

RFP1 user's guide

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RFP1 user's guide

Document part number H-1000-5430-04-B



RFP1 user's guide

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RFP1 general information

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 ORIGINAL LANGUAGE VERSION

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WEEE



The use of this symbol on Renishaw products and / or accompanying documentation indicates that the product should not be mixed with general household waste upon disposal. It is the responsibility of the end user to dispose of this product at a designated collection point for waste electrical and electronic equipment (WEEE) to enable reuse or recycling. Correct disposal of this product will help to save valuable resources and prevent potential negative effects on the environment. For more information, please contact your local waste disposal service or Renishaw distributor.

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Software notices

The RFP1 product includes embedded software to which the following notices apply:

EULA

The software is subject to the terms and conditions of the software licence agreement at www.renishaw.com/legal/softwareterms.

Third party licences

Third party licence information can be found in the following UCCsuite installation directory:

...\Renishaw\UCC\Utilities\UCCassist Mark II\Firmware\RFP\Licences

In a typical installation the location address will be:

C:\Program Files (x86)\Renishaw\UCC\Utilities\UCCassist Mark II\Firmware\RFP\Licences

Notice to United States Government Contract and Prime Contract Customers

This software is commercial computer software that has been developed by Renishaw exclusively at private expense. Notwithstanding any other lease or licence agreement that may pertain to, or accompany the delivery of, this computer software, the rights of the United States Government and/or its prime contractors regarding its use, reproduction and disclosure are as set forth in the terms of the contract or subcontract between Renishaw and the United States Government, civilian federal agency or prime contractor respectively. Please consult the applicable contract or subcontract and the software licence incorporated therein, if applicable, to determine your exact rights regarding use, reproduction and/or disclosure.

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Warranty

Unless you and Renishaw have agreed and signed a separate written agreement, the equipment and/or software are sold subject to the Renishaw Standard Terms and Conditions supplied with such equipment and/or software, or available on request from your local Renishaw office.

Renishaw warrants its equipment and software for a limited period (as set out in the Standard Terms and Conditions), provided that they are installed and used exactly as defined in associated Renishaw documentation. You should consult these Standard Terms and Conditions to find out the full details of your warranty.

Equipment and/or software purchased by you from a third-party supplier is subject to separate terms and conditions supplied with such equipment and/or software. You should contact your third-party supplier for details.

Care of equipment

Renishaw probes and associated systems 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.

Company registration details

Renishaw plc. Registered in England and Wales. Company no: 1106260. Registered office: New Mills, Wotton-under-Edge, Gloucestershire, GL12 8JR, UK.

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Packaging

To aid end user recycling and disposal the materials used in the different components of the packaging are stated here:

Packaging component	Material	94/62/EC code	94/62/EC number
Storage box	Polypropylene	PP	05
Packing foam	Low density polyethylene	LDPE	04
Label	Polypropylene	PP	05
Bag	Low density polyethylene	LDPE	04



CAUTION: If it is necessary to return any part of the system please ensure it is packaged carefully. Failure to do so could result in transit damage for which the customer would be liable. Products supplied in plastic boxes must be returned in the original packaging.

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Patents

Features of Renishaw's RFP1 and associated products (such as REVO-2) are the subjects of one or more of the following patents and patent applications::

CN100453970	EP1877727	JP2016-533484	US10260856	WO2014/191729
CN101166951	EP1877732	JP2019-522213	US10627259	WO2015/049341
CN101166953	EP1989504	JP2019-536032	US11105607	
CN101405563	EP2002206	JP5196356	US2020-0049498	
CN101405564	EP2002207	JP5350216	US7533574	
CN101490430	EP2035719	JP5425476	US7809523	
CN101772690	EP2140318	JP5485889	US7861430	
CN101821579	EP2167911	JP5653581	US7885777	
CN101828092	EP2183545	JP5658863	US7971365	
CN102305613	EP2183546	JP5689681	US8006398	
CN102483319	EP2431707	JP5706158	US8186882	
CN102906533	EP2475954	JP5757950	US8302321	
CN103842766	EP2564151	JP5851969	US8425119	
CN105408723	EP2764324	JP5943547	US8474148	
CN105793695	EP3004797	JP6013533	US8511898	
CN107532930	EP3052926	JP6199870	US8601701	
CN109964098	EP3289314	JP6348577	US8756973	
CNZL201780045928.3	EP3491333	JP7042620	US8792707	
	EP3542130		US8923603	
			US8978261	
			US9038282	
			US9329030	
			US9366519	
			US9903713	
			USRE46012	

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RFP1 product compliance

EU declaration of conformity

Contact Renishaw plc or visit www.renishaw.com/EUCMM for the full EU declaration.

UK declaration of conformity

Contact Renishaw plc or visit www.renishaw.com/UKCMM for the full UK declaration.

EMC conformity

This equipment must be installed and used in accordance with this installation guide. This product is intended for industrial use only and should not be used in a residential area or connected to a low voltage power supply network which supplies buildings used for residential purposes.

FCC (USA only)

Information to user (47 CFR 15.105)

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 the 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 you will be required to correct the interference at your own expense.

Information to user (47 CFR 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.

Equipment label (47 CFR 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.
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ICES-001 (Canada only)

This ISM device complies with Canadian ICES-001(A) / NMB-001(A).

Cet appareil ISM est conforme à la norme ICES-001(A) / NMB-001(A) du Canada.

REACH regulation

Information required by Article 33(1) of Regulation (EC) No. 1907/2006 ("REACH") relating to products containing substances of very high concern (SVHCs) is available at:

www.renishaw.com/REACH

China RoHS

Contact Renishaw plc or visit www.renishaw.com/ChinaRoHSCMM for the full China RoHS tabulation.



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RFP1 safety

Before unpacking and installing the RFP system, the user should carefully read the safety instructions below and ensure that they are followed at all times by all operators.

The RFP system should only be used with the REVO-2 head.

Operators must be trained in the use and application of the REVO-2 system and accompanying products, in the context of the machine it is fitted to, before being allowed to operate that machine.

Permanent magnets are used in some components of the REVO-2 system and associated products. It is important to keep them away from items which may be affected by magnetic fields, e.g. data storage systems, pacemakers and watches.



WARNING: Avoid touching the probe (including counter balance arms) when attached to the REVO-2 head, especially when it is engaged (servo LED green) and the system is ready for measurement. If contact is made with the hardware, the tool will need to be reconfigured before continuing.

RFP1 probe LED emissions

The RFP1 probe incorporates high power LED lights and should not be used in the event of serious damage to any part of the probe. In such cases immediately disconnect the power source, remove and do not attempt to reuse the parts. Contact your supplier for advice.



CAUTION: This equipment uses LED illumination that may flash at a variable rate. Avoid exposure or seek advice from your medical practitioner if you are susceptible to photosensitivity or related health effects.

RFP1 environmental conditions

Ambient operating temperature range	+10 °C to +40 °C
Storage temperature range	-25 °C to +70 °C
Operating humidity	0% to 80% (non-condensing)
Storage humidity	0% to 80% (non-condensing)

Electrical specification

The REVO-2 head and probe electronics are powered from the UCC S5. The head motors are powered from the SPA3. The VPCP is powered by a separate power supply that is supplied by Renishaw. Any additional backlighting is powered by a separate power supply that is supplied by Renishaw. No additional power supplies are required.

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RFP1 references and associated documents

The following Renishaw documents are referred to in this document or may be a source of further relevant information. They can easily be acquired from Renishaw web site www.renishaw.com.

Title	Document number
Installation and user's guide: REVO-2 and RSP2	H-1000-7590
Installation and user's guide: RSP3	H-1000-5124
Installation and user's guide: SFP2	H-1000-5365
User's guide: RVP	H-1000-3322
User's guide: RFP1	H-1000-5430
Installation guide: UCC S5	H-1000-7598
Installation guide: SPA3-2	H-1000-5364
Installation & user's guide: MCULite-2, MCU5-2 and MCU W-2	H-1000-5280
Installation and user's guide: MRS modular rack system	H-1000-5088
Installation guide: MRS2 modular rack system	H-1000-5255
Installation guide: REVO-2 change system port spacing guide	H-1000-5408
Technical specifications guide: Styli and accessories	H-1000-3200

RFP1 system description

The REVO fringe probe (RFP1) is a non-contact structured light sensor for the REVO® system offering highly accurate measurement of surface topology on an infinite positioning, 5-axis CMM platform. RFP1 increases the multi-sensor capability of the REVO system, which now offers interchangeable tactile scanning, touch-trigger, surface finish, non-contact structured light and vision probes.

The RFP system is managed by the same I++ DME compliant interface as REVO-2 and DMIS support is available through MODUS 1.11 onwards or other suitable metrology software which offers use of the RFP system.

RFP system specific software includes RFP Digitiser, an online I++ client that collects data from parts without CAD models as part of a reverse engineering process and RFP Inspection Planner, a tool for path planning and generating DMIS part programs from CAD.

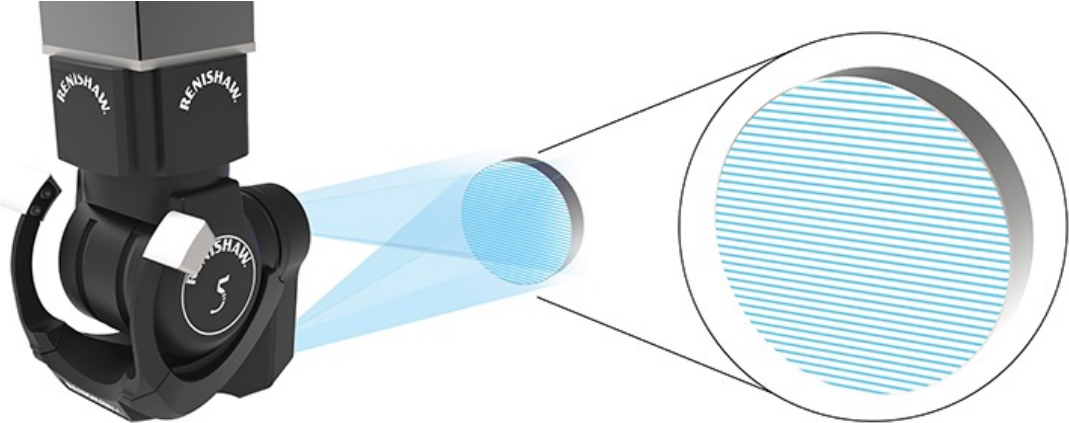
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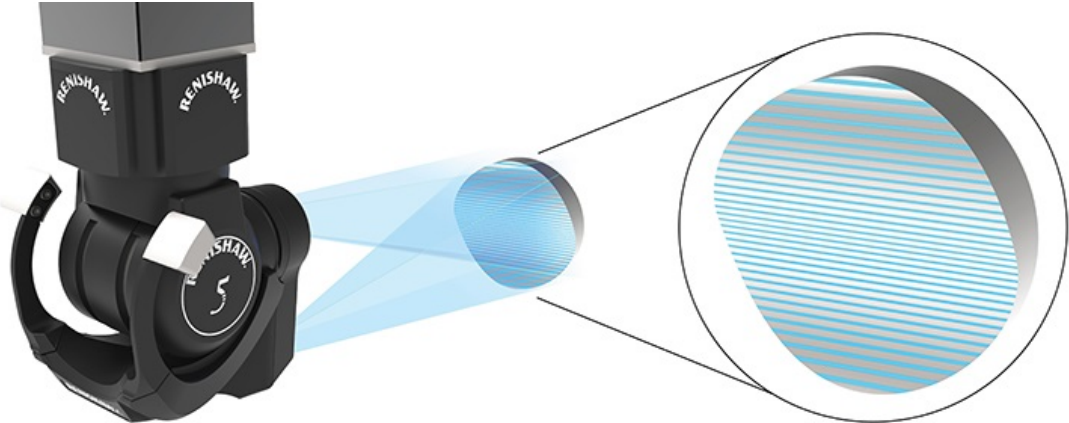
Operating principle

RFP1 projects a sinusoidal fringe pattern onto the surface of the part and the camera takes images of the pattern deformation caused by the surface topology.

On a flat plane the pattern will be uniform:



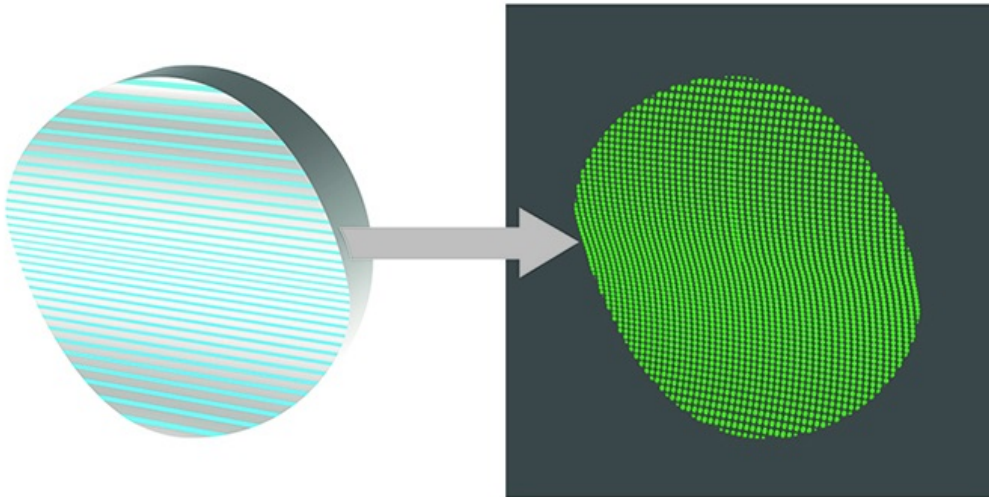
Changes in surface topology cause deformation of the pattern:



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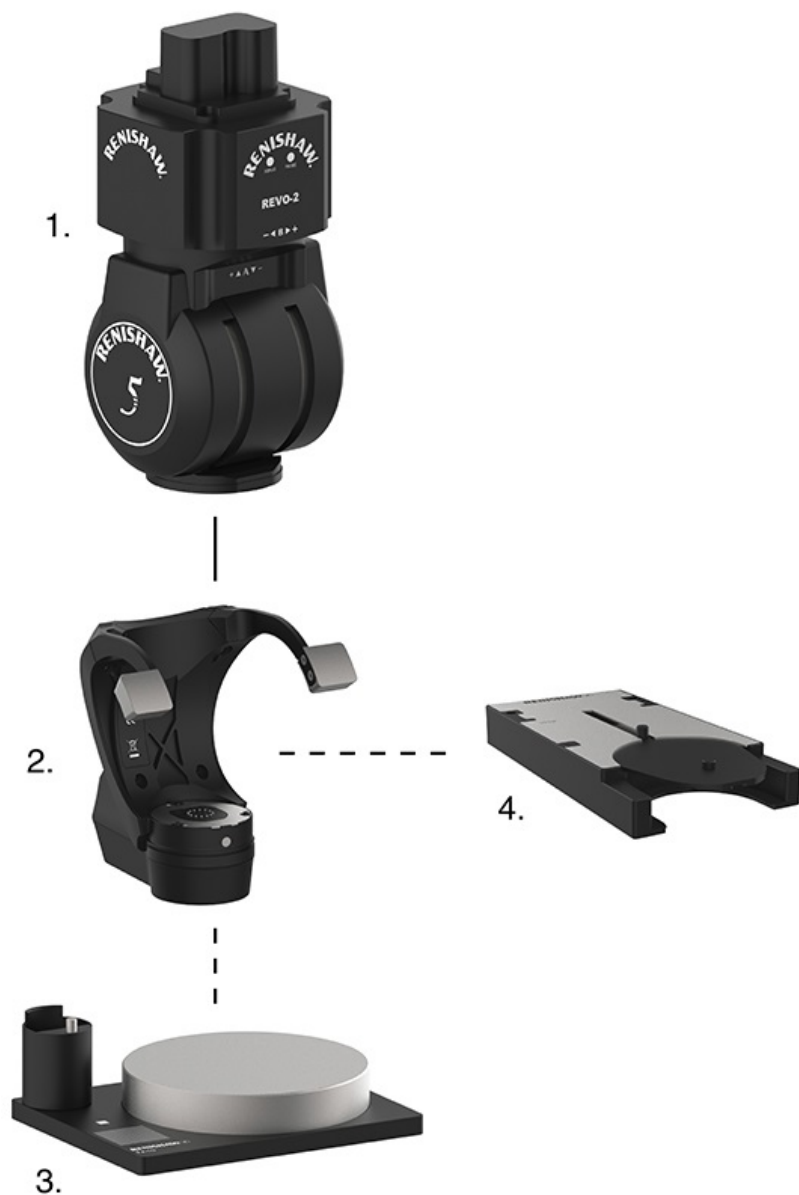
The change in fringe intensity at each point is used to calculate the absolute 3D position of that point on the part surface. A patch of XYZ position data points is returned for each fringe capture with up to 640,000 points in each patch.



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System components overview



Key	Description	Part number
1	REVO-2 head	A-5759-0001
2	RFP1 probe	A-5417-0010
3	FA10 calibration artefact	A-5417-0021
4	VPCP probe change port	A-5378-0081

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RFP1

RFP1 is the probe component of the system and houses the fringe projector, camera and digital signal processor. It is automatically interchangeable with other probe options using the VPCP heated change port.

FA10 calibration artefact

The FA10 is an optical calibration artefact used to calibrate RFP1. RSP2 is used on this artefact to link RFP1 with other sensors within the same coordinate reference frame. The RFP1 fringe pattern is calibrated against a ceramic plate with a tight flatness tolerance. The calibration routine for RFP1 is fully automated through MODUS and UCCsuite.

VPCP

VPCP can be mounted to an MRS2 rack system to house, and allow the automated changing of, RFP1. The rack port is temperature controlled to ensure that the probe is at the correct operating temperature.



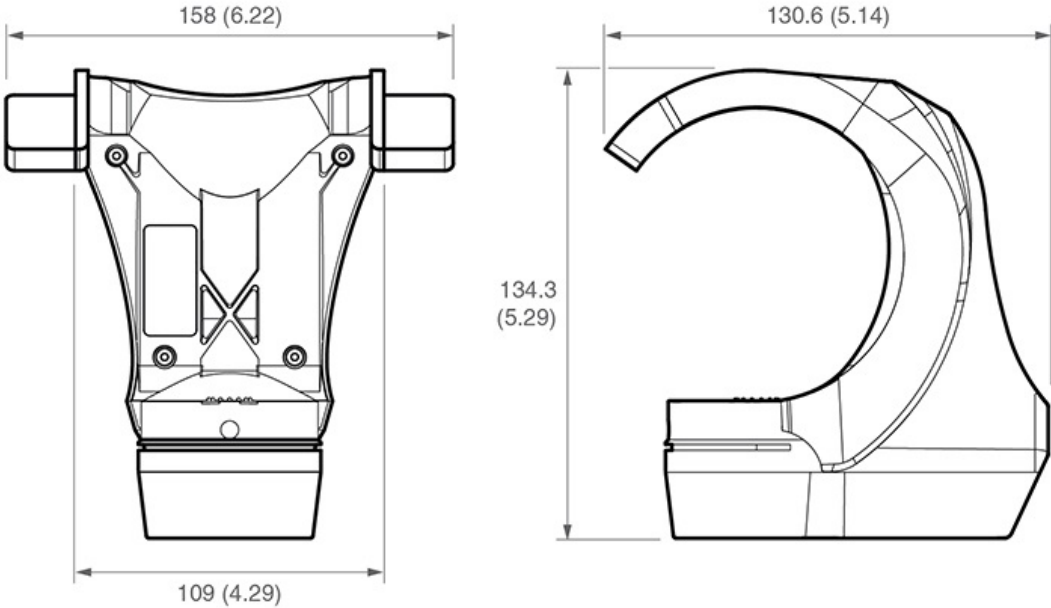
NOTE: Each time the CMM / system is switched on, RFP1 must be left in the VPCP for one hour to reach the correct operating temperature before first use.

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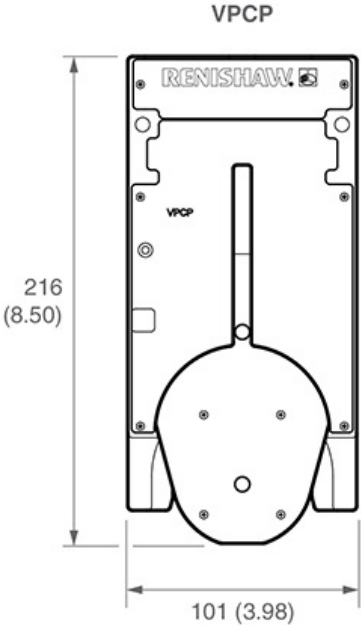
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RFP1 dimensional information

RFP1



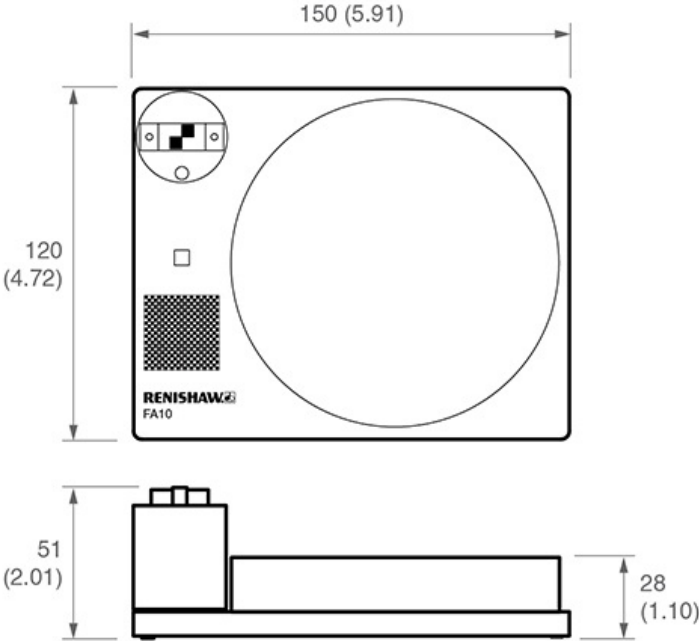
VPCP



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FA10



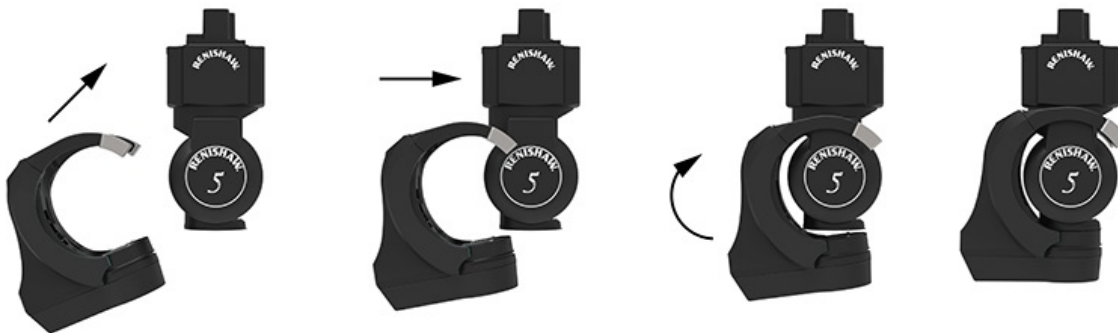
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Manually mounting / removing RFP1 from REVO-2

i **NOTE:** Mounting / removal of RFP1 to / from REVO-2 should be carried out using a VPCP and automatic change cycle. If it is necessary to manually attach / detach RFP1 use the following procedure.

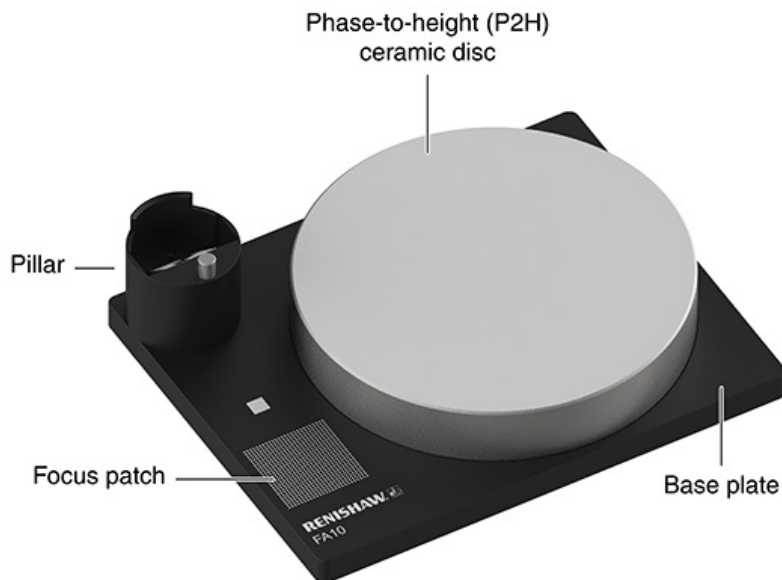
1. Align the front of the head with the probe (look at the 'Renishaw' engraving on the front of probe or alignment marks as applicable).
2. Carefully slide the RFP1 up, then horizontally forwards onto the REVO-2 head, ensuring the counterweights do not foul the head as they pass.
3. Carefully align the probe to the head, allowing the magnetic attraction to gently connect the kinematic joints.
4. To detach, securely hold the probe and gently tilt to break the kinematic joints. Removal is the reverse of step 2.



RFP1 calibration

FA10 calibration artefact

Data collected by RFP1 is in the same reference frame as data collected by the REVO-2 tactile probes. The FA10 artefact is used to calibrate RFP1 and provides the link between RFP1 and the tactile reference frame.



The calibration routines are automatically controlled by UCCsuite and proceed as follows:

Locating the FA10 artefact using RSP2 and providing the tactile data for linking to RFP1

1. Fix the FA10 artefact onto the bed of the CMM as shown at the end of this section ('Fixing FA10 calibration artefact to CMM').
2. Run the routine in UCCsuite to locate the FA10 artefact using a calibrated RSP2 tool:
 - The software will prompt the user to position the RSP2 above the location peg on the pillar of the FA10 artefact
 - The remainder of the moves will be performed automatically
 - Care must be taken to ensure that there is enough space / machine volume around the FA10 artefact to reach all parts of the artefact
3. Points will be taken as follows:
 - On the location peg to determine height and initial location
 - On the pillar to determine orientation of the artefact
 - On the chequerboard target to determine position
 - Around the circumference of the phase-to-height (P2H) disk to determine position
 - On the P2H disc to determine plane height and axis
 - On the focus patch to determine height

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Calibrating an RFP1

1. At the start of the qualification process, the RFP1 will move from its current position to the safe position values defined in the FA10 dialogue box.
 - User must take care to ensure that there is a clear line of sight from the current position to the FA10 safe position before requesting a qualification
2. Images will be taken on the P2H disk to normalise the illumination levels and set the triangulation spot position.
3. RFP1 will take images of the pillar to determine the properties of the camera lens.
 - This aligns the RFP1 camera position to the REVO-2 reference frame, providing the link to RSP2 calibration
4. RFP1 will then take images of the P2H ceramic disc surface to calibrate the fringe pattern.
 - The triangulation spot is also calibrated during this stage
5. A verification routine is performed automatically at the end of a qualification routine.
 - RFP1 takes images of the pillar at different head angles to verify the lens parameters

Verification of an RFP1

1. At the start of the verification process, the RFP1 will move from its current position to the safe position values defined in the FA10 dialog box.
 - User must take care to ensure that there is a clear line of sight from the current position to the FA10 safe position before requesting a verification
2. RFP1 takes images of the pillar at different head angles to verify the lens parameters.

Using FA10 for vision calibration

FA10 can also be used to calibrate RVP, instead of using the VA11 calibration artefact.

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Fixing FA10 calibration artefact to CMM

The FA10 calibration artefact is designed to be fixed securely to the bed of the CMM to allow accurate and repeatable calibration of RFP1. The diagrams below show how to fix the FA10 to the bed of the CMM.

1. Locate an appropriate threaded hole in the bed of the machine.
2. Position the artefact plate above the threaded hole.
3. Screw the correct cap head bolt through the hole into the threaded hole on the machine. The supplied washer can be used to correctly fit smaller diameter bolts.
4. Tighten with a hex wrench.
5. Attach the calibration pillar to the kinematic mount. Integral magnets will secure it in place. Polarisation of the magnets will ensure the pillar is fitted in the correct orientation.



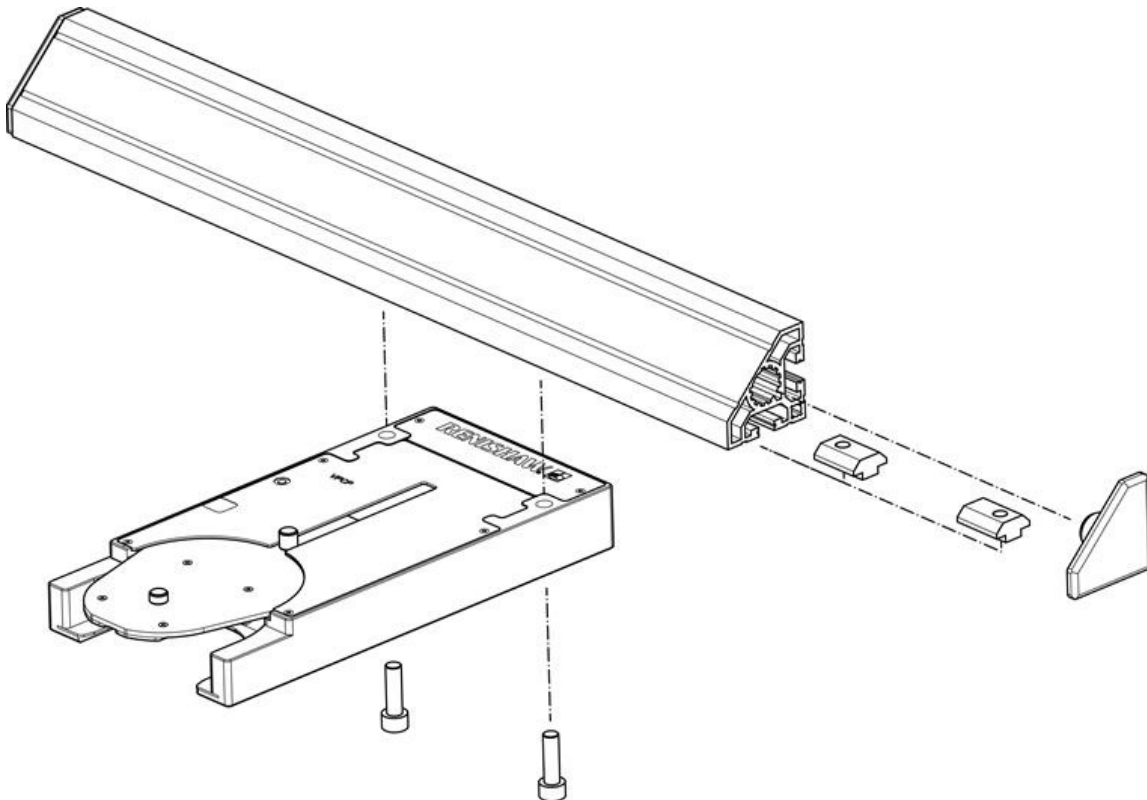
RFP1 installation

i **NOTE:** Please refer to the REVO-2 change port system spacing guide (Renishaw part number H-1000-5408) for full details of the recommended spacing for positioning all sensors and artefacts on the MRS / MRS2 rail.

Fitting VPCP to the MRS / MRS2 rack

The VPCP heated change ports can be fixed to an MRS or MRS2 rack system. It is recommended that they are attached to the MRS / MRS2 rail using the following procedure, where it is assumed that the MRS / MRS2 rack system is correctly installed.

1. Insert one of the fixing screws through the VPCP.
2. Position the VPCP underneath the rail and locate the respective T-nut within the rail*.
3. Hand tighten the fixing screw into the T-nut and repeat the process for the next fixing screw.
4. Position the VPCP and tighten both fixing screws using the hexagonal key supplied.



i * **NOTE:** T-nuts must be used with the MRS system. However T-nuts and D-nuts are compatible with the MRS2 system.

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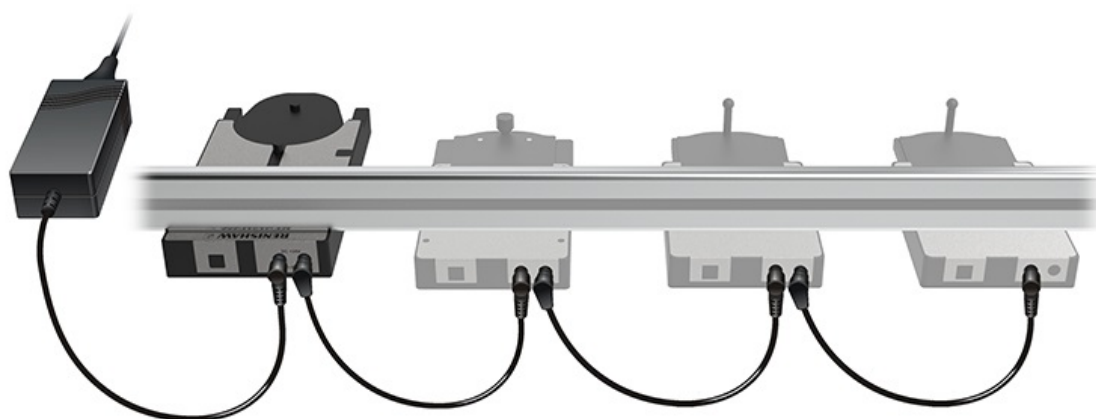
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Connecting VPCP to PSU

Using a PSU other than the one supplied by Renishaw is not recommended.

DC extension cables are available for the PSU but the length **should not exceed 15 m** otherwise the performance can be affected.

It is possible to power up to four REVO system ports with one PSU using the daisy-chain technique shown below.



NOTE: Nothing other than VPCP or other REVO system ports should be connected to the PSU. No more than four can be powered from one PSU. No more than one PSU should be connected to a daisy chain of ports. Ports need to be next to each other on the MRS2 rail for daisy chaining. Power can be connected to either end of the daisy chain. Turn off or disconnect the mains supply to the PSU before fitting DC power cables to the ports.

Spares

Part description	Renishaw part number
DC daisy-chain cable	P-CA82-0019
DC extension cable (1.5 m)	A-3060-0016
PSU	P-EA02-0021
DC extension cable (5 m)	A-3060-0017
DC extension cable (10 m)	A-3060-0018

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VPCP switch settings

The temperature can be set using the rotary switch on the rear of the port:




Position	Description
0 - 3	Reserved for future use
4 (factory set)	Suitable for specified system ambient temperature
5 - 9	Reserved for future use

i **NOTE:** Please do not change the settings without contacting your supplier.

! **CAUTION:** This unit is not sealed. Please do not insert anything into the gaps under the port lid as it can cause damage to internal components within the product.

Cleaning the RFP system

 **CAUTION:** Always adhere to the safety instructions given on the general safety recommendations and instructions in this document. Failure to do so could lead to personal injury.


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

Kinematic couplings

The kinematic coupling mechanisms incorporated throughout the system have precision ball seating and permanent magnets. It is recommended that all these features be cleaned before first use, and thereafter at regular intervals.

A cleaning kit for the precision ball seating and permanent magnet is available from your Renishaw supplier (part number A-1085-0016). It comprises strips of yellow tack material. Use the yellow tack to clean the areas indicated with arrows numbered [1] on the image below.

With clean hands, tear off a small piece, shape into a small ball and press into / onto each of the features in turn, rotating to a fresh piece of material as you work around.

 **CAUTION:** Ensure no yellow tack debris is left on the surface. The yellow tack should not be used for the electrical contacts [2] or the optical windows [3].

Electrical contacts

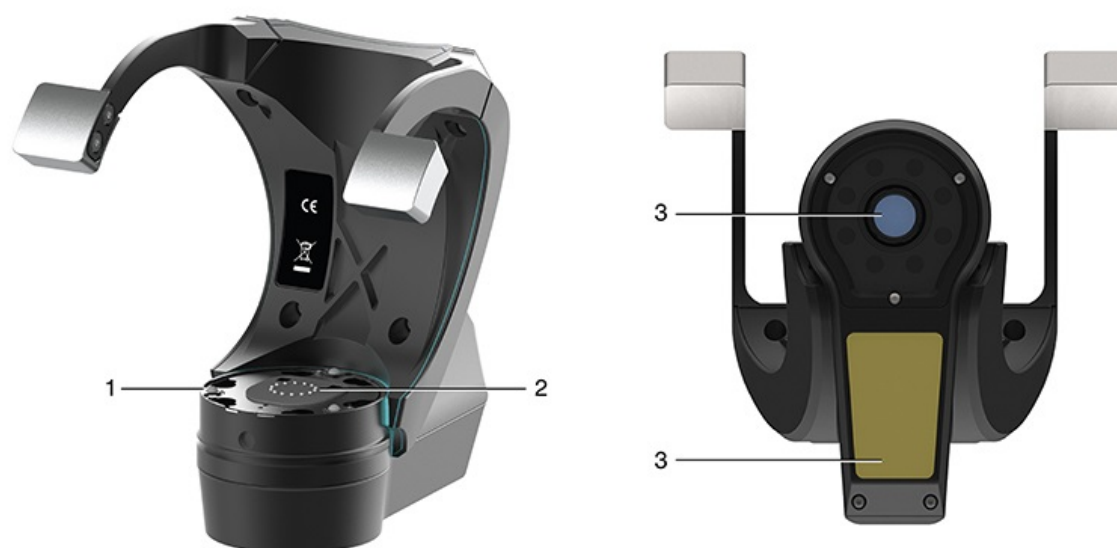
The electrical contacts, indicated with arrows numbered [2] in the image below, should be carefully cleaned with an alcohol-based cleaner (e.g. IPA) and a lint-free bud. The frequency of cleaning depends on the local environmental conditions, but should be at least every five hundred changes.

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Optical windows

The RFP1 optical windows [3] should be cleaned using an optical lens cleaning kit to blow or brush debris away from the window. If debris is still visible, then the optical window should be carefully wiped with a lint free bud and high-purity isopropyl alcohol (IPA). Extreme care must be taken to avoid damaging the optical coating or scratching the glass. Latex gloves should be worn during the cleaning procedure and no attempt to directly touch the optical windows should be made.

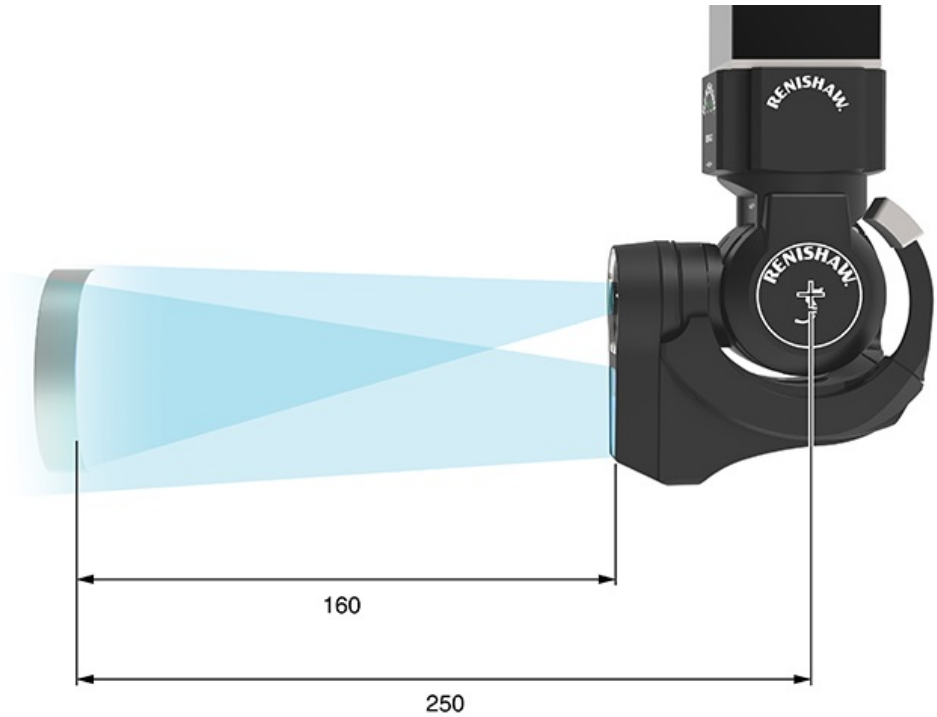


NOTE: Cleanliness of the optical windows is important to maintain the highest level of performance of the probe and modules. If any contamination cannot be removed and is resulting in degraded metrology performance, please contact your local Renishaw office.

Technical terminology

Probe length and stand-off

Probe length is the distance between the A-axis centre of the REVO-2 head and the centre of the measurement volume. This is equivalent to the probe length for RSP2 and RSP3 probes. Stand-off is the distance between the end of RFP1 and the plane at the centre of the measurement volume.

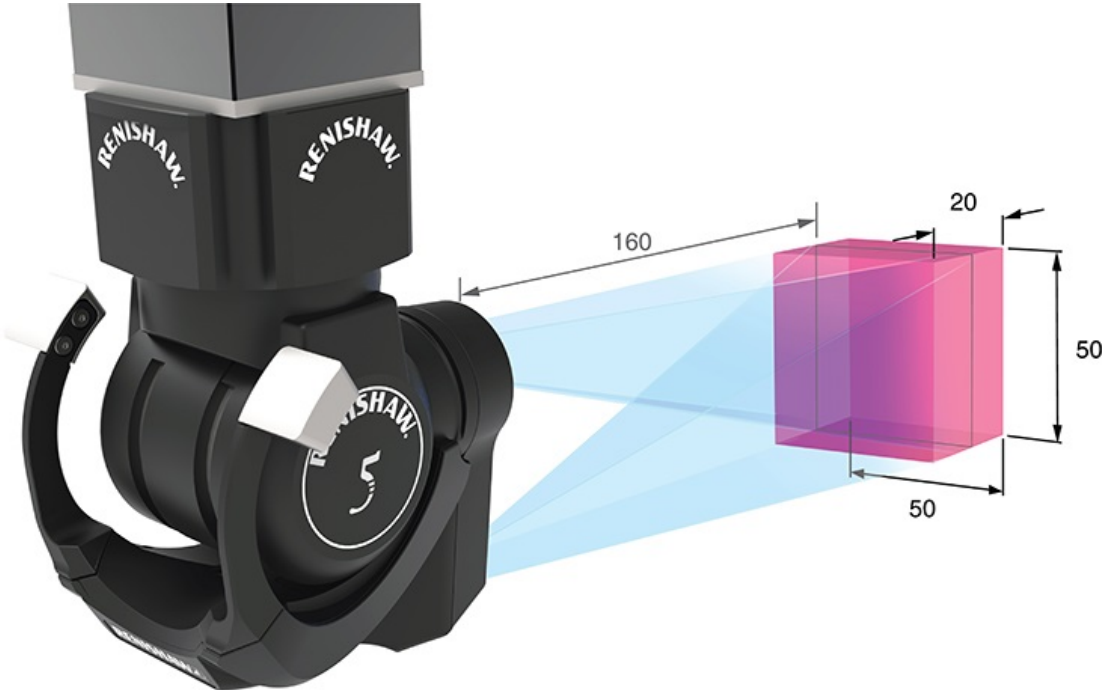


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Measurement volume

Data will be returned from surfaces within the measurement volume and in line of sight of the projector and camera. No data will be returned from areas of the fringe pattern falling on surfaces outside of this volume.



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please visit our main website at
www.renishaw.com/contact**