

# High performance 5-axis measurement



**Fast scanning and discrete point measurement**



**Elimination of measurement bottlenecks**



**Unparalleled flexibility**



## 5-axis measurement technology

For more than 40 years, Renishaw has delivered innovations that have been milestones in industrial metrology, from the original touch-trigger probe and motorised indexing head to repeatable stylus changing and modular scanning systems. Renishaw's 5-axis measurement technology represents the biggest step-change in measurement capability that we have ever introduced, resulting from the biggest research and development program that we have ever undertaken.

### What is 5-axis measurement?

Based on advanced head, sensor and control technology, Renishaw's 5-axis measurement technology delivers unprecedented measuring speed and flexibility, whilst avoiding the speed versus accuracy compromises inherent in conventional techniques. It boosts measurement throughput, minimises lead times and gives manufacturers a more comprehensive appreciation of the quality of their products.

Unlike systems based around indexing heads or fixed probes, 5-axis motion enables the stylus to follow a continuous path around complex components without having to leave the surface to index the head. Controller algorithms that synchronise CMM and head motion produce an optimal tip path and minimise CMM dynamic errors.



## Increased throughput

The ultimate scanning speed of a CMM is limited by machine dynamics, typically to between 80 and 150 mm/sec. However, long before we reach this limit, measurement accuracy falls away – often limiting the effective maximum measuring speed to between 10 and 20 mm/sec.

### How?

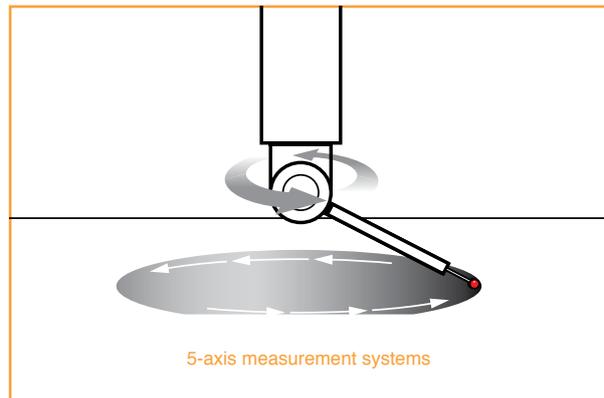
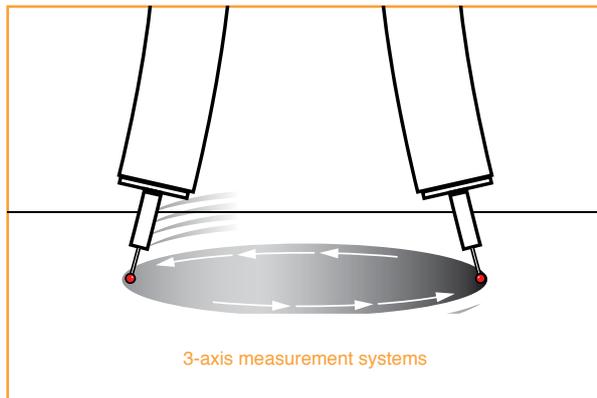
Non-linear motion on a Cartesian CMM induces accelerations and decelerations that twist and deflect the machine structure, and these dynamic deflections result in measurement errors that increase with measurement speed and acceleration.

To avoid dynamic deflections, Renishaw's 5-axis measurement minimises machine accelerations, whilst moving the stylus very rapidly over the component surface.

## Reduce measurement cycle times without compromising accuracy

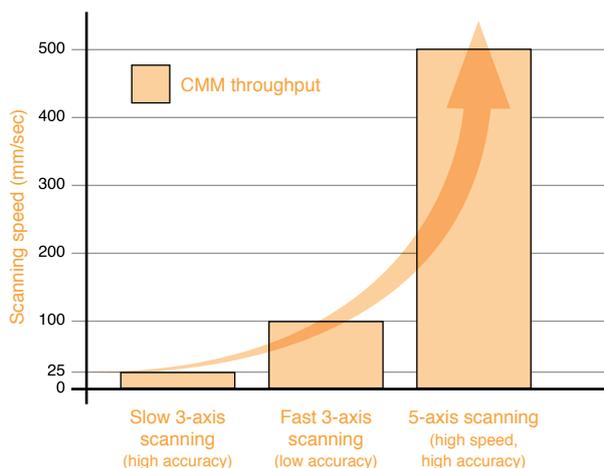
- eliminate bottlenecks
- rapid process feedback
- high speed head and sensor calibration
- less time spent indexing and more time spent measuring
- avoid changing stylus clusters

## CMM dynamics' scanning effect



## Advantages of Renishaw's 5-axis measurement

Renishaw's 5-axis measurement breaks through the dynamic performance barrier by minimising the accelerations and hence the inertial loads on the machine structure. Renishaw's dynamic heads do most of the measurement work, enabling exceptional throughput without compromising accuracy.



## Renishaw's unique 5-axis measuring features

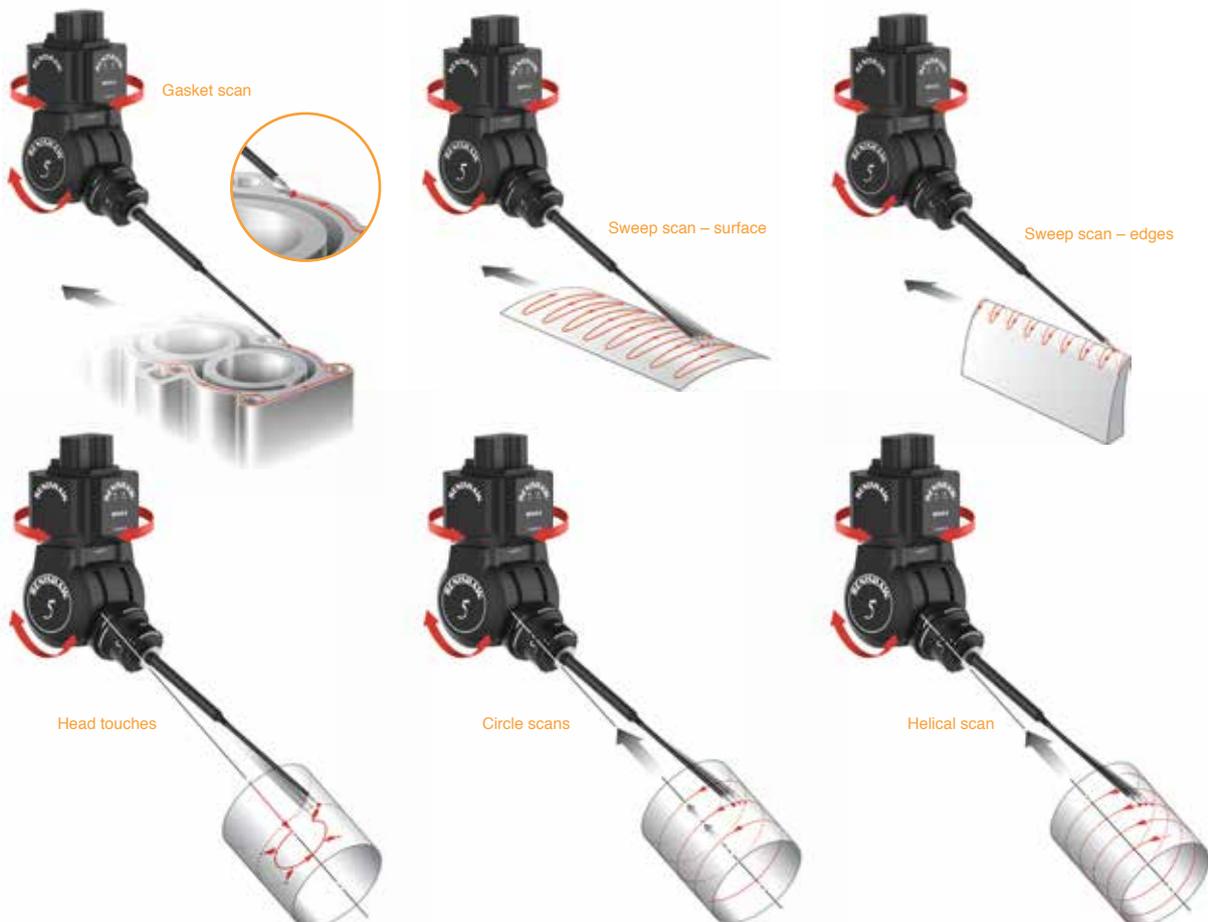
Renishaw's 5-axis measurement technology not only allows you to replicate your current measurement strategies faster than before, but also makes new ways of scanning possible. The 5-axis motion and infinite positioning capability of the REVO head enable blended scanning, seamlessly combining two different scanning techniques. Bores can be measured using touch points, circular scans or helical scans, whilst data on contoured surfaces and edges can be captured with a sweeping motion of the head.

### 5-axis scanning

- Simultaneous motion control of 5 axes
- Data gathered 'on the fly' whilst the head is moving
- Dynamic 2-axis head provides most of the stylus motion
- Unique tip-sensing probe technology
- Scanning with 5 axes of simultaneous motion allows unparalleled measurement flexibility

### 5-axis touch-trigger

- 'Head-touches' take measurement points faster, with improved accuracy and repeatability
- 5-axis motion eliminates time spent indexing the head
- Infinite positioning capability guarantees optimal feature access, minimising stylus changes
- 5-axis simultaneous motion allows larger parts to be measured on the CMM by minimising the space required around the part for head rotation



## REVO® – 5-axis multi-sensor scanning system

REVO is a revolutionary measuring head and probe system from Renishaw. Every process and feature in a REVO system has been designed to enable users to achieve previously unobtainable levels of inspection throughput:

- 5-axis scanning of complex form; REVO's ability to gather very large quantities of accurate inspection data at ultra-high scanning speeds is invaluable.
- Very high speed gathering of touch points using the servo head's infinitely variable 2-axis motion.
- Innovative, patented tip-sensing probe technology allowing the sensing to be very close to the surface measured, yielding better accuracy.
- Novel calibration; Renishaw's 5-axis measurement tip-sensing probe (RSP2) requires only a single tip calibration to be accurate at all angles of rotation, typically saving several hours in the set-up routine.
- Infinite positioning and 5-axis synchronised motion, which facilitates access to features.
- Multi-sensor capability for optimum probe selection.

### REVO-2 dynamic scanning head

The REVO-2 measuring head features spherical air bearing technology in each of its 2 axes, driven by brushless motors linked to high-resolution encoders to provide fast, ultra-high accuracy positioning.

Measure faster

- up to 50 times faster surface speed than 3-axis scanning

Measure more points

- 4000 points per second acquisition rate

Measure more accurately

- with the REVO tip-sensing RSP2

Measure more features

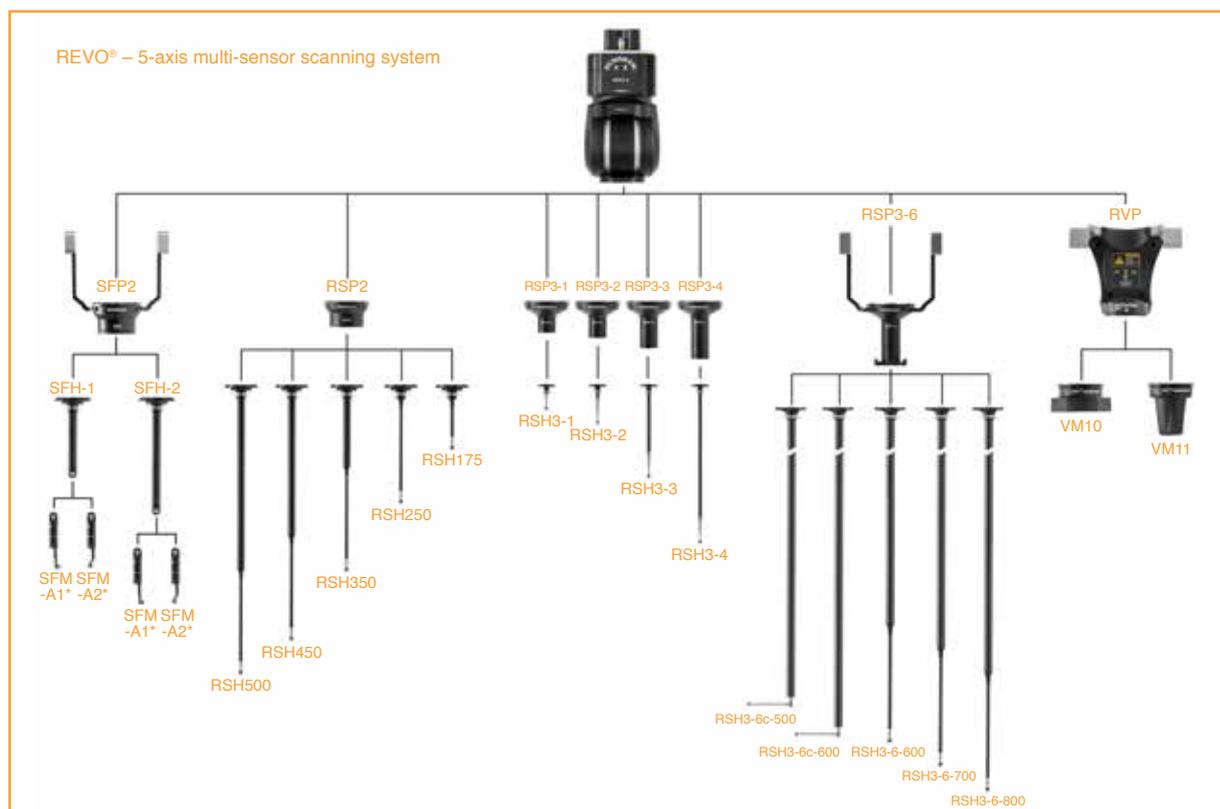
- infinite positioning for unparalleled flexibility

Measure without compromise

- 100% inspection for optimal part verification and process control

Measure surface finish

- integral motorised C-axis rotation for optimised feature access
- automated, operator-independent CMM surface finish measurement



\* Other SFM modules are available

# REVO® system probes

## RSP2

RSP2 is a dedicated lightweight tip-sensing probe for use on REVO systems, capable of 2D-scanning (x, y) and 3D-touch trigger measurement.

The RSP2 has a universal body to which a number of different length stylus holders, with a maximum reach of 500 mm, can be fitted. The RSP2 works by using an enclosed laser that is directed onto a reflector at the stylus tip. As the stylus touches the part and bends, the reflector is displaced. The altered return path of the laser is then sensed and the exact tip position of the stylus is known because the reflector and stylus ball are close together. Stylus wear is minimised by the low scanning forces that are required.



## RSP3

RSP3 provides the REVO system with 3D-scanning (x, y, z) and crank stylus capabilities.

The RSP3 is used for 3-axis scanning with a fixed REVO-2 head angle during measurement. The range of probes allows different lengths of stylus to be used whilst maintaining optimum metrology performance.

Based on the SP25M technology pivoting motion system with two diaphragm springs, one of the RSP3 springs allows movement in all directions whilst the other (pivot) spring is stiff in (probe) x and y, but allows movement in Z.

Unlike the SP25M, in RSP3 the probe and module elements are built as one. A range of RSP3 probes are now available to allow a range of stylus lengths to be used.





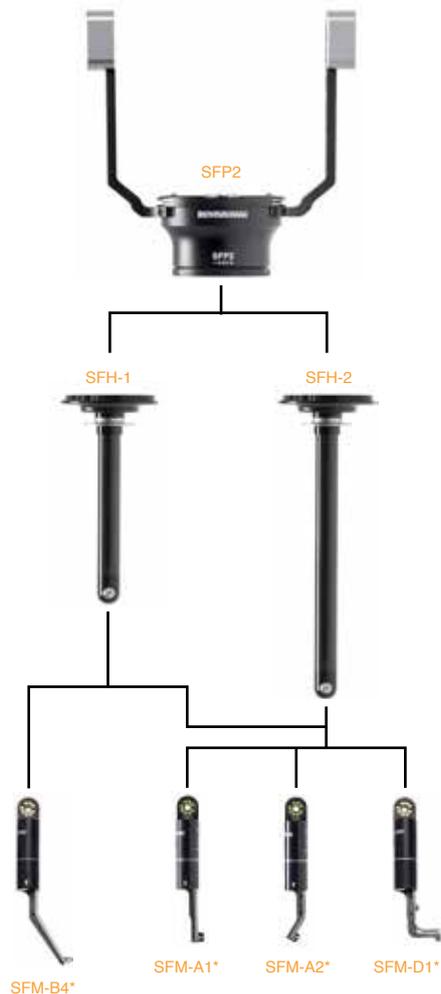
## SFP2 surface finish probe

Surface finish measurement has traditionally required the use of hand-held sensors or moving the part onto a dedicated measuring machine.

The REVO SFP2 probe makes surface finish inspection an integral part of your CMM measurement, enabling automatic switching from dimensional to surface finish measurement.

The SFP2 probe, part of the REVO system, offers numerous benefits:

- SFP2 benefits from REVO's infinite positioning and 5-axis movement, and features an integral motorised C-axis.
- CMM programs can now include automated and operator-independent surface finish measurement. All results, including surface finish data, are recorded and stored in a single location for easy retrieval.
- Integrated surface finish and dimensional inspection can remove the need for dedicated surface measurement equipment, reducing factory footprint and eliminating the risks and overhead of unnecessary part handling.



## System characteristics:

The SFP2 system consists of a probe and a range of modules and is automatically interchangeable with all other probe options available for REVO, providing the flexibility to easily select the optimum tool to inspect a wide range of features, all on one CMM platform. Data from multiple sensors is automatically referenced to a common datum.

The surface finish system is managed by the same I++ DME compliant interface as the REVO system, and full user functionality is provided by Renishaw's MODUS™ metrology software.

## SFM surface finish modules

The SFP2 module variants offer a range of tip arrangements which, combined with the knuckle joint between module and holder, provide access to the most difficult to reach features.

Each SFM module is its own miniature measuring device, incorporating Renishaw's proprietary encoder system to transduce the motion of the stylus tip.

Specialised modules have been designed to meet the unique demands of specific part features such as valve guide ways, curved blade surfaces and spool bore short lands.

\* Other modules are available

## RSP3-6

RSP3-6 provides enhanced capability for accessing deep bores and inspecting features within large parts.

The probe can carry a range of stylus holders for applications requiring straight and cranked extensions and can be used for both touch-trigger and 2D scanning measurement.

### Probe characteristics:

- Reach - Available with straight extensions up to 800 mm from REVO-2's A-axis centre of rotation, and cranked extensions up to 600 mm.
- Accuracy - Scanning accuracy; typically better than 10  $\mu\text{m}$  form error (filtered) and 5  $\mu\text{m}$  diameter error. Touch-trigger accuracy; typically better than 3  $\mu\text{m}$  form and diameter error
- Part of the REVO 5-axis multi-sensor system - Long extensions combined with 5-axis movements for better part access and multi-sensor changing for increased flexibility.

## RVP vision probe

RVP provides high performance 5-axis measurement for non-contact applications.

5-axis motion between part features and real time image processing dramatically increase data collection rates for small features and delicate or flexible parts that cannot be measured using tactile probes.

The RVP system comprises a vision probe body, vision modules, rack ports and a calibration artefact. The image capture and processing components of the system are held inside the vision probe body and include an industry standard, robust, CMOS sensor for reliable image capture.

The vision modules allow a range of features with different sizes and shapes to be inspected. All vision modules contain integral LED lighting to achieve a sharp contrast between holes and part material. Background feature enhancement is also available using backlighting combined with bespoke part fixturing.



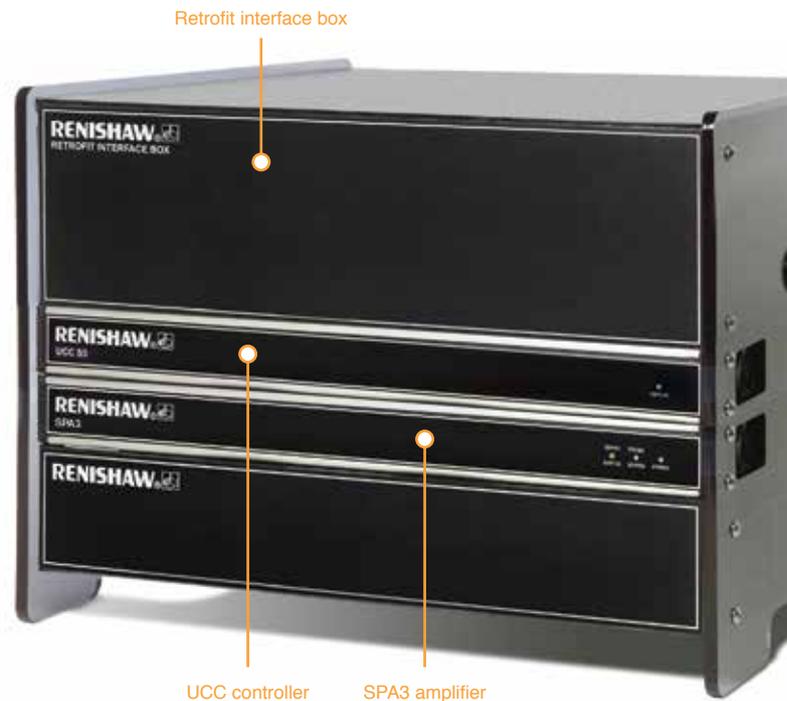
## 5-axis measurement controller technology

The motion controller is a vital factor governing the performance of any CMM. Renishaw's UCC controllers provide the powerful platform for 5-axis measurement systems, bringing unprecedented flexibility and productivity to CMM users.

The UCC is designed to meet the exacting demands of 5-axis scanning and the processing of 4,000 data points per second at speeds of up to 500 mm/sec. It also provides smooth, simultaneous motion of the CMM and head axes ensuring minimal dynamic deflection of the CMM structure for optimal metrology performance.



Renishaw's UCC controller range supports the I++DME command protocol which is also supported by the majority of CMM metrology software products. The system operates on a Client (application software) / Server (controller software) basis where the responsibility for metrology performance lies with the Server. Renishaw has developed the UCCserver application to manage all aspects of CMM metrology and probe calibration.



### The REVO-2 probe changer system

The REVO-2 probe changer system allows automatic REVO-2 probe and stylus holder changing, enhancing flexibility through the use of a range of stylus configurations.

RCPTC-2 and -3 are thermally controlled ports specially designed for changing the REVO probes. RCPTC-2 is used for RSP2 and RSP3 probes. RCPTC-3 is used for RSP3-6 and SFP2 probes.

Key features of the RCPTCs:

- Maintain the probes at operating temperature when not in use, for optimum metrology.
- Compatible with MRS.

The RCP2 is configured to change RSP2 and SFP2 stylus holders, whereas FCR25 is used for RSP3 stylus holders.

### REVO-2 probe calibration

Calibration on traditional CMM systems consumes a considerable amount of time that could otherwise be used for part measurement. Using a table mounted sphere, the simple and practical calibration technique for REVO-2 determines the actual head and probe geometry, allowing measurement in any position from a single operation.



## PH20 – use your head!

The 5-axis technology pioneered by Renishaw's award-winning REVO is available for touch-trigger applications with dramatic impact on inspection timescales, costs, capability and flexibility on all sizes of CMM.

### Increased throughput

PH20's unique head touches allow measurement points to be taken by moving only the head rather than the CMM structure.

Using only the rapid rotary motion of the head, points can be taken faster, and with improved accuracy and repeatability. Furthermore, 5-axis motion eliminates time spent indexing the head.

Together, these speed increases typically result in a 3-fold improvement in throughput over conventional systems.

### Easy access to features at any angle

PH20's infinite positioning capability guarantees optimal feature access, minimising stylus changes.

5-axis simultaneous motion allows larger parts to be measured on the CMM by minimising the space required around the part for head rotation.

PH20 automatically aligns itself with the part coordinate system, avoiding stylus collisions and the requirement for accurate fixtures.



## Improved touch-trigger metrology performance

- Repeatability – improved when ‘head touch’ method is used
- Accuracy – improved by using feature orientation based calibration and ‘head touches’
- Pre-travel variation – automatically compensated during the calibration
- Module changing tip offset – automatically corrected following a module change.

## Available with your new CMM or as a retrofit to existing equipment

- Compact design – suitable for a wide range of CMMs
- Renishaw CMM controller – I++DME communication, wide selection of metrology software
- Indexing head compatibility – no requirement to modify existing programs in the majority of cases
- Integral TP20 probe – allows re-use of existing equipment
- Mechanical bearings – no air supply required



## Integral industry standard TP20 probe

Users of the PH20 probe head will immediately have access to the range of proven TP20 probe modules, providing a wide selection of trigger forces, directional sensing options and extensions to meet application requirements\*. The detachable modules provide crash protection and can be automatically changed using the TCR20 change rack.

\*Except for the extended force module

## The range of modules

A range of application specific, stylus modules is available:



- The low force module (LF) for high accuracy with short styli and delicate materials.



- The medium force module (MF) is suitable for vibration resistance when using longer styli.



- The standard force module (SF) is suitable for most applications.



- The 6-way module (6W) for measuring grooves and undercuts.



- Two standard force extension modules (EM1 and EM2) improve reach and offer better metrology performance than using equivalent length styli.

## About Renishaw

Renishaw is an established world leader in engineering technologies, with a strong history of innovation in product development and manufacturing. Since its formation in 1973, the company has supplied leading-edge products that increase process productivity, improve product quality and deliver cost-effective automation solutions.

A worldwide network of subsidiary companies and distributors provides exceptional service and support for its customers.

### Products include:

- Additive manufacturing and vacuum casting technologies for design, prototyping, and production applications
- Dental CAD/CAM scanning systems and supply of dental structures
- Encoder systems for high-accuracy linear, angle and rotary position feedback
- Fixturing for CMMs (co-ordinate measuring machines) and gauging systems
- Gauging systems for comparative measurement of machined parts
- High-speed laser measurement and surveying systems for use in extreme environments
- Laser and ballbar systems for performance measurement and calibration of machines
- Medical devices for neurosurgical applications
- Probe systems and software for job set-up, tool setting and inspection on CNC machine tools
- Raman spectroscopy systems for non-destructive material analysis
- Sensor systems and software for measurement on CMMs
- Styli for CMM and machine tool probe applications

For worldwide contact details, visit [www.renishaw.com/contact](http://www.renishaw.com/contact)



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