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Renishaw touch-trigger probing technology

Rugged and flexible solutions for discrete point measurement on CMMs

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Touch-trigger probe technologies

Resistive

- Simple
- Compact
- Rugged

Strain-gauge

- Solid-state switching
- High accuracy and repeatability
- Long operating life

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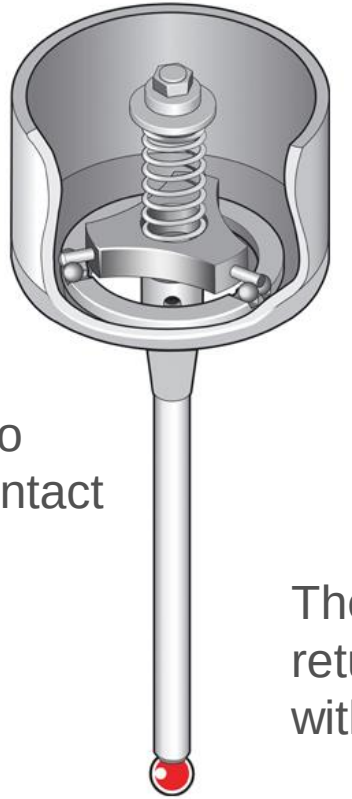
Kinematic resistive probe operation

A trigger signal is generated on contact with the component surface and is used to stop the machine



A spring holds the stylus against the kinematic contacts and returns the probe to a seated position following contact between the stylus and the part

Three rods, each resting on two balls, providing six points of contact in a kinematic location

The stylus ball is uniquely located, returning to the same position to within 0.00004 “ (1 micron)

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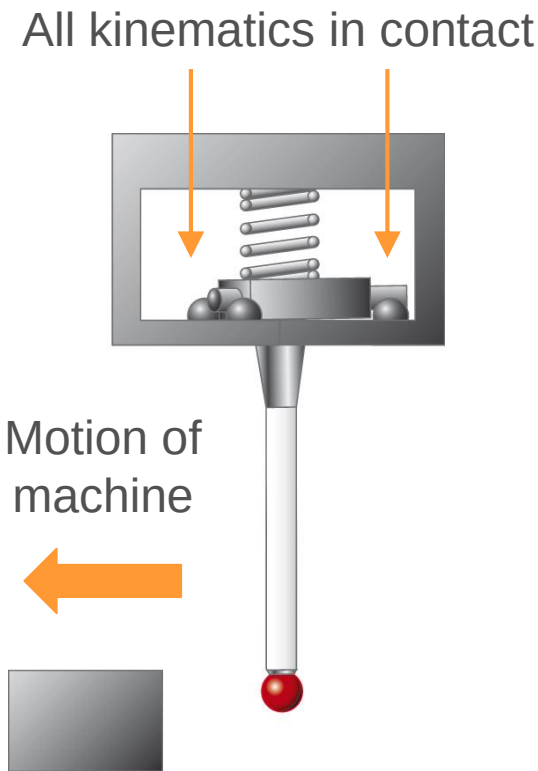
Kinematic resistive probe operation

- Probe in seated position



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Kinematic resistive probe operation

- Probe in seated position
- Stylus makes contact with component

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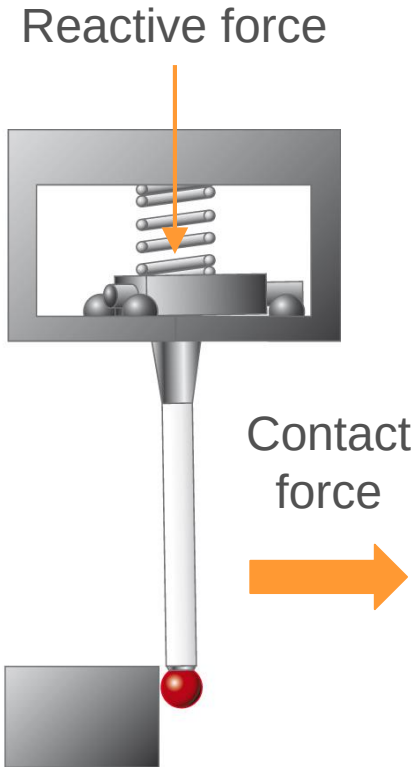
Kinematic resistive probe operation

- Probe in seated position
- Stylus makes contact with component
- Contact force resisted by reactive force in probe mechanism resulting in bending of the stylus



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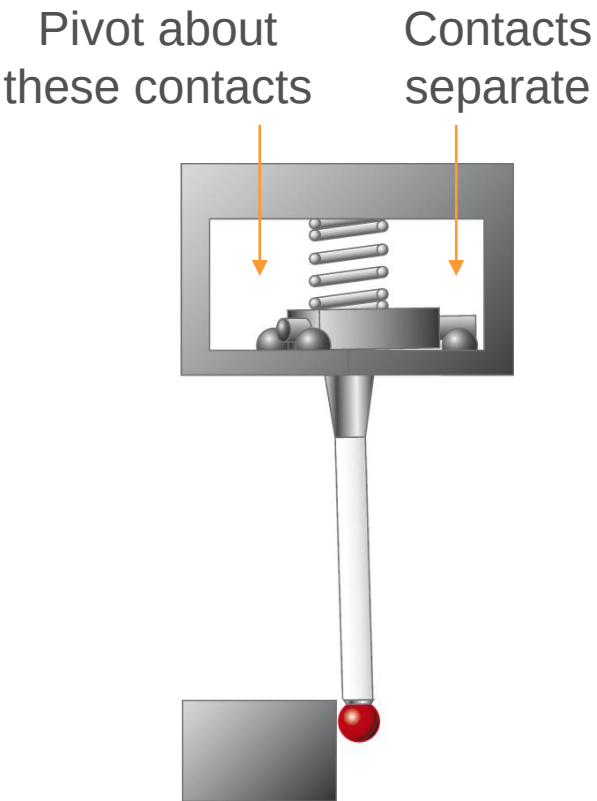
Kinematic resistive probe operation

- Probe in seated position
- Stylus makes contact with component
- Contact force resisted by reactive force in probe mechanism resulting in bending of the stylus
- Stylus assembly pivots about kinematic contacts, resulting in one or two contacts moving apart
- Trigger generated before contacts separate



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Kinematic resistive probe operation

- Probe in seated position
- Stylus makes contact with component
- Contact force resisted by reactive force in probe mechanism resulting in bending of the stylus
- Stylus assembly pivots about kinematic contacts, resulting in one or two contacts moving apart
  - Trigger generated before contacts separate
- Machine backs off surface and probe reseats

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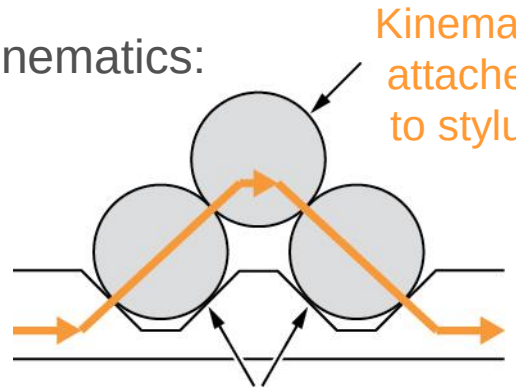
Kinematic resistive probe operation

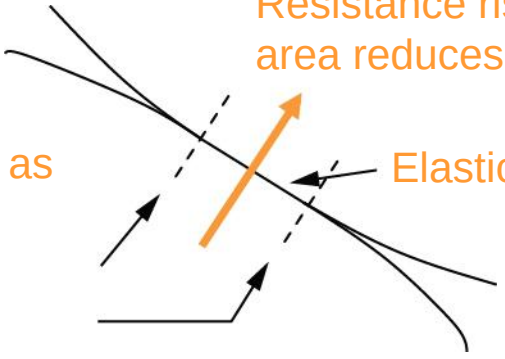
Electrical switching

- Electrical circuit through contacts
- Resistance measured
- Contact patches reduce in size as stylus forces build

Section through kinematics:



Close-up view of kinematics:



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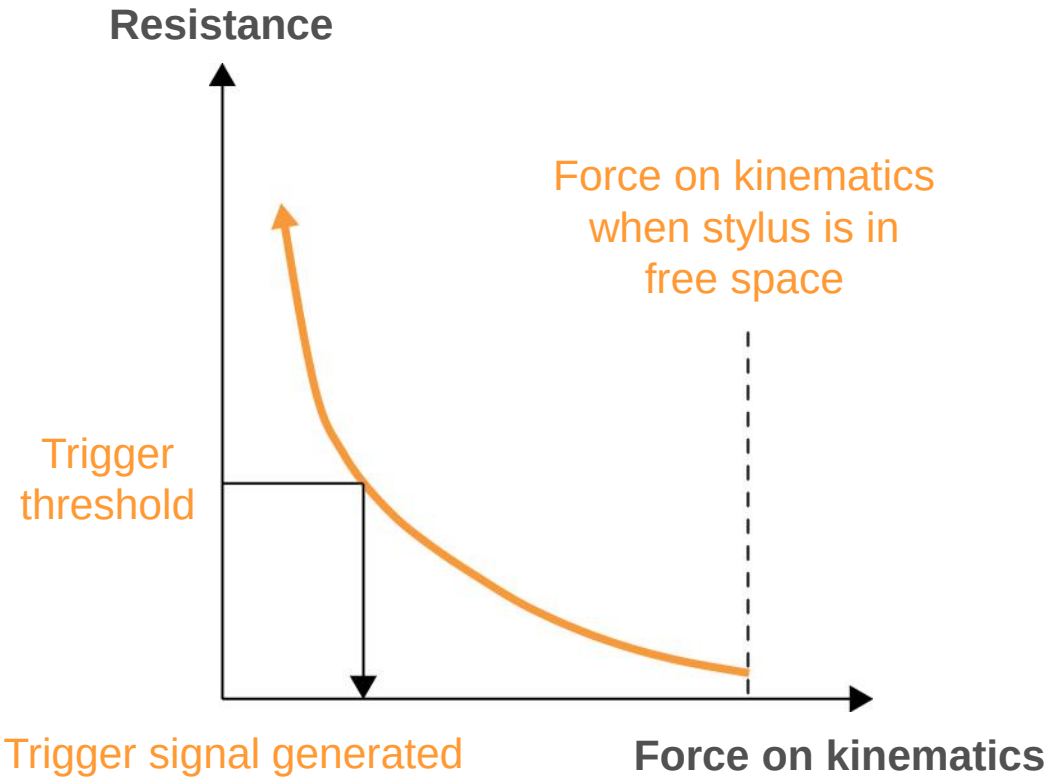
Kinematic resistive probe operation

Electrical switching

- Resistance breaches threshold and probe triggers
- Kinematics are still in contact when probe triggers
  - Stylus in defined position
- Current cut before kinematics separate to avoid arcing



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Factors in measurement performance

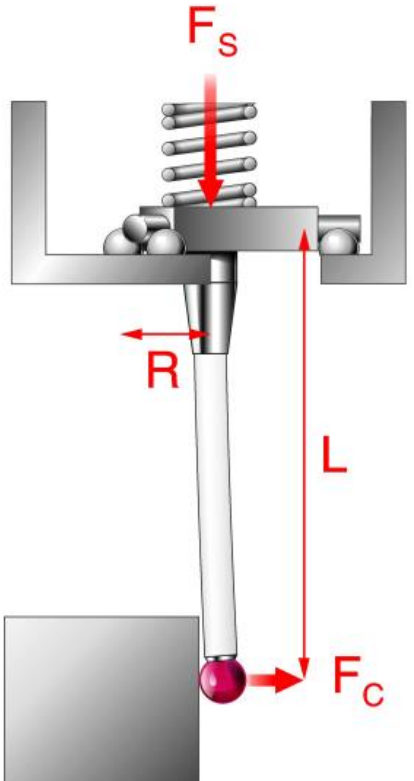
Pre-travel

- Stylus bending under contact loads before trigger threshold is reached
- **Pre-travel depends on F_C and L**
- Trigger is generated a short distance after the stylus first touches the component

$$F_C \times L = F_S \times R$$

L and F_S are constant

$\therefore F_C$ is proportional to R



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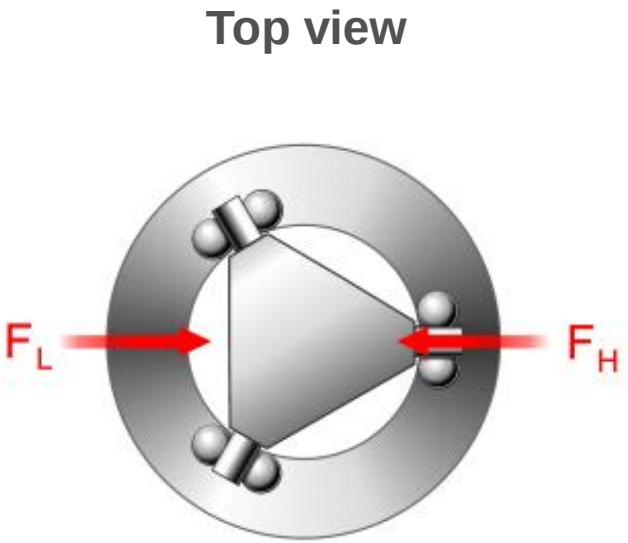
Factors in measurement performance

Pre-travel variation - ‘lobing’

- Trigger force depends on probing direction, since pivot point varies
  - F_C is proportional to R
- Therefore, pre-travel varies around the XY plane



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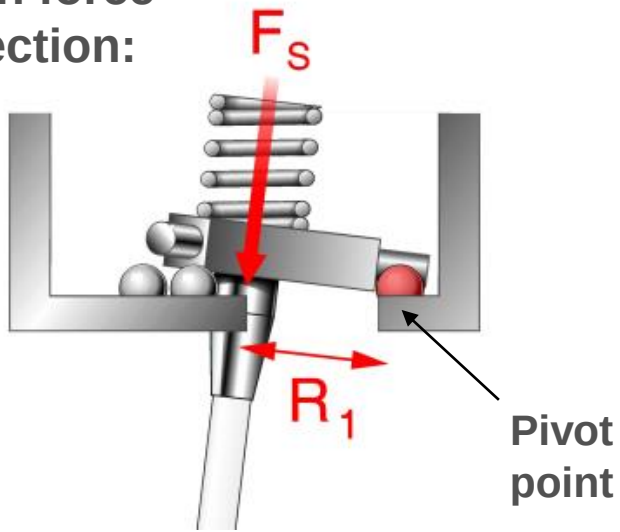
Factors in measurement performance

Pre-travel variation - ‘lobing’

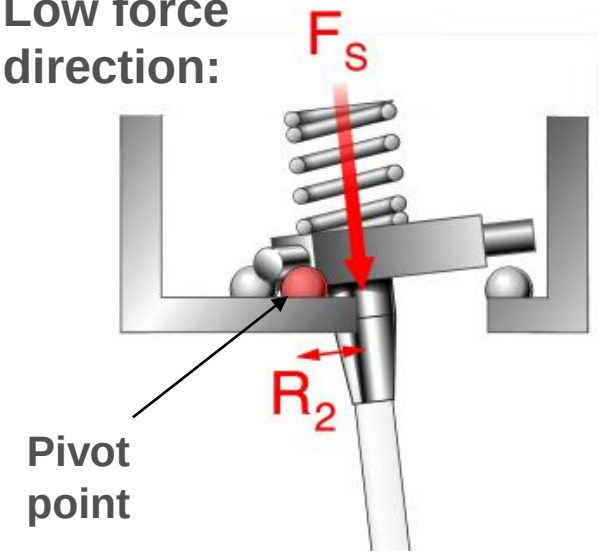
High force direction:



$R_1 > R_2$

$F_{C1} > F_{C2}$

Low force direction:



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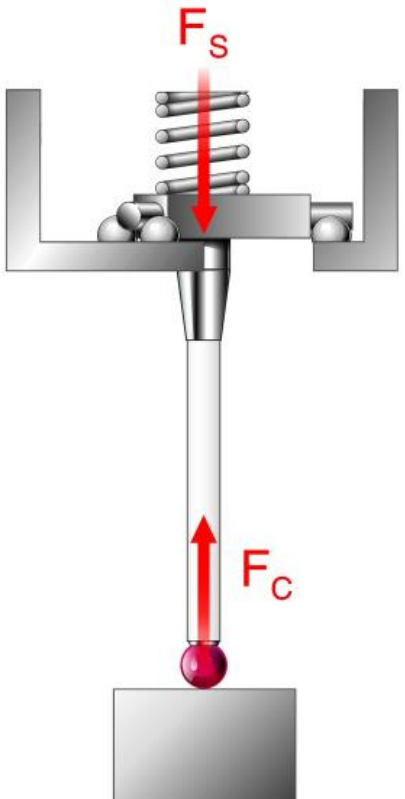
Factors in measurement performance

Pre-travel variation - ‘lobing’

- Trigger force in Z direction is higher than in XY plane
  - No mechanical advantage over spring
  - $F_C = F_S$
- Kinematic resistive probes exhibit 3D (XYZ) pre-travel variation
  - Combination of Z and XY trigger effects
  - Low XYZ PTV useful for contoured part inspection

Test data:

- ISO 10360-2 3D form
- TP20 with 50 mm stylus: 4.0 µm (0.00016 in)



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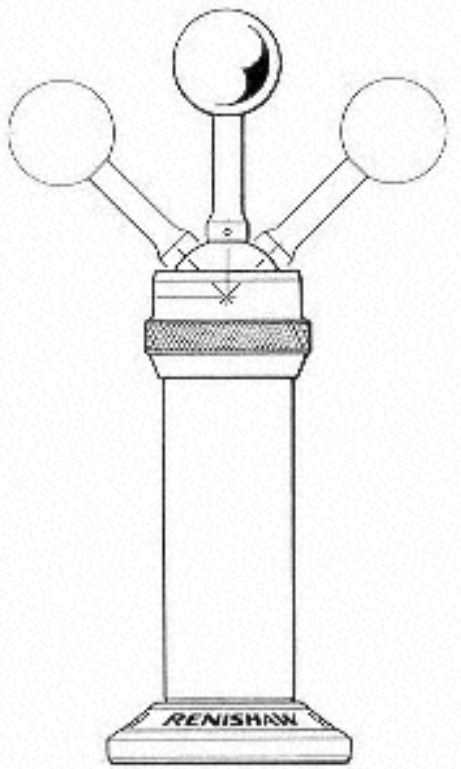
Factors in measurement performance

Probe calibration

- Pre-travel can be compensated by probe calibration
- A datum feature (of known size and position) is measured to establish the average pre-travel
- Key performance factor is repeatability

Limitations

- On complex parts, many probing directions may be needed
- Low PTV means simple calibration can be used for complex measurements
- If PTV is significant compared to allowable measurement error, may need to qualify the probe / stylus in each probing direction



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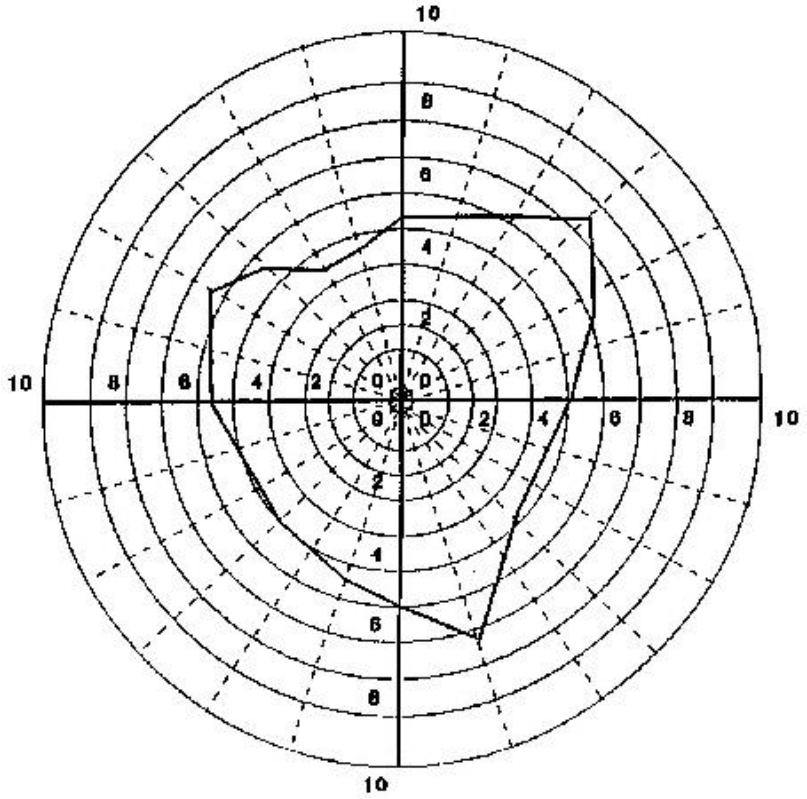
Factors in measurement performance

Typical pre-travel variation

Scale in µm

- XY plane

Probe:	TP6
Stylus:	50 mm
Pre-travel variation:	3.28 µm
Trigger force:	15 gram
Repeatability (2 Sigma):	0.5 µm



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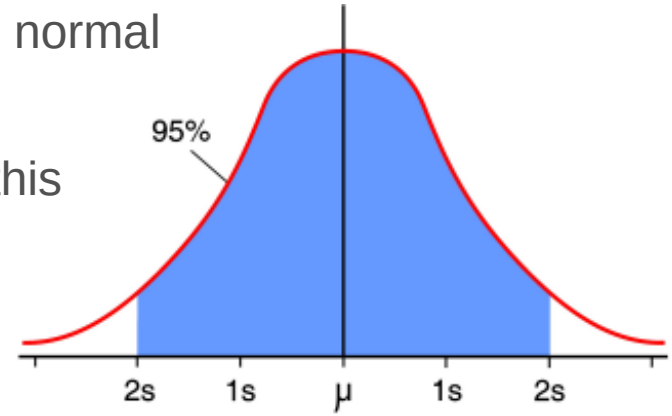
Factors in measurement performance

Repeatability

- The ability of a probe to trigger at the same point each time
  - A random error with a normal distribution
  - For a given probe and probing condition, repeatability is equal to twice the standard deviation (2σ) of the normal distribution
  - 95% confidence level that all readings taken in this mode will repeat within $\pm 2\sigma$ from a mean value



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Factors in measurement performance

Hysteresis

- Error arising from the direction of the preceding probing move
  - Maximum hysteresis occurs when a measurement follows a probing moves in opposite directions to each other in the probe's XY plane
  - Hysteresis error increases linearly with trigger force and stylus length
  - Kinematic mechanism minimises hysteresis

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Factors in measurement performance

Ranked in terms of importance

Repeatability

- Key requirement of any trigger probe
- Fundamental limit on system measurement performance
- Hysteresis contributes to measurement repeatability

Pre-travel variation

- Can be calibrated, provided all probing directions are known
- Measurement accuracy will be reduced if probe used in un-qualified direction and PTV is high
- Increases rapidly with stylus length

Hysteresis

- Small error factor for probes with kinematic mechanisms

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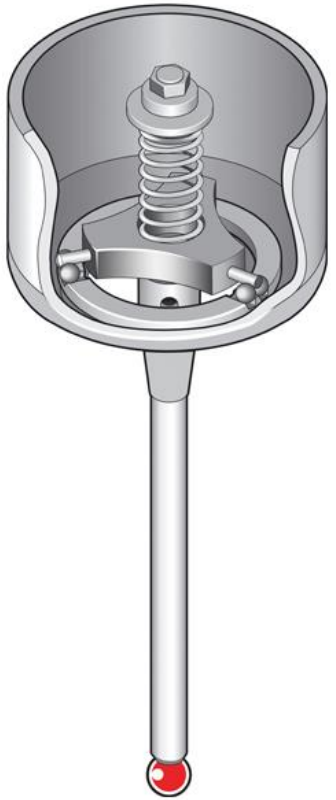
Kinematic resistive probe technology

Simple electro-mechanical switching

- Resistive probes use the probe kinematics as an electrical trigger circuit
- Pre-travel variation is significant due to the arrangement of the kinematics



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Kinematic resistive probe characteristics

- **Extremely robust**
- **Compact**
  - Good part access
  - Suitable for long extensions
- **Good repeatability**
  - Excellent performance with shorter styli
  - Low contact and overtravel forces minimise stylus bending and part deflection
- **Universal fitment**
  - Simple interfacing
- **Cost-effective**
- **Finite operating life**
  - Electro-mechanical switching

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TP20 stylus changing probe

Concept

- Direct replacement for TP2
  - Ultra-compact probe at just Ø13.2 mm
- TP20 features fast and highly repeatable stylus changing
  - Manual or automatic
  - Enhanced functionality through extended force and extension modules

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TP20 stylus changing probe

Benefits

- Reduced cycle times achieved by fast stylus changing without re-qualification
- Optimised probe and stylus performance with seven specialised probe modules
- Easily retrofitted to all Renishaw standard probe heads (M8 or autojoint coupling)
- Compatible with existing touch-trigger probe interfaces
- Metrology performance equivalent to industry proven TP2 system but with greater flexibility of operation

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TP20 stylus modules

Optimal measuring performance

- Seven specialised probe modules allow optimisation of stylus arrangement for best accuracy and feature access in all user applications
- Module attaches to probe body via a quick release, highly repeatable kinematic coupling
- Module range covers all forces supported by TP2
- 6-way module replaces TP2-6W

TP20 probe body

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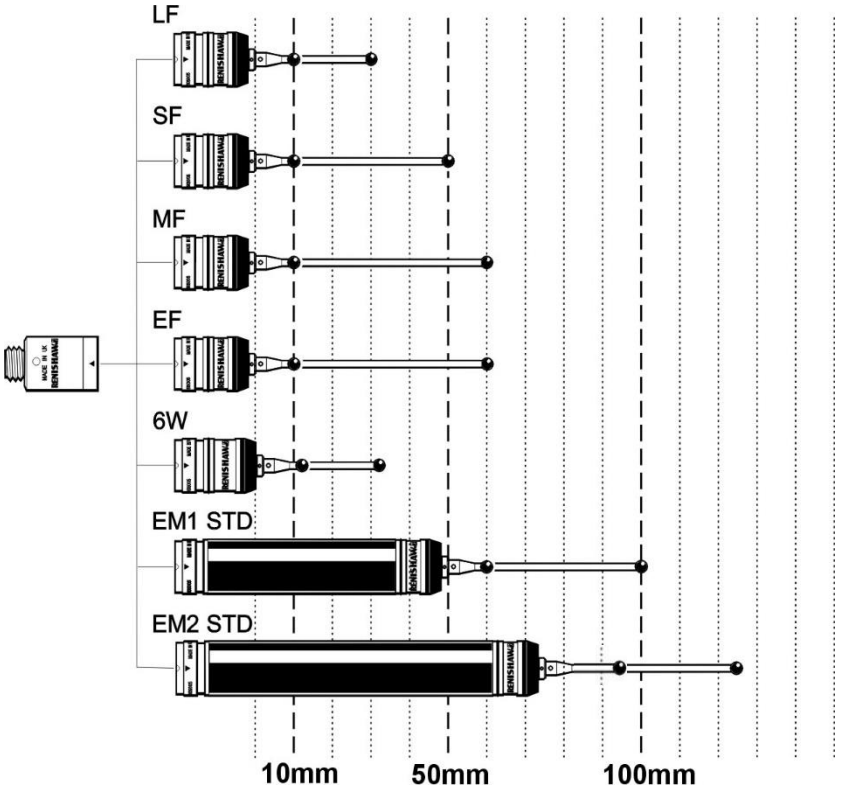
Comparative module and stylus lengths



Soft materials

General use

Longer or heavier styli

Grooves and undercuts

Reach up to 125 mm (5 in)

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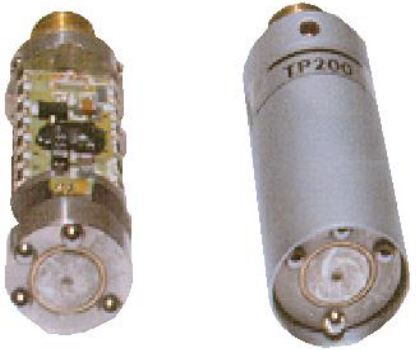
Strain-gauge probe technology

- **Solid state switching**
  - Silicon strain gauges measure contact forces transmitted through the stylus
  - Trigger signal generated once a threshold force is reached
  - Consistent, low trigger force in all directions
  - Kinematics retain the stylus / not used for triggering



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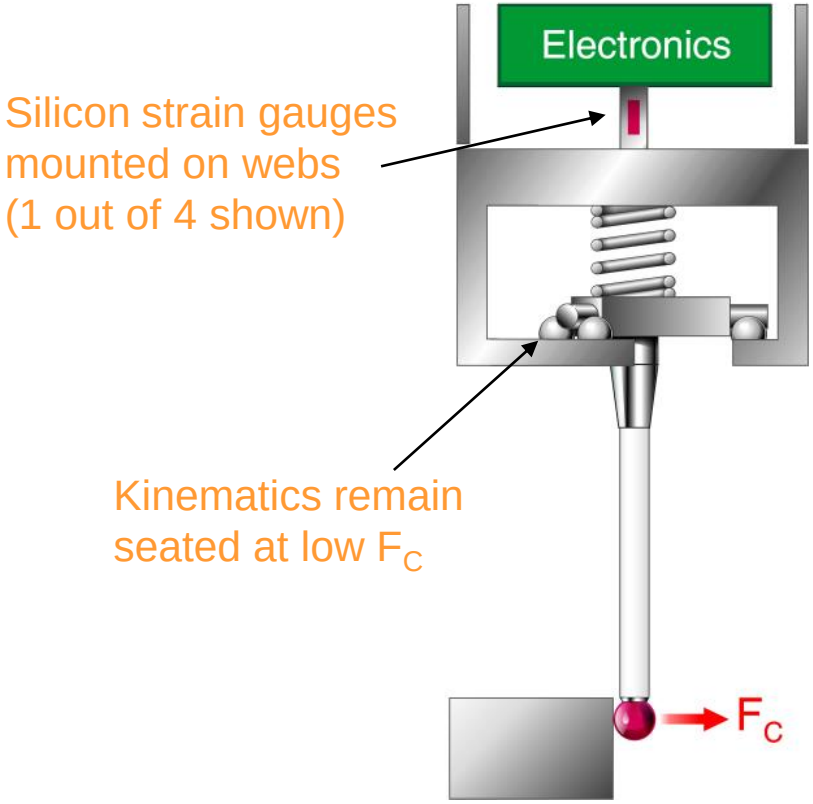
Strain-gauge probe operation

Force sensing

- Four strain gauges are mounted on webs inside the probe body
  - X, Y and Z directions, plus one control gauge to counter thermal drift
- Low contact forces from the stylus tip is transmitted via the kinematics, which remain seated at these low forces
- Gauges measure force in each direction and trigger once force threshold is breached (before kinematics are unseated)



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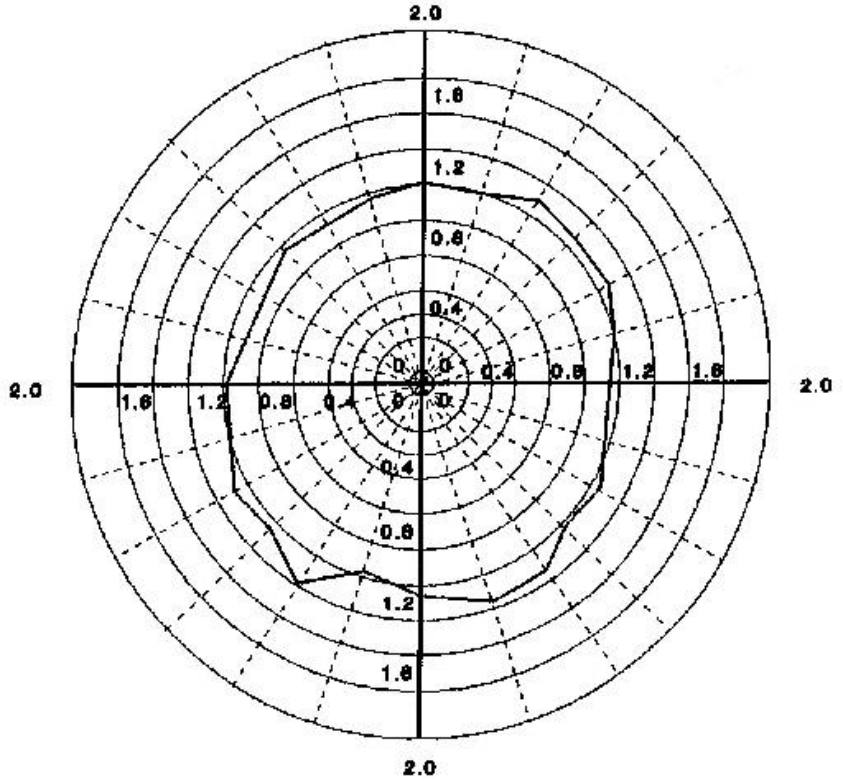
Strain-gauge probe operation

Low lobing measurement

Scale in µm

- Trigger force is uniform in all directions
  - Very low pre-travel variation

Probe:	TP7M
Stylus:	50 mm M4
Maximum variation:	0.34 µm
Sensitivity:	HIGH



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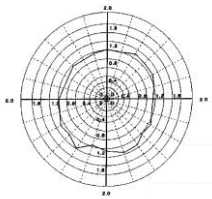
Strain-gauge probe operation

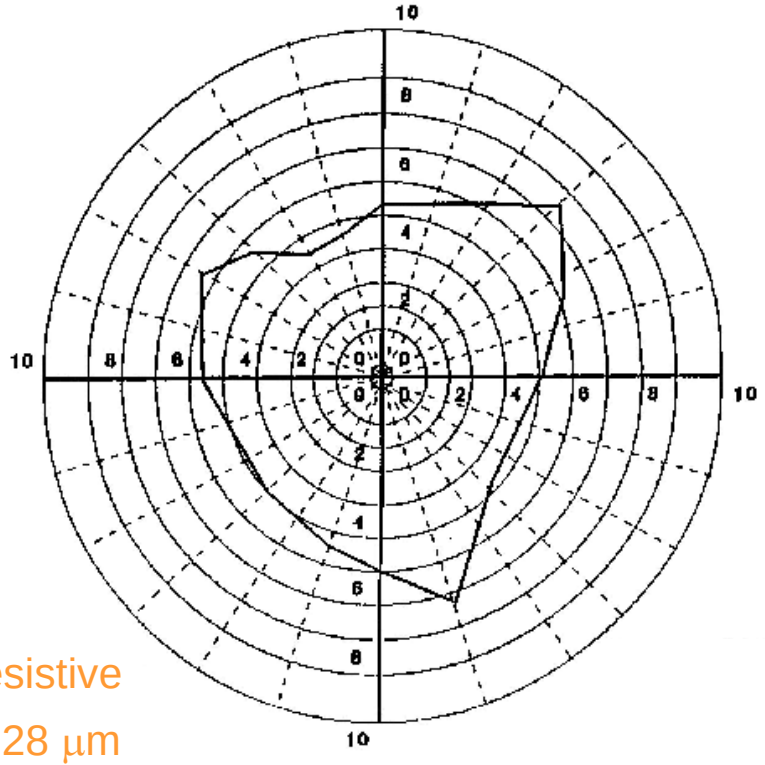
Lobing comparison

- Plots at same scale



Strain-gauge

XY PTV = 0.34 µm



Kinematic resistive

XY PTV = 3.28 µm

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Strain-gauge probe characteristics

High accuracy and repeatability

- Probe accuracy even better than standard kinematic probes
- Minimal lobing (very low pre-travel variation)

Reliable operation

- No reseat failures
- Suitable for intensive "peck" or "stitch" scanning
- Life greater than 10 million triggers

Flexibility

- Long stylus reach
- Suitable for mounting on articulating heads and extension bars
- Stylus changing available on some models

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TP7M strain-gauge probe

Concept

- 25 mm (1 in) diameter probe
- Autojoint mounted for use with PH10M PLUS
  - Multi-wire probe output

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TP7M strain-gauge probe

Benefits

- Highest accuracy, even when used with long styli - up to 180 mm long ("GF" range)
- Compatible with full range of multi-wired probe heads and extension bars for flexible part access
- Plus general strain-gauge benefits:
  - Non-lobing
  - No reseat failures
  - Extended operating life
  - 6-way measuring capability

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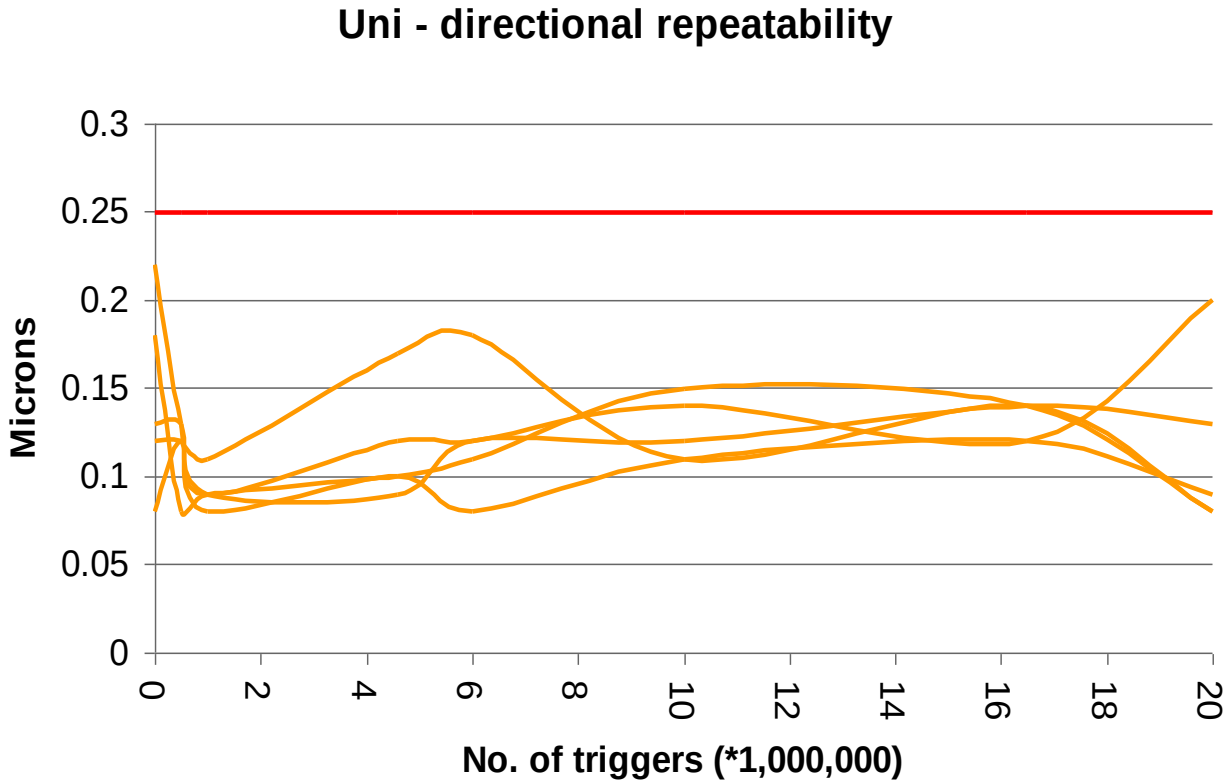
TP7M performance



Test results from five probes

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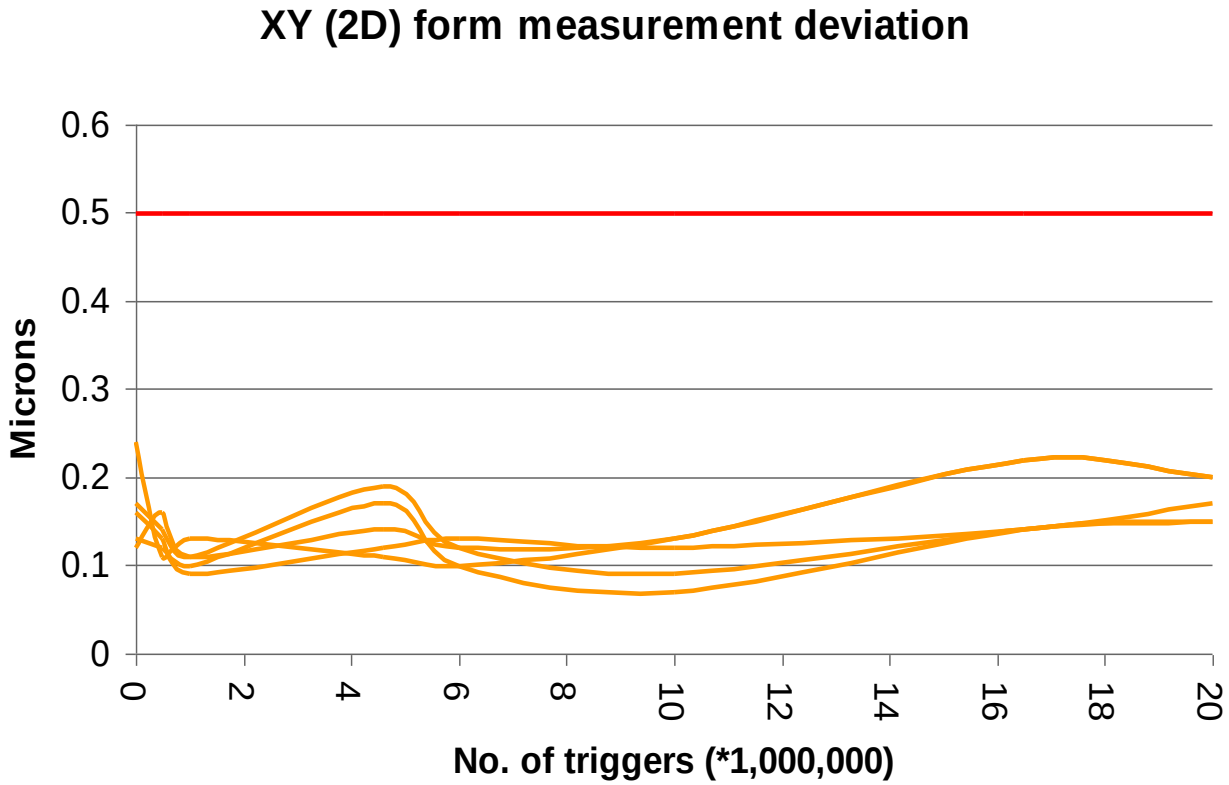
TP7M performance



Test results from five probes

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TP200 stylus changing probe

Concept

- TP2-sized probe, with strain gauge accuracy
- Stylus changing for greater flexibility and measurement automation
- 2-wire probe output (like TP20)

Benefits

- Long stylus reach - up to 100 mm long ("GF" range)
- Match stylus to the workpiece using high-speed stylus changing
  - Improve accuracy for each feature
  - No re-qualification
  - Manual or automatic changing with SCR200
- Compatible with full range of heads and extension bars

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TP200 stylus modules

Optimal sensor performance

- 6-way operation ±X, ±Y and ±Z
- Two types of module:
  - SF (standard force)
  - LF (low force) provides lower overtravel force option for use with small ball styli and for probing soft materials
- Detachable from probe sensor via a highly repeatable magnetic coupling
  - Provides overtravel capability
- Suitable for both automatic and manual stylus changing
- Module life of >10 million triggers

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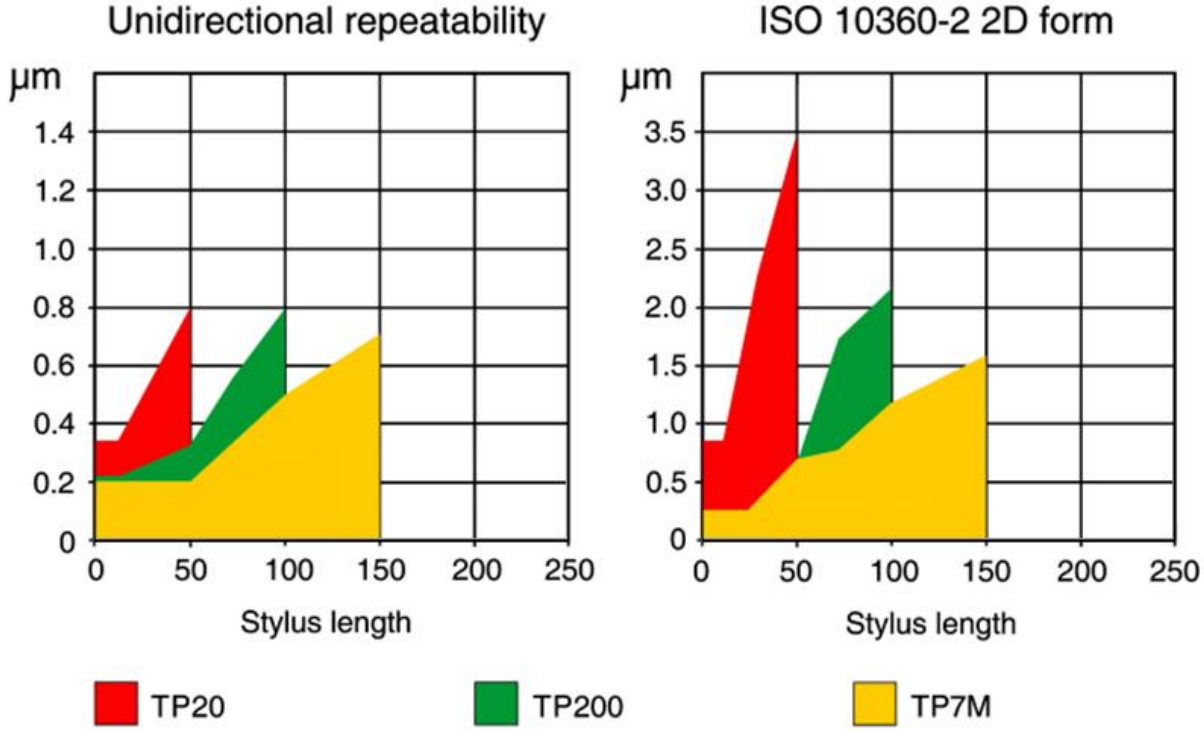
Trigger probe measurement performance comparison



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Renishaw touch-trigger probing technology

Thank you for your attention…

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SP25M

The world's most compact and versatile scanning probe system

Issue 10

RENSCAN technology

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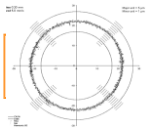
SP25M brings exciting new benefits

SP25M encompasses RENSCAN™ technology

System components - a highly modular concept



Design characteristics, performance & specification

Ordering information

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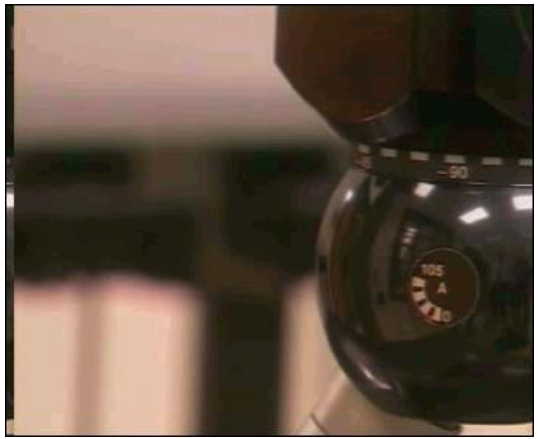
- **Two sensors in one!**
  - a **SCANNING** probe for form measurement and reverse engineering applications, capable of high-accuracy scanning across a stylus length range of 20 mm to 200 mm
  - a **TOUCH TRIGGER** probe, using the versatile **TP20** range of stylus modules



Flexibility through modular design

Scanning with SP25M is fast, accurate and flexible

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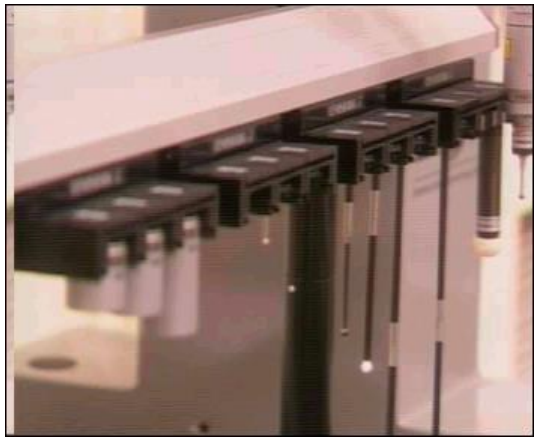
- **Unmatched flexibility**
  - highly modular design permits the perfect measurement solution to suit the application
  - the most flexible change rack system ever!
- **Cost effectiveness**
  - low priced entry-level scanning kits with easy upgrade to include other system elements



Flexibility through modular design

Flexible module and stylus changing

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- **Feature access**
  - **ultra-compact at Ø25 mm** for superior part accessibility (small enough to be inserted into many features)

Probe small enough to enter the part

Compact size enhances feature access

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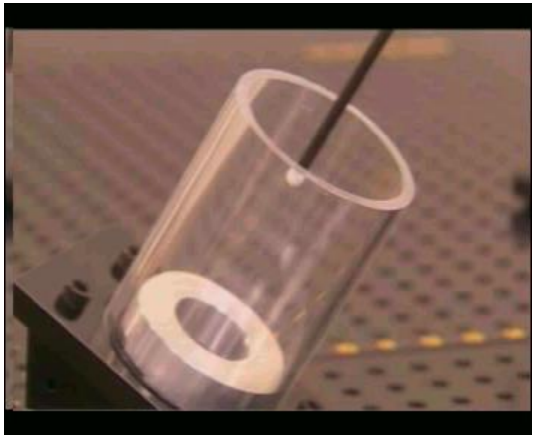
- **Feature access**
  - total **reach of nearly 400 mm** (15.7 in) is possible by using a probe extension bar
  - **three scanning modules** each optimised for a specific range of stylus lengths
  - stiff **carbon fibre stylus extensions** for excellent effective working length
  - uses **M3 styli** up to **200 mm** (7.9 in)

100 mm extensi on

Carbon fibre extensions for accuracy and long EWL



Feature access - SP25M

- probe can be mounted on an articulating head means that many features can be accessed with fewer styli
- lower stylus costs
- shorter cycle times

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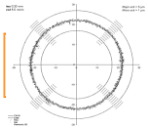
SP25M brings exciting new benefits

SP25M encompasses RENSCAN™ technology

System components - a highly modular concept



Design characteristics, performance & specification

Ordering information

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Our innovative RENSCAN™ technology scanning philosophy is encompassed by the SP25M probe system ...

- **Speed and accuracy**
  - sensors with high dynamic response to provide high accuracy data at high speed
  - accuracy through sophisticated probe calibration
  - match styli materials to applications for best results
- **Flexibility**
  - probe changing, stylus changing, articulation
- **Cost effectiveness**
  - innovative hardware and scanning techniques reduce complexity
  - robust designs and responsive service for lower lifetime costs

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SP25M's specific design objectives have been met ...

- the **most compact scanning** and **touch trigger** probe available
- innovative pivoting sensor design optimised for **high accuracy across 20mm to 200 mm stylus range**
- system modularity to provide **unmatched user flexibility**
- **passive design** to avoid unnecessary system complexity
- **isolated optical metrology** to avoid stacked axis errors
- **compact and light**, with excellent dynamic response

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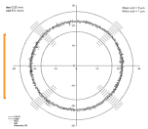
SP25M brings exciting new benefits

SP25M encompasses RENSCAN™ technology

System components - a highly modular concept



Design characteristics, performance & specification

Ordering information

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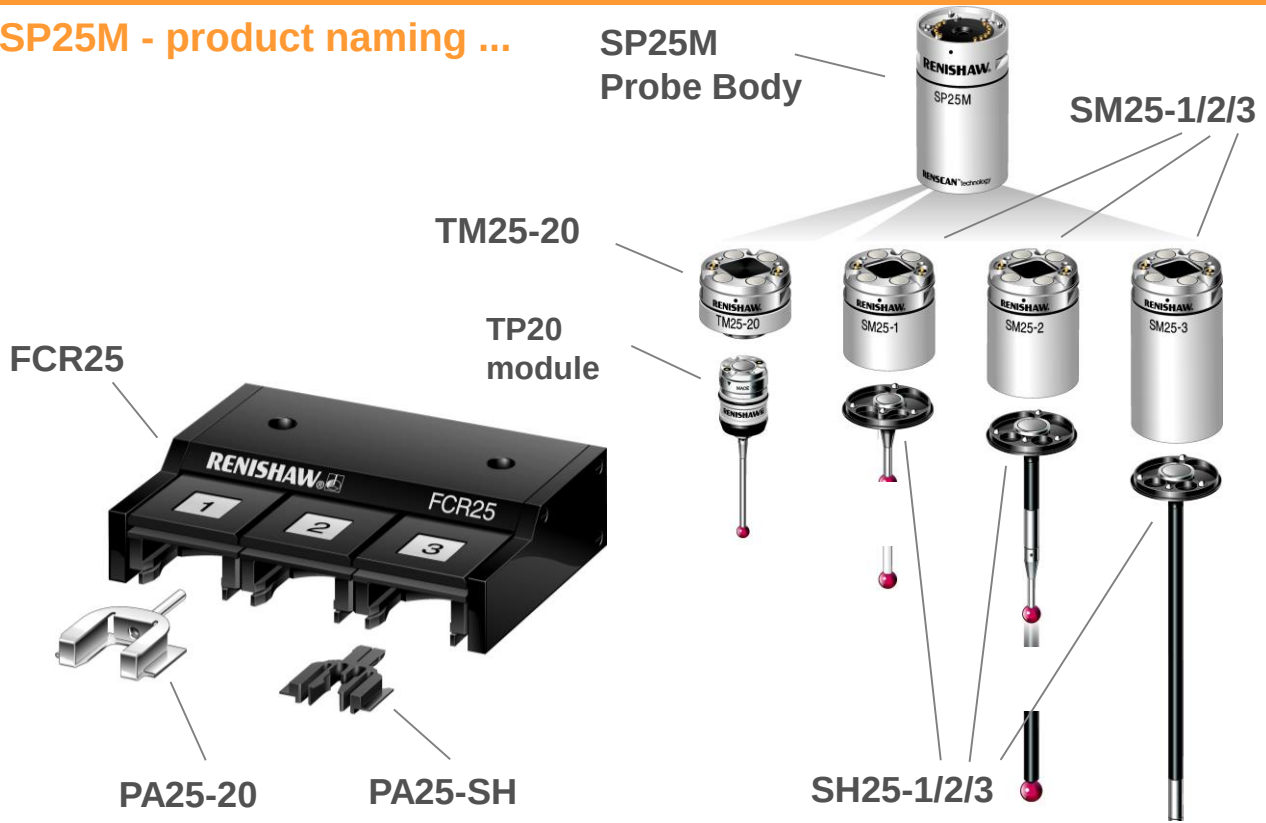
SP25M - product naming ...



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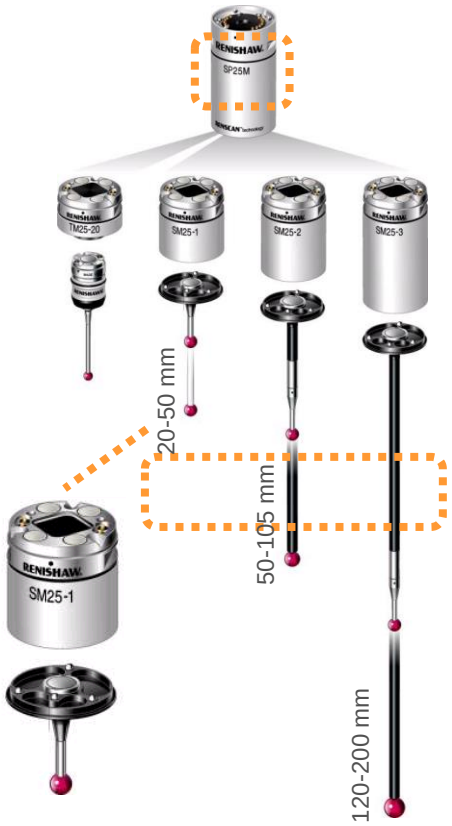
SP25M - as a SCANNING PROBE ...

- the **probe body** has Autojoint mounting for compatibility with PH10M/Q, PM6M and PHS1 heads, extensions bars and ACR1/2 sensor changers
- there are three **scanning modules (SM25-1/2/3)**, which have matching **stylus holders (SH25-1/2/3)**
  - each has a design optimised to maintain high accuracy and low contact forces over the following dedicated range of stylus lengths:

    SM25-1 + SH25-1 (20mm - 50mm)

    SM25-2 + SH25-2 (50mm - 105mm)

    SM25-3 + SH25-3 (120mm - 200mm)



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SP25M - as a TOUCH TRIGGER PROBE ...

- the **probe body** - would have the SM25-# scanning module replaced by the...
- **TTP module adaptor (TM25-20)** which directly carries any of Renishaw's TP20 range of stylus modules:
  - **TP20 LF/SF/MF/EF**
  - **TP20 EM1/EM2**
  - **TP20-6W**

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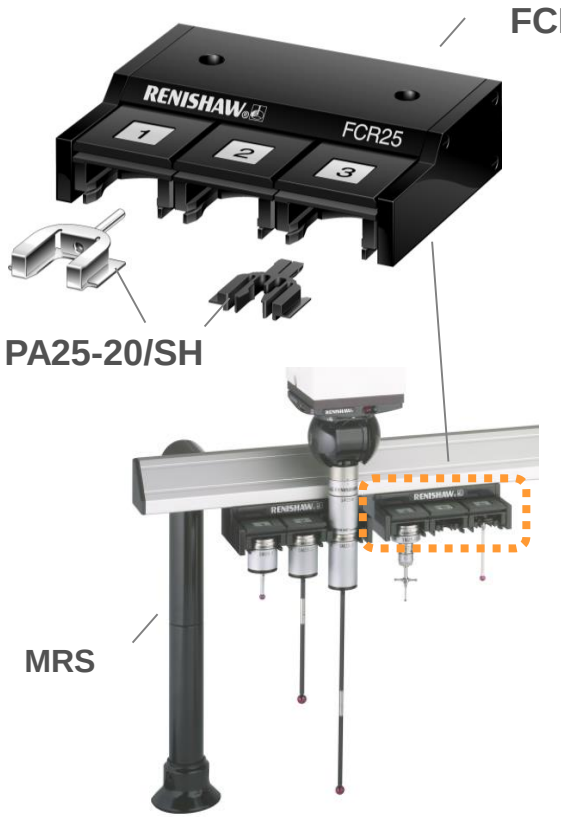
FCR25 - the most flexible change rack ever from Renishaw …

- rapidly **change between scanning and touch trigger mode** to match the ideal solution to the application
- **FCR25** is a triple-port unit, each port is **easily configured to carry any system element** of the system:
  - SM25-1/2/3
  - SH25-1/2/3
  - TM25-20
  - TP20 modules
- **FCR25's** are **mounted to the MRS** to thus provide 3, 6, 9, 12, 15 etc port systems
- **provides unmatched versatility !!!**



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FCR25 - will also be used with an integral leg to provide compact 3/6 port standalone racks…

FCR25-L6 - the 6 port version

FCR25-L3 - the 3 port version

- ideally **suited to vision CMM's** and smaller traditional CMM's where working volume is restricted
- lowest possible height
- can hold SM25-2 + SH25-2 (with 100 mm stylus length)
- overtravel protection (as for MCR20)
- **provides unmatched versatility !!!**

FCR25-L6

FCR25-L3

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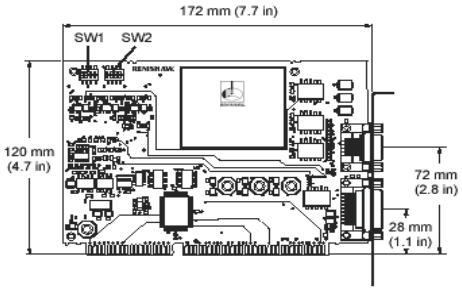
Interfacing options - SP25M can be integrated by different methods...

- **OEM's controller**
  - **AC3 interface card** (ISA Bus) is provided



- **Renishaw's UCC1 controller**
  - UCC1 with full scanning upgrade is required plus a **daughter card for the SP25M**

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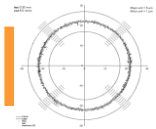
SP25M brings exciting new benefits

SP25M encompasses RENSCAN™ technology

System components - a highly modular concept



Design characteristics, performance & specification

Ordering information

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SP25M probe body houses the optical transducer ...

- isolated optical transducer uses proven IRED beams and PSD sensor technology (see later slide)
- **Autojoint** provides compatibility with all Renishaw's multiwired heads and extension bars
- The SM25-1/2/3 scanning modules and TM25-20 touch trigger adaptor mount directly to the body via repeatable kinematic joint
- ultra-compact mechanism - fits inside Ø25 mm (Ø1 in) probe

Autojoint

Optical transducer system

Kinematic mount for SM25-# or TM25-20

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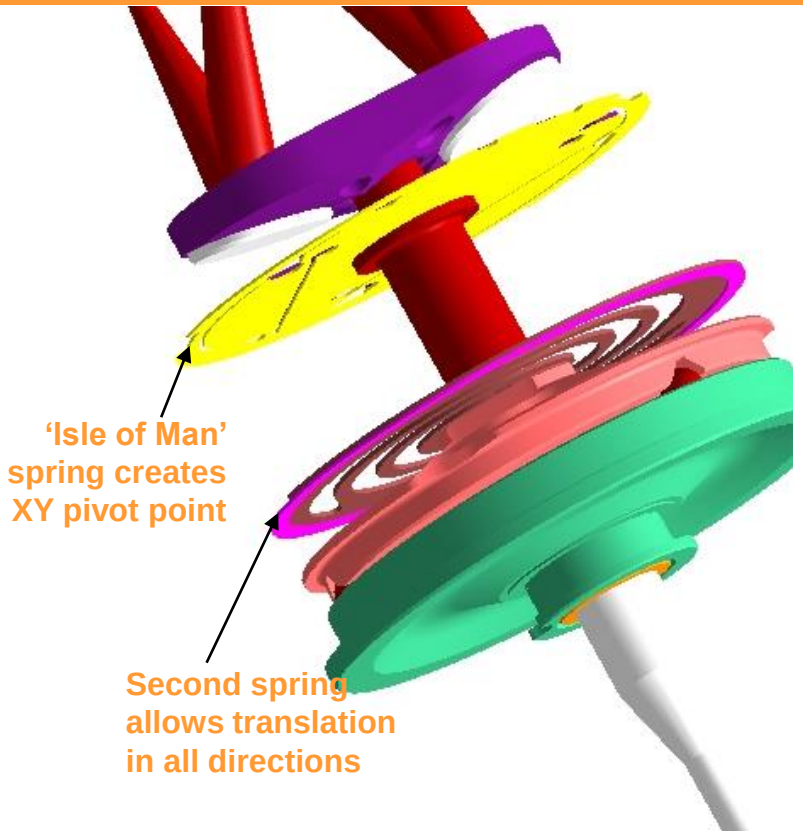
SM25-1/2/3 scanning modules house the motion system ...

- patented, pivoting mechanism featuring two diaphragm springs
- **optimised to give** very low inertia, low spring rates of < 0.6 N/mm and **high accuracy over dedicated stylus range**
- high natural frequency (rigid member) when in contact with the component
- ultra-compact mechanism - fits inside Ø25 mm (Ø1 in) probe
- **0.5 mm spherical radius measuring range**



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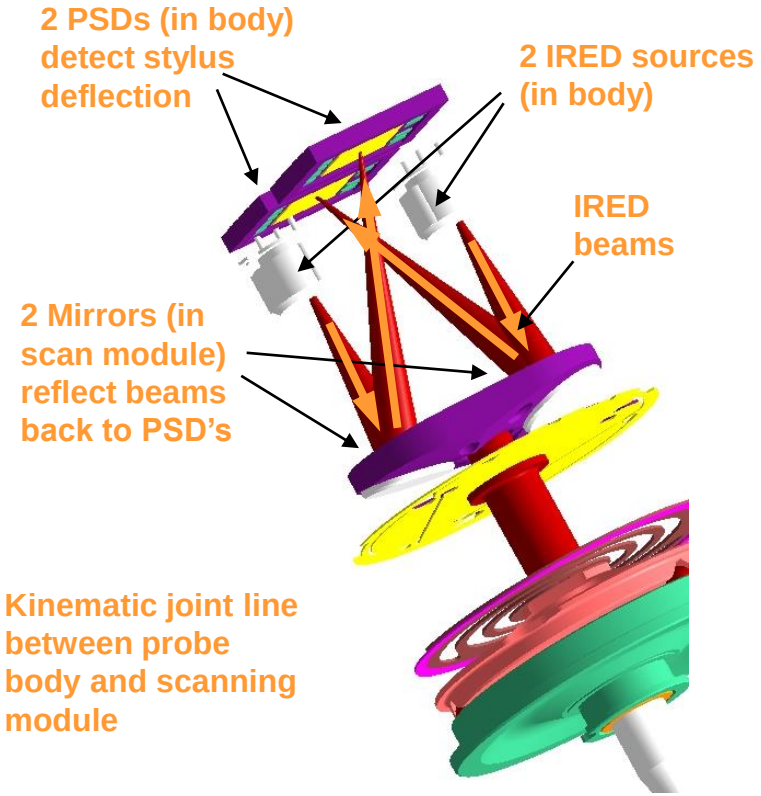
SP25M designed for “isolated optical metrology”

- IREDs in probe body reflect light off mirrors in scanning module back onto PSDs
- highly integrity performance - motion is faithfully translated to PSD’s
- non-linear outputs are compensated by sophisticated 3rd order polynomial algorithms
- no moving wires



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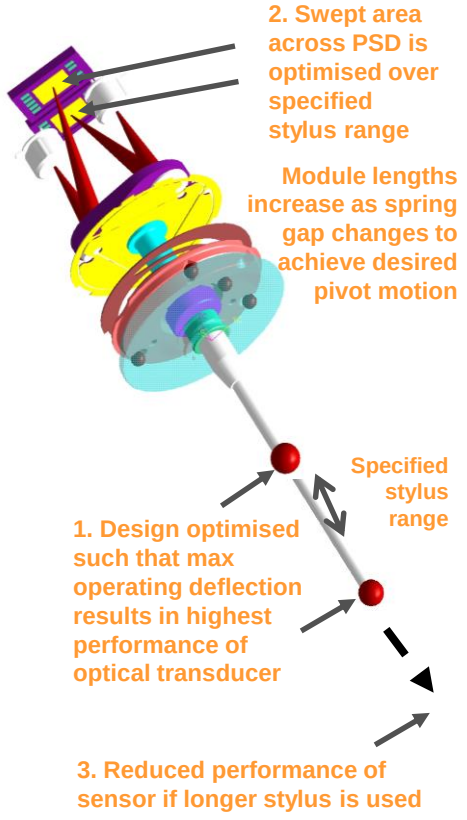
Why are there 3 scan modules to cover the stylus range? - traditionally, increasing stylus length leads to reducing accuracy **SP25M addresses this characteristic …**

- scan modules designed for optimum output from PSD sensors when using shortest stylus at max operating deflection (resulting in largest pivot motion/swept area over PSD's by IRED beams - so giving best gain, resolution and highest accuracy metrology) whilst restricting loss of performance as longer stylus is used (by ensuring sufficient coverage of sensor is maintained resulting in low degradation of accuracy performance)
- if excessive stylus length is used, the pivot motion angle rapidly reduces (resulting in less swept area over PSD's and non optimised transducer performance giving reduced accuracy)



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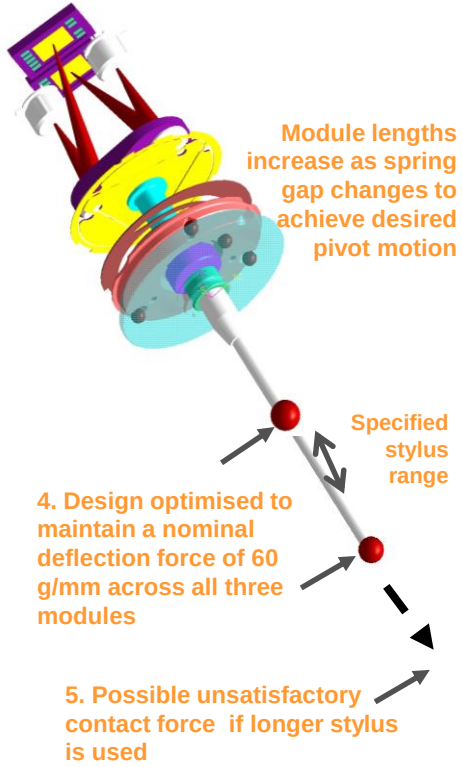
Why are there 3 scan modules to cover the stylus range? - traditionally, increasing stylus length leads to reducing accuracy **SP25M addresses this characteristic …**

- the dedicated range for each stylus module also means that contact forces at the tip can be closely maintained (if we were to use excessive stylus lengths the force would reduce, reducing stability and accuracy)
- the fixed extension design of SH25-2/3 prevents use of illegally short stylus
- high accuracy data maintained as stylus length increases (see next slide)
- unique design of SP25M can result in 2-3 times better accuracy than SP600



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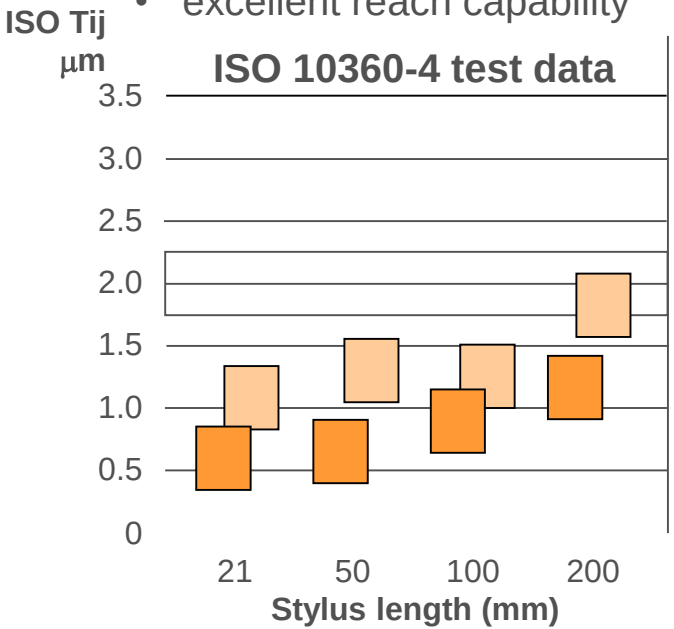
Superior scanning performance ...

- accurate form measurement, **even with long styli**
- excellent reach capability



Test conditions:

CMM spec:	0.5 + L / 1000
Test speed:	5 mm/sec
Controller:	UCC1
Filter:	None / 60 Hz
Values:	Unknown path

Filtered (60 Hz harmonic)

No filter (raw data)

Module/Stylus used:

21 = SM25-1 with 21 x ∅3 mm, SS stem

50 = SM25-1 with 50 x ∅5 mm, Ceramic stem

100 = SM25-2 with 100 x ∅6 mm, GF stem

200 = SM25-3 with 200 x ∅6 mm, GF stem

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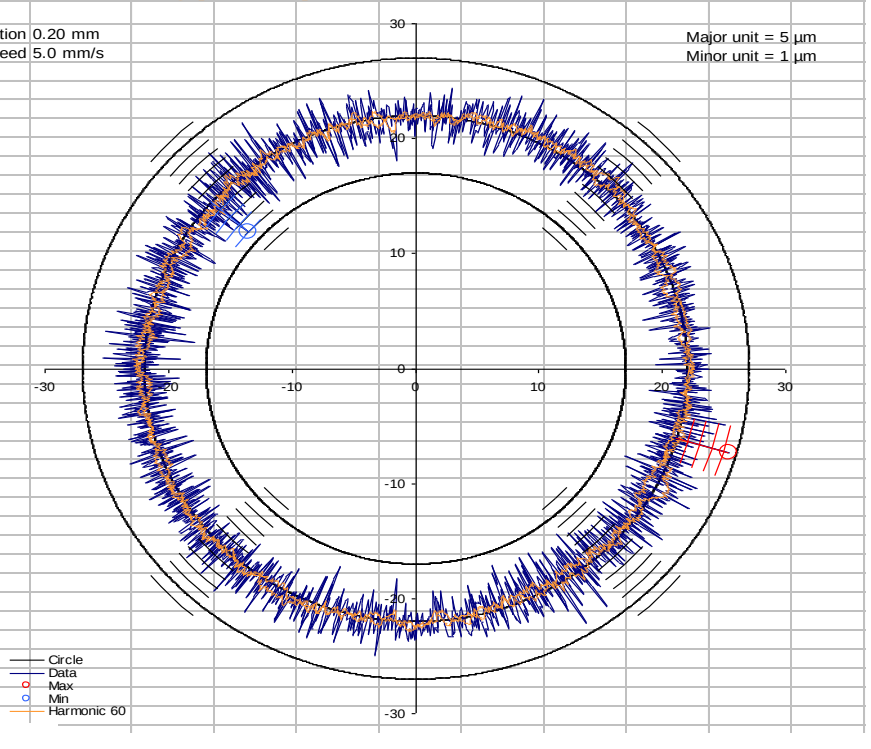
Design characteristics, performance and specification

Noise comparison - SP600M typical plot

Date Time :	11-Oct-01	9:45		
Ring Gauge Ø	49.9982	mm	Deflection	0.20 mm
Stylus ball Ø	6.0000	mm	Speed	5.0 mm/s
Theorical Radius	21.9991	mm		
Best Fitted Circle				
x	264.2450	mm		
y	341.6805	mm		
z	-62.8915	mm		
Radius	21.9974	mm		
Radius Error				
	1.72	µm		
Normal errors (µm)				
RMS	**1.25**	0.43		
Max	**4.4**	1.4		
Min	**-4.0**	-1.5		
Span	**8.5**	2.9		
Harmonic filter	Order = 60 upr			
Cut off	*wc = 376.99 rad*			
(upr = Undulation Per Revolution)				
Form identification				
Ellipse	0.28 µm	356.85 °		
Tri lobe	0.05 µm	208.54 °		
Circle Plane Normal				
nx	0			
ny	0			
nz	1			
Data collected with	2673	*points*		
	2	*turns*		



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Design characteristics, performance and specification

Noise comparison - SP25M has lower noise and better gain

Date Time :	19-Sep-02	14:44
Ring Gauge Ø	49.9995	mm
Stylus ball Ø	6.0010	mm
Theorical Radius	21.9993	mm

Deflection 0.20 mm
Speed 5.0 mm/s

Best Fitted Circle

Open File
Analysis

x	346.8979	mm
y	301.0396	mm
z	317.0860	mm
Radius	22.0002	mm

Radius Error

-0.98 µm

Normal errors (µm)

RMS	**0.40**	0.24
Max	**1.4**	0.6
Min	**-1.8**	-0.7
Span	**3.2**	1.3

Harmonic filter Order = 60 upr
Cut off wc = 376.99 rad
(upr = Undulation Per Revolution)

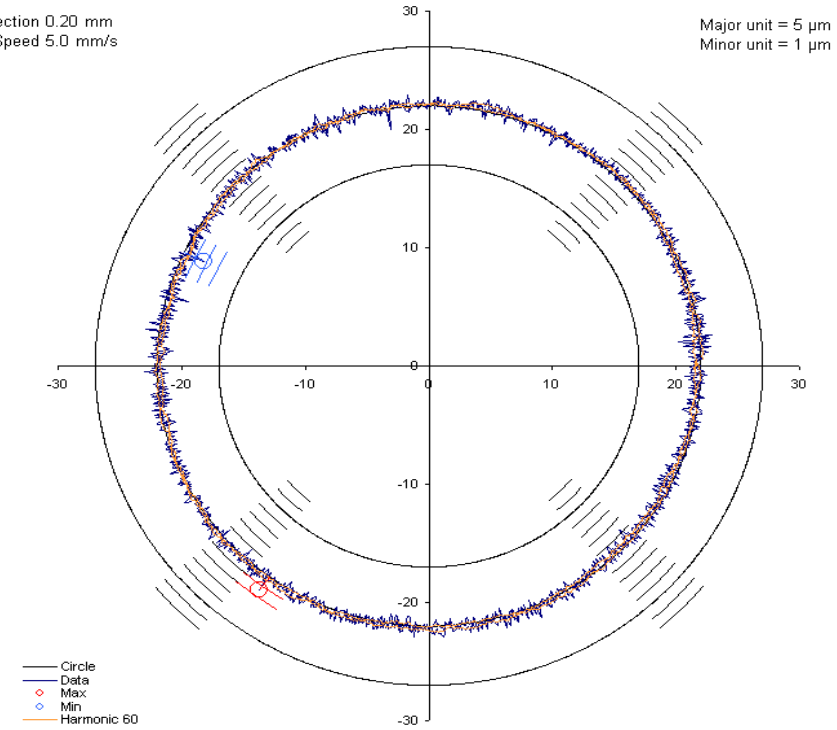
Form identification

Ellipse	0.24 µm	308.74 °
Tri lobe	0.01 µm	333.66 °

Circle Plane Normal

nx	0
ny	0
nz	1

Data collected with	2647	*points*
	2	*turns*



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SP25M specification:

Mounting	Autojoint mount (compatible with PH10M, PH6M, PHS1) - may also be mounted using an extension bar	
Probe physical size	Ø25mm - length variable (see dimensional slide)	
Probe mass	SP25M probe body	65g
	SM25-1 + SH25-1	35g (excl stylus)
	SM25-2 + SH25-2	40g (excl stylus)
	SM25-3 + SH25-3	49g (excl stylus)
	TM25-20	40g (excl TP20 module)
Measurement range	±0.5mm spherical radius in all orientations	
Overtravel range	X,Y = ±2.0mm (min)	+Z = 1.7mm -Z = 1.2mm

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SP25M specification:

Spring rate	60 - 20 g/mm nominal (dependant on stylus length)		
Stylus range	M3, standard range - new GF styli available		
Stylus carrying range	SM25-1 + SH25-1	Use 21-50mm stylus (EWL = 21-50mm)	
	SM25-1 + SH25-1	Use 21-75mm stylus (EWL = 50-105mm)	
	SM25-1 + SH25-1	Use 21-100mm stylus (EWL = 120-200mm)	
Crash protection	X & Y	via break-off of module/stylus holder	
	Z	via bumpstop design	

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SP25M specification:

Power supply		+12V to -12V, 5V (±5%) DC
Signal outputs		Non-linear and non-orthogonal analogue outputs. Rate, gain and resolution are not fixed
Calibration method	Non-linear, 3rd order polynomial method is required	
Automatic changer(s) element)	FCR25	(triple ported unit for mounting to MRS - each port can be configured to accept any system
		FCR25-L3 (3 port standalone rack with single leg)
		FCR25-L6 (6 port standalone rack with single leg)

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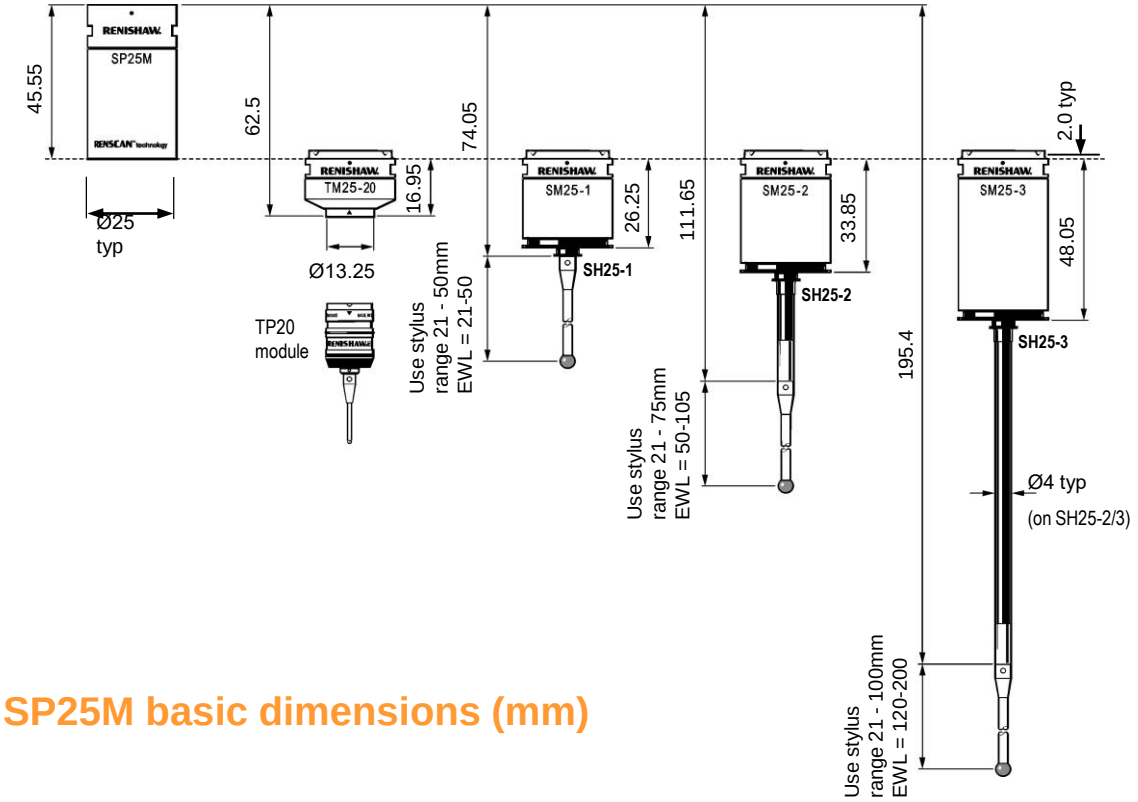

SP25M basic dimensions (mm)

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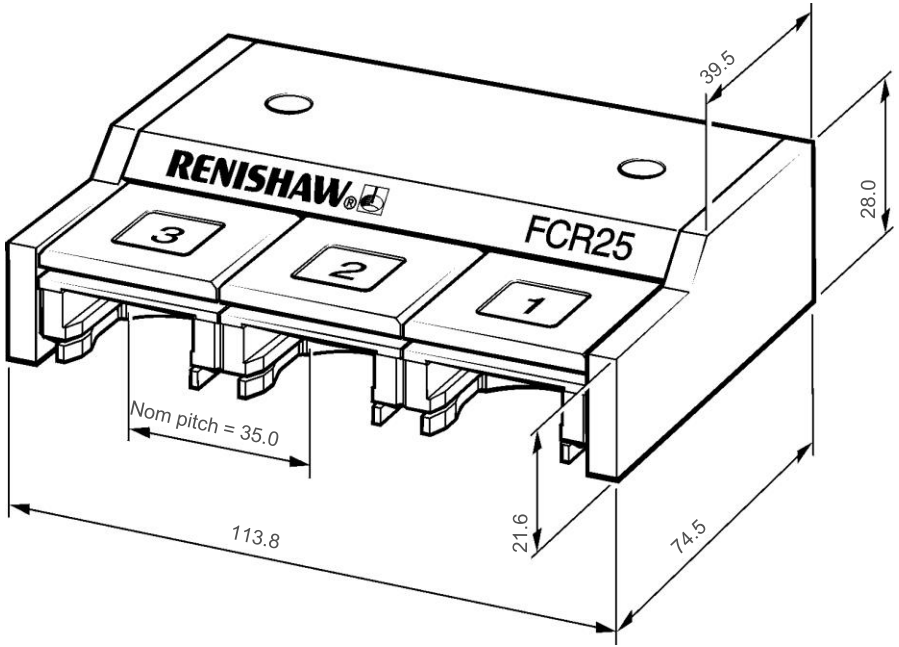
Design characteristics, performance and specification



FCR25 basic dimensions (mm)

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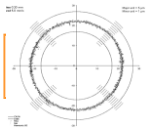
SP25M brings exciting new benefits

SP25M encompasses RENSCAN™ technology

System components - a highly modular concept



Design characteristics, performance & specification

Ordering information

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Please contact your local Renishaw supplier for pricing details

SAVES 20% OFF LIST

Part No.	Description
A-2237-1015	**SP25M special SCAN/TTP full combination kit**
this kit and is	The full scanning system plus the capability to use TP20 modules - includes all the equipment in these separate kits (see later slide) supplied as one complete kit:
1/SH25-1	**- 1 x A-2237-1001 SP25M scanning kit #1** - includes SM25-
	- 1 x A-2237-1102 SM25-2 scanning module kit

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Part No.	Description
A-2237-1001	**SP25M scanning probe kit #1** 1 x SP25M body, 1 x SM25-1 scanning module kit (see later slide)
A-2237-1002	**SP25M scanning probe kit #2** 1 x SP25M body, 1 x SM25-2 scanning module kit (see later slide)
A-2237-1003	**SP25M scanning probe kit #3** 1 x SP25M body, 1 x SM25-3 scanning module kit (see later slide)

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Part No.	Description
A-2237-1101	**SM25-1 scanning module kit** 1 x SM25-1, 2 x SH25-1
A-2237-1102	**SM25-2 scanning module kit** 1 x SM25-2, 2 x SH25-2
A-2237-1103	**SP25M scanning probe kit #3** 1 x SM25-3, 2 x SH25-3

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Part No.	Description
A-2237-1200	**TM25-20 TTP module adaptor only** 1 x TM25-20
A-2237-1201	**TM25-20 TTP module adaptor kit #1** 1 x TM25-20, 2 x TP20 ‘STD’ modules

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Part No.	Description
A-2237-1401	**FCR25 flexible change rack** (mounts to MRS) 1 x FCR25, 3 x PA25-SH, 3 x PA25-20 (PA25-SH/20 are Port Adaptor inserts for SH25-1/2/3 stylus holders and TP20 modules)
A-2237-tbc	**3 port FCR25 rack with leg (standalone rack)** 1 x FCR25 with integral leg, 3 x PA25-SH, 3 x PA25-20
A-2237-tbc	**6 port FCR25 rack with leg (standalone rack)** 2 x FCR25 with integral leg, 3 x PA25-SH, 3 x PA25-20

Note - the standalone racks will be available later

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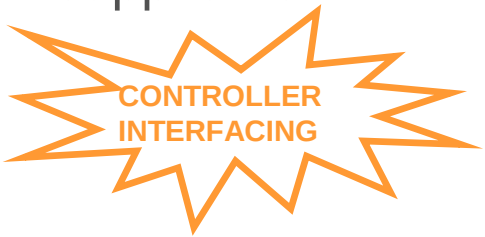

Part No.	Description
A-2237-1601	AC3 interface card
A-1333-0022	UCC1 SP25M daughter card

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SP25M

The world's most compact and versatile scanning probe system

ANY QUESTIONS ?

RENSCAN technology