New Products

FORMTRACER Avant
(Surface Texture Measuring Instruments)
C3000 / 4000 Series
Refer to page L-10 for details.

FORMTRACER
(Surface Texture Measuring Instruments)
CS-3300 Series
Refer to page L-12 for details.

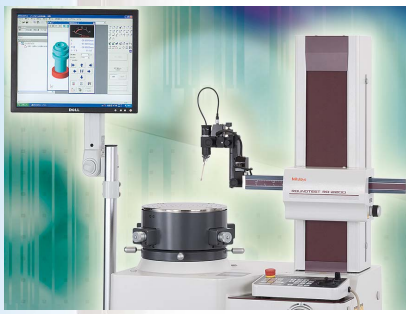
Roundtest Extreme
(CNC Roundness/Cylindricity Measuring System)
RA-6000CNC
Refer to page L-24 for details.

Surftest

Contracer

Formtracer

Roundtest



INDEX

Surftest

Performs brilliantly in many situations such as in the quality control room, on the factory floor and on the production line.

Surftest SJ-210
SERIES 178 — On-site Surface Roughness Tester

MeasurLink® ENABLED
Data Management Software by Mitutoyo

SPECIFICATIONS

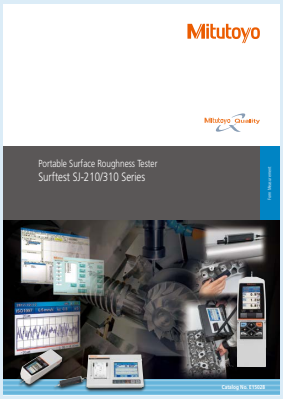
Model No.			Standard drive unit		Retractable drive unit		Transverse tracing drive unit	
			SJ-210 (0.75 mN type)	**SJ-210** (4 mN type)	**SJ-210** (0.75 mN type)	**SJ-210** (4 mN type)	**SJ-210** (0.75 mN type)	**SJ-210** (4 mN type)
Order No.		mm	**178-560-11**	**178-560-12**	**178-562-11**	**178-562-12**	**178-564-11**	**178-564-12**
		inch/mm	**178-561-11**	**178-561-12**	**178-563-11**	**178-563-12**	**178-565-11**	**178-565-12**
Measuring range	X axis		16.0 mm				5.6 mm	
	Detector	Range	360 µm (-200 µm to +160 µm)					
		Range/Resolution	360 µm/0.02 µm, 100 µm/0.006 µm, 25 µm/0.002 µm					
Measuring force/Stylus tip shape			Depends on the Order No.: 0.75 mN/2 µmR 60° (when the Order No. ends with "**-11**") 4 mN/5 µmR 90° (when the Order No. ends with "**-12**")					
Applicable standards			JIS 1982/JIS 1994/JIS 2001/ISO 1997/ANSI/VDA					
Assessed profile			Primary profile, Roughness profile, DF profile, Roughness motif profile					

MeasurLink® ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

Compact type all-in-one surface roughness tester has evolved by meeting customer demands

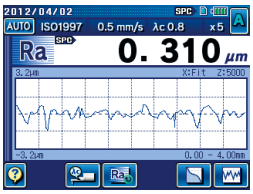
- The color LCD can display not only calculation results and measurement conditions, but also surface roughness waveforms. In addition, bigger character size contributes to visibility.
- Built-in rechargeable battery allows measurement without a mains power supply connection.



Refer to the Surftest **SJ-210/310** Series Brochure (**E15028**) for more details.

Surftest SJ-310
SERIES 178 — On-site Surface Roughness Tester

MeasurLink® ENABLED
Data Management Software by Mitutoyo



SPECIFICATIONS

Model No.			Standard drive unit		Retractable drive unit		Transverse tracing drive unit	
			SJ-310 (0.75 mN type)	**SJ-310** (4 mN type)	**SJ-310** (0.75 mN type)	**SJ-310** (4 mN type)	**SJ-310** (0.75 mN type)	**SJ-310** (4 mN type)
Order No.		mm	**178-570-11**	**178-570-12**	**178-572-11**	**178-572-12**	**178-574-11**	**178-574-12**
		inch/mm	**178-571-11**	**178-571-12**	**178-573-11**	**178-573-12**	**178-575-11**	**178-575-12**
Measuring range	X axis		16.0 mm				5.6 mm	
	Detector	Range	360 µm (-200 µm to +160 µm)					
		Range/Resolution	360 µm/0.02 µm, 100 µm/0.006 µm, 25 µm/0.002 µm					
Measuring force/Stylus tip shape			Depends on the Order No.: 0.75 mN/2 µmR 60° (when the Order No. ends with "**-11**") 4 mN/5 µmR 90° (when the Order No. ends with "**-12**")					
Applicable standards			JIS 1982/JIS 1994/JIS 2001/ISO 1997/ANSI/VDA					
Assessed profile			Primary profile, Roughness profile, DF profile, Roughness motif profile, Waviness motif profile					

MeasurLink® ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

Advanced handheld tester that is easy to operate and meets a variety of needs

- Equipped with a large, touch-screen color graphic LCD for intuitive operation and excellent ease of use.
- Equipped with a high-speed thermal printer (approx. 1.5 times faster than conventional models) as standard, allows for printing of BAC and ADC curves in addition to calculation results (including pass/fail judgments) and assessment profiles. The printer can also print horizontally to match the content displayed on the LCD, and has an easy-to-understand layout.

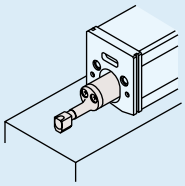
Refer to the Surftest **SJ-210/310** Series Brochure (**E15028**) for more details.

Optional Accessories for Surftest SJ-210/310

Detector

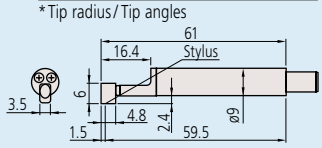
Unit: mm

• Standard detectors

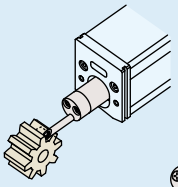


Order No.	Measuring force	Stylus profiles*	Remarks
178-296	0.75 mN	2 μmR/60°	Dedicated to the standard/retractable drive unit
178-390	4 mN	5 μmR/90°	
178-387	0.75 mN	2 μmR/60°	Dedicated to the transverse tracing drive unit
178-386	4 mN	5 μmR/90°	
178-391	4 mN	10 μmR/90°	Dedicated to the standard/retractable drive unit

*Tip radius/Tip angles

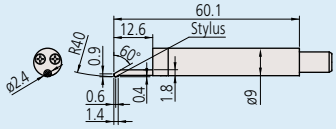


• Gear-tooth surface detectors

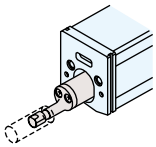


Order No.	Measuring force	Stylus profiles*
178-388	0.75 mN	2 μmR/60°
178-398	4 mN	5 μmR/60°

*Tip radius/Tip angles

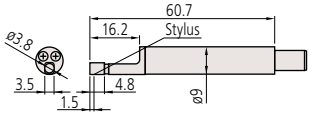


• Small hole detectors

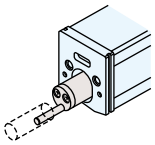


Order No.	Measuring force	Stylus profiles*	Remarks
178-383	0.75 mN	2 μmR/60°	Minimum measurable hole diameter: ø4.5 mm
178-392	4 mN	5 μmR/90°	

*Tip radius/Tip angles

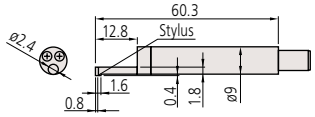


• Extra small hole detectors

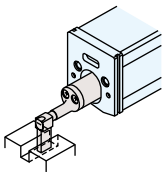


Order No.	Measuring force	Stylus profiles*	Remarks
178-384	0.75 mN	2 μmR/60°	Minimum measurable hole diameter: ø2.8 mm
178-393	4 mN	5 μmR/90°	

*Tip radius/Tip angles

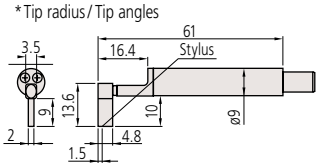


• Deep groove detectors



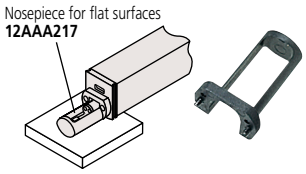
Order No.	Measuring force	Stylus profiles*	Remarks
178-385	0.75 mN	2 μmR/60°	Not available for the transverse tracing drive unit
178-394	4 mN	5 μmR/90°	

*Tip radius/Tip angles



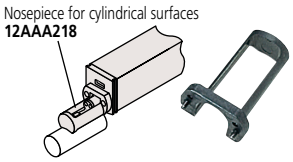
Optional Accessories for Drive Units

•Nosepiece for flat surfaces



12AAA217
- Standard accessory for the standard/retractable drive unit of the **SJ-310** Series
- Not available for the transverse tracing drive unit

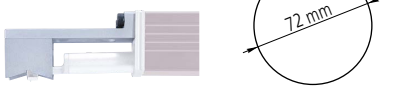
•Nosepiece for cylindrical surfaces

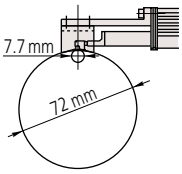


12AAA218
- Standard accessory for the standard/retractable drive unit of the **SJ-310** Series
- Not available for the transverse tracing drive unit

•V-type adapter

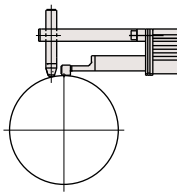
12AAE644
- Transverse tracing type standard accessory.
- Dedicated to the transverse tracing drive unit.





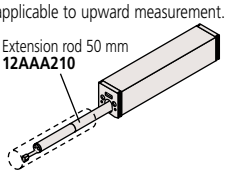
•Point-contact adapter

12AAE643
- Transverse tracing type standard accessory.
- Dedicated to the transverse tracing drive unit.



•Extension rod (50 mm) (Note: Only one rod can be used.)

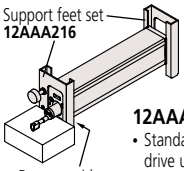
12AAA210
- Not available for the transverse tracing drive unit
- Not applicable to upward measurement.

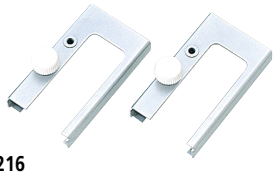


•Extension cable (1 m) (Note: Only one rod can be used.)

12BAA303
- For the connection between the calculation display unit and drive unit

•Support feet set

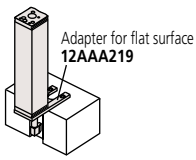




12AAA216
- Standard accessory for the standard/retractable drive unit of the **SJ-310** Series
- Not available for the transverse tracing drive unit
- Adjustment range is 28 mm from bottom face.

•Adapter for flat surface

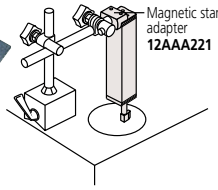
12AAA219
- Not available for the transverse tracing drive unit



•Magnetic stand adapter

12AAA221
Mounting spigot diameter is 8 mm.

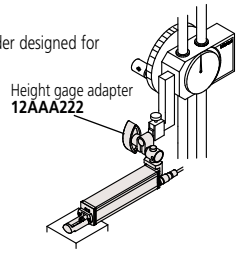
12AAA220
Mounting spigot diameter is 9.5 mm.



•Height gage adapter

Note: Suiable for a height gage holder designed for 9×9 mm section scribers.

12AAA222



L

Surftest

Performs brilliantly in many situations such as in the quality control room, on the factory floor and on the production line.

Surftest SJ-410
SERIES 178 — Compact Surface Roughness Tester

MeasurLink® ENABLED
Data Management Software by Mitutoyo

SPECIFICATIONS

Model No.			SJ-411		SJ-412	
Order No.		mm	178-580-11	178-580-12	178-582-11	178-582-12
		inch/mm	178-581-11	178-581-12	178-583-11	178-583-12
Measuring range	X axis		25 mm		50 mm	
	Z axis (detector)		800 µm, 80 µm, 8 µm Up to 2,400 µm when using an optional stylus.			
Detector	Detection method		Differential inductance			
	Resolution		0.01 µm (800 µm range), 0.001 µm (80 µm range), 0.0001 µm (8 µm range)			
	Stylus tip shape (Angle/Radius)		60°/2 µm	90°/5 µm	60°/2 µm	90°/5 µm
	Measuring force		0.75 mN	4 mN	0.75 mN	4 mN
	Radius of skid curvature		40 mm			
	Measuring methods		Skidless/Skidded (switchable)			
Drive unit (X axis)	Measuring speed		0.05, 0.1, 0.2, 0.5, 1.0 mm/s			
	Drive speed		0.5, 1, 2, 5 mm/s			
	Straightness		0.3 µm/25 mm		0.5 µm/50 mm	
Up/down inclination unit	Vertical travel		10 mm			
	Inclination adjustment angle		±1.5°			
Applicable standards			JIS 1982/JIS 1994/JIS 2001/ISO 1997/ANSI/VDA			
Parameter			Ra, Rq, Rz, Ry, Rp, Rv, Rt, R3z, Rsk, Rku, Rc, RPc, RSm, Rmax*1, Rz1max*2, S, HSC, RzJIS*3, Rppi, RΔa, RΔq, Rlr, Rmr, Rmr(c), Rσc, Rk, Rpk, Rvk, Mr1, Mr2, A1, A2, Vo, λa, λq, Lo, Rpm, tp*4, Htp*4, R, Rx, AR, W, AW, Wx, Wte Customizable			
Filtered profile			Primary profile, Roughness profile, DF profile, Waviness profile, Roughness motif profile, Waviness motif profile			
Analysis graph			Material ratio curve, Profile height amplitude distribution curve			
Data compensation functions			Parabola, Hyperbola, Ellipse, Circle, Tilt, No compensation			
Filter			2CR, PC75, Gaussian			
Cutoff value	λc		0.08, 0.25, 0.8, 2.5, 8 mm			
	λs *5		2.5, 8, 25 µm			
Sampling length			0.08, 0.25, 0.8, 2.5, 8, 25 mm			
Number of intervals			x1, x2, x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15, x16, x17, x18, x19, x20			
Arbitrary length			0.1 to 25 mm		0.1 to 50 mm	
Calculation display unit	Customization		Selection of display/evaluation roughness parameter			
	Simplified contour analysis function		Step, Step quantity, Area, Coordinate difference			
	D.A.T. (Digimatic Adjustment Table) function		Helps to level workpiece prior to skidless measurement			
	Real sampling function		Inputs the displacement of the detector while stopping the drive unit			
	statistical processing		Calculates the maximum value, minimum value, average value, standard deviation, pass rate and histogram for each parameter.			
	Judgment*6		Maximum value rule, 16 % rule, mean value rule, standard deviation (1σ, 2σ, 3σ)			
	Storing measurement condition		Max. 10 (calculation display unit)			
	Print function (Built-in thermal printer)		Measurement condition/Calculation result/Judgment result/Calculation result per segment/ Tolerance value/Evaluation curve/Graphic curve/Material ratio curve/Profile height amplitude distribution curve/Environmental setting items/Statistical result (Histogram)			
	Display language		16 languages (Japanese, English, German, French, Italian, Spanish, Portuguese, Korean, Chinese (simplified/traditional), Czech, Polish, Hungarian,Turkish, Swedish, Dutch)			
	Storage function		Built-in memory: Measurement condition (Up to 10) Memory card (optional): 500 measurement conditions, 10000 measured profiles, 500 display images, 10000 text files, 500 statistical data, 1 backup file of device setting data, 10 data of Trace 10			
	External I/O functions		USB I/F, Digimatic output, RS-232C I/F, Foot switch I/F			
Power supply	Battery Charging time/Endurance		Built-in battery (rechargeable Ni-MH battery)/AC adapter Charging time of the built-in battery: about 4 hours (may vary due to ambient temperature) Endurance: about 1000 measurements (differs slightly due to use conditions/environment)			
	Max. power consumption		50 W			
External dimensions (W×D×H)	Calculation display unit		275×198×109 mm			
	Up/down inclination unit		130.9×63×99 mm			
	Drive unit		128×35.8×46.6 mm		154.5×35.8×46.6 mm	
Mass	Calculation display unit		1.7 kg			
	Up/down inclination unit		0.4 kg			
	Drive unit		0.6 kg		0.64 kg	
Standard Accessories			Detector*7/Standard stylus*8 **178-601** Roughness specimen (Ra3 µm) **270732** Receipt paper (Standard type: 5-roll set) **12BAL402** Protective sheet for the LCD (x1 sheet) **12BAR507** Touch pen **12AAN041** Carrying case		AC adapter, Power cable, Flat-blade screwdriver, Phillips screwdriver, Hex wrench, Strap for the touch pen, Operation manual, One-sheet manual, Warranty card	

*1 Calculation is available only when selecting the VDA, ANSI, or JIS 1982 standards.
*2 Calculation is available only when selecting the ISO 1997 standard. *3 Calculation is available only when selecting the JIS 2001 standard.
*4 Calculation is available only when selecting the ANSI standard. *5 Not available when selecting the JIS 1982 standard.
*6 Only the mean value rule is available for the ANSI standard. 16 % rule is not available when selecting the VDA standard.
*7 Depending on the Order No. of the **SJ-410** Series main unit, **178-396** or **178-397** is provided as standard.
*8 Standard stylus (**12AAC731** or **12AAB403**) supporting the provided detector is provided as standard.

MeasurLink® ENABLED
Data Management Software by Mitutoyo

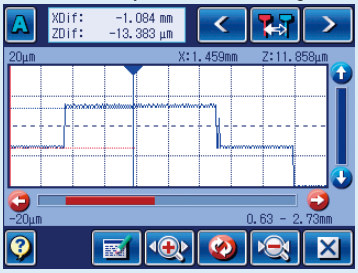
Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

PROPRIETARY INSPECTION CERTIFICATE

An inspection certificate is supplied as standard. Refer to page U-11 for details.

Dramatic improvement on compact type surface roughness testers

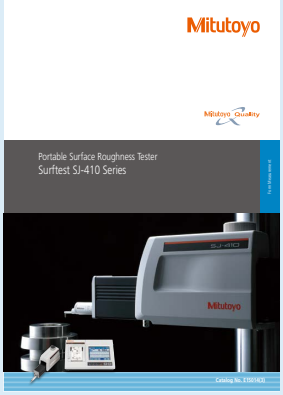
- Equipped with a large, touch-screen color graphic LCD to achieve both intuitive operation and high operability.
- Skidded and skidless measurement are switchable to perform optimum evaluation according to the measurement setup.
- A wide-range, high-resolution detector and a very accurate drive unit provide superior high-accuracy measurement in its class.
- **Detector**
  Measuring range: 800 µm
  Resolution: 0.0001 µm (when the measuring range is 8 µm)
- **Drive unit**
  Straightness/Drive length: 0.3 µm/25 mm (**SJ-411**)
  Straightness/Drive length: 0.5 µm/50 mm (**SJ-412**)
- Simplified contour analysis (Step, Step quantity, Area, Coordinate difference) is available using the point cloud data collected to evaluate the surface roughness.
  Allows the evaluation of detailed shapes that cannot be achieved by contour measuring instruments.



- Allows the evaluation of surface roughness in a circumferential direction using the skidless measurement and R-surface compensation functions.
- Conforms to the latest ISO standard and ANSI/VDA standard in addition to the JIS standard (2001/1994/1982).
- Achieves the performance of a desktop type surface roughness tester in combination with the simplified stand and associated optional accessories.

Optional Accessories for SJ-410 Consumables

• Receipt paper Standard type (5-roll set)	**270732**
• Receipt paper High-durability paper (5-roll set)	**12AAA876**
• Protective sheet for the touch panel (x10 sheets)	**12AAN040**
• Memory card (2 GB)	**12AAW452**



Refer to the Surftest **SJ-410** Series Brochure (**E15014**) for more details.

MeasurLink ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

PROPRIETARY INSPECTION CERTIFICATE

An inspection certificate is supplied as standard. Refer to page U-11 for details.

Surftest SJ-500/SV-2100 SERIES 178 — Dedicated Control Unit Type Surface Roughness Tester

MeasurLink ENABLED
Data Management Software by Mitutoyo

High precision and high performance type surface roughness tester with a dedicated control unit, offering a user-friendly display and simple operation.

- Equipped with a 7.5-inch, color TFT LCD, color icons and touch panel controls, the display unit is easy to read and simple to operate.
- A built-in joystick on the control unit allows quick and easy positioning. The manual adjustment knob allows fine positioning of a small stylus for measuring small holes.
- In addition to the roughness parameters compliant with ISO/JIS/ANSI/VDA surface roughness standards, contour analysis is also available.

SV-2100M4

SJ-500

SV-2100S4

SPECIFICATIONS

Model No.		SJ-500	SV-2100M4*1	SV-2100S4*1	SV-2100H4*1	SV-2100W4*1
Stand type		(Optional)*2	Manual stand	Motorized stand		
Measuring range	Z1 axis (detector)	800 µm, 80 µm, 8 µm				
	X axis	50 mm	100 mm			
Resolution	X axis	0.05 µm				
	Z1 axis (detector)	0.01 µm (800 µm), 0.001 µm (80 µm), 0.0001 µm (8 µm)				
	Z2 axis (column)	—	—	1 µm		
Assessed profile		Primary profile, Roughness profile, Waviness profile, DF profile, Roughness motif profile, Waviness motif profile				

*1 While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.
*2 Stand for **SJ-500** is optional.

MeasurLink ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

PROPRIETARY INSPECTION CERTIFICATE

An inspection certificate is supplied as standard. Refer to page U-11 for details.

Surftest SJ-500P/SV-2100M4 Data Processing Unit (PC) Surface Roughness Testers

MeasurLink ENABLED
Data Management Software by Mitutoyo

A superior data processing tester with PC data analysis for higher efficiency.

SJ-500P

SV-2100M4 (PC type)

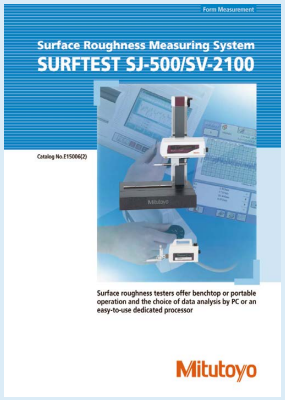
FORMTRACEPAK: Best-selling Surface Roughness Analysis Program

Best-selling dedicated software for surface roughness measurement and analysis.
Features a flexible printer format and creation of an original inspection certificate.

SPECIFICATIONS

Type of data processing unit		PC type	
Model No.		SJ-500P	SV-2100M4*2
Elevating shaft mechanism of stand		—*1	Manual operation only
Measuring range	X axis	50 mm	100 mm
	Z1 axis (detector)	800 µm, 80 µm, 8 µm	
Z2-axis (column) travel range		—	350 mm
Resolution	X axis	0.05 µm	
	Z1 axis (detector)	0.01 µm (800 µm), 0.001 µm (80 µm), 0.0001 µm (8 µm)	
	Z2 axis (column)	—	—
Applicable standards		JIS 1982/JIS 1994/JIS 2001/ISO 1997/ANSI/VDA	
Assessed profile		Primary profile, Roughness profile, Waviness profile, Filtered waviness profile, Rolling circle waviness profile, Rolling circle center line waviness profile, Envelope residual profile, DIN4776 profile, Roughness motif profile, Waviness motif profile	

*1 The simplified stand or manual column stand is available as an optional accessory.
*2 While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.



Refer to the Surftest **SJ-500**/**SV-2100** Brochure (**E15006**) for more details.

Mitutoyo

Surftest

Performs brilliantly in many situations such as in the quality control room, on the factory floor and on the production line.

Surftest Extreme SV-3000CNC/SV-M3000CNC SERIES 178 — CNC Surface Roughness Testers

MeasurLink® ENABLED
Data Management Software by Mitutoyo

SV-3000CNC
(Inclinable drive unit + Y-axis table)

SV-M3000CNC
(Surface Roughness Tester with built-in Y axis.)
(The photo represents a special specification model.)

SV-3000CNC SPECIFICATIONS

Model No.			SV-3000CNC
X1 axis (drive unit)	Measuring range		200 mm
	Resolution		0.05 µm
	Scale type		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200 mm/s
		Joystick mode	0 to 50 mm/s
	Measuring speed		0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0 mm/s
	Measuring direction		Backward
	Straightness		0.5 µm/200 mm
Y axis (table)	Measuring range		200 mm
	Resolution		0.05 µm
	Drive speed	CNC mode	Max. 200 mm/s
		Joystick mode	0 to 50 mm/s
	Maximum table loading		20 kg
Z2 axis (column)	Travel range	Z2 axis (column, type **S**)	300 mm
		Z2 axis (column, type **H**)	500 mm
	Resolution		0.05 µm
	Scale type		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200 mm/s
		Joystick mode	0 to 50 mm/s
Base unit	Base size (width×depth)		750×600 mm
	Base material		Granite

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

SV-M3000CNC SPECIFICATIONS

Model No.			SV-M3000CNC
X1 axis (drive unit)	Measuring range		200 mm
	Resolution		0.05 µm
	Scale type		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200 mm/s
		Joystick mode	0 to 50 mm/s
	Measuring speed		0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0 mm/s
	Straightness	When using a standard detector	0.5 µm/200 mm
Z2 axis (column)	Measuring range		500 mm
	Resolution		0.05 µm
	Scale type		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200 mm/s
		Joystick mode	0 to 50 mm/s
Y axis	Measuring range		800 mm
	Resolution		0.05 µm
	Scale type		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200 mm/s
		Joystick mode	0 to 50 mm/s
	Measuring speed		0.02 to 2 mm/s
	Straightness	When using a standard detector holder	Narrow range 0.5 µm/50 mm
			Wide range 2 µm/800 mm
Base unit	Base size (width×depth)		600×1500 mm
	Base material		Steel
	Maximum table loading		300 kg

MeasurLink® ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

PROPRIETARY INSPECTION CERTIFICATE
Mitutoyo guarantees the product quality

An inspection certificate is supplied as standard. Refer to page U-11 for details.

- The X1, Y and Z2 axes have a maximum drive speed of 200 mm/s.
  This permits high-speed positioning that can potentially result in a large increase in the throughput of multiple-profile/multiple-workpiece measurement tasks.
- Capable of inclined plane measurement through 2 axis simultaneous control in X and Y.
- Models equipped with the α axis allow continuous measurement on horizontal and inclined surfaces by power-tilting the X1 axis.
- It is possible to expand the measuring range for multiple workpieces through positioning in Y.
- All connecting cables are contained within the measuring instrument to eliminate any inconvenience during measurement.
- Since the Z1-axis detector incorporates an anti-collision safety device, the detector unit will automatically stop if it touches a workpiece or fixture.
- Surftest Extreme **SV-M3000CNC** (CNC Surface Roughness Tester with a movable Y-axis table) that handles measurement of large/heavy workpieces, such as engine blocks or crankshafts, is also available.
- Optional external control function (Ext I/O) through bidirectional communication (RS-232C) with the PLC (programmable logic controller) is available.

Refer to the CNC Form Measuring Instrument Series Brochure (**E15021**) for more details.

Contracer

High precision + High-function + High operability = Contracer

MeasurLink ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

PROPRIETARY INSPECTION CERTIFICATE

An inspection certificate is supplied as standard. Refer to page U-11 for details.

Contracer CV-2100 SERIES 218 — Contour Measuring Instruments

MeasurLink® ENABLED
Data Management Software by Mitutoyo

CV-2100M4

Contour Measuring System enabling measurement that is fast, accurate, and easy.

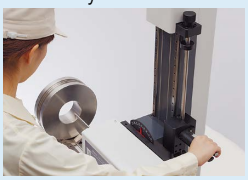
- The operation flow is significantly shortened by arranging the controls for stylus position change, measurement start/stop and return on the front of the drive unit.

Centralized front control panel

- Fine and coarse X-axis positioning can be performed easily by using the jog shuttle that covers the whole measuring range.

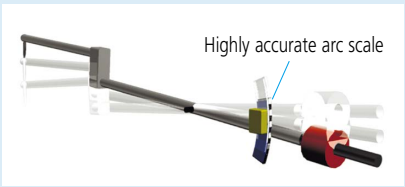
Motor-driven jog shuttle

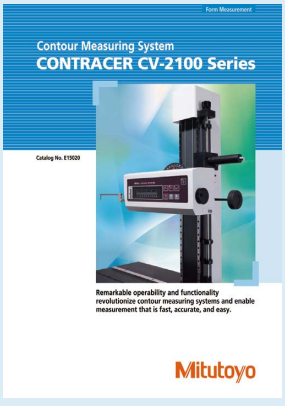
- The quick-vertical-motion stand allows operators to swiftly and easily move the drive unit to and from the measurement height without having to push or pull (only for **CV-2100M4**).



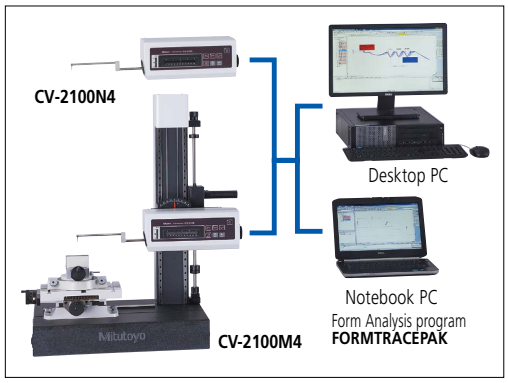
Quick-vertical-motion stand

- The detector unit (Z1 axis) is equipped with a highly accurate arc scale. This scale directly tracks the arc locus of the stylus tip so that the most accurate compensation can be applied to the scale output, which leads to higher accuracy and resolution. Operators are free from bothersome operations such as measurement magnification switching and calibrating each magnification as required for analog instruments.





Refer to the Contracer **CV-2100** Series Brochure (**E15020**) for more details.



Optional Column Stand for CV-2100N4

- Allows the use of the **CV-2100N4** in a fixed configuration.

218-042

Base material: Granite
Inclination range: ±45°
Vertical travel: 320 mm
Mass: 110 kg
Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

SPECIFICATIONS

Model No.		CV-2100M4	CV-2100N4
Measuring range	X axis	100 mm	
	Z1 axis (detector unit)	50 mm	
Z2-axis (column) travel range		350 mm	—
X-axis inclination angle		±45°	
Resolution	X axis	0.1 µm	
	Z1 axis	0.1 µm	
Drive method	X axis	Motor (0 to 20 mm/s)	
	Vertical travel (Z-axis column)	Manual (Quick-vertical-motion, fine)	—
Measuring speed		0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0, 5.0 mm/s	
Straightness (when the X axis is horizontal)		2.5 µm/100 mm	
Accuracy (20 °C)	X axis	±(2.5+0.02L) µm L = Measurement Length (mm)	
	Z1 axis	±(2.5+|0.1H|) µm H = Measurementt height from horizontal position within ±25 mm	
Measuring direction		Both pulling and pushing directions	
Measuring face direction		Downward direction	
Measuring force		30±10 mN (3 gf)	
Traceable angle (using the standard stylus)		Ascent 77°, Descent 87° (according to surface property)	
External dimensions (W×D×H)		745×450×885 mm	651×143×138.5 mm
Mass		145.8 kg	5.8 kg

Note 1: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.
Note 2: For the **CV-2100N4**, a manual column stand (optionally available) or custom fixture is required.

L

Mitutoyo

Formtracer

Hybrid machine with dual-role capability

FORMTRACER Avant S3000 Series
SERIES 178 — Surface Texture Measuring Instruments

MeasurLink® ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

An inspection certificate is supplied as standard. Refer to page U-11 for details.

FTA-S4S3000

- **FORMTRACER Avant S3000** Series are highly functional and user-friendly surface roughness measuring systems with innovative design features.
- **The FORMTRACER Avant S3000** Series includes models with inclined drive unit. Inclining the drive unit makes it easier to approach target surfaces and measure large workpieces.

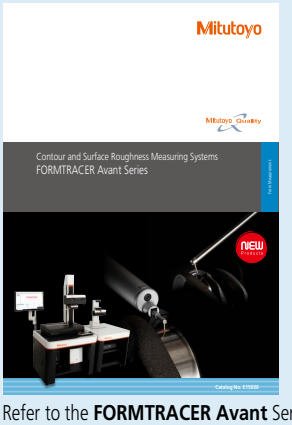
Inclined drive unit

- Equipped with an operability focused, new style remote box. The new part program key strongly supports manual part-programming.
- High throughput is achieved thanks to high drive speed (X axis: Max. 80 mm/s, Z2 axis: Max. 30 mm/s) and acceleration (X axis: 30 mm/s^2).
- All connecting cables are contained within the measuring instrument to eliminate any inconvenience during measurement.
- The Z1-axis detector is equipped with a built-in anti-collision safety device.
- A variety of detector holders (optional) are available.
- A detector for measuring contours can be retrofitted.

Large sized base models and high-column models are added to the line-up.

Remote box with user-friendly operability

Detector holder (optional)



Refer to the **FORMTRACER Avant** Series Brochure (**E15030**) for more details.

SPECIFICATIONS

Model No.		FTA-S4S3000	FTA-H4S3000	FTA-W4S3000	FTA-L4S3000	FTA-S8S3000	FTA-H8S3000	FTA-W8S3000	FTA-L8S3000
Measuring range	X axis	100 mm				200 mm			
	Z1 axis	800 µm, 80 µm, 8 µm							
Straightness (when the X axis is horizontal)		(0.05+0.001L) µm L = Measurement Length (mm)				(0.1+0.002L) µm L = Measurement Length (mm)			
X-axis inclination angle		±45° (Only for models with X-axis inclining drive unit)							
Z2-axis (column) travel range		300 mm	500 mm		700 mm	300 mm	500 mm		700 mm
Base size (W×D)		60×450 mm		1000×450 mm		600×450 mm		1000×450 mm	
Base material		Granite							

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

MeasurLink ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

PROPRIETARY INSPECTION CERTIFICATE

An inspection certificate is supplied as standard. Refer to page U-11 for details.

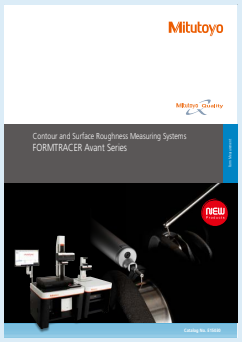
FORMTRACER Avant C3000/4000 Series
SERIES 218 — Surface Texture Measuring Instruments

MeasurLink® ENABLED
Data Management Software by Mitutoyo

- **FORMTRACER Avant C3000/4000** Series are highly functional and user-friendly contour measuring systems with innovative design features.
- **FORMTRACER Avant C3000/4000** Series comes with the inclined drive unit as standard, making approach to the target surface and measurement of large workpieces much easier.


Inclined drive unit

- Equipped with an operability focused, new style remote box. The new part program key strongly supports manual part-programming.
- High throughput is achieved thanks to high drive speed (X axis: Max. 80 mm/s, Z2 axis: Max. 30 mm/s) and acceleration (X axis: 30 mm/s^2).
- All connecting cables are contained within the measuring instrument to eliminate any inconvenience during measurement.
- The Z1-axis detector is equipped with a built-in anti-collision safety device.
- A detector for measuring contours can be retrofitted.
- The arm of the detector is a user-friendly, magnetic, one-touch, detachable mechanism.
- **C4000** type is a highly functional contour measuring system that has a wide-range digital detector (measuring range: 60 mm), top/bottom plane continuous measurement function, automatic variable measuring force function, and stylus drop detection function.



Refer to the **FORMTRACER Avant** Series Brochure (**E15030**) for more details.


Large sized base models and high-column models are added to the line-up.


Remote box with user-friendly operability

Detector

SPECIFICATIONS

Model No.			FTA-S4C3000 FTA-S4C4000	FTA-H4C3000 FTA-H4C4000	FTA-W4C3000 FTA-W4C4000	FTA-L4C3000 FTA-L4C4000	FTA-S8C3000 FTA-S8C4000	FTA-H8C3000 FTA-H8C4000	FTA-W8C3000 FTA-W8C4000	FTA-L8C3000 FTA-L8C4000
Measuring range		X axis	100 mm				200 mm			
		Z1 axis	60 mm (±30 mm in horizontal situation)							
Straightness (when the X axis is horizontal)			0.8 µm/100 mm				2 µm/200 mm			
Accuracy (20 °C)	C3000	X axis	(0.8+0.01L) µm L = Measurement Length (mm)				(0.8+0.015L) µm L = Measurement Length (mm)			
		Z1 axis (detector unit)	±(1.2+|2H|/100) µm H = Measurement height from the horizontal position (mm)							
	C4000	X axis	(0.8+0.01L) µm L = Measurement Length (mm)				(0.8+0.015L) µm L = Measurement Length (mm)			
		Z1 axis (detector unit)	±(0.8+|2H|/100) µm H = Measurement height from the horizontal position (mm)							
X-axis inclination angle			±45°							
Z2-axis (column) travel range			300 mm	500 mm		700 mm	300 mm	500 mm		700 mm
Base size (W×D)			600×450 mm		1000×450 mm		600×450 mm		1000×450 mm	
Base material			Granite							

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

Mitutoyo

Formtracer

Hybrid machine with dual-role capability

FORMTRACER Avant D3000/4000 Series SERIES 525 — Surface Texture Measuring Instruments

MeasurLink® ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

An inspection certificate is supplied as standard. Refer to page U-11 for details.

FTA-S4D3000
(Detector for surface roughness measurement equipped, with monitor arm)

FTA-S4D3000
(Detector for form/contour measurement equipped, with monitor arm)

- **FORMTRACER Avant D3000/4000** Series are highly functional and user-friendly surface roughness and contour measuring systems with innovative design features. Both surface roughness measurement and contour measurement are available on a single system just by replacing the detector.
- The contour/roughness detector can be replaced without turning off the controller power and without using any tool. Furthermore, the detector is recognized automatically.
- **FORMTRACER Avant D** Series comes with the inclined drive unit as standard, making approach to the target surface and measurement of large workpieces much easier.
- Equipped with an operability focused, new style remote box. The new part program key strongly supports manual part-programming.
- High throughput is achieved thanks to high drive speed (X axis: Max. 80 mm/s, Z2 axis: Max. 30 mm/s) and acceleration (X axis: 30 mm/s^2).
- All connecting cables are contained within the measuring instrument to eliminate any inconvenience during measurement.
- The Z1-axis detector is equipped with a built-in anti-collision safety device.
- A detector for measuring contours can be retrofitted.
- The arm of the detector for contour measurement is a magnetic, one-touch, detachable mechanism.
- **D4000** type is a highly functional contour measuring system with a digital detector (measuring range: 60 mm) that enables wide range measurement, top/bottom plane continuous measurement function, automatic variable measuring force function, and stylus drop detection function.

Large sized base models and high-column models are added to the line-up.

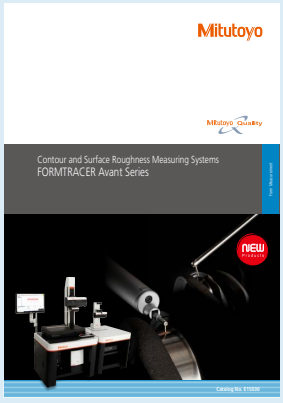
Inclined drive unit

Connecting cables are contained within the measuring instrument.

Remote box with user-friendly operability

Detector holder (optional)

Detector



Refer to the **FORMTRACER Avant** Series Brochure (**E15030**) for more details.

SPECIFICATIONS

Model No.			FTA-S4D3000 FTA-S4D4000	FTA-H4D3000 FTA-H4D4000	FTA-W4D3000 FTA-W4D4000	FTA-L4D3000 FTA-L4D4000	FTA-S8D3000 FTA-S8D4000	FTA-H8D3000 FTA-H8D4000	FTA-W8D3000 FTA-W8D4000	FTA-L8D3000 FTA-L8D4000
Surface roughness measurement										
Measuring range		X axis	100 mm				200 mm			
		Z1 axis	800 µm, 80 µm, 8 µm							
Straightness (when the X axis is horizontal)			(0.05+0.001L) µm L = Measurement Length (mm)				(0.1+0.002L) µm L = Measurement Length (mm)			
Contour measurement										
Measuring range		X axis	100 mm				200 mm			
		Z1 axis	60 mm (±30 mm in horizontal situation)							
Straightness (when the X axis is horizontal)			0.8 µm/100 mm				2 µm/200 mm			
Accuracy (20 °C)	D3000	X axis	(0.8+0.01L) µm L = Measurement Length (mm)				(0.8+0.015L) µm L = Measurement Length (mm)			
		Z1 axis (detector unit)	±(1.2+|2H|/100) µm H = Measurement height from the horizontal position (mm)							
	D4000	X axis	(0.8+0.01L) µm L = Measurement Length (mm)				(0.8+0.015L) µm L = Measurement Length (mm)			
		Z1 axis (detector unit)	±(0.8+|2H|/100) µm H = Measurement height from the horizontal position (mm)							
Common specifications										
X-axis inclination angle			±45°							
Z2-axis (column) travel range			300 mm	500 mm		700 mm	300 mm	500 mm		700 mm
Base size (W×D)			600×450 mm		1000×450 mm		600×450 mm		1000×450 mm	
Base material			Granite							

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

MeasurLink ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

PROPRIETARY INSPECTION CERTIFICATE

An inspection certificate is supplied as standard. Refer to page U-11 for details.

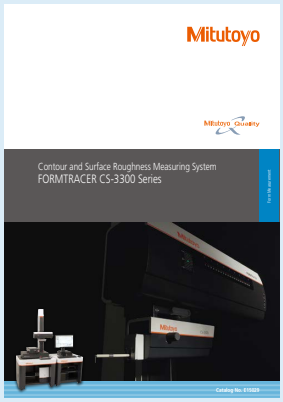
CS-3300 Series
SERIES 525 — Surface Texture Measuring Instruments

MeasurLink® ENABLED
Data Management Software by Mitutoyo

- **CS-3300** Series are highly functional and user-friendly surface roughness and contour measuring systems with innovative design features.
- Large sized base models and high-column models are newly added to the line-up.
- Equipped with a wide range and high resolution Z1-axis detector.
- **CS-3300** Series comes with the inclined drive unit as standard, making approach to the target surface and measurement of large workpieces much easier.
- Equipped with an operability focused, new style remote box. The new part program key strongly supports manual part-programming.
- High throughput is achieved thanks to high drive speed (X axis: Max. 80 mm/s, Z2 axis: Max. 30 mm/s).
- All connecting cables are contained within the measuring instrument to eliminate any inconvenience during measurement.
- The Z1-axis detector is equipped with a built-in anti-collision safety device.

CS-3300H8

CS-3300H8
(With monitor arm)



Refer to the **FORMTRACER Avant CS-3300** Series Brochure (**E15029**) for more details.

Inclinable drive unit

Detector sliding mechanism

Connecting cables are contained within the measuring instrument.

L

SPECIFICATIONS

Model No.			CS-3300S4	CS-3300H4	CS-3300W4	CS-3300L4	CS-3300S8	CS-3300H8	CS-3300W8	CS-3300L8
Measuring range	X axis		100 mm				200 mm			
	Z1 axis		5 mm (±2.5 mm in horizontal situation)							
Straightness (when the X axis is horizontal)			0.2 μm/100 mm				0.8 μm/200 mm			
Accuracy (20 °C)	X axis		±(0.8+0.01L) μm L = Measurement Length (mm)				(0.8+0.015L) μm L = Measurement Length (mm)			
	Z1 axis (detector unit)		±(1.5+|2H|/100) μm H = Measurement height from the horizontal position (mm)							
Detector (Z1 axis)	Detection method		Differential inductance							
	Measuring force		0.75 mN							
	Stylus tip	Standard	Tip radius 2 μm, Tip angle 60°, Diamond (surface roughness/contour)							
		Cone	Tip radius 25 μm, Tip angle 30°, Sapphire (contour)							
	Stylus up/down		Available (stoppable at mid-stroke if required)							
X-axis inclination angle			±45°							
Z2-axis (column) travel range			300 mm	500 mm		700 mm	300 mm	500 mm		700 mm
Base size (W×D)			600×450 mm		1000×450 mm		600×450 mm		1000×450 mm	
Base material			Granite							

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

Mitutoyo

Formtracer

Hybrid machine with dual-role capability

Formtracer Extreme
SV-C4500CNC/SV-C4500CNC HYBRID TYPE1
SERIES 525 — CNC Surface Roughness and Contour Measuring Systems

MeasurLink® ENABLED
Data Management Software by Mitutoyo

SV-C4500CNC (Contour detector shown mounted together with the inclinable drive unit and Y-axis table)

SV-C4500CNC HYBRID TYPE1
(Mounting example of non-contact detector)

SV-C4500CNC SPECIFICATIONS

Model No.			SV-C4500CNC
X1 axis (Drive unit)		Measuring range	200 mm
		Resolution	0.05 µm
		Scale type	Reflective-type linear encoder
	Contour	Straightness	2 µm/200 mm
		Accuracy (20 °C)	±(0.8+4L/200) µm L: Measuring length (mm)
	Surface roughness	Straightness	0.5 µm/200 mm
Z1 axis (Detector)	Contour	Measuring range	60 mm (±30 mm from the horizontal)
		Resolution	0.02 µm
		Scale type	Arc
		Accuracy (20 °C)	±(0.8+|2H|/100) µm H: Measuring height from horizontal position (mm)
	Surface roughness	Measuring range	800 µm, 80 µm, 8 µm
		Resolution	0.01 µm, 0.001 µm, 0.0001 µm
Z2 axis (Column)		Drive range	Specification is selectable from 300 mm or 500 mm.
		Resolution	0.05 µm

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

SV-C4500CNC HYBRID TYPE1 SPECIFICATIONS

Model No.			SV-C4500CNC HYBRID TYPE1
X1 axis (Drive unit)		Measuring range	200 mm
		Resolution	0.05 µm
		Scale type	Reflective-type linear encoder
	Contour	Straightness (20 °C)	2 µm/200 mm
		Accuracy	±(0.8+4L/200) µm L: Measuring length (mm)
	Surface roughness	Straightness	0.5 µm/200 mm
	Non-contact type	Straightness	0.5 µm/200 mm
		Accuracy	±(0.8+4L/200) µm L: Measuring length (mm)
Y axis		Measuring range	200 mm
		Resolution	0.05 µm
		Maximum table loading	20 kg
Z1 axis	Contour	Measuring range	60 mm (±30 mm from the horizontal)
		Resolution	0.02 µm
		Scale type	Arc
		Accuracy (20 °C)	±(0.8+|2H|/100) µm H: Measuring height from horizontal position (mm)
	Surface roughness	Measuring range	800 µm, 80 µm, 8 µm
		Resolution	0.01 µm, 0.001 µm, 0.0001 µm
	Non-contact type detector **CPS2525***1	Measuring range	1.2 mm
		Resolution	25 nm
	Non-contact type detector **CPS0517***1	Measuring range	0.1 mm
		Resolution	5 nm
Z2 axis		Drive range	500 mm
		Resolution	0.05 µm

*1 Select either **CPS2525** or **CPS0517**.

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

MeasurLink® ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

PROPRIETARY INSPECTION CERTIFICATE

An inspection certificate is supplied as standard. Refer to page U-11 for details.

SV-C4500CNC

- High-accuracy stylus type CNC Surface Roughness/Contour Measuring System that allows measurement of surface roughness and form/contour with one unit through detector replacement.
- For models with the α axis, it is possible to perform continuous measurement over horizontal and inclined surfaces by power-tilting the X1 axis. In addition, automatic measuring force adjustment function of Z1-axis detector for contour measurement enables automatic measurement with constant measuring force even with the X1-axis tilted.
- For models with the Y-axis table, it is possible to expand the measuring range for multiple workpieces through positioning in the Y-axis direction.
- Since the Z1-axis detector incorporates an anti-collision safety device, the machine will automatically stop if the detector touches a workpiece or jig.
- Optional external control function (Ext I/O) through bidirectional communication (RS-232C) with the PLC (programmable logic controller) is available.

SV-C4500CNC HYBRID TYPE1

- CNC Surface Roughness/Contour Measuring System equipped with a non-contact type detector as well as a contact type surface roughness contour measuring detector.
- Equipped with the Y-axis table, it is possible to expand the measuring range for multiple workpieces through positioning in the Y-axis direction.
- Since the Z1-axis detector incorporates an anti-collision safety device, the machine will automatically stop if the detector touches a workpiece or jig.
- Optional external control function (Ext I/O) through bidirectional communication (RS-232C) with the PLC (programmable logic controller) is available.

MeasurLink ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

PROPRIETARY INSPECTION CERTIFICATE
Mitutoyo guarantees the product quality. Mitutoyo guarantees the product quality.

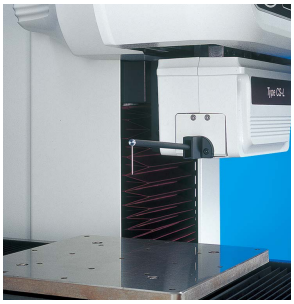
An inspection certificate is supplied as standard. Refer to page U-11 for details.

Formtracer Extreme CS-5000CNC/CS-H5000CNC SERIES 525 — CNC Surface Roughness and Contour Measuring Systems

MeasurLink® ENABLED
Data Management Software by Mitutoyo

- High-accuracy stylus type CNC Surface Measuring System that allows batch measurement of surface roughness and form/contour.
- The X1 and Z2 axes have maximum drive speeds of 40 mm/s and 200 mm/s, respectively. This permits high-speed positioning that can potentially result in a large increase in the throughput of multiple-profile/multiple-workpiece measurement tasks.
- The high resolution linear encoder is incorporated in the X1 and Z1 axes so that high resolution is achieved and batch measurement of form/contour and surface roughness can be made.
- The active control method is employed for the Z1-axis detector to implement a wide-range measurement capability wherein the variation in dynamic measuring force is restricted.
- Since the Z1-axis detector incorporates an anti-collision safety device, the detector unit will automatically stop if it touches a workpiece or fixture.
- For models with the α axis, it is possible to perform continuous measurement over horizontal and inclined surfaces by power-tilting the X1 axis. (**CS-5000CNC** only)
- For models with the Y-axis table, it is possible to expand the measuring range for multiple workpieces through positioning in the Y-axis direction.
- Optional external control function (Ext I/O) through bidirectional communication (RS-232C) with the PLC (programmable logic controller) is available.

CS-H5000CNC
(with Y-axis table)



Wide-range detector employing active control technology

SPECIFICATIONS

Model No.			CS-5000CNC	CS-H5000CNC
X1 axis	Measuring range		200 mm	
	Resolution		0.005 µm	
	Scale type		Transmission-type linear encoder	
	Drive speed	CNC mode	Max. 40 mm/s	
		Joystick mode	0 to 40 mm/s	
	Measuring speed		0.02, 0.05, 0.1, 0.2 mm/s (surface roughness), 0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0 mm/s (form/contour)	
	Measuring direction		Forward/backward	
	Straightness	with standard stylus	(0.1+0.0015L) µm L: traverse length (mm)	(0.05+0.0003L) µm L: traverse length (mm)
		with 2X-long stylus	(0.2+0.0015L) µm L: traverse length (mm)	(0.1+0.0015L) µm L: traverse length (mm)
	Accuracy (20 °C)		±(0.3+0.002L) µm L: traverse length (mm)	±(0.16+0.001L) µm L: traverse length (mm)
α axis	Inclination range		-45° (CCW), +10° (CW)	—
Z1 axis (Detector)	Measuring range	with standard stylus	12 mm	
		with 2X-long stylus	24 mm	
	Resolution	with standard stylus	0.0008 µm	
		with 2X-long stylus	0.0016 µm	
	Vertical movement of the stylus		Arc motion	
	Scale type		Transmission-type linear encoder	
	Accuracy (20 °C)		±(0.3+|0.02H|) µm H: probing height (mm)	±(0.07+|0.02H|) µm H: probing height (mm)
	Measuring force	with standard stylus	4 mN (Fixed)	
		with 2X-long stylus	0.75 mN (Fixed)	
	Traceable angle		Ascent: 60°, Descent: 60° (Depends on the surface texture.)	
	Stylus tip shape	Standard stylus	Tip radius: 5 µm, Tip angle: 40°, Diamond	
		Standard ball stylus	Tip ball radius: 0.25 mm, Sapphire	
		2X-long stylus	Tip radius: 5 µm, Tip angle: 40°, Diamond	
		2X-long stylus	—	Tip radius: 2 µm, Tip angle: 60°, Diamond tip
		2X-long ball stylus	Tip ball radius: 0.25 mm, Sapphire	
	Face of stylus		Downward	
Z2 axis (Column)	Travel range	Z2 axis (column, type S)	300 mm	
		Z2 axis (column, type H)	500 mm	
	Resolution		0.05 µm	
	Scale type		Reflective-type linear encoder	
	Drive speed	CNC mode	Max. 200 mm/s	
		Joystick mode	0 to 50 mm/s	
Base	Base size (W×D)		750×600 mm	
	Base material		Granite	

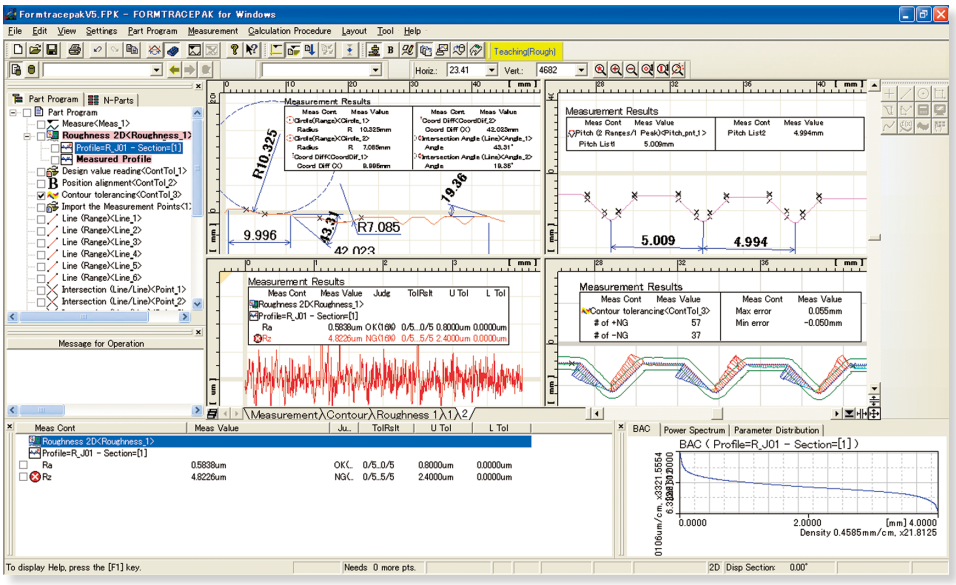
Note: While the appearance of the natural stone base varies according to the source, the high stability for which this material is known can always be relied upon.

L

Formtracer

Hybrid machine with dual-role capability

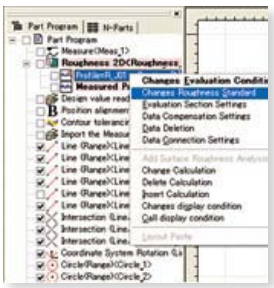
Surface Roughness/Contour Analysis Program FORMTRACEPAK



- **FORMTRACEPAK** functions offer total support for controlling the measurement system, surface roughness analysis, contour analysis, contour tolerancing, and inspection report creation.

• Editing measurement procedures

The items displayed in the measurement procedure window can be directly modified. You can, for example, perform new analyses by modifying the evaluation setup or roughness standard.



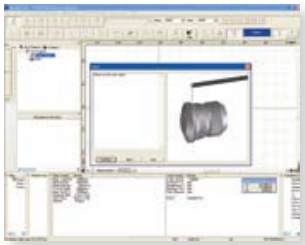
• Operation messaging

The operation message window for explaining the next step is incorporated.

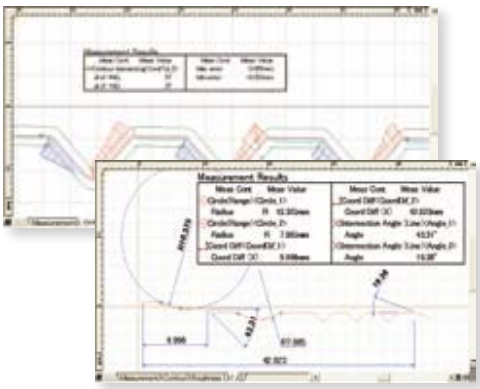
• Measurement control

To make only a single measurement, you can create a part program in the single mode. To measure multiple workpieces of an identical shape, you can use the teaching mode. Since you can embed the entire flow, from making measurement to printing a report, into a part program, you can efficiently make measurements, analyze data, and output a report. A function is also provided that enables you to insert comments accompanied with photographs at desired timings, enabling you to embed the roles described in a measurement procedure document that specifies important points such as work settings.

To make immediate measurements, you can use the pull-down menu to easily select and call up the desired operating procedure.



• Versatile graphics windowing for data and analysis

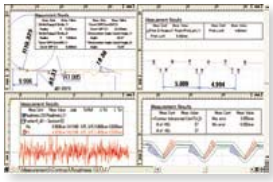


Tab-selection graphics window

Just select a tab to display the measurement data required, such as contour, roughness, or tolerancing results.

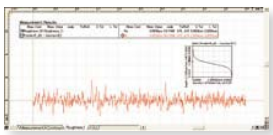
Dividing the screen into two or four windows

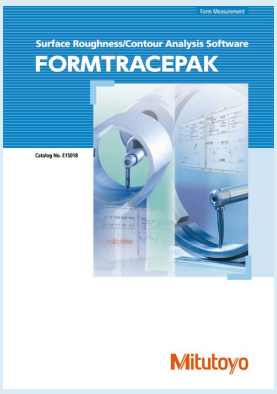
The screen can be divided into two, or four, windows for the convenient display of measurement data (for contour and roughness), analysis results, and contour tolerancing data, as required.



Displaying the results in the graphics window

You can paste the graphics obtained from measurements, as well as measurement values (including pass/fail results) and an analysis graph, into the graphics window. This enables you to check the graphics and measurement results at a glance using the graphics window alone.

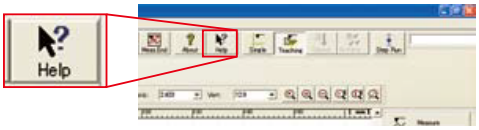




Refer to the **FORMTRACEPAK** Brochure (**E15018**) for more details.

- **Online help functions**

Online help that can be viewed any time is incorporated into the software. In addition to index and keyword searches, a status-saving help button, which displays menus and Windows help with a click of the mouse, is provided.

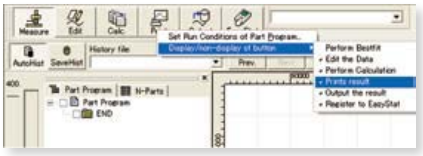


- **Multiple language support (18 languages)**

You can switch the language to be used in the measurement, analysis, and layout windows. After measurements have been made, you can switch to another language and create a report in that language. This function can be used worldwide.

- **Button-editing function**

You can hide buttons that are not used frequently. For example, you can choose to display only those buttons that are used frequently and increase the size of the displayed graphics window, thereby customizing the window to suit your needs.



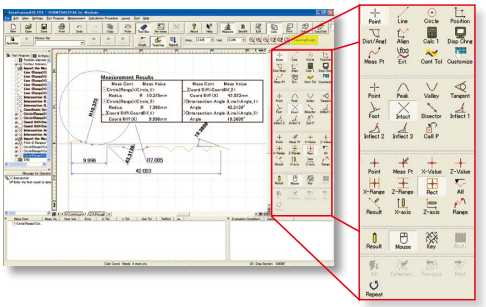
- **Simple statistical commands**

You can perform statistical calculations of roughness parameters and contour analysis results without using a separate program such as Excel.

Contour measurement

- **Contour analysis**

A wide variety of commands, which form the basic elements for analysis, are provided, including those for points (10 types), lines (6 types) and circles (6 types). A rich set of commands that combine these elements to calculate angles, pitches and distances as well as performing contour tolerancing and design value generation are also provided as standard features. These functions, combined with the function that enables you to customize the calculation command buttons by hiding less frequently used commands, help you to tailor the window according to the user's environment.

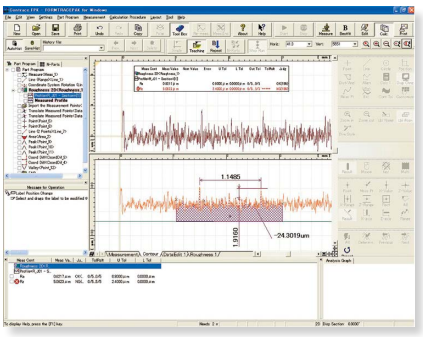


- **Contour-tolerancing as a standard feature**
- **Design value generation**
- **Data combination**
- **Simple pitch calculation**

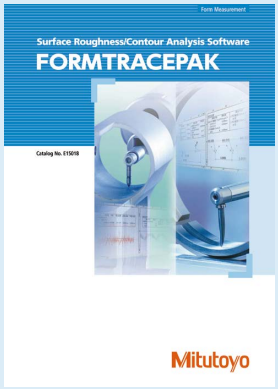
Surface roughness measurement

- **Surface roughness analysis**

FORMTRACEPAK can perform surface roughness analyses that conform to various standards such as ISO, JIS, ANSI and VDA. For comparing measurement values with the tolerance limits, you can use the 16 % rule or the maximum value rule. Furthermore, since **FORMTRACEPAK** comes with parameter calculation functions as well as a rich set of graphic analysis functions, it can be widely utilized for everything from routine quality control to R&D applications. It also includes many other functions such as the function for eliminating (compensating) shapes, such as slopes and radiused surfaces (R-surfaces), and data deletion.



- **Micro contour analysis**
- **Simple input using drawing symbols**
- **Multiple-point measurement**
- **Analysis using multiple-point measurements**
- **Reference length dialog box**
- **Analysis condition modification with preview**
- **R-surface automatic measurement**



Refer to the **FORMTRACEPAK** Brochure (**E15018**) for more details.

L

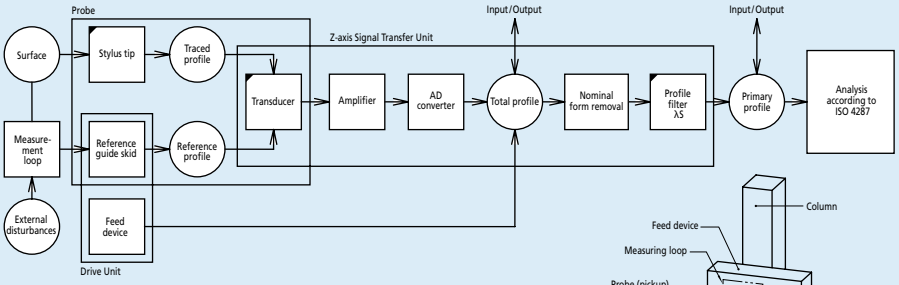
Quick Guide to Precision Measuring Instruments

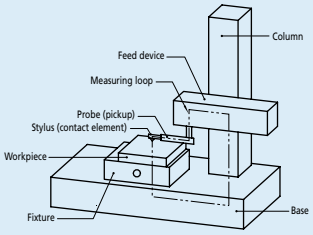
Surftest (Surface Roughness Testers)

ISO 4287: 1997 Geometrical Product Specifications (GPS) – Surface Texture: Profile method– Terms, definitions, and surface texture parameters
ISO 4288: 1996 Geometrical Product Specifications (GPS) – Surface Texture: Profile method– Rules and procedures for the assessment of surface texture
ISO 3274: 1996 Geometrical Product Specifications (GPS) – Surface Texture: Profile method– Nominal characteristics of contact (stylus) instruments
ISO 11562: 1996 Geometrical Product Specifications (GPS) – Surface texture: Profile method– Metrological characteristics of phase correct filters

Elements of Contact Type Surface Roughness Measuring Instruments

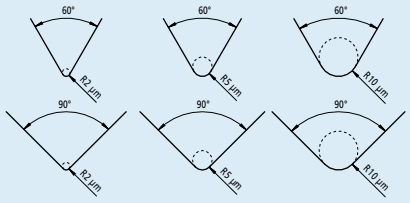
ISO 3274: 1996 (JIS B 0651: 2001)





Stylus Shape

A typical shape for a stylus end is conical with a spherical tip.
Tip radius: r_{tip} = 2 µm, 5 µm or 10 µm
Cone angle: 60°, 90°
In typical surface roughness testers, the conical angle of the stylus end is 60° unless otherwise specified.



Static Measuring Force

Nominal radius of curvature of stylus tip: µm	Static measuring force at the mean position of stylus: mN	Tolerance on static measuring force variations: mN/µm
2	0.75	0.035
5	0.75 (4.0) *1	0.2
10		

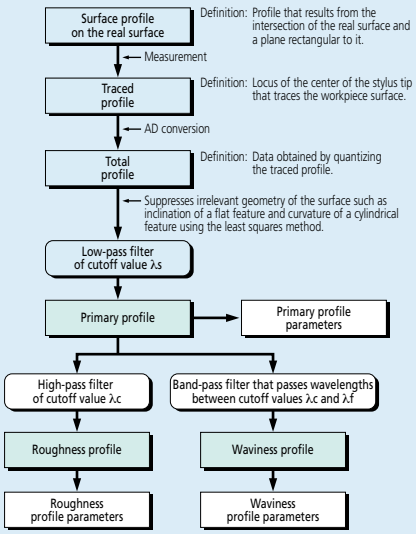
*1 The maximum value of static measuring force at the average position of a stylus is to be 4.0 mN for a probe with a special structure including a replaceable stylus.

Metrological Characterization of Phase Correct Filters

ISO 11562: 1996 (JIS B 0632: 2001)

A profile filter is a phase-correct filter without phase delay (cause of profile distortion dependent on wavelength).
The weight function of a phase-correct filter shows a normal (Gaussian) distribution in which the amplitude transmission is 50 % at the cutoff wavelength.

Data Processing Flow



Relationship between Cutoff Value and Stylus Tip Radius

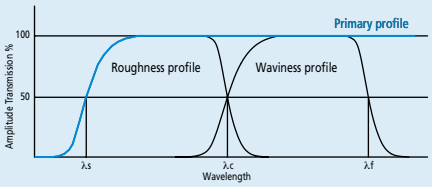
The following table lists the relationship between the roughness profile cutoff value λc, stylus tip radius r_{tip}, and cutoff ratio λc/λs.

λc mm	λs µm	λc/λs	Maximum r_{tip} µm	Maximum sampling length µm
0.08	2.5	30	2	0.5
0.25	2.5	100	2	0.5
0.8	2.5	300	2 *1	0.5
2.5	8	300	5 *2	1.5
8	25	300	10 *2	5

*1 For a surface with Ra>0.5 µm or Rz>3 µm, a significant error will not usually occur in a measurement even if r_{tip} = 5 µm.
*2 If a cutoff value λs is 2.5 µm or 8 µm, attenuation of the signal due to the mechanical filtering effect of a stylus with the recommended tip radius appears outside the roughness profile pass band. Therefore, a small error in stylus tip radius or shape does not affect parameter values calculated from measurements. If a specific cutoff ratio is required, the ratio must be defined.

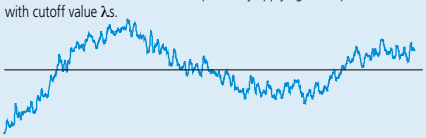
Surface Profiles

ISO 4287:1997 (JIS B 0601: 2013)



Primary Profile

Profile obtained from the measured profile by applying a low-pass filter with cutoff value λs.

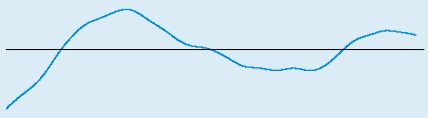


Roughness Profile

Profile obtained from the primary profile by suppressing the longer wavelength components using a high-pass filter of cutoff value λc.

Waviness Profile

Profile obtained by applying a band-pass filter to the primary profile to remove the longer wavelengths above λf and the shorter wavelengths below λc.



Roughness sampling length for non-periodic profiles

ISO 4288: 1996 (JIS B 0633: 2001)

Table 1: Sampling lengths for aperiodic profile roughness parameters (Ra, Rq, Rsk, Rku, $R\Delta q$), material ratio curve, probability density function, and related parameters

Ra µm	Sampling length lr mm	Evaluation length ln mm
(0.006)<Ra≤0.02	0.08	0.4
0.02 <Ra≤0.1	0.25	1.25
0.1 <Ra≤2	0.8	4
2 <Ra≤10	2.5	12.5
10 <Ra≤80	8	40

Table 2: Sampling lengths for aperiodic profile roughness parameters (Rz, Rv, Rp, Rc, Rt)

Rz $Rz1max.$ µm	Sampling length lr mm	Evaluation length ln mm
(0.025)<Rz, $Rz1max.$≤0.1	0.08	0.4
0.1 <Rz, $Rz1max.$≤0.5	0.25	1.25
0.5 <Rz, $Rz1max.$≤10	0.8	4
10 <Rz, $Rz1max.$≤50	2.5	12.5
50 <Rz, $Rz1max.$≤200	8	40

1) Rz is used for measurement of Rz, Rv, Rp, Rc, and Rt.
2) $Rz1max.$ only used for measurement of $Rz1max.$, $Rv1max.$, $Rp1max.$, and $Rc1max.$.

Table 3: Sampling lengths for measurement of periodic roughness profile roughness parameters and periodic or aperiodic profile parameter RSm

RSm mm	Sampling length lr mm	Evaluation length ln mm
0.013 <RSm≤0.04	0.08	0.4
0.04 <RSm≤0.13	0.25	1.25
0.13 <RSm≤0.4	0.8	4
0.4 <RSm≤1.3	2.5	12.5
1.3 <RSm≤4	8	40

Procedure for determining a sampling length if it is not specified

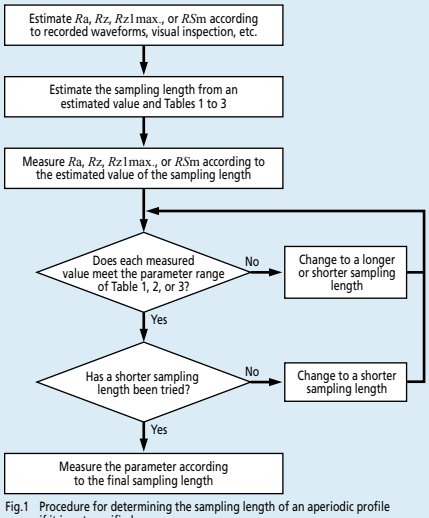


Fig.1 Procedure for determining the sampling length of an aperiodic profile if it is not specified.

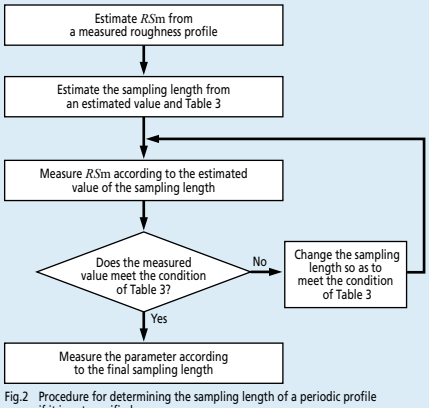


Fig.2 Procedure for determining the sampling length of a periodic profile if it is not specified.

L

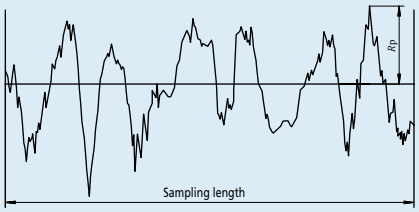
Definition of Parameters

ISO 4287: 1997, Amd. 1: 2009 (JIS B 0261: 2013)

Amplitude Parameters (peak and valley)

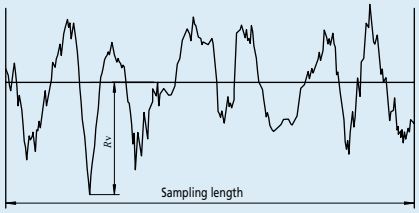
Maximum peak height of the primary profile *Pp*
Maximum peak height of the roughness profile *Rp*
Maximum peak height of the waviness profile *Wp*

Largest profile peak height *Zp* within a sampling length



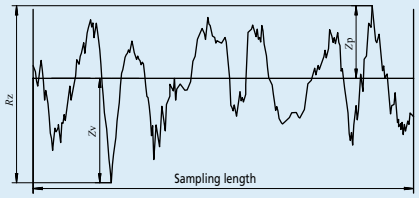
Maximum valley depth of the primary profile *Pv*
Maximum valley depth of the roughness profile *Rv*
Maximum valley depth of the waviness profile *Wv*

Largest profile valley depth *Zv* within a sampling length



Maximum height of the primary profile *Pz*
Maximum height of the roughness profile *Rz*
Maximum height of the waviness profile *Wz*

Sum of height of the largest profile peak height *Zp* and the largest profile valley depth *Zv* within a sampling length

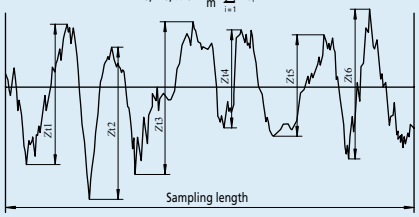


In the old JIS and ISO 4287-1: 1984, *Rz* was used to indicate the "ten point height of irregularities". Care must be taken because differences between results obtained according to the existing and old standards are not always negligibly small. (Be sure to check whether the drawing instructions conform to existing or old standards.)

Mean height of the primary profile elements *Pc*
Mean height of the roughness profile elements *Rc*
Mean height of the waviness profile elements *Wc*

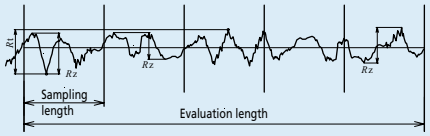
Mean value of the profile element heights *Zt* within a sampling length

$$Pc, Rc, Wc = \frac{1}{m}\sum_{i=1}^{m} Zt_i$$



Total height of the primary profile *Pt*
Total height of the roughness profile *Rt*
Total height of the waviness profile *Wt*

Sum of the height of the largest profile peak height *Zp* and the largest profile valley depth *Zv* within the evaluation length



Amplitude Parameters (average of ordinates)

Arithmetical mean deviation of the primary profile *Pa*
Arithmetical mean deviation of the roughness profile *Ra*
Arithmetical mean deviation of the waviness profile *Wa*

Arithmetic mean of the absolute ordinate values Z(x) within a sampling length

$$Pa, Ra, Wa = \frac{1}{l}\int_0^l |Z(x)|dx$$

with l as *lp*, *lr*, or *lw* according to the case.

Root mean square deviation of the primary profile *Pq*
Root mean square deviation of the roughness profile *Rq*
Root mean square deviation of the waviness profile *Wq*

Root mean square value of the ordinate values Z(x) within a sampling length

$$Pq, Rq, Wq = \sqrt{\frac{1}{l}\int_0^l Z^2(x)dx}$$

with l as *lp*, *lr*, or *lw* according to the case.

Skewness of the primary profile *Psk*
Skewness of the roughness profile *Rsk*
Skewness of the waviness profile *Wsk*

Quotient of the mean cube value of the ordinate values Z(x) and the cube of *Pq*, *Rq*, or *Wq* respectively, within a sampling length

$$Rsk = \frac{1}{Rq^3}\left[\frac{1}{lr}\int_0^{lr} Z^3(x)dx\right]$$

The above equation defines *Rsk*. *Psk* and *Wsk* are defined in a similar manner. *Psk*, *Rsk*, and *Wsk* are measures of the asymmetry of the probability density function of the ordinate values.

Kurtosis of the primary profile *Pku*
Kurtosis of the roughness profile *Rku*
Kurtosis of the waviness profile *Wku*

Quotient of the mean quartic value of the ordinate values Z(x) and the fourth power of *Pq*, *Rq*, or *Wq* respectively, within a sampling length

$$Rku = \frac{1}{Rq^4}\left[\frac{1}{lr}\int_0^{lr} Z^4(x)dx\right]$$

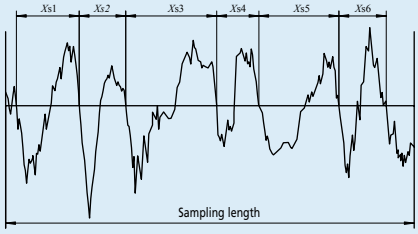
The above equation defines *Rku*. *Pku* and *Wku* are defined in a similar manner. *Pku*, *Rku*, and *Wku* are measures of the sharpness of the probability density function of the ordinate values.

Spacing Parameters

Mean width of the primary profile elements *PSm*
Mean width of the roughness profile elements *RSm*
Mean width of the waviness profile elements *WSm*

Mean value of the profile element widths *Xs* within a sampling length

$$PSm, RSm, WSm = \frac{1}{m}\sum_{i=1}^{m} Xs_i$$



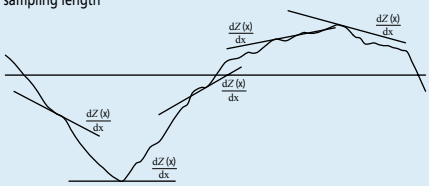
Peak count number based on the primary profile elements *PPc*
Peak count number based on the roughness profile elements *RPc*
Peak count number based on the waviness profile elements *WPc*

$$RPc = \frac{1}{RSm}$$

Hybrid Parameters

Root mean square slope of the primary profile *PΔq*
Root mean square slope of the roughness profile *RΔq*
Root mean square slope of the waviness profile *WΔq*

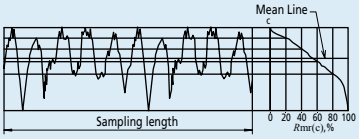
Root mean square value of the ordinate slope dZ/dX within a sampling length



Curves, Probability Density Function, and Related Parameters

Material ratio curve of the profile (Abbott-Firestone curve)

Curve representing the material ratio of the profile as a function of section level c



Material ratio of the primary profile *Pmr* (c)
Material ratio of the roughness profile *Rmr* (c)
Material ratio of the waviness profile *Wmr* (c)

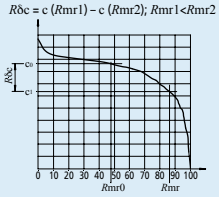
Ratio of the material length of the profile elements *Ml* (c) at a given level c to the evaluation length

$$Pmr\,(c), Rmr\,(c), Wmr\,(c) = \frac{Ml(c)}{ln}$$

Section height difference of the primary profile *Pδc*
Section height difference of the roughness profile *Rδc*
Section height difference of the waviness profile *Wδc*

Vertical distance between two section levels of a given material ratio

$$R\delta c = c\,(Rmr1) - c\,(Rmr2);\ Rmr1 < Rmr2$$



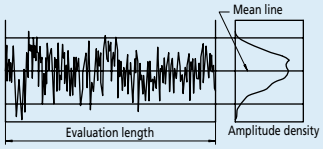
Relative material ratio of the primary profile *Pmr*
Relative material ratio of the roughness profile *Rmr*
Relative material ratio of the waviness profile *Wmr*

Material ratio determined at a profile section level *Rδc* related to the reference section level c_0

$$Pmr, Rmr, Wmr = Pmr\,(c_1), Rmr\,(c_1), Wmr\,(c_1)$$
where $c_1 = c_0 - R\delta c\,(P\delta c, W\delta c)$
$c_0 = c\,(Pm0, Rmr0, Wmr0)$

Probability density function
(profile height amplitude distribution curve)

Sample probability density function of the ordinate Z(x) within the evaluation length

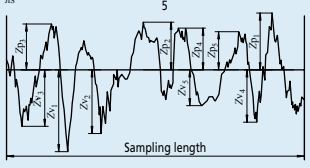


JIS Specific Parameters

Ten-point height of irregularities, Rz_{JIS}

Sum of the absolute mean height of the five highest profile peaks and the absolute mean depth of the five deepest profile valleys, measured from the mean line within the sampling length of a roughness profile. This profile is obtained from the primary profile using a phase-correct band-pass filter with cutoff values of lc and ls.

$$Rz_{JIS} = \frac{|Zp_1+Zp_2+Zp_3+Zp_4+Zp_5| + |Zv_1+Zv_2+Zv_3+Zv_4+Zv_5|}{5}$$



Symbol	Used profile
Rz_{JIS82}	Surface profile as measured
Rz_{JIS94}	Roughness profile derived from the primary profile using a phase-correct high-pass filter

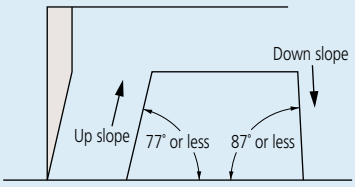
Arithmetic mean deviation of the profile Ra_{75}

Arithmetic mean of the absolute values of the profile deviations from the mean line within the sampling length of the roughness profile (75 %). This profile is obtained from a measurement profile using an analog high-pass filter with an attenuation factor of 12db/octave and a cutoff value of λc.

$$Ra_{75} = \frac{1}{ln}\int_0^{ln} |Z(x)|dx$$

Mitutoyo

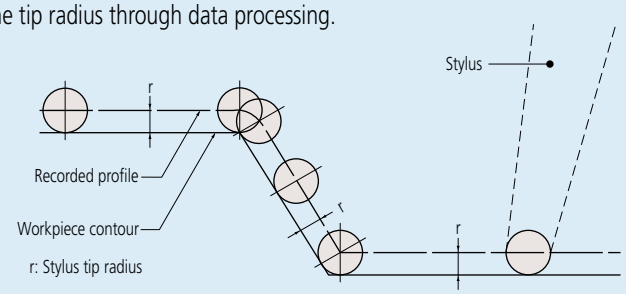
Traceable Angle



The maximum angle at which a stylus can trace upwards or downwards along the contour of a workpiece, in the stylus travel direction, is referred to as the traceable angle. A one-sided sharp stylus with a tip angle of 12° (as in the above figure) can trace a maximum 77° of up slope and a maximum 87° of down slope. For a conical stylus (30° cone), the traceable angle is smaller. An up slope with an angle of 77° or less overall may actually include an angle of more than 77° due to the effect of surface roughness. Surface roughness also affects the measuring force.

Compensating for Stylus Tip Radius

A recorded profile represents the locus of the center of the ball tip rolling on a workpiece surface. (A typical radius is 0.025 mm.) Obviously this is not the same as the true surface profile so, in order to obtain an accurate profile record, it is necessary to compensate for the effect of the tip radius through data processing.

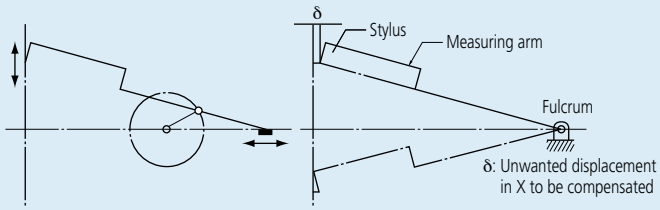


If a profile is read from the recorder through a template or scale, it is necessary to compensate for the stylus tip radius beforehand according to the applied measurement magnification.

Compensating for Arm Rotation

When the stylus traces through a circular-arc, error arises in the X-axis direction of the recorded profile. Possible methods for compensating for this effect are as follows:

1) Mechanical compensation
2) Electrical compensation



3) Software processing. To measure a workpiece contour that involves a large displacement in the vertical direction with high accuracy, one of these compensation methods needs to be implemented.

Accuracy

As the detector units of the X-and Z-axes incorporate scales, the magnification accuracy is displayed not as a percentage but as the linear displacement accuracy for each axis.

Overload Safety Cutout

If an excessive force (overload) is exerted on the stylus tip due, perhaps, to the tip encountering a too-steep slope on a workpiece feature, or a burr, for example, a safety device automatically stops operation and sounds an alarm buzzer. This type of instrument is commonly equipped with separate safety devices for the tracing direction (X axis) load and vertical direction (Z axis) load.

Circular-Arc / Linear Tracing

The locus traced by the stylus tip during vertical stylus movement can be a circular arc or a straight line. Ensuring a straight-line locus entails complex mechanics, while in the case of a circular-arc locus, if the amplitude of stylus displacement is large in the vertical direction, an error (δ) in the recorded profile in the horizontal direction arises. (See figure at lower left)

Z-axis Measurement Methods

Though the X-axis measurement method commonly adopted is by means of a digital scale, the Z-axis measurement divides into analog methods (using a differential transformer, for example) and digital scale methods.
Analog methods vary in Z-axis resolution depending on the measurement magnification and measuring range. Digital scale methods have fixed resolution.
Generally, a digital scale method provides higher accuracy than an analog method.

Contour analysis methods

You can analyze the contour with one of the following two methods after completing the measurement operation.

Data processing section and analysis program

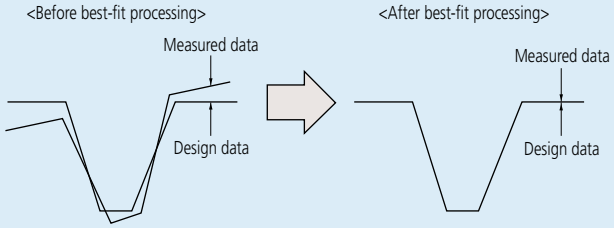
The measured contour is input into the data processing section in real time and a dedicated program performs the analysis using the mouse and/or keyboard. The angle, radius, step, pitch and other data are directly displayed as numerical values. Analysis combining coordinate systems can be easily performed. The graph that goes through stylus radius correction is output to the printer as the recorded profile.

Tolerancing with Design Data

Measured workpiece contour data can be compared with design data in terms of actual and designed shapes rather than just analysis of individual dimensions. In this technique each deviation of the measured contour from the intended contour is displayed and recorded. Also, data from one workpiece example can be processed so as to become the master design data to which other workpieces are compared. This function is particularly useful when the shape of a section greatly affects product performance, or when its shape has an influence on the relationship between mating or assembled parts.

Best-fitting

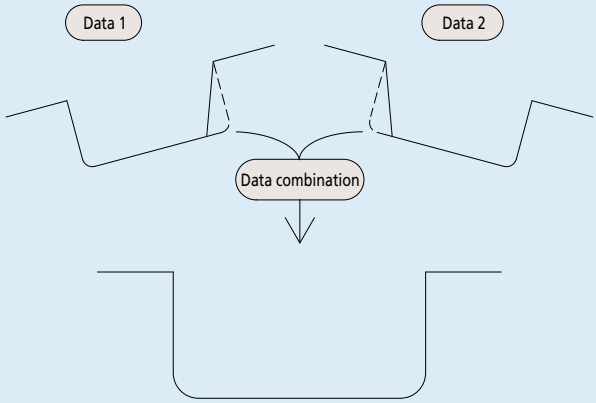
If there is a standard for surface profile data, tolerancing with design data is performed according to the standard. If there is no standard, or if tolerancing only with shape is desired, best-fitting between design data and measurement data can be performed.



The best-fit processing algorithm searches for deviations between both sets of data and derives a coordinate system in which the sum of squares of the deviations is a minimum when the measured data is overlaid on the design data.

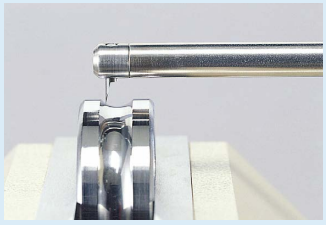
Data Combination

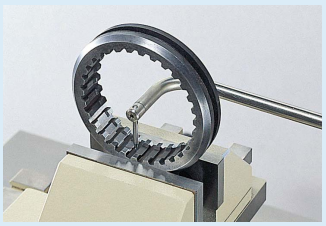
Conventionally, if tracing a complete contour is prevented by stylus traceable-angle restrictions then it has to be divided into several sections that are then measured and evaluated separately. This function avoids this undesirable situation by combining the separate sections into one contour by overlaying common elements (lines, points) onto each other. With this function the complete contour can be displayed and various analyses performed in the usual way.

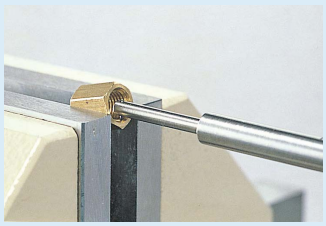


Measurement Examples

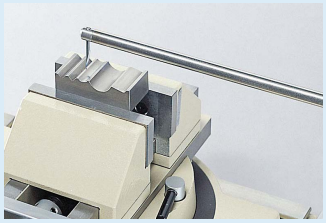

Aspheric lens contour


Inner/outer ring contour of a bearing


Internal gear teeth


Female thread form


Male thread form


Gage contour

L

Mitutoyo

Roundtest

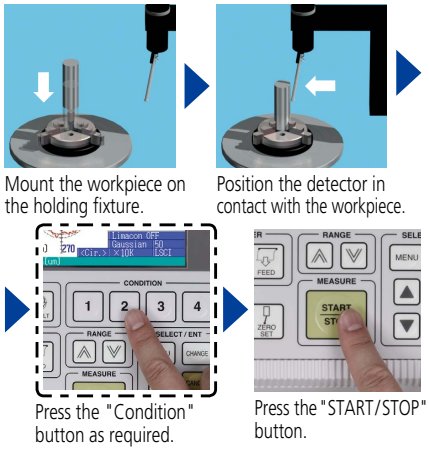
To realize efficient centering and leveling combined with high-precision measurement

Roundtest RA-10
SERIES 211 — Roundness Measuring Instrument

MeasurLink® ENABLED
Data Management Software by Mitutoyo

RA-10

Simple measurement procedure



SPECIFICATIONS

Model No.			RA-10
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.04+6H/10000) μm H: Probing height (mm)
		Axial direction	(0.04+6X/10000) μm X: distance from the center of rotation (mm)
	Maximum probing diameter		ø100 mm
	Maximum loading mass		10 kg
Vertical movement	Vertical travel		117 mm
X axis	Travel range		75 mm (–25 mm to 50 mm from the rotation center)
Detector*	Measuring range		±1000 μm

* Only the standard length stylus is applicable to this detector. The long type cannot be used.

Roundtest RA-120/120P
SERIES 211 — Roundness Measuring Instruments

MeasurLink® ENABLED
Data Management Software by Mitutoyo

RA-120

RA-120P

The analysis capabilities for the various models (**RA-120/120P/10**) vary. For details, refer to page L-26.

SPECIFICATIONS

Model No.			RA-120	RA-120P
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.04+6H/10000) μm H: Probing height (mm)	
		Axial direction	(0.04+6X/10000) μm X: distance from the center of rotation (mm)	
	Maximum probing diameter*1		ø280 mm (ø380 mm: for the vertical position when detector holder is installed reversely, the maximum probing height is up to 50 mm from the table top.)	
	Maximum loading mass		25 kg	
Vertical movement	Vertical travel		280 mm	
X axis	Travel range		165 mm (–25 mm to 140 mm from the rotation center)	
Detector*2	Measuring range		±1000 μm	

*1 Auxiliary stage for a low-height workpiece (optional) is required for the measurement 20 mm or less in the radial direction from the center point of the table and 20 mm or less from the table top.
*2 Only the standard length stylus is applicable to this detector. The long type cannot be used.

MeasurLink® ENABLED
Data Management Software by Mitutoyo

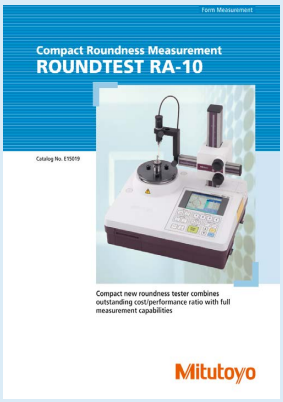
Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

PROPRIETARY INSPECTION CERTIFICATE

An inspection certificate is supplied as standard. Refer to page U-11 for details.

A cost-effective compact instrument that enables full-scale roundness evaluation.

- Offers easy operation for anyone.
  A large, simple key arrangement is used.
- User-friendly operation.
  Measurement results and recorded profiles are easy to view with the large LCD, and can then be printed by the built-in thermal line printer. Furthermore, optional functions to improve usability can be offered.

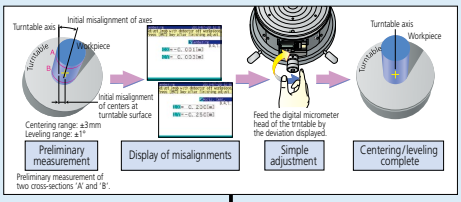


Refer to the Roundtest **RA-10** Brochure (**E15019**) for more details.

Easy operation, compact and outstanding cost/performance ratio, designed for use on the shop-floor right beside the production line.

- D.A.T. (Digimatic Adjustment Table) function aids adjustments such as centering and leveling, and substantially reduces the time required for preliminary setup operations.

What is the D.A.T. function? <Patented>

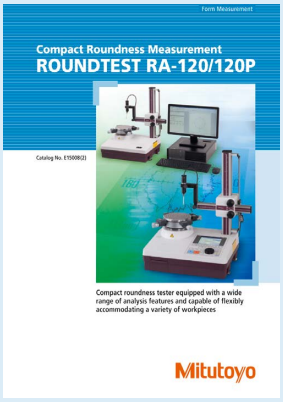


Dedicated analysis unit type (RA-120)

- Compact, lightweight design from incorporating electronic components inside the main unit.

Data analysis by PC (RA-120P)

- **ROUNDPAK**, a data analysis program employs Windows OS and archived higher level of analysis.



Refer to the Roundtest **RA-120/120P** Brochure (**E15008**) for more details.

MeasurLink ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

PROPRIETARY INSPECTION CERTIFICATE

An inspection certificate is supplied as standard. Refer to page U-11 for details.

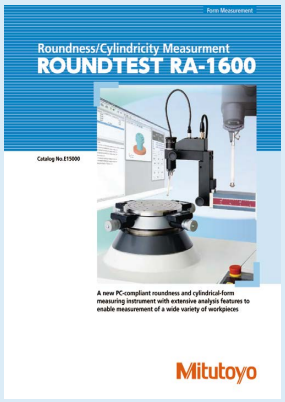
Roundtest RA-1600
SERIES 211 — Roundness/Cylindricity Measuring System

MeasurLink ENABLED
Data Management Software by Mitutoyo

- Compact body and a wide measuring range assures precision that compares well with that of higher-grade models.
- D.A.T. (Digital Adjustment Table) function aids manual workpiece centering and leveling.
- Safety mechanism provided in the detection section as a standard feature.
- A sliding mechanism (optional sliding detector holder) can be installed in the detector holder. It enables one-touch measurement of a workpiece with a deep hole having a thick wall, which has been difficult with the standard detector.

Detector safety mechanism

RA-1600



Refer to the Roundtest **RA-1600** Brochure (**E15000**) for more details.

SPECIFICATIONS

Model No.			RA-1600
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.02+6H/10000) µm H: Probing height (mm)
		Axial direction	(0.02+6X/10000) µm X: Distance from the center of rotation (mm)
	Maximum loading mass		25 kg
	Maximum probing diameter		ø280 mm
Vertical movement (Z-axis column unit)	Vertical travel		300 mm
X axis	Travel range		165 mm (–25 mm to +140 mm from the rotation center)
Detector	Measuring range	Standard	±400 µm/±40 µm/±4 µm
		Tracking	±5 mm

Roundtest RA-2200
SERIES 211 — Roundness/Cylindricity Measuring System

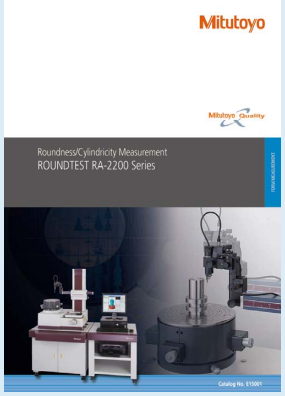
MeasurLink ENABLED
Data Management Software by Mitutoyo

Achieved the world's highest level of accuracy for this class of machine. A high-performance automatic system equipped with a high-speed automatic centering/leveling function.

- High-speed automatic centering/leveling function contributes to a significant reduction in the man-hours required for setups.
- A fully automatic system which performs processing automatically from part program calling, centering/leveling, measurement, calculation, all the way through to printing.
- Capable of continuous inside/outside diameter measurement without changing the detector orientation (up to 50 mm ID).
- The automatic positioning function of the turntable enables automatic measurement in combination with table rotation and slider/column movement.
- Advanced graphical analysis such as power spectrum chart is available.
- A sliding mechanism is incorporated in the detector holder part.

RA-2200 AS
System vibration isolator (with side table)

RA-2200 AS
System vibration isolator (monitor arm type)*
* Printer table (provided by the customer) not shown.



Refer to the Roundtest **RA-2200** Series Brochure (**E15001**) for more details.

SPECIFICATIONS

Model No.			RA-2200AS	RA-2200DS	RA-2200AH	RA-2200DH
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.02+3.5H/10000) µm H: Probing height (mm)			
		Axial direction	(0.02+3.5X/10000) µm X: Distance from the center of rotation(mm)			
	Maximum loading mass		30 kg			
	Maximum probing diameter		ø300 mm			
Vertical movement (Z-axis column unit)	Vertical travel		300 mm		500 mm	
X axis	Travel range		175 mm (–25 mm to +150 mm from the rotation center)			
Detector	Measuring range	Standard	±400 µm/±40 µm/±4 µm			
		Tracking	±5 mm			

L

Roundtest

To realize efficient centering and leveling combined with high-precision measurement

MeasurLink® ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

Mitutoyo guarantees the product quality. Mitutoyo guarantees the product quality. PROPRIETARY INSPECTION CERTIFICATE

An inspection certificate is supplied as standard. Refer to page U-11 for details.

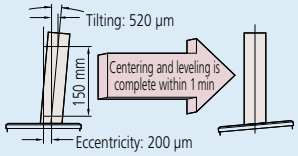
Roundtest RA-H5200 SERIES 211 — Roundness/Cylindricity Measuring System

MeasurLink® ENABLED
Data Management Software by Mitutoyo

RA-H5200AH
with side table

A high-performance automatic system equipped with a high-speed automatic centering/leveling function achieves the world's highest-level of accuracy.

- High-speed automatic centering/leveling function contributes to a significant reduction in the man-hours required for setups.



- A fully automatic system which performs processing automatically from part program calling, centering/leveling, measurement, calculation, all the way through to printing.
- Capable of continuous inside/outside diameter measurement without changing the detector orientation (up to 50 mm ID).
- The automatic positioning function of the turntable enables automatic measurement in combination with table rotation and slider/column movement.
- Advanced graphical analysis such as a power spectrum chart is available.
- A sliding mechanism is incorporated in the detector holder.

SPECIFICATIONS

Model No.			RA-H5200AS	RA-H5200AH
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.02+3.5H/10000) µm H: Probing height (mm)	
		Axial direction	(0.02+3.5X/10000) µm X: Distance from the center of rotation (mm)	
	Maximum loading mass		80 kg (On auto-centering: 65 kg)	
	Maximum probing diameter		ø400 mm	
Vertical movement (Z-axis column unit)	Vertical travel		350 mm	550 mm
X axis	Travel range		225 mm (–25 mm to +200 mm from the rotation center)	
Detector	Measuring range	Standard	±400 µm/±40 µm/±4 µm	
		Tracking	±5 mm	

Roundtest Extreme RA-2200 CNC SERIES 211 — CNC Roundness/Cylindricity Measuring System

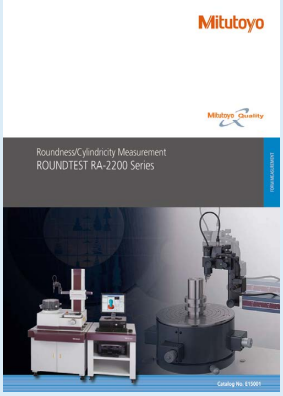
MeasurLink® ENABLED
Data Management Software by Mitutoyo

RA-2200 CNC
System vibration isolator (with side table)

- **Highly accurate and easy-to-use turntable.**
  The turntable with automatic centering and leveling function is equipped as standard, which frees operators from manual centering and leveling operations.
- **A function to change the detector posture enables CNC automatic measurement.**
  Automatic control of holder arm posture (vertical/horizontal) and the rotation feature of the detector (rotates in 1° increments in the range of 0 to 270°) enables continuous measurement of various feature combinations, such as OD/ID and/or top/bottom plane measurements.
- **A positioning sensor to achieve CNC high-accuracy automatic measurement.**
  A Mitutoyo linear scale is used in the X-axis drive unit to directly detect the position of the drive unit. It guarantees the highly precise positioning vital for automatic measurement.
- **A roughness detector (optional) is supported.**

SPECIFICATIONS

Model No.			RA-2200 CNC
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.02+3.5H/10000) µm H: Probing height (mm)
		Axial direction	(0.02+3.5X/10000) µm X: Distance from the center of rotation (mm)
	Maximum loading mass		30 kg
	Maximum probing diameter		ø256 mm
Vertical movement (Z-axis column unit)	Vertical travel		300 mm / 500 mm
X axis	Travel range		175 mm
Detector	Measuring range	Standard	±400 µm/±40 µm/±4 µm
		Tracking	±5 mm



Refer to the Roundtest **RA-2200** Series Brochure (**E15001**) for more details.

MeasurLink ENABLED
Data Management Software by Mitutoyo

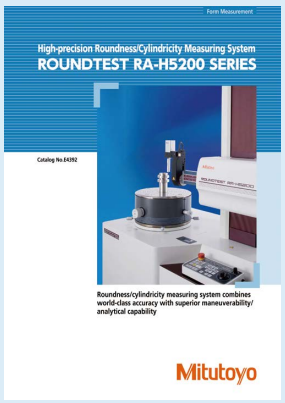
Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

PROPRIETARY INSPECTION CERTIFICATE

An inspection certificate is supplied as standard. Refer to page U-11 for details.

Top productivity and performance from a CNC machine with highest-level accuracy.

- The turntable with automatic centering and leveling function is equipped as standard, which frees operators from manual centering and leveling operations.
- Automatic control of holder arm posture (vertical/horizontal) and the rotation feature of the detector (rotates in 1° increments in the range of 0 to 270°) enables continuous measurement of various feature combinations, such as OD/ID and/or top/bottom plane measurements.
- A Mitutoyo linear scale is used in the X-axis drive unit to directly detect the position of the drive unit. It guarantees the highly precise positioning vital for automatic measurement.
- A roughness detector (optional) is supported.



Refer to the Roundtest **RA-H5200** Series Brochure (**E4392**) for more details.

MeasurLink ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

The best accuracy achieved in the class of large cylindricity measuring machine.

- Loading capacity is 350 kg, and the highest rotational accuracy in the class is achieved. Besides roundness and cylindricity, the flatness can be measured in high accuracy. The workpiece that requires high accuracy measurement such as large and heavy cylindrical parts can be measurement.
- For the ID measurement of a deep hole, such as a main shaft of machine tool, a deep hole measuring unit (specially made, without CNC functions) is available.
- A Mitutoyo linear scale is used in the X-axis drive unit to directly detect the position of the drive unit. It guarantees the highly precise positioning vital for automatic measurement.

Roundtest Extreme RA-H5200 CNC SERIES 211 — CNC Roundness/Cylindricity Measuring System

MeasurLink ENABLED
Data Management Software by Mitutoyo

RA-H5200 CNC
with side table

SPECIFICATIONS

Model No.			RA-H5200 CNC	
Z-axis column unit			Standard column specification (Vertical travel: 350 mm)	High column specification (Vertical travel: 550 mm)
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.02+3.5H/10000) µm H: Probing height (mm)	
		Axial direction	(0.02+3.5X/10000) µm X: Distance from the center of rotation (mm)	
	Maximum loading mass		80 kg (On auto-centering: 65 kg)	
	Maximum probing diameter		ø356 mm	
Vertical movement (Z-axis column unit)	Vertical travel		350 mm	550 mm
X axis	Travel range		225 mm	
Detector	Measuring range	Standard	±400 µm/±40 µm/±4 µm	
		Tracking	±5 mm	

Roundtest Extreme RA-6000 CNC SERIES 211 — CNC Roundness/Cylindricity Measuring System

MeasurLink ENABLED
Data Management Software by Mitutoyo

RA-6000 CNC

SPECIFICATIONS

Model No.			RA-6000 CNC
Turntable	Rotational accuracy *1*2 (JIS B 7451-1997)	Radial direction	(0.05+6H/10000) µm H: Probing height (mm)
		Axial direction	(0.05+6X/10000) µm X: Distance from the center of rotation (mm)
	Maximum loading mass		350 kg
	Maximum probing diameter		ø880 mm
Vertical movement (Z-axis column unit)	Vertical travel		1050 mm
X axis	Travel range		465 mm
Detector	Measuring range	Standard	±400 µm/±40 µm/±4 µm
		Tracking	±5 mm

*1 The temperature at which the accuracy can be guaranteed is 20 °C.
*2 The rotational accuracy has been obtained when load is applied to the rotation center.

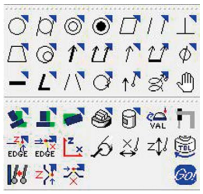
L

Mitutoyo

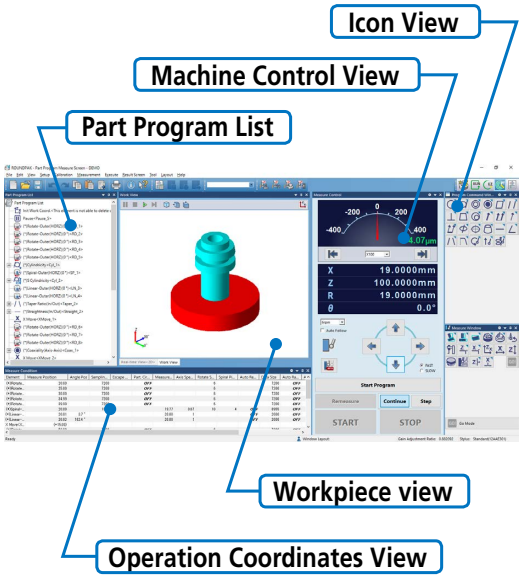
Roundtest

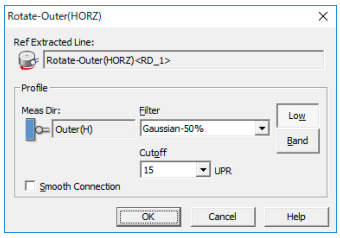
To realize efficient centering and leveling combined with high-precision measurement

ROUNDPAK
Roundness/Cylindricity measurement/Analysis software

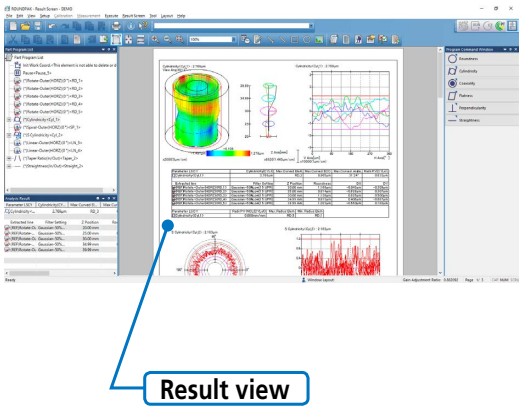


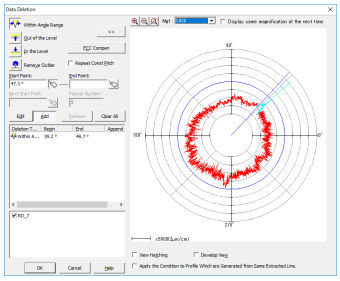
• A wide variety of parameters including those for roundness/cylindricity, as well as flatness and parallelism, are provided as standard features. You can visually select these parameters using icons. **ROUNDPAK** also comes with specialized functions, such as the design value best-fit analysis function, the harmonic analysis function, and a function for recording the peak or trough points on a circumference. Data that has already been collected can be easily used for re-calculation, or deleted.





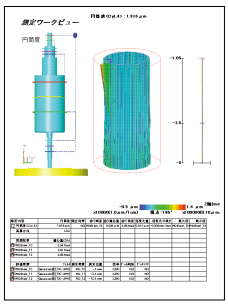
Recalculation

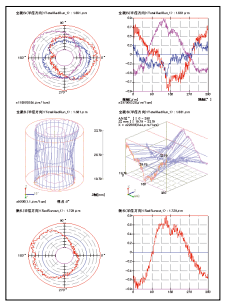




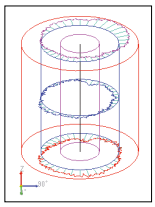
Data deletion

• The customer can create reports in custom formats by specifying how the analysis results will be displayed, as well as the sizes and positions of graphics. The analysis result window can be directly utilized as a layout window. Since the measurement procedure, including the layout information, is saved, the entire process, from measurement start, calculation, result saving, and finally to printing, can be automatically executed.

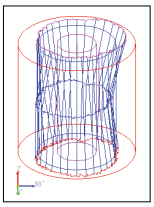




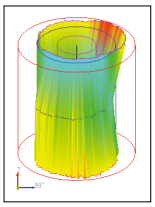
• Analysis results such as cylindricity and coaxiality can be visually expressed in 3D graphics.



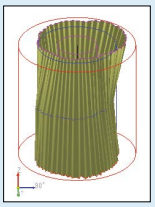
Normal display



Wire-frame display

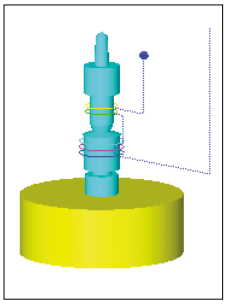


Surface-map display



Shading display

• An offline teaching function is provided to create a part program (measurement procedure) without an actual measurement target, enabling the user to virtually execute the measurement operation in a 3D simulation window.



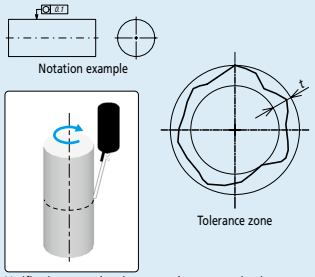
Analysis type \ Model		RA-2200/H5200 RA-2200CNC/ H5200CNC/6000CNC	RA-1600	RA-120P	RA-120	RA-10
Roundness		✓	✓	✓	✓	✓
Cylindricity		✓	✓			
Concentricity		✓	✓	✓	✓	✓
Coaxiality	Axis element	✓	✓	✓	✓	✓
	Axis	✓	✓	✓		
Flatness		✓	✓	✓	✓	✓
Parallelism		✓	✓	✓	✓	
Perpendicularity		✓	✓	✓	✓	
Radial deviation		✓	✓			
Thickness deviation		✓	✓	✓	✓	
Radial runout		✓	✓	✓	✓	✓
Total runout		✓	✓			
Diameter measurement		✓	✓			
Straightness		✓	✓			
Inclination		✓	✓			
Taper		✓	✓			
Diameter contour tolerancing		✓	✓			
Rectilinear contour tolerancing		✓	✓			
Width measurement (only CNC)		✓ (only CNC)				
Power spectrum		✓	✓			
Harmonic analysis		✓	✓	✓		
Profile operation		✓	✓	✓		
Tapered surface analysis		✓	✓			

L

Roundtest (Roundform Measuring Instruments)

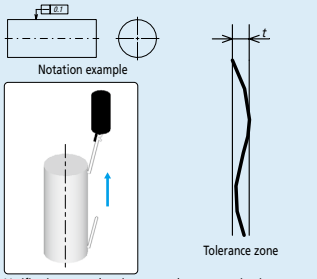
Geometrical tolerances ISO/DIS 1101: 1996*1, ISO 5459*2

Roundness
Any circumferential line must be contained within the tolerance zone formed between two coplanar circles with a difference in radii of t



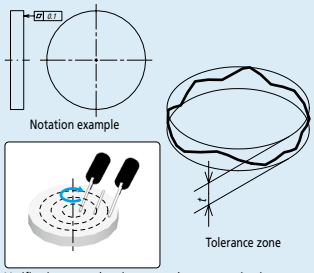
Verification example using a roundness measuring instrument

Straightness
Any line on the surface must lie within the tolerance zone formed between two parallel straight lines a distance t apart and in the direction specified



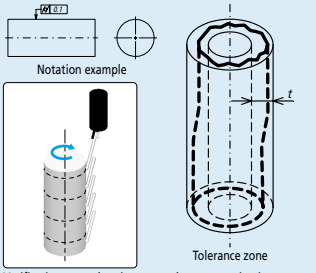
Verification example using a roundness measuring instrument

Flatness
The surface must be contained within the tolerance zone formed between two parallel planes a distance t apart



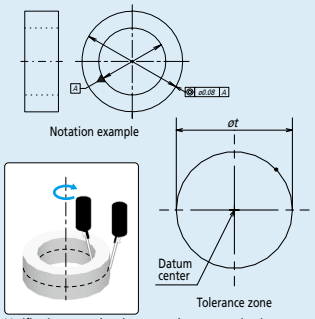
Verification example using a roundness measuring instrument

Cylindricity
The surface must be contained within the tolerance zone formed between two coaxial cylinders with a difference in radii of t



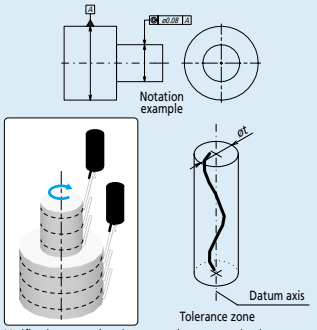
Verification example using a roundness measuring instrument

Concentricity
The center point must be contained within the tolerance zone formed by a circle of diameter t concentric with the datum



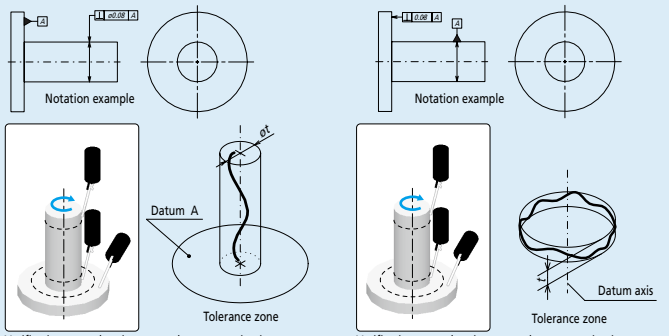
Verification example using a roundness measuring instrument

Coaxiality
The axis must be contained within the tolerance zone formed by a cylinder of diameter t concentric with the datum



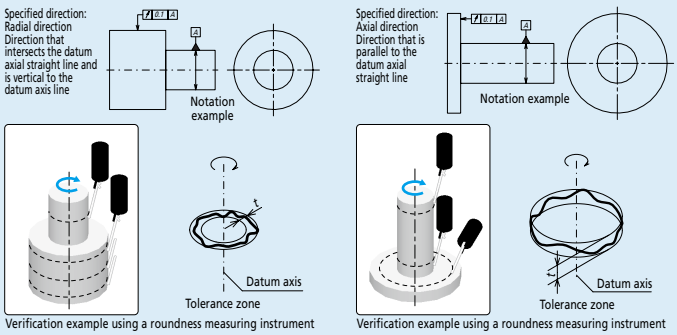
Verification example using a roundness measuring instrument

Perpendicularity
The line or surface must be contained within the tolerance zone formed between two planes a distance t apart and perpendicular to the datum



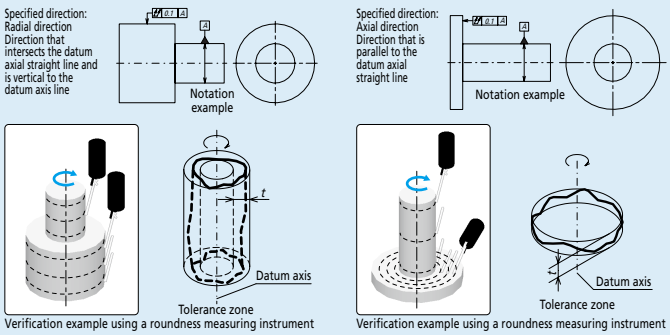
Verification example using a roundness measuring instrument

Circular Runout (Radial and Axial)
The line must be contained within the tolerance zone formed between two coplanar and/or concentric circles a distance t apart concentric with or perpendicular to the datum



Verification example using a roundness measuring instrument

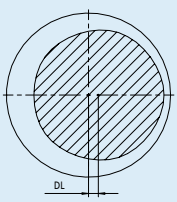
Total Runout (Radial and Axial)
The surface must be contained within the tolerance zone formed between two coaxial cylinders with a difference in radii of t, or planes a distance t apart, concentric with or perpendicular to the datum

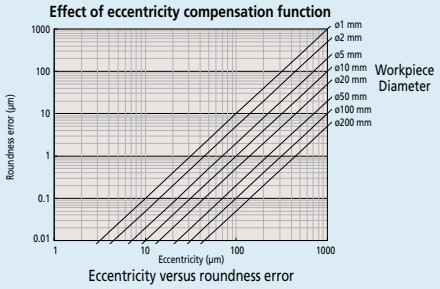


Verification example using a roundness measuring instrument

Adjustment prior to Measurement ISO 4291:1985*3

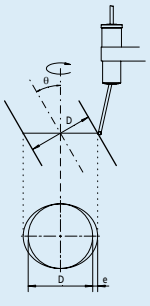
Centering
A displacement offset (eccentricity) between the Roundtest's turntable axis and that of the workpiece results in distortion of the measured form (limaçon error) and consequentially produces an error in the calculated roundness value. The larger the eccentricity, the larger is the error in calculated roundness. Therefore the workpiece should be centered (axes made coincident) before measurement.
Some roundness testers support accurate measurement with a limaçon error correction function.
The effectiveness of this function can be seen in the graph below.

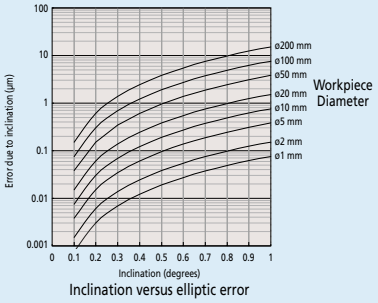




Eccentricity versus roundness error

Leveling
Any inclination of the axis of a workpiece with respect to the rotational axis of the measuring instrument will cause an elliptic error. Leveling must be performed so that these axes are sufficiently parallel.

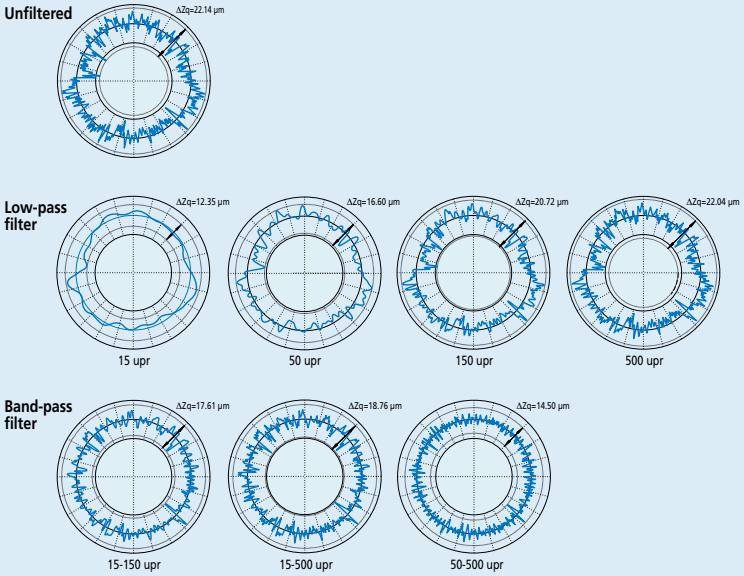




Inclination versus elliptic error

Effect of Filter Settings on the Measured Profile ISO 12181-2: 2011*4

Profiles can be filtered in various ways to reduce or eliminate unwanted detail, with a cut-off value set in terms of undulations per revolution (upr). The effect of different upr settings is shown in the diagrams below, which illustrate how the measured roundness value decreases as lower upr settings progressively smooth out the line.



Filtering

	2CR filter	Gaussian filter
Standard	ISO 4291: 1985*3	ISO 12181-1: 2011*5
Attenuation rate	75 %	50 %

Terms and abbreviated terms ISO 12181-1: 2011*5

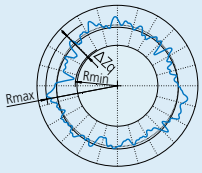
Abbreviated terms	Terms
LSCI	Least squares reference circle
LSCY	Least squares reference cylinder
LSLI	Least squares reference line
LSPL	Least squares reference plane
LCD	Local cylindricity deviation
LFD	Local flatness deviation
LRD	Local roundness deviation
LSD	Local straightness deviation
MICI	Maximum inscribed reference circle
MICY	Maximum inscribed reference cylinder
MCCI	Minimum circumscribed reference circle
MCCY	Minimum circumscribed reference cylinder
MZCI	Minimum zone reference circles
MZCY	Minimum zone reference cylinder
MZLI	Minimum zone reference lines
MZPL	Minimum zone reference planes
UPR	Undulations per revolution

Evaluating the Measured Profile Roundness ISO 12181-1: 2011*5, ISO 4291: 1985*3

Roundness testers use the measurement data to generate reference circles whose dimensions define the roundness value. There are four methods of generating these circles, as shown below, and each method has individual characteristics so the method that best matches the function of the workpiece should be chosen.
Each method results in a different center position for the reference circles and therefore affects the axial location of the circular feature measured.

Least Square Circle (LSC)

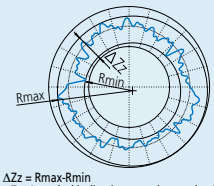
A circle is fitted to the measured profile such that the sum of the squares of the departure of the profile data from this circle is a minimum. The roundness figure is then defined as the difference between the maximum deviation of the profile from this circle (highest peak to the lowest valley).



ΔZq = Rmax-Rmin
ΔZq: A symbol indicating roundness value by LSC.

Minimum Zone Circles (MZC)

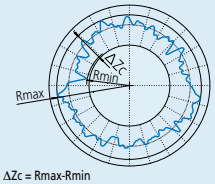
Two concentric circles are positioned to enclose the measured profile such that their radial difference is a minimum. The roundness figure is then defined as the radial separation of these two circles.



ΔZz = Rmax-Rmin
ΔZz: A symbol indicating roundness value by MZC.

Minimum Circumscribed Circle (MCC)

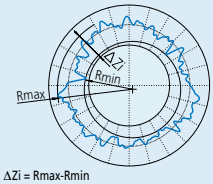
The smallest circle that can enclose the measured profile is created. The roundness figure is then defined as the maximum deviation of the profile from this circle. This circle is sometimes referred to as the 'ring gage' circle.



ΔZc = Rmax-Rmin
ΔZc: A symbol indicating roundness value by MCC.

Maximum inscribed Circle (MIC)

The largest circle that can be enclosed by the profile data is created. The roundness figure is then defined as the maximum deviation of the profile from this circle. This circle is sometimes referred to as the `plug gage' circle.



ΔZi = Rmax-Rmin
ΔZi: A symbol indicating roundness value by MIC.

Parameters and abbreviated terms ISO 12181-1: 2011*5

Abbreviated terms	Parameter	Reference element*			
		Minimum zone	Least square	Minimum circumscribed	Minimum inscribed
CYLtt	Cylinder taper		✓		
STRsg	Generatrix straightness deviation		✓		
STRlc	Local generatrix straightness deviation		✓		
CYLp	Peak-to-reference cylindricity deviation		✓		
FLTp	Peak-to-reference flatness deviation		✓		
RONp	Peak-to-reference roundness deviation		✓		
STRp	Peak-to-reference straightness deviation		✓		
CYLt	Peak-to-valley cylindricity deviation	✓	✓	✓	✓
FLTt	Peak-to-valley flatness deviation	✓	✓		
RONt	Peak-to-valley roundness deviation	✓	✓	✓	✓
STRt	Peak-to-valley straightness deviation	✓	✓		
CYLv	Reference-to-valley cylindricity deviation		✓		
FLTv	Reference-to-valley flatness deviation		✓		
RONv	Reference-to-valley roundness deviation		✓		
STRv	Reference-to-valley straightness deviation		✓		
CYLq	Root-mean-square cylindricity deviation		✓		
FLTq	Root-mean-squareflatness deviation		✓		
RONq	Root-mean-square roundness deviation		✓		
STRq	Root-mean-square straightness deviation		✓		
STRsa	Straightness deviation of the extracted median line	✓	✓	✓	✓

* The reference elements to which the parameter can be applied.

*1 ISO/DIS 1101: 1996 Geometrical Product Specifications (GPS) - Geometrical tolerancing - Tolerancing of form, orientation, location and run-out
*2 ISO 5459 Technical drawings - Geometrical tolerancing - Datums and datum-systems for geometrical tolerances
*3 ISO 4291: 1985 Methods for the assessment of departure from roundness - Measurement of variations in radius
*4 ISO 12181-2: 2011 Geometrical Product Specifications (GPS) - Roundness - Part2: Specification operators
*5 ISO 12181-1: 2011 Geometrical Product Specifications (GPS) - Roundness - Part 1: Vocabulary and parameters of roundness