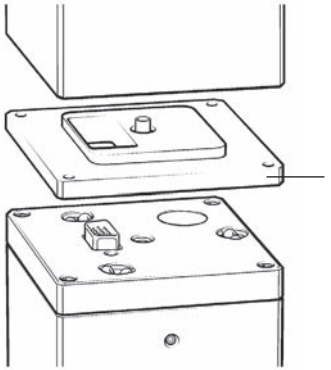


Figure 11 - Orientation and attachment of the KM80 to the quill

4.2 Attaching the SM80 quill adaptor plate

Screw the shank firmly to the SM80 and offer it up to the quill. Slot the shank into the fixing mechanism of the CMM and tighten. Care should be taken to ensure that the SM80 is held as securely as possible. To ensure that the probe will be aligned facing forwards (with the LED facing towards the front of the CMM), position the SM80 in the quill such that the touchel connector is facing towards the rear of the quill (facing towards the rear of the CMM).

CAUTION: Poor shank mounting can impair measuring accuracy and therefore this mounting method should be avoided wherever possible

4.3 Attaching the KM6080 quill adaptor plate

The KM6080 has the same mechanical footprint as the PH50 (60 mm × 60 mm) and is attached to the quill using four screws. It is important to orientate the KM6080 on the quill such that the probe is aligned facing forwards (with the LED facing towards the front of the CMM).

4.4 Mounting the SP80 body to the quill adaptor plate

The SP80 probe body has the female half of the kinematic joint incorporated in its top plate. The male half of the kinematic is incorporated in the KM80, the KM6080 and the SM80. To attach the probe to the quill adaptor plate proceed as follows (figure 12):

1. Align the probe such that the 15-way connector on the top face is aligned with either the KM80 / KM6080 aperture or the mating connector in SM80, whichever is applicable.

2. If using the KM80 / KM6080, make the necessary connection with the probe cable within the quill. If using the SM80, ensure that the connector halves mate correctly during the next step.

3. Carefully locate the two halves of the kinematic joint together. Insert the S10 key into the autojoint key slot (at rear of probe) and turn the key clockwise until it locks tight.

Reverse the above procedure to remove the probe from the CMM taking care to prevent the probe from falling.

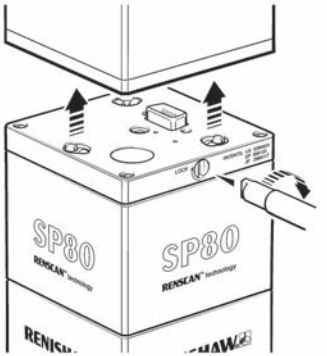


Figure 12 - Attaching the SP80 to the quill adaptor plate (KM80 shown)

4.5 Mounting the SH80 stylus holder on the SP80 body

The SH80 incorporates the male half of a magnetic kinematic joint that connects to the female half of the joint on the bottom of the SP80 probe body. The SH80 carries M5 styli, and has a 5-way centre design that can be rotationally adjusted for infinite angle position of the stylus.

Offer up the SH80 to the SP80, whilst aligning the triangular alignment marks indicating the front of the probe (figure 13), and allow the magnetic attraction to make the kinematic joint – the damping mechanism located in the SH80 will ensure a gentle connection.

Figure 13 - Mounting the SH80 on the SP80 body

4.6 Mounting styli on the SH80 and styli orientation

4.6.1 Mounting styli on the SH80

It is recommended that the SH80 is removed from the probe body when attaching styli.

M5 stylus arrangements are directly screwed into the 5-way cube on the SH80. Where required, use step down adaptors to smaller thread styli or select cubes and knuckles to create the required cluster. However wherever possible, M5 styli should be used to ensure the stiffness of construction.

4.6.2 Styli orientation

The stylus cluster can be rotationally adjusted to its required position by adjustment of the 5-way cube as follows (figure 14):

1. Releasing the rotational clamping screw using a hexagonal key.
2. Rotating the stylus cluster to the required position.
3. Tighten the rotational clamping screw.

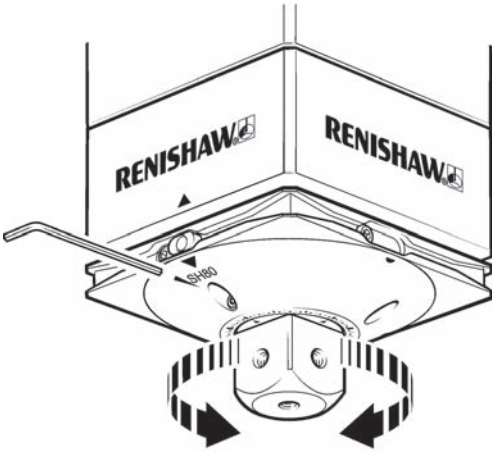


Figure 14 - Rotational stylus adjustment

4.7 Installing the SP80 UCC1/UCC2 daughtercard

The SP80 UCC1/UCC2 daughtercard fits directly into one of the daughtercard slots within the UCC product. For further details please refer to the UCC1 installation guide (Renishaw part number H-1000-5056) or the UCC2 installation guide (Renishaw part number H-1000-5223).

4.8 Connecting the IU80 interpolator unit

The IU80 is connected to the SP80 by the machine cable and the short adaptor cable. The output of the IU80 is then transferred either to the Renishaw CC6 PCI counter card, or to an OEM controller via an unterminated cable. See the installation diagrams in section 5, ‘System interconnection and electrical integration' for cable details.

4.9 Installing SCP80 stylus change ports and the MRS

Some preparatory work is necessary before the SCP80s can be installed. The SCP80 mounts directly to the MRS rail (figure 15). To maximise the working length of the rail, it is recommended that the MRS legs be set up using the step back adaptors supplied with the MRS kit. Please see below for circumstances where the height and/or rigidity of the standard MRS kit needs to be enhanced by using the MRS heavy duty legs. Before the SCP80 can be used, it must be aligned with the relevant quill adaptor plate to ensure satisfactory operation of the change cycle (see section 4.9.4 and 4.9.5).

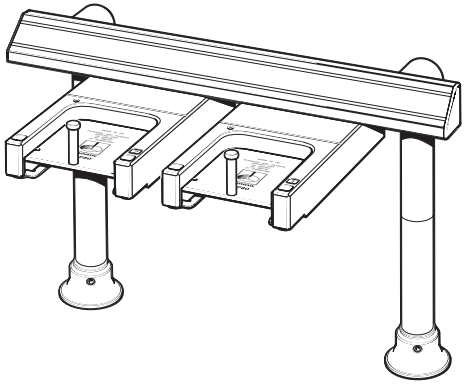


Figure 15 - MRS with SCP80 stylus change ports

4.9.1 Installing a standard MRS kit

The standard MRS kit should be constructed and installed as described in MRS installation and user's guide (H-1000-5088). Mount the legs by using the step back adaptor method.

The standard MRS kit comprises:

- 1 × MRS rail (choice of 400, 600 or 1000 mm long)
- 2 × step back adaptors (connecting to rear face of rail and to top of leg)
- 4 × MRS legs (Ø25 mm × 125 mm long – threaded connections)
- 2 × MRS feet (mounted to CMM table and connecting to bottom of leg)
- 1 × kit containing fixings and tools

4.9.2 Installing the optional MRS heavy duty legs

Where an MRS installation has numerous SCP80s containing heavy stylus arrangements, or vertical stylus arrangements exceeding 190 mm, it is recommended that the optional MRS heavy duty leg kits are used to provide additional rigidity/height. These kits are purchased separately to match the number of legs used on the MRS. Mount the legs using the step back adaptor method.

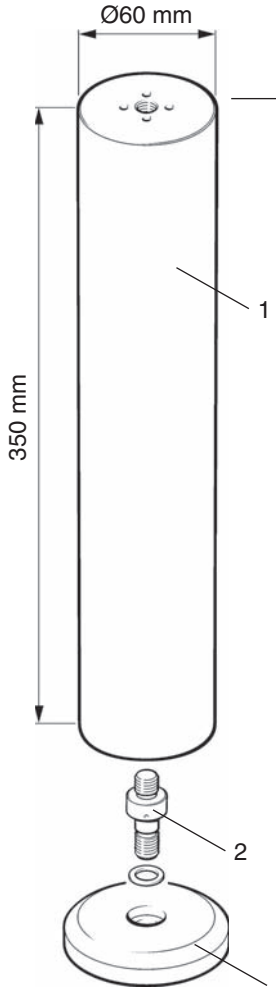
The MRS heavy-duty leg kit comprises:

- 1 × heavy duty leg (Ø60 mm × 350 mm long – threaded connections)
- 1 × footplate and double-ended threaded stud (selection)

Installation procedure (please refer to figures 16, 17 and 18)

1. The heavy duty leg kit is mounted to the CMM table and immediately beneath the standard MRS leg assembly.
2. Locate the first footplate [3] with a suitable threaded socket on the CMM table having consideration for the required position of the MRS rail that will accommodate all loaded SCP80s within the working volume. Fasten the footplate to the table using the double-ended threaded stud* [2].
3. Locate the second footplate [3] at the appropriate distance along the chosen CMM axis and follow step 2 above.
4. Screw the heavy duty leg [1] to the top of the threaded stud [2] and hand-tighten. Repeat for second leg assembly.
5. Place the first MRS foot [7] on top of the heavy duty leg [1] and secure using the M10 bolt [6]. Repeat for second leg assembly.
6. Proceed with the remaining construction of the MRS system as described in the MRS installation and user's guide (H-1000-5088):
    - Aligning the MRS feet to the CMM axis
    - Fixing the standard MRS legs to the rail using step back adaptors
    - Fixing the standard MRS legs to the MRS foot

* Two sets of double ended threaded studs are provided to suit different CMM table configurations. The thread sizes supplied are M10, M8 and M6. Alternatively, 3/16" UNC and 5/16" UNC can be provided on request by your Renishaw supplier.



MRS heavy duty leg kit

1. Heavy duty leg
2. Double-ended threaded stud
3. Footplate

Standard MRS kit parts

4. Standard MRS leg
5. Leg to foot adaptor
6. M10 bolt
7. MRS foot
8. MRS rail
9. Step back adaptor
10. Tee nut and bolt

Figure 16 - Heavy duty leg kit

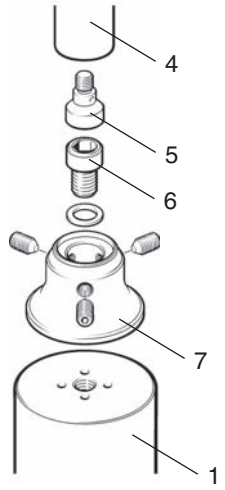


Figure 17 - Connecting the standard leg to the heavy duty leg

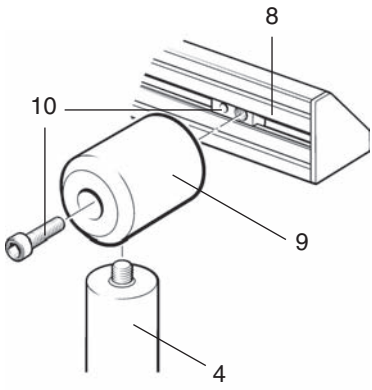


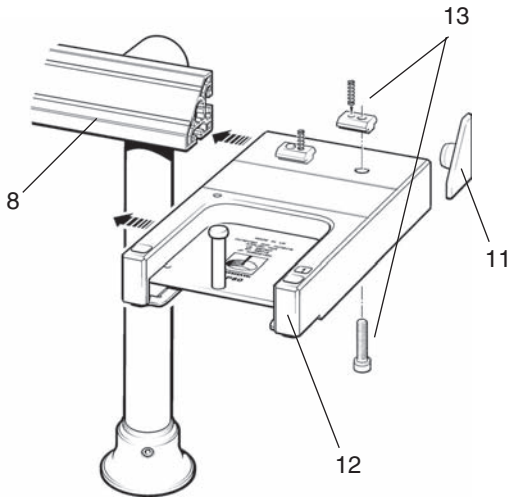
Figure 18 - Step back adaptor arrangement

4.9.3 Fitting the SCP80 to the MRS rail

It is recommended that the SCP80 ports are attached to the MRS rail using the following procedure, where it is assumed that the MRS system is correctly installed as described earlier in this section.

Installation procedure (please refer to figure 19)

1. Loosely assemble the T-nuts and bolts [13] to the mounting holes in the SCP80 [12].
2. Carefully remove the endcap [11] from one end of the MRS rail [8].
3. Offer up the SCP80 [12] to the MRS rail [8] and align the T-bolts with the slot on the underside of the rail.
4. Slide the SCP80 onto the rail to the desired position, ensuring that sufficient operating clearance exists to carry out all SH80 docking routines.
5. Using the hexagonal key supplied, hand-tighten the T-nuts and bolts.
6. Align the SCP80 to the CMM axes, as described below, before finally tightening it to the MRS rail.



8. MRS rail
11. Endcap
12. SCP80
13. T-nuts and bolts

Figure 19 - Mounting the SCP80 to the MRS rail

4.9.4 Alignment of the SCP80 to the CMM axes

The alignment of the SCP80 to the CMM axes should be checked to be within the limits shown in figure 20.

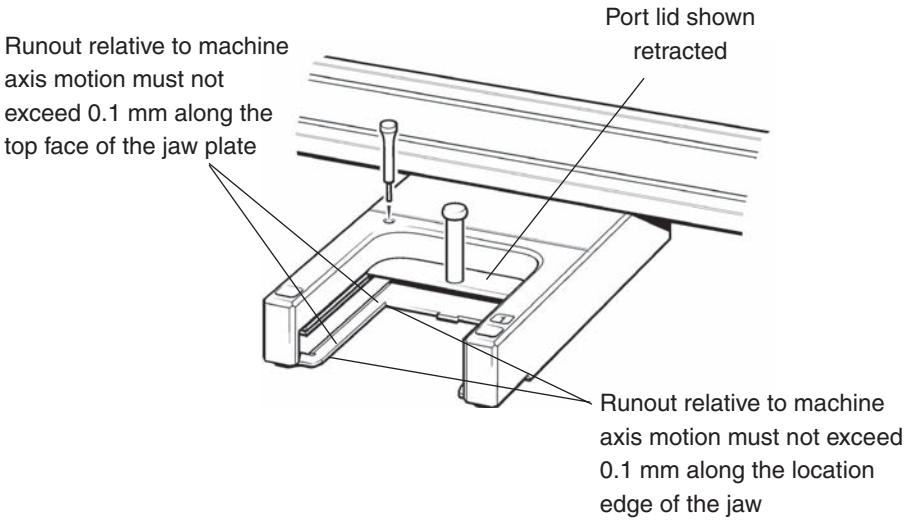


Figure 20 - Alignment of SCP80 to the CMM axes

4.9.5 Aligning the KM80, KM6080 or SM80 for use with the SCP80

To ensure satisfactory operation during the change cycle, the KM80, KM6080 quill adaptor plate or SM80 shank mount must be aligned to the CMM axes within the limits shown in figure 21.

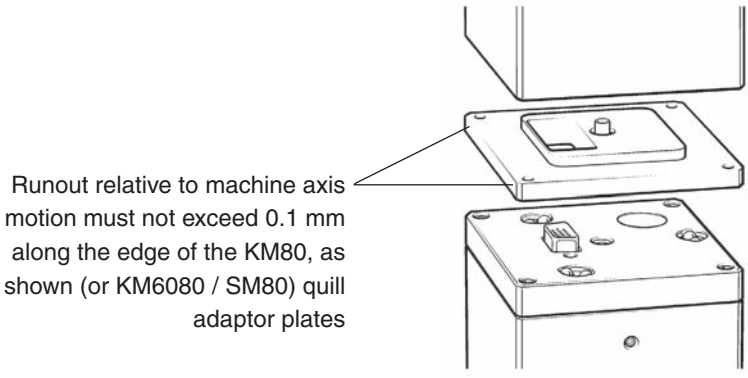


Figure 21 - Aligning the KM80 with the CMM axes

5 System interconnection and electrical integration

This section describes the system interconnection options together with relevant cable pin-out information.

SP80 can be integrated in the following ways:

- Direct integration with Renishaw's UCC1/UCC2 controller. This requires the use of a UCC1/UCC2 SP80 daughtercard.
- Using Renishaw's CC6 PCI counter card together with Renishaw's IU80 interpolator unit.
- OEM designed counter card used with Renishaw's IU80 interpolator unit.
- OEM designed counter card and interpolator unit.

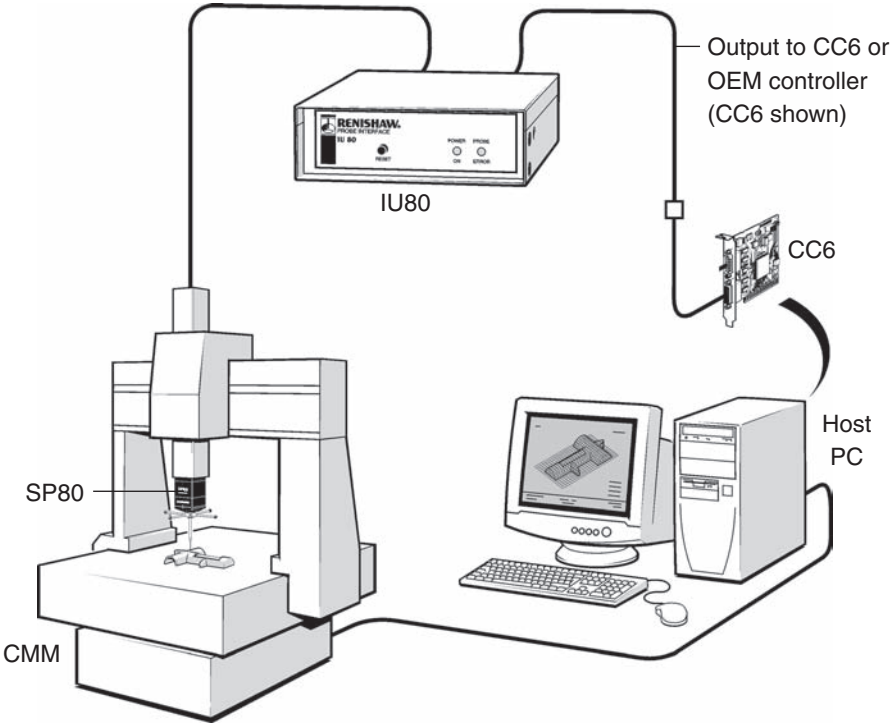


Figure 22 - SP80 integration (with IU80 and CC6)

5.1 SP80 probe connector pin-outs

The electrical connections to and from the SP80 are through the 15 way HDD connector at the top of the probe body. The pin-outs of the probe connector are detailed in table 3 below:

Table 3 - SP80 probe connector pin-puts

Pin	Function		Pin	Function
1	V ref. (see note below)		9	$\overline{\text{PROBE PRESENT}}$
2	0 V		10	$\overline{\text{GREEN LED OFF}}$
3	N/C		11	$\overline{\text{RED LED ON}}$
4	Cos Z		12	Sin Z
5	Cos Y		13	Sin Y
6	Cos X		14	Sin X
7	+9 V to +18 V		15	N/C
8	N/C		Shell	Screen

NOTES: V ref. is nominally 2.5 V and is the zero crossing reference for the Sin and Cos output signals. This reference voltage, and all other signal inputs must be monitored downstream of the probe using a high impedance buffered input.

The effective impedance of any input signal to ground should be >100 KW. Failure to comply with this requirement may result in an apparent fault, or reduction in amplitude of the Sin and Cos outputs. Contact Renishaw for advice if uncertain.

The recommended cable specification for the SP80 probe is the same as the current motorised head cable (PH10) which is:

- Mating connectors must be metal bodied
- The overall cable screen is continuous and connected to the system ground on the user's equipment through the bodies of the connectors
- The maximum overall single core resistance between the SP80 and the IU80 interpolator must be <2.5 Ohms

The maximum cable length between the SP80 and the interface method should be ≤50 m.

5.2 Connecting SP80 using the KM80 or KM6080

The standard SP80 probe kit is supplied with a 250 mm long PL157 cable (figure 23). This connects to the 15-way, high-density D-type connector on top of the SP80, through a slot in the KM80 (or KM6080), and is terminated in a Lemo connector which mates to the CMM machine cable. The cable pin-outs are detailed opposite. Refer to figure 23 below and table 4 opposite:

15 way HDD 14 way Lemo

Figure 23 - PL157 - probe adaptor cable

Table 4 - Cable pin-outs (SP80 > KM80 > KM6080 > M/C cable > IU80)			
	PL157 probe cable		Machine cable
Signal / Connector	15 way HDD connector	14 way Lemo connector	15 way male D connector
V ref	1	13	8
0 V	2	4	4
	3	Not connected	
Cos Z	4	12	3
Cos Y	5	2	1
Cos X	6	8	11
+19 V to +18 V	7	10	15
	8	Not connected	
PROBE PRESENT	9	14	5
GREEN LED OFF	10	3	6
RED LED ON	11	5	10
Sin Z	12	9	7
Sin Y	13	1	14
Sin X	14	6	12
	15	Not connected	
Screen		11	Body

5.3 Connecting SP80 using the SM80

The SM80 converts the output connector on the SP80 to a Touchel connector on the rear face of the SM80. The Touchel connector is then designed to be connected directly to a standard PH10 system wiring scheme using a standard PH10M head cable. Refer to figure 24 below and table 5 opposite:

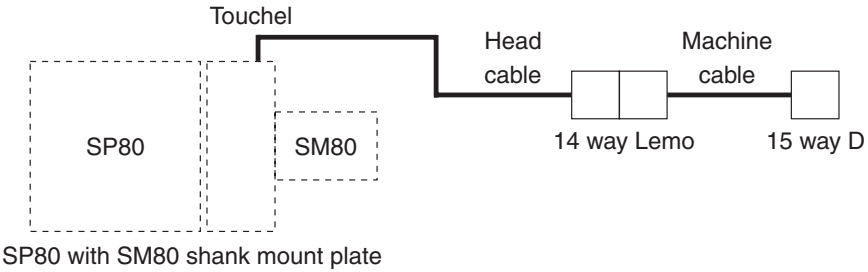
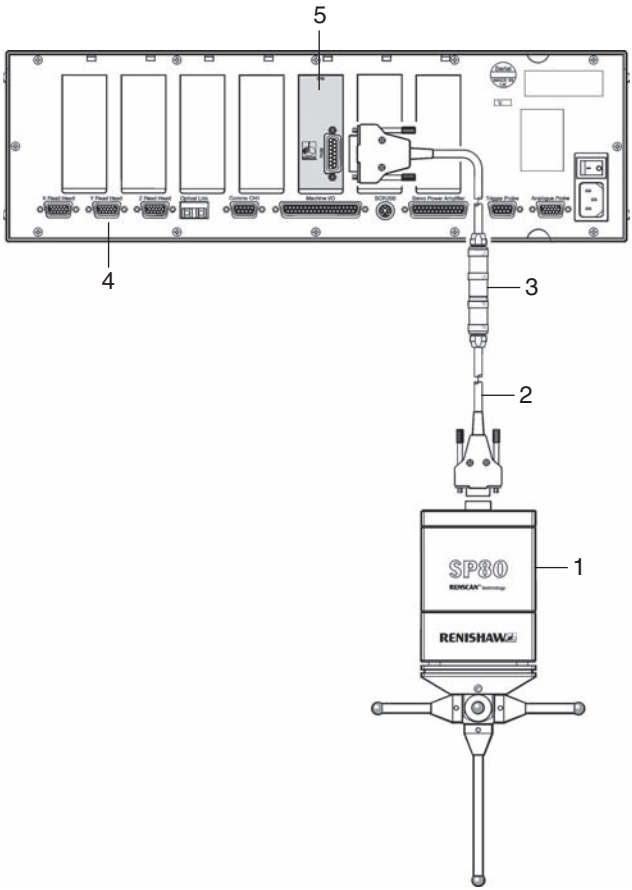


Figure 24 - Connecting SP80 > SM80 > head cable > machine cable

Table 5 - Cable pin-outs (SP80 > SM80 > head cable > M/C cable > IU80)				
	PL157 probe cable		Machine cable	
Signal / Connector	15 way HDD connector	Touchel connector	14 way Lemo connector	15 way male D connector
V ref	1	J	13	8
0 V	2	M	4	4
	3		Not connected	
Cos Z	4	G	12	3
Cos Y	5	D	2	1
Cos X	6	F	8	11
+19 V to +18 V	7	B	10	15
	8		Not connected	
PROBE PRESENT	9	K	14	5
GREEN LED OFF	10	C	3	6
RED LED ON	11	H	5	10
Sin Z	12	A	9	7
Sin Y	13	E	1	14
Sin X	14	L	6	12
	15		Not connected	
Screen		N/O	11	Body

5.4 Interconnecting SP80 to UCC1/UCC2



1. SP80 scanning probe (shown for mounting to CMM via KM80)
2. PL157 - SP80 to Lemo adaptor cable
3. PLM6/7/8/9 - standard machine cable
4. UCC1/UCC2 controller
5. UCC1/UCC2 SP80 daughtercard

Figure 25 - Interconnecting SP80 to UCC1/UCC2

5.4.1 Connecting the SP80 UCC1/UCC2 daughtercard

CAUTION: This daughtercard is designed only to accept the SP80 probe. Fitting of the PH10 system to this card can cause damage to the UCC1/UCC2 system.

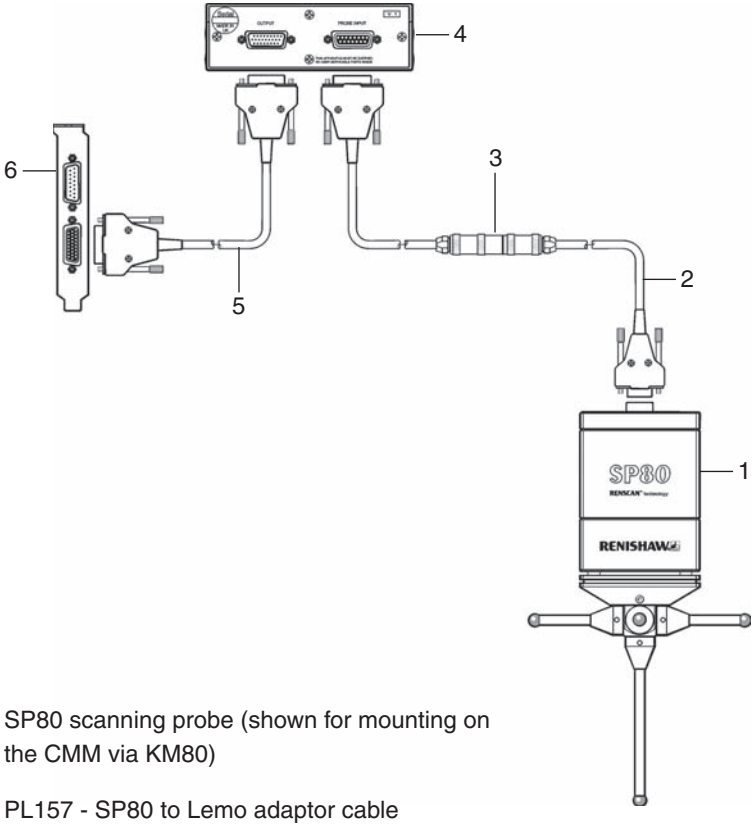
The SP80 daughtercard has a 15-way, D-type connector that accepts the standard machine cable and connects the SP80 probe to the UCC1/UCC2 system.

The connections for the SP80 connector are shown in the table below:

Table 6 - SP80 UCC1/UCC2 daughtercard connector

Pin	Function
1	Cos Y
2	
3	Cos Z
4	0 V
5	$\overline{\text{PROBE PRESENT}}$
6	$\overline{\text{GREEN LED OFF}}$
7	Sin Z
8	V ref.
9	
10	$\overline{\text{RED LED ON}}$
11	Cos X
12	Sin X
13	
14	Sin Y
15	+15 V
Shell	Screen

5.5 Interconnecting SP80 to IU80 and CC6



1. SP80 scanning probe (shown for mounting on the CMM via KM80)
2. PL157 - SP80 to Lemo adaptor cable
3. PLM6/7/8/9 - standard machine cable
4. IU80 interpolator box
5. PL158 - IU80 output cable to CC6
6. CC6 PCI counter card

Figure 26 - Interconnecting SP80 to IU80 and CC6

5.5.1 Connecting IU80 to CC6

The IU80 conditions the SP80 signal into an RS422 differential quadrature scale signal. This unit is required when a UCC1/UCC2 is not used for the integration of the probe. The IU80 has a 15-way D-input connector to accept the standard PH10 machine cable, and a 26-way D-output connector, incorporating all axis outputs from the probe.

The IU80 connects to the CC6 counter card using the PL158 cable. The connections are detailed in table 7 below.

* **NOTE:** The IU80 RESET function (pin 3 below) is only available with IU80s manufactured to version 3 and above.

Table 7 - Connecting IU80 to CC6

IU80 output 26 way HDD	Signal	CC6 input pin 26 way HDD
1	X axis log A	1
2	N/C	
3	IU80 RESET *	9
4	IU80 ERROR	4
5	N/C	
6	$\overline{\text{Z axis log B}}$	6
7	N/C	
8	$\overline{\text{PROBE PRESENT}}$	2
9	GREEN LED OFF	7
10	RED LED ON	8
11	$\overline{\text{X axis log A}}$	11
12	X axis log B	12
13	$\overline{\text{X axis log B}}$	13
14	Y axis log A	14
15	$\overline{\text{Y axis log A}}$	15
16	Y axis log B	16
17	$\overline{\text{Y axis log B}}$	17

Table continued on next page.

Table 7 - Connecting IU80 to CC6 continued		
IU80 output 26 way HDD	**Signal**	**CC6 input pin 26 way HDD**
18	N/C	
19	N/C	N/C
20	Z axis log A	20
21	$\overline{Z}$ axis log A	21
22	Z axis log B	22
23	+12 V @ 250 mA max	24
24	+5 V @ 1 A max	23
25	0 V	25
26	N/C	N/C
Shell	Screen	Shell

For further information concerning the CC6 system please ask your local Renishaw contact.

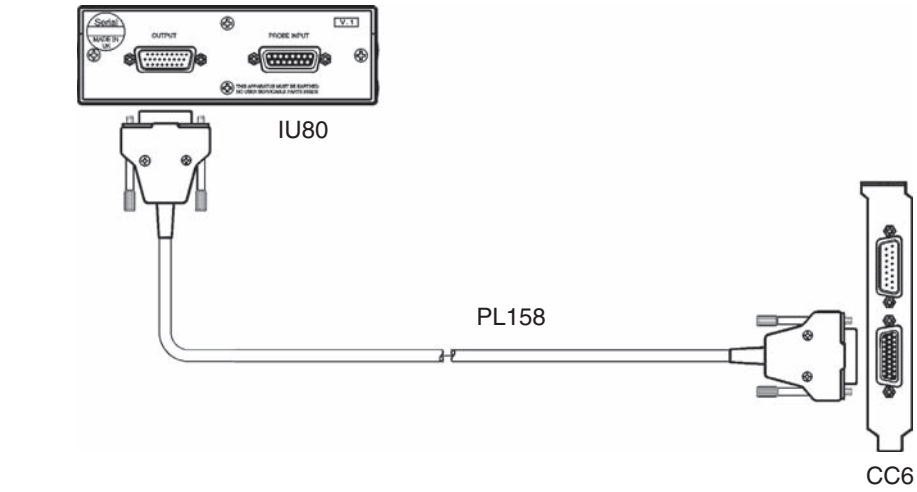
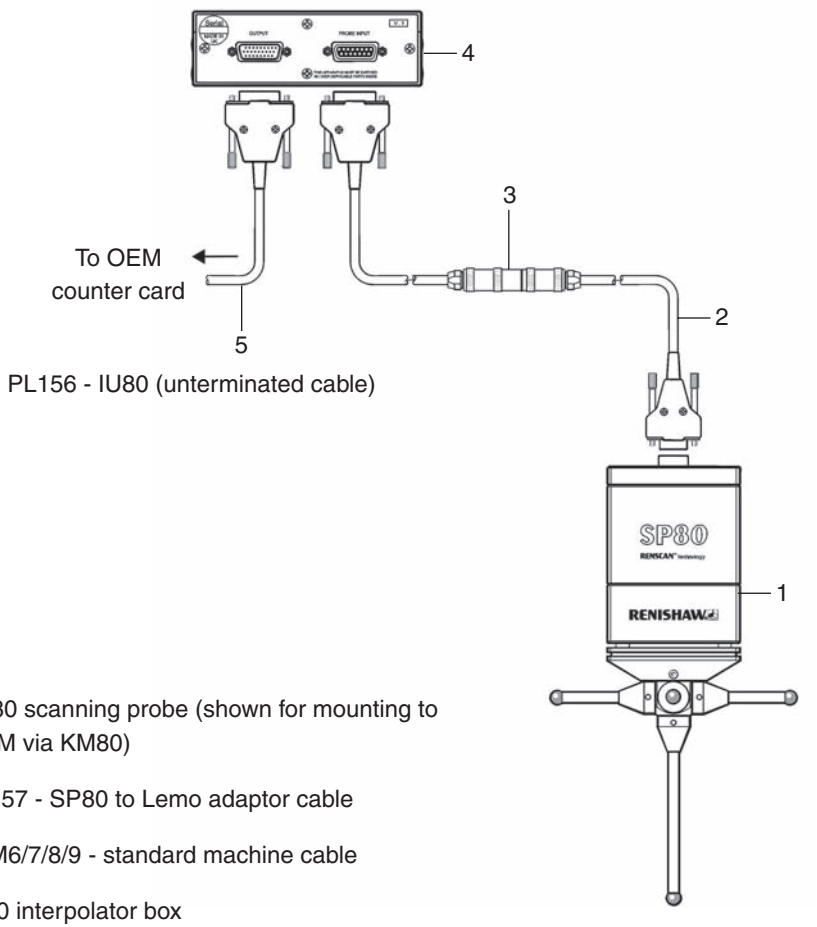


Figure 27 - PL158 - IU80 to CC6 cable

5.6 Interconnecting SP80 to IU80 and OEM counter card



1. SP80 scanning probe (shown for mounting to CMM via KM80)
2. PL157 - SP80 to Lemo adaptor cable
3. PLM6/7/8/9 - standard machine cable
4. IU80 interpolator box
5. PL156 - IU80 output cable to OEM counter card (unterminated)

Figure 28 - Interconnecting SP80 to IU80 and OEM counter card

5.6.1 Connecting IU80 to an OEM counter card

The output of the IU80 can be connected directly to the CMM controller using an unterminated PL156 cable. The connections are detailed in table 8 below.

*** NOTE:** The IU80 RESET function (pin 3 below) is only available with IU80s manufactured to version 3 and above.

Table 8 - Connecting IU80 to OEM counter card

IU80 output 26 way HDD	Signal	Electrical characteristics	Colour
1	X axis log A	EIA-422A	Red
2	N/C		N/C
3	IU80 RESET *	TTL	White/blue
4	IU80 ERROR	TTL	Blue
5	N/C		N/C
6	/Z axis log B	EIA-422A	Green
7	N/C		N/C
8	/PROBE PRESENT	TTL	Yellow/blue
9	GREEN LED OFF	TTL	Yellow
10	RED LED ON	TTL0	White
11	/X axis log A	EIA-422A	Black
12	X axis log B	EIA-422A	Brown
13	/X axis log B	EIA-422A	Violet
14	Y axis log A	EIA-422A	Orange
15	/Y axis log A	EIA-422A	Pink
16	Y axis log B	EIA-422A	Turquoise
17	/Y axis log B	EIA-422A	Grey
18	N/C		N/C
19	N/C		N/C
20	Z axis log A	EIA-422A	Red/blue
21	/Z axis log A	EIA-422A	Green/red

Table continued on next page.

Table 8 - Connecting IU80 to OEM counter card continued			
IU80 output 26 way HDD	**Signal**	**Electrical characteristics**	**Colour**
22	Z axis log B	EIA-422A	Yellow/red
23	+9 V to +18 V	300 mA max	White/red
24	+5 V	1 A max	Reb/black
25	0 V		Red/brown
26	N/C		N/C
Shell	Screen		Screen

6 Using the SCP80 stylus change port

6.1 Establishing the SCP80 port datum

The following section describes the recommended procedure for datuming each installed SCP80 port. Before commencing the following should have been completed:

- The SCP80 ports should have previously been fitted to the MRS rail and aligned to the CMM axes
- The SP80 probe should have been correctly installed, aligned and fitted with a suitable M5 stylus
- The probe and stylus should have been calibrated and made ready to take single point measurements

NOTE: The examples given here assume that the MRS/SCP80 rack system is aligned to the X axis of the CMM, being along the rear or the working area.

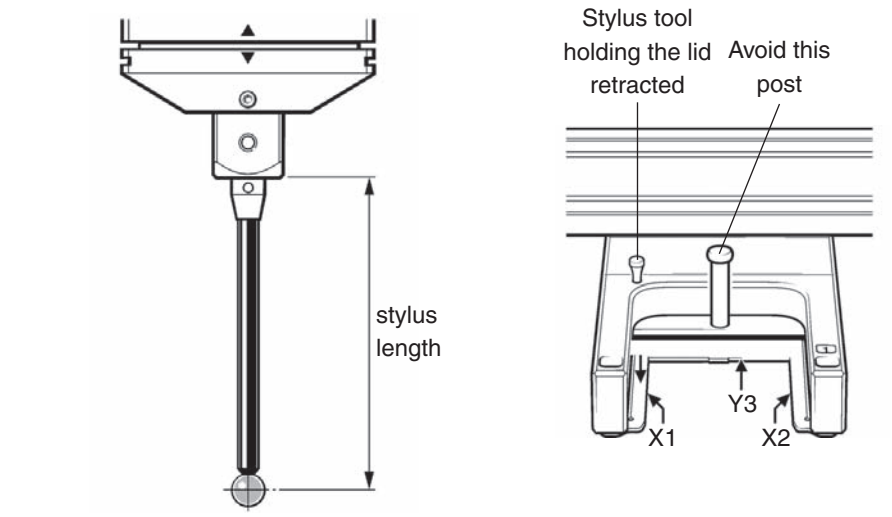


Figure 29 – Illustrations relating to port datuming procedure

6.2 Procedure for establishing the port datum

Please refer to figure 29 for clarification. The following routine should be completed using manual CMM control.

1. Open the port lid to the extreme of travel and place a stylus tightening tool or similar object into the retaining hole to keep it in place.

2. Take 4 points on the jaw plate as follows:
   - Take points 1 and 2 across the central jaw and record X values
   - Take point 3 at the rear edge and record the Y value
   - Take point 4 on the top face of the jaw plate and record the Z value

3. Create the X and Y port datums as follows:
   - X origin = (X1 + X2)/2
   - Y origin = Y3 – 41.5 mm + (stylus tip diameter/2)*
   - Store the datum's then assign them, and the port, an identification number

4. Create the Z port datum using one of the following methods:

   The Z origin must be created in a way that enables satisfactory changing of the SH80 in the SCP80 over the entire stylus range (mass) that the SP80 can carry. This range is from 33 g to 500 g with the effect that 'droop' increases with mass.

   METHOD 1 (preferred)

   This method will ensure the SH80 enters the docking slot of SCP80 such that the docking features are centrally aligned in the Z axis.

   - Using the port calibration stylus supplied with the probe kit, the probe should be nulled. A temporary Z port datum should be calculated as follows:

     Temporary Z origin = Z4 – (stylus length + (stylus tip diam/2)* + 38 mm)

   - Then for all other stylus configurations, with differing mass, the Z port datum should be calculated as follows:

     Z origin = Z4 – (stylus length + (stylus tip diam/2)* + 38 mm – ZOFFSET)

     (Where ZOFFSET is the value of any Z axis droop observed with heavier styli mass).

   - Store the datum then assign it, and the port, an identification number.

* Assuming no tip compensation when measuring.

METHOD 2 (non-preferred)

This method is simpler to use and merely uses a constant ZOFFSET value which will allow any stylus configuration within the SP80 carrying range of 33 g to 500 g to be docked.

However, the user will notice the following characteristics during docking when using this method: with lighter styli the SH80 will be seen to pull downward, and with heavier styli the SH80 will be seen to pull upward.

- Using the port calibration stylus supplied with the probe kit, the Z port datum should be calculated as follows:

  Z origin = Z4 – (stylus length + (stylus tip diam/2)* + 37 mm)

- Store the datum and assign it, and the port, an identification number

* Assuming no tip compensation when measuring.

6.3 Put down and pick up routines

The recommended pick up and put down routines are detailed below and consist of driving sequentially through 4 positions.

NOTE: The speed of motion during the change cycle should be restricted to 20 mm/s maximum.

Table 9 - Put down routine for SH80/SCP80

	Axis co-ordinates		
Move description	**X (mm)**	**Y (mm)**	**Z (mm)**
Move to clearance position	X0	Y-100	Z0
Inhibit probe signal			
Reduce CMM speed to 20 mm/s			
Enter port	X0	Y0	Z0
Detach the SH80	X0	Y0	Z+30
Exit port to clearance position	X0	Y-100	Z+30
Restore normal CMM drive speed			

Table 10 - Pick up routine for SH80/SCP80

	Axis co-ordinates		
Move description	**X (mm)**	**Y (mm)**	**Z (mm)**
Move to clearance position	X0	Y-100	Z+30
Inhibit probe signal			
Reduce CMM speed to 20 mm/s	X0	Y0	Z+30
Enter port	X0	Y0	Z0
Detach the SH80	X0	Y-100	Z0
Exit port to clearance position			Z0
Restore normal CMM drive speed			

7 System integration notes

The following sections identify various probe characteristics that customers will need to be aware of during the integration of the SP80 system.

7.1 Return to zero

The probe has a nominal absolute centre position where the functions of stylus configuration and probe orientation cause it to rest. Because of small amounts of internal friction, when the probe is displaced from this zero point, the stylus will not return to exactly the same point on the scale and the axis deflection readings will show a different value. Typically, after a 1 mm deflection, the probe will return to within 10 µm of its free state original position.

This characteristic of probe performance is called **RETURN TO ZERO** and is a feature of all analogue probes. It is not a source of error as the scale system continues to monitor position. Rather it is merely a factor which must be taken into account when designing control software for using the probe. It can be given a value which represents the diameter of a sphere around the nominal zero position within which the probe will return to reset after any displacement.

It is important to take this into account as it affects the minimum amount of deflection necessary before the stylus is considered to be in contact with the surface. Because the stylus can return to a value other than the nominal zero, the CMM must recognise the fact that the range of rest positions of the stylus must not cause the machine motion, as the stylus is not necessarily in contact with a surface even though it is “deflected”. The CMM software should have a parameter for this minimum probe deflection and only deflections above this amount should be considered as the stylus being in contact with a surface.

7.2 Probe initialisation (home routine)

The SP80 utilises digital scale and readhead technology and requires the scale system to be referenced prior to usage following power being supplied to the probe.

The procedure for this is to remove the SH80 stylus holder from the SP80 probe body and permit the probe mechanism to return to its zero reference position, when the probe is in this position the scales within the head should be referenced (set to 0). This 'null' position should be recorded.

NOTE: The above 'null' position procedure has to be completed every time power is removed from the probe/system.

When each SH80 is attached, complete with stylus cluster, the offset from the 'null' position should be recorded and stored for that particular arrangement. This should be recalled every time the stylus holder is reattached.

The difference in position at rest from the offset can be attributed to the return to zero property of the probe. Note that the accuracy of the 'home' position will be +/- 10 µm.

7.3 Probe inertia

Due to the inertia of the SP80 motion system high CMM accelerations may cause non-contact probe deflections to exceed thresholds set within the control algorithms, this inertia will vary according to the stylus arrangement.

8 Modes of operation

8.1 Qualification (calibration of the probe)

The SP80 probe requires qualification (calibration) before it is able to give accurate positional data.

After the probe and stylus combination is calibrated it can be used in a variety of ways. Principally these will be as either a single point measurement probe or a profile measurement-scanning probe. Please refer to the modes below.

8.2 Scanning mode

SP80 can be used as a continuous deflection contact scanning probe for profile measurement or for surface digitising purposes. In this case the CMM controller must respond to the deflections of the probe in real time to maintain surface contact.

Renishaw has extensive experience of scanning and offers support and advice on scanning algorithms and control software. Please contact Renishaw for further information.

8.3 Single point measurement mode

The following are methods that can be used for taking single point measurements using a calibrated SP80. OEM's are advised to evaluate each of these to determine the best solution for their own system.

8.3.1 Static averaging method

SP80 can be used to take single points to give increased accuracy whilst reducing the effects of machine vibration by performing static averaging.

The probe stylus should be made to contact the workpiece and deflect the stylus to the recommended amount (50 microns). The CMM should be halted and kept nominally stationary.

Whilst the machine is stationary, surface position readings should be taken which are then averaged to give one single surface point. The longer the system is kept stationary, the more readings can be gathered to give a more accurate result and to average out the effect of machine vibration.

8.3.2 Extrapolate to zero method

Data is acquired whilst in contact and moving normal to the surface, either on the way in or whilst backing off. This is extrapolated to zero probe displacement position. It has the advantage that the measurement takes place at zero force, minimising the deflection on probe, stylus and CMM, and additionally is less sensitive to probe calibration.

8.3.3 Threshold methods

There are two types of threshold method as described below. Type 1 takes data whilst driving the probe onto the part to a pre-set deflection threshold, whilst type 2 takes data whilst backing off to the pre-set deflection threshold.

Type 1

A target deflection threshold should be set. The probe is driven onto the part until this target deflection threshold is seen, at which time the controller simultaneously stores all CMM axes together with the probe deflections - this is the data point.

Type 2

A target deflection should be set. Additionally, an upper target deflection should be set which will enable a back off move to the target deflection to be executed at a constant velocity. The probe is driven onto the part until the upper target deflection is seen; at which time the motion should halt and a back off move should commence. When the target deflection is seen, the controller simultaneously stores all CMM axes together with the probe deflections - this is the data point.

9 Maximising performance

9.1 Calibration

- The probe and stylus must be calibrated correctly. Renishaw has extensive experience of scanning and offers support and advice on scanning algorithms and control software suited to SP80. Please contact Renishaw for further information.

9.2 Probe deflection

- Scanning deflections should be kept small, as the machine settings and application will allow loads on the probe, stylus and CMM quill to be minimised.
- The probe must be operated within its calibrated deflection range. For best performance, take measurements at the mid-point of the calibration deflection limits. It is recommended that the probe is calibrated at deflections of 0.2 mm and 0.8 mm, with best measurement data then achieved at 0.5 mm.

9.3 Touch/scan speed

Performance will vary with probe speeds:

- Longer heavy stylus combinations will require slower speeds.
- Generally, best performance is obtained at speeds less than 10 mm/sec.
- Avoid abrupt changes to CMM speed while taking measurements.

9.4 Cleanliness

- Ensure both stylus and workpiece are clean.

9.5 CMM maintenance

- Ensure that the CMM has been correctly maintained and has been corrected for geometrical errors such as axis squareness, pitch, roll and yaw etc.
- Ensure that the CMM has an error map which is up to date and enabled in the control system.
- Check the system accuracy from time to time by running an ISO 10360-4 test or other similar routine.
- Regularly check the volumetric measuring performance of the CMM by using Renishaw's MCG machine checking gauge.

9.6 Stylus selection

NOTE: For more detailed information about the range of Renishaw styli please refer to the styli and accessories technical specifications booklet Renishaw part number H-1000-3200).

Of particular interest to SP80 users is section 6. This details not only an extensive range of M5 styli that are compatible with the SP80, but also includes a complete range of carbon fibre extension bars of 11 mm or 20 mm diameter, and up to 500 mm long.

9.6.1 Best practice when using a stylus

In order to maintain accuracy at the point of contact we recommend that you:

- Keep styli short
- Minimise joints
- Keep the ball as large as possible
- Regularly inspect stylus tips for wear or damage

9.6.2 Accuracy at the point of contact

As industry has developed its requirement for increasingly diverse and complex manufactured parts, inspection systems have had to work hard to keep up. The use of CMMs with probing systems and in-process inspection on machine tools are two of the solutions offered by Renishaw to help you maximise your productivity and maintain the highest possible standards of quality.

Successful gauging depends very much on the ability of the probe's stylus to access a feature and then maintain accuracy at the point of contact. At Renishaw, we have used our expertise in probe and stylus design to develop a comprehensive range of CMM styli to offer you the greatest possible precision.

These notes explain the critical features of each stylus type, helping you to choose the right design for each inspection need.

9.6.3 What is a stylus?

A stylus is that part of the measuring system which makes contact with the component, causing the probe mechanism to displace. The generated signal enables a measurement to be taken. The feature to be inspected dictates the type and size of stylus used. In all cases, however, maximum rigidity of the stylus and perfect sphericity of the tip are vital.

The performance of your gauging can easily be degraded if you use a stylus with poor ball roundness, poor ball location, bad thread fit or a compromised design that allows excessive bending during measurement. To ensure the integrity of the data you gather, make certain that you specify and use a stylus from the comprehensive range of genuine Renishaw styli.

9.6.4 Ball materials available with Renishaw styli

- **Ruby**

The industry standard and the optimum stylus ball material for a vast majority of measurement applications, ruby is one of the hardest known materials. Synthetic ruby is 99% pure aluminium oxide, which is grown into crystals (or 'boules') at 2000 °C using the Verneuil process.

The boules are then cut and gradually machined into a highly spherical form. Ruby balls are exceptionally smooth on the surface, have great compressive strength and a high resistance to mechanical corrosion.

Very few applications exist where ruby is not the best ball material, however there are two such applications where balls manufactured from other materials are recommended.

- **Silicon nitride**

The first is for heavy duty scanning applications on aluminium. Because the materials attract, a phenomenon known as 'adhesive wear' can occur which involves build up of aluminium from the surface onto the ball. A better ball material for such applications is silicon nitride.

Silicon nitride possesses many similar properties to ruby. It is a very hard and wear resistant ceramic which can be machined into very high precision spheres. It can also be polished to an extremely smooth surface finish. Silicon nitride does not have the attraction to aluminium and so does not exhibit the adhesive wear seen with ruby in similar applications. Silicon nitride does, however, show significant abrasive wear characteristics when scanning on steel surfaces so its applications are best confined to aluminium.

- **Zirconia**

The second circumstance where ruby may be problematic is once again in heavy duty scanning applications on cast iron. Interaction between the two materials can result in 'abrasive wear' of the ruby ball surface. For such applications, zirconia balls are recommended.

Zirconia is a particularly tough ceramic material with hardness and wear characteristics approaching those of ruby. Its surface properties, however, make it an ideal material for aggressive scanning applications on cast iron components.

9.6.5 Stem material available with Renishaw styli

- **Steel**

Stems manufactured from non-magnetic stainless steel are used widely for styli with ball/tip diameters of 2 mm or greater and with lengths up to 30 mm. Within this range, one-piece steel stems offer the optimum stiffness to weight ratio, giving adequate ball/stem clearance without compromising stiffness with a joint between the stem and threaded body.

- **Tungsten carbide**

Tungsten carbide stems are best used for maximising stiffness with either small stem diameters, required for ball diameters of 1 mm and below, or over longer lengths up to 50 mm. Beyond this, weight can become a problem or stiffness is lost due to deflection at the stem to body joint.

- **Ceramic**

For ball diameters greater than 3 mm, and lengths over 30 mm, ceramic stems offer stiffness comparable to steel, but are significantly lighter in weight than tungsten carbide. Ceramic stemmed styli can also offer additional crash protection to your probe as the stem will shatter in a collision.

- **Carbon fibre (Renishaw GF)**

There are many grades of carbon fibre materials, however Renishaw GF combines optimum stiffness characteristics, both longitudinally and in torsion (important in star constructions) with extremely low weight. Carbon fibre is inert and this, combined with a special resin matrix, provides excellent protection in the most hostile machine tool environments.

Renishaw GF is ideal for maximising stiffness while giving very low mass for styli above 50 mm in length. It is the optimum stem material for high accuracy strain gauge technology probes with excellent vibration damping characteristics and negligible co-efficient of thermal expansion.

10 Maintenance

The SP80 probe is a serviceable part. In the event of a problem, please contact your supplier for assistance.

Following the simple maintenance procedures given below will prolong the operational life and continued high performance of the system. The user should determine the frequency of inspection and maintenance actions according to the conditions of use.

CAUTION: Always adhere to the safety instructions given in this guide. Failure to do so could adversely affect the performance of the probe and/or lead to personal injury.

10.1 SP80 probe body and stylus holders

The external surfaces of all system components should only be cleaned using a soft, lint free cloth. All parts must always be kept dry.

The kinematic coupling mechanisms, incorporated throughout the system, have a precision ball-on-ball seating, electrical contacts and permanent magnets. The coupling has been tested in a wide variety of environments and is highly tolerant of non-metallic dust, but regular inspection and cleaning is recommended to ensure continued high performance of the probe system.

Renishaw supplies a kit for easy cleaning of the kinematic coupling, which is available from your local Renishaw supplier, part number A-1085-0016.

10.2 SCP80 stylus changing port

Periodic cleaning of the ports, lids and outer surfaces, using a soft lint free cloth, is recommended to prevent contamination of stored stylus holders.

10.3 Styli

Stylus balls, threads and mating faces should be cleaned using a proprietary cleaning cloth or solvent such as isopropyl alcohol. Stylus balls should be regularly inspected for damage or 'pick-up' of component material (a problem sometimes encountered with continuous scanning).

11 Part ordering information

Table 11

Part number	Description
A-2238-0700	SP80 probe kit 1 (includes SP80 probe body, KM80, SH80, stylus and tools)
A-2238-0703	KM80 quill mount adaptor plate
A-2238-0704	SM80 shank mount adaptor plate
A-2238-0705	SH80 stylus holder
A-2238-0706	SCP80 stylus change port
A-2238-0020	KM6080 60 × 60 mm to 80 × 80 mm quill mount adaptor plate
A-2238-0720	IU80 interpolator unit
A-1333-0021	UCC1 SP80 daughtercard
A-4068-0400	CC6 countercard
A-4192-0001	MRS modular rack system (400 mm rail length)
A-4192-0002	MRS modular rack system (600 mm rail length)
A-4192-0003	MRS modular rack system (1000 mm rail length)
A-4192-0020	MRS heavy duty leg kit
A-1016-7129	PL156 IU80 unterminated output cable
A-1016-7132	PL157 probe to machine cable
A-1016-7133	PL158 IU80 to CC6 cable

Appendix 1 - International safety instructions

DE - Sicherheitshinweise

Abgesehen vom Endanschlag gibt es keinen Überlaufschutz in der +Z-Achse. Deshalb muss Ihre Steuerung die Maschinenbewegung in der +Z-Achse stoppen können bevor der Endanschlag erreicht wird. Ist dies nicht der Fall, ist beim Bedienen oder Überwachen des SP80 Systems eine Schutzbrille zu tragen, um Verletzungen durch einen Tastereinsatzbruch zu verhindern.

Vor Bedienung der Maschine muss das Bedienungspersonal über Gebrauch und Anwendung des SP80-Messtastersystems und der zugehörigen Produkte in Verbindung mit der damit ausgerüsteten Maschine geschult werden.

ACHTUNG: Einige Bauteile des SP80 Systems enthalten Permanentmagnete. Wichtig! Halten Sie den SP80 von Gegenständen fern, die durch diese Magnetfelder beeinträchtigt werden können, wie z.B. Datenspeicher, Herzschrittmacher, Uhren usw.

DK - Sikkerhed

Der er ingen overvandringsbeskyttelse på +Z-aksen bortset fra et endestop. Styresystemet skal derfor være i stand til at stoppe maskinens bevægelse på probens +Z-akse før endestoppet nås. Hvis dette ikke er tilfældet, skal der benyttes sikkerhedsbriller under drift eller observation af SP80-systemet for at undgå personskade i tilfælde af, at tasten går i stykker.

Maskinoperatører skal undervises i brugen og applikationen af SP80-systemet i henhold til den maskine, det er monteret på, før de får lov til at drive den pågældende maskine.

FORSIGTIG: Permamagneter bruges i nogle af SP80-systemets komponenter. Det er vigtigt, at de ikke kommer i nærheden af dele, som kan blive påvirket af magnetiske felter som fx. datalagringssystemer, pacemakere og ure etc.

EL - Ασφάλεια

Δεν υπάρχει άλλη μηχανική προστασία υπέρβασης διαδρομής στον άξονα +Z εκτός από έναν τερματικό αναστολέα. Το σύστημα ελέγχου του μηχανήματος πρέπει επομένως να είναι σε θέση να διακόπτει την κίνηση της μηχανής στον άξονα +Z του ανιχνευτή, πριν από την προσέγγιση στον τερματικό αναστολέα. Σε διαφορετική περίπτωση, ο χρήστης πρέπει να φοράει συσκευή προστασίας των ματιών όταν χειρίζεται ή παρακολουθεί τη λειτουργία του συστήματος SP80 για να αποφύγει τυχόν τραυματισμό στην περίπτωση θραύσης του επαφέα.

Οι χειριστές πρέπει να είναι εκπαιδευμένοι στη χρήση και εφαρμογή του SP80 σε σχέση με το μηχάνημα στο οποίο τοποθετείται, για να τους επιτραπεί να χρησιμοποιήσουν το συγκεκριμένο μηχάνημα.

ΠΡΟΣΟΧΗ: Σε ορισμένα εξαρτήματα του συστήματος SP80 χρησιμοποιούνται μόνιμοι μαγνήτες. Είναι σημαντικό να κρατάτε τους μαγνήτες μακριά από στοιχεία που μπορεί να επηρεαστούν από μαγνητικά πεδία, π.χ. συστήματα αποθήκευσης δεδομένων, βηματοδότες, ρολόγια, κ.λπ.

ES - Seguridad

La única protección de sobrerrecorrido en el eje +Z es un final de carrera. Por lo tanto, el sistema de control deberá ser capaz de detener el movimiento de la máquina en el eje +Z de la sonda antes de alcanzar el final de carrera. De no ser así, deberán emplearse gafas de seguridad siempre que se manipule o supervise el funcionamiento del sistema SP80 para evitar daños en caso de rotura del palpador.

Los operadores deben recibir formación sobre el uso y la aplicación del sistema SP80 adecuándose al tipo de máquina en el que se ha montado, antes de poder utilizarla.

PRECAUCIÓN: Algunos componentes del sistema SP80 y sus accesorios utilizan imanes permanentes. Es muy importante mantenerlos alejados de otros elementos que puedan verse afectados por los campos magnéticos, por ejemplo, sistemas de almacenamiento de datos, marcapasos, relojes, etc.

FI - Turvallisuutta

+Z-akselilla ei ole muuta liikealueen ylityssuojaa kuin päätytoppari. Tämän vuoksi ohjausjärjestelmän on kyettävä keskeyttämään koneen +Z akselin liike ennen kuin päätytoppari on saavutettu. Mikäli näin ei ele, SP80-järjestelmää käytettäessä ja sen toimintaa seurattaessa tulee käyttää suojalaseja henkilövahinkojen estämiseksi mittakärjen mahdollisesti rikkoutuessa.

Koneen käyttäjille täytyy opettaa SP80-järjestelmän käyttö ja soveltaminen kyseisessä koneessa ennen koneen käytön aloittamista.

VAROITUS: Joissakin SP80-järjestelmän osissa käytetään kestomagneetteja. On tärkeää ettei kestomagneettien lähelle viedä esineitä jotka saattavat reagoida magneettikenttiin, kuten esim. tiedontallennusvälineitä, tahdistimia, kelloja, jne.

FR - Securité

Il n'y a pas de protection contre la sur-course dans l'axe du palpeur +Z, si ce n'est celle de la butée. Le système de commande de la machine doit donc pouvoir stopper le mouvement de la machine sur cet axe de palpage avant que la butée du palpeur ne soit atteinte. Si ce n'est pas le cas, il faut porter des lunettes de sécurité pour faire fonctionner le système SP80 ou observer son fonctionnement, afin d'éviter tous risques de blessure en cas de rupture du stylet.

Avant d'être autorisés à utiliser cette machine, les opérateurs doivent être formés à l'usage et aux applications du système SP80 et ce, dans le contexte de la machine sur laquelle ce système est installé.

ATTENTION: Le système SP80 comporte des aimants permanents. Il faut impérativement tenir à distance des éléments susceptibles d'être affectés par les champs magnétiques comme les systèmes de stockage de données, pacemakers, montres-bracelets, etc.

IT - Sicurezza

Lungo la direzione asse sonda Z+ è presente solamente un fine corsa meccanico. Non è presente nessun altro dispositivo di fine corsa . Il vostro sistema di controllo deve essere quindi in grado di fermare il movimento macchina lungo la direzione asse Z+ della sonda prima che venga raggiunto il fine corsa meccanico . Se questo non fosse possibile l'operatore deve indossare occhiali di protezione mentre sta osservando le operazioni svolte dalla sonda SP80 per evitare possibili danni causati dalla rottura dello stilo .

L'operatore macchina deve essere istruito sull' uso e sulle applicazioni della sonda SP80 sulla macchina dove è montata prima che gli venga permesso di operare sulla stessa.

AVVERTENZA: Magneti permanenti sono usati in alcune parti della sonda SP80. Fare attenzione a non porli in vicinanza di oggetti che potrebbero venire influenzati dai campi magnetici, come ad esempio sistemi di archiviazione dati, pacemaker, orologi e così via.

NL - Veiligheid

Uw machinesturing moet daarom in staat zijn om de beweging van de machine in de +Z-richting van de taster te stoppen voordat de eindaanslag bereikt wordt. Indien dit niet het geval is, dan moet er een veiligheidsbril gedragen worden wanneer het SP80 systeem bediend of geobserveerd wordt om letsel te voorkomen als een stylus breekt.

Gebruikers van de machine moeten worden opgeleid in het gebruik en de toepassing van de SP80 in relatie tot de machine waarop deze is geplaatst voordat zij toestemming krijgen de machine te bedienen.

LET OP: Sommige onderdelen van het SP80 systeem zijn voorzien van permanente magneten. Het is belangrijk om voorwerpen die door de magnetische velden beïnvloed kunnen worden, zoals gegevensopslagsystemen, pacemakers en horloges, uit de buurt te houden van deze magneten.

PT - Segurança

Não existe proteção contra excesso de avanço no eixo +Z além de um fim de curso. Portanto, o seu sistema de controle deve ser capaz de interromper o movimento da máquina no eixo +Z do apalpador antes que ele atinja o fim de curso. Caso isto não seja possível, óculos de segurança serão necessários quando estiver operando ou observando a operação do sistema SP80, para proteção de acidentes em caso de quebra da ponta.

Os operadores deverão estar treinados no uso e na aplicação do SP80 na máquina onde ele estiver instalado antes de serem autorizados a operar a máquina.

CUIDADO: Ímãs permanentes são usados em alguns componentes do sistema SP80. É importante mantê-los longe de equipamentos ou partes que possam ser afetados por campos magnéticos, como sistemas de armazenamento de dados, marca-passos, relógios etc.

SV - Säkerhet

+Z-axeln har inget annat överrörelseskydd än ett ändanslag. Det styrsystem som används måste därför kunna stoppa maskinrörelsen i probens +Z-axel innan ändanslaget nås. Om så inte är fallet måste du använda skyddsglasögon när du använder SP80-systemet, eller övervakar dess funktion, för att undvika skador för den händelse mätspetsen går sönder.

Maskinoperatörerna måste utbildas i hur SP80-systemet ska användas, med beaktande av den maskin det är installerat på, innan de tillåts använda maskinen.

OBS! Permanentmagneter används i vissa komponenter på SP80-systemet. Det är viktigt att hålla dem borta från sådant som kan skadas av magnetfält, t.ex. datalagringsenheter, pacemakers, klockor etc.

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 website at www.renishaw.com/contact

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