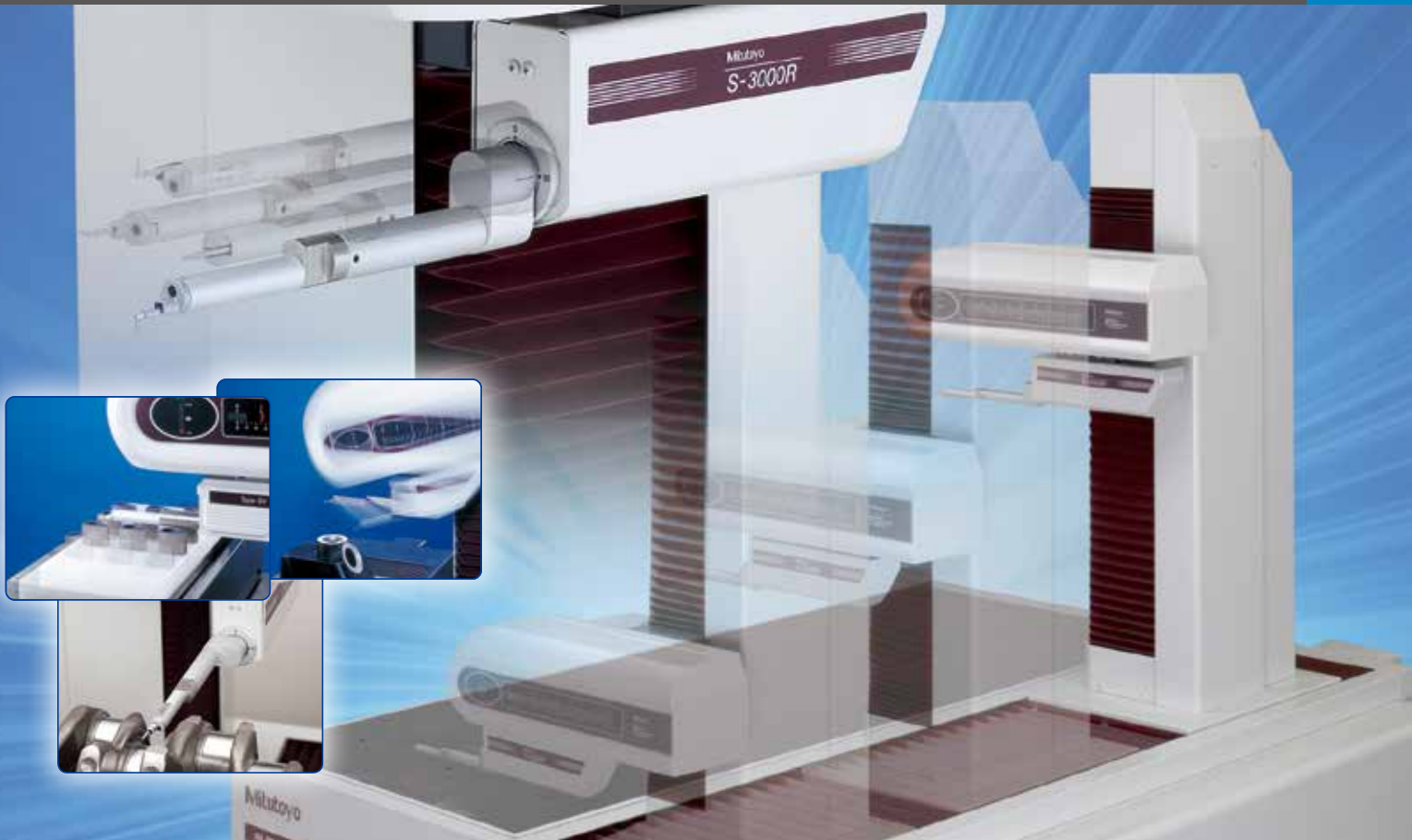# Mitutoyo

Surface Roughness/Contour/Surface Texture Measuring Instrument
CNC Form Measuring Instrument Series
Surftest Extreme
Formtracer Extreme

Form Measurement

S-3000R

Mitutoyo

CNC Surface Roughness Measuring Instrument

Surftest Extreme

CNC Surface Roughness / Contour Measuring Instrument
CNC Surface Texture Measuring Instrument
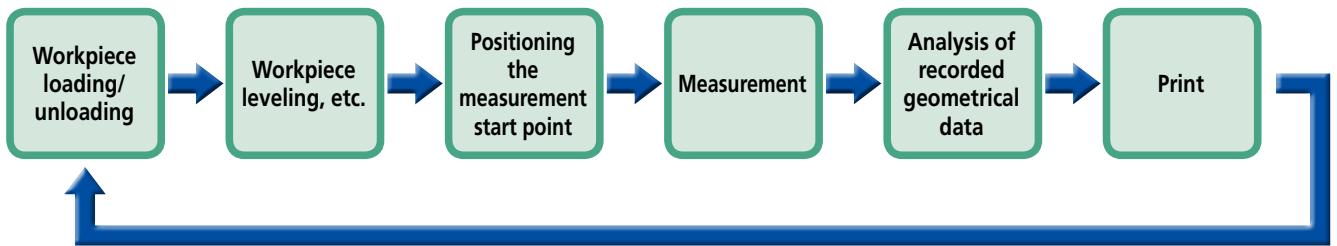
Formtracer Extreme

The world's leading range of CNC Form Measuring Instruments ushers in a new age of automated measurement. Simply switching to the dedicated part program for each workpiece greatly improves measurement throughput and helps maximize productivity.

Towards improved measurement efficiency

Ties up the operator for an extended period of time.

■ **Existing measurement process**

| Workpiece loading/ unloading | → | Workpiece leveling, etc. | → | Positioning the measurement start point | → | Measurement | → | Analysis of recorded geometrical data | → | Print |

To be repeated for all workpieces.

■ **CNC Measurement**

As soon as a workpiece pallet is loaded, measurement can be started.

A CNC measuring machine runs unmanned. Now the operator can commit to other tasks.

Crankshaft

Time for measurement

Manual 90 minutes → **CNC 20 minutes**
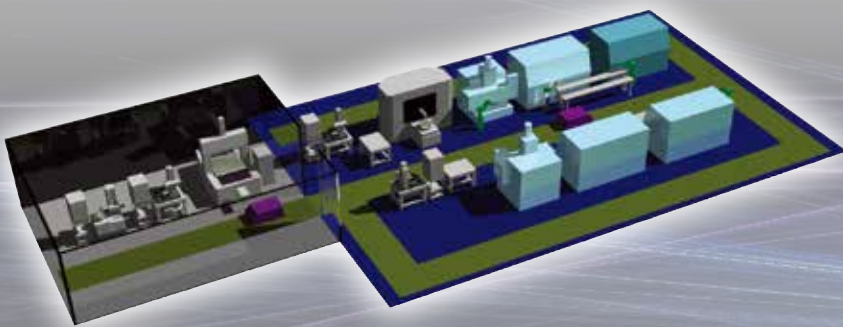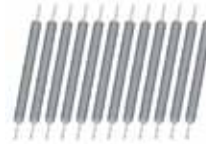
Measurement conditions

Number of measurement points: Approx. 40 points
Measuring position: Pin/Journal/Thrust surface.
Measuring direction: Along the axis of each cylindrical unit/On the surface of each thrust bearing.
Preliminary arrangements: Shifting workpiece/Changing workpiece position/Alignment
Analysis items: Surface roughness/Straightness

Alignment in the direction of measurement or mounting the shaft takes time, and can require two people!

Printer roll

Time for measurement

Manual 50 minutes → **CNC 15 minutes**
(Each estimated time covers measurement of ten rolls.)

Measurement conditions

Number of measurement points: Approx. 3 points/Workpiece
Measuring position: On the cylinder's generatrix.
Measurement direction: Along the generatrix axis
Preliminary arrangements: Workpiece change/Alignment
Analysis items: Surface roughness/Straightness

Little time is required to measure only one piece. However, as the number of pieces to be measured within a day becomes large, so does the total time required for alignment, resulting in a time-consuming job!

Cylinder head

Time for measurement

Manual 90 minutes → **CNC 30 minutes**

Measurement conditions

Number of measurement points: Approx. 60 points
Measuring position: Six surfaces and the inside diameter of each bore.
Measuring direction: Multiple directions including the top, bottom, and side surfaces; and in the inclined holes.
Preliminary arrangements: Shifting workpiece/Changing workpiece position/Alignment, etc.
Analysis items: Surface roughness/Contour and profile

Since more than ten position changes are required to set the workpiece at the measuring point, the measurement efficiency is badly affected!

Aspheric surface lens

Time for measurement

Manual 40 minutes → **CNC 5 minutes**

Measurement conditions

Number of measurement points: Approx. 2 points
Measurement position: Along two lines crossing each other on the sectional plane perpendicular to the optical axis
Measurement direction: Backward
Preliminary Arrangements: Workpiece rotation/Workpiece leveling/Optical axis positioning
Analysis items: Contour and profile/Tolerance zone measurement data/Surface roughness

It is critical to measure at the sectional profile, which is perpendicular to the optical axis and necessitates a significant amount of time for establishing the complete settings!

Transmission gear

Time for measurement

Manual 20 minutes → **CNC 5 minutes**
(Each estimated time covers measurement of four teeth.)

Measurement conditions

Number of measurement points: Approx. 4 points
Measuring position: Near tip of tooth.
Measuring direction: Tangent line
Preliminary arrangements: Workpiece rotation/Workpiece positioning
Analysis item: Contour and profile

Although the rotary positioning at every 90° requires simple repetitive operations, a significant difference will result in the amount of time required and the accuracy depending on the operator's skill.

Rotor/Spindle for motors

Time for measurement

Manual 40 minutes → **CNC 20 minutes**
(Measurement of 20 workpieces is estimated within each time period.)

Measurement conditions

Number of measurement points: Approx. 2 points/Workpiece
Measuring position: On the cylinder's generatrix
Measurement direction: Along the generatrix axis
Preliminary arrangements: Workpiece change/Alignment
Analysis items: Surface roughness/Straightness

It takes little time to measure only one piece. However, since it is often the case that many workpieces are measured during each job, the total setting time required may become too large for piece-by-piece setting!

Valve body

Time for measurement

Manual 40 minutes → **CNC 15 minutes**

Measurement conditions

Number of measurement points: Approx. 20 points
Measuring position: Seating surface and holes
Measurement direction: Top surface and the hole inside diameter in any of the three directions.
Preliminary arrangements: Shifting workpiece/Changing workpiece position/Alignment, etc.
Analysis items: Surface roughness

The seating surface can be measured easily after shifting the workpiece appropriately. However, it is not so easy to measure the inside surface roughness of a hole, since the measuring position may be difficult to see by the operator during positioning!
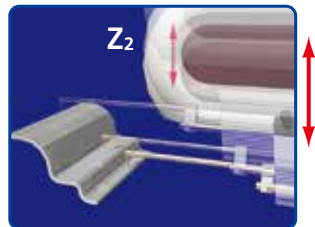
A Range of Functions Enhance Your Measurement Efficiency

Accelerating measurement efficiency through new measuring functions under CNC control

- **Tracking measurement function**

  The Z_2-axis* control makes the target range of form (contour) tracing measurement wider than that covered by only the detector unit.
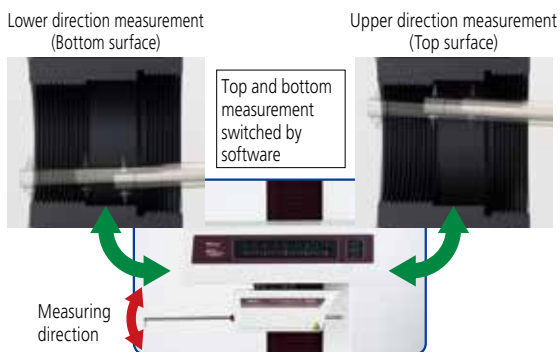
  * Upward and downward movement of detector unit

- **Upper/lower surface continuous measurement function (for contour measurement)**

  Upper and lower surfaces can be measured continuously by using Mitutoyo's double-sided conical stylus.

  This continuous measurement data can be used to facilitate analysis of features that were difficult to measure before, such as the effective diameter of an internal screw-thread.

  Lower direction measurement (Bottom surface)

  Upper direction measurement (Top surface)

  Top and bottom measurement switched by software

  Measuring direction

- **Inclined plane measurement function (surface roughness)**

  Simultaneous control over the X axis and Y axis enables oblique-movement measurement to be performed.

  Even continuous measurement can be achieved without re-setting the workpiece so that the measuring direction can be parallel to the drive unit.

  X-axis displacement range
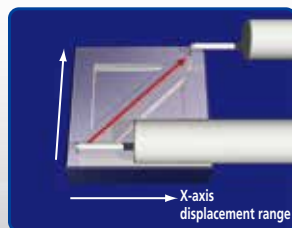
- Confining all cables needed for the detector and drive unit internally has eliminated cable friction that could be one of the causes of a measurement error, while at the same time achieving high-speed drive.

Part program-guided automatic continuous measurement of multiple points/multiple workpieces

- The use of the Y-axis table makes it possible to perform automatic continuous measurement of multiple workpieces (measurement points).
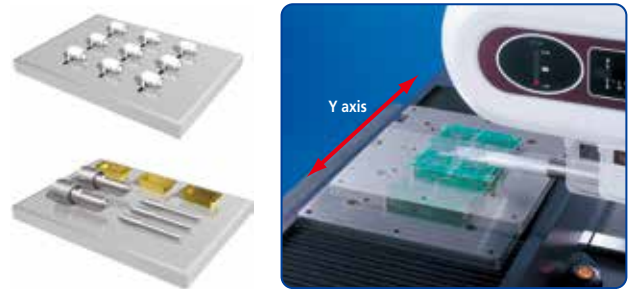
  Y axis

  Y-axis table

- Models with the α axis (incorporated with the drive unit tilting function) enable continuous measurement on multiple sections of surfaces including inclined portions without changing the initial set up.
- Installs the Automatic Leveling Function using the α axis or optional Auto Leveling Table.
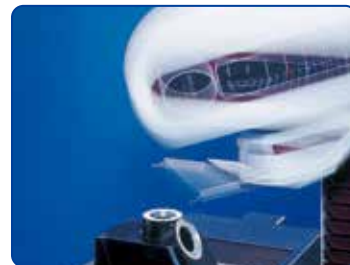
  With α axis

High-throughput measurement enabled by fast positioning

- Thanks to its high drive speed (a maximum of 200 mm/s*), which is the fastest in the world, and multiple-axis simultaneous control, the detector can be positioned practically instantaneously on the target measurement point.

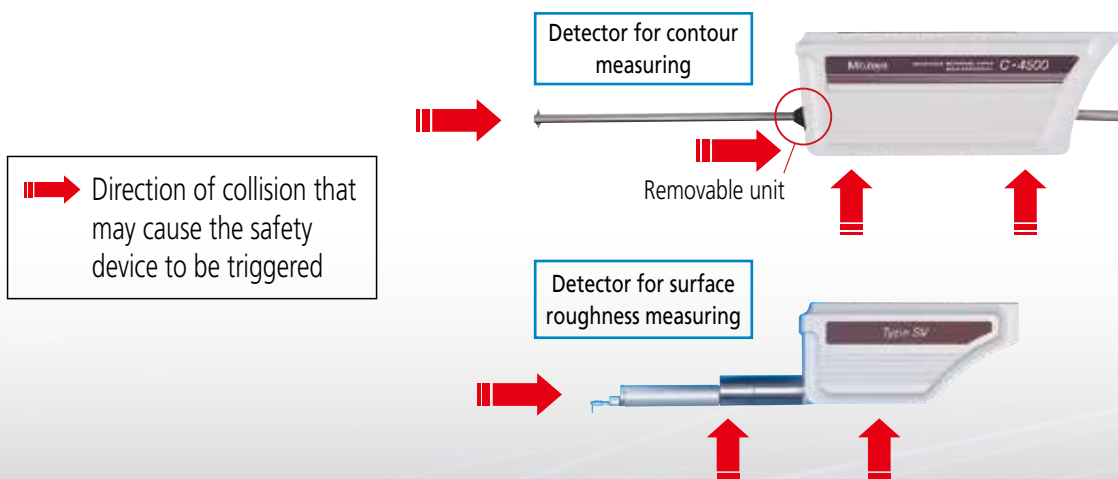 (* Maximum 40 mm/s for CS-5000CNC)

Easy-to-use Remote Box allows the operator to control the measuring unit at hand

- Easy-to-understand operation buttons identified by each icon marked on the top.
- Also provided with the Speed Override Knob, which allows the operator to change the traveling speed even during automatic execution.

Speed Override Knob that allows real-time change of traveling speed

Easy-to-understand operation buttons
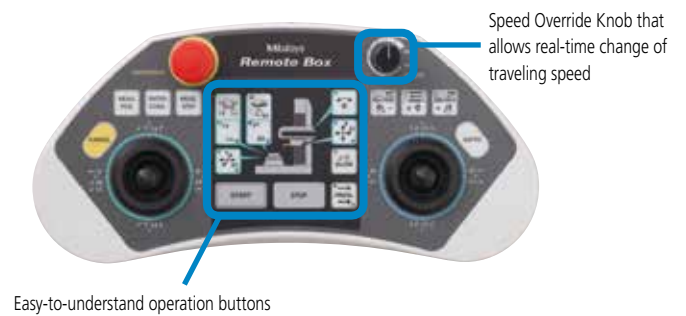
An anti-collision safety function is also provided to protect the operator, measuring unit, and/or workpiece from damage.

→ This safety device will automatically stop the measuring unit should a collision occur.

Direction of collision that may cause the safety device to be triggered

Detector for contour measuring

Removable unit

Detector for surface roughness measuring

Mitutoyo

FORMTRACEPAK, the surface roughness/contour analysis software that strongly supports CNC measurement

- **Workpiece identification (coordinate system alignment)**

  It is possible to measure the same point even when the current workpiece is positioned in a place offset from that which was set at the time of creating the part program, if the operator establishes the workpiece coordinate system another time.

Identifies the coordinate system through edge measurement.
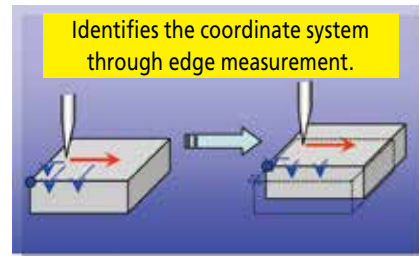
- **Supports multiple-part measurement.**

  By repeatedly running one section of a part program using the loop function, it is possible to batch-measure multiple workpieces having an identical form.

Repeated measurement via the loop function

One workpiece
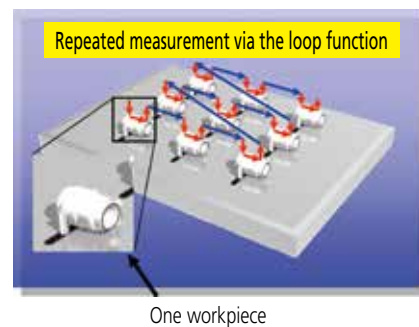
- **Supports automation.**

  The optional software FORMEio, which enables external control, allows users to control the measuring instrument and monitor its status through a PLC (Programmable Logic Controller).

Contributes greatly to your productivity improvement by increasing measurement throughput. The world's leading range of CNC Form Measuring Instruments ushers in a new age of automated measurement.

Surftest Extreme
SV-3000CNC
(With drive unit inclination mechanism)

Surftest Extreme
SV-M3000CNC
(Y-axis column moving type Surface Roughness Measuring Instrument)
(Picture above is special specification)

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

Formtracer Extreme
SV-C4500CNC
(Example of mounting detector for contour measurement)
(With drive unit inclination mechanism and Y-axis table)

Formtracer Extreme
CS-5000CNC / CS-H5000CNC
(Picture above is **CS-H5000CNC** with **3D** Auto-leveling Table and compact θ^1-axis/Y-axis table)

Mitutoyo

CNC Surface Roughness Measuring Instrument

Surftest Extreme SV-3000CNC

■ Features

- The X_1, Y and Z_2 axes have a maximum drive speed of 200 mm/s, which permits high-speed positioning that may result in a large increase in the throughput of multiple-profile/multiple-workpiece measurement tasks.
- It is possible to perform inclined plane measurements through 2-axis simultaneous control in the X- and Y-axis directions.
- For models with the α-axis drive, it is possible to perform continuous measurement over horizontal and inclined surfaces by power-tilting the X_1 axis.
- It is possible to expand the measuring range for multiple workpieces, etc., through positioning in Y.
- Equipped with the Z_1-axis detector (0.75 mN measuring force) as standard.

SV-3000CNC
(Pictured with drive unit inclination mechanism and Y-axis table)

Specifications

■ SV-3000CNC

Column type			Standard column type	High column type
X₁ axis	Measuring range		200 mm	
	Resolution		0.05 µm	
	Scale unit		Reflective-type linear encoder	
	Drive speed	CNC mode	Max. 200 mm/s	
		Joystick control mode	0 to 50 mm/s	
	Measuring speed		0.02 to 2 mm/s	
	Measuring direction		Backward	
	Straightness		0.5 µm/200 mm	
Y-axis table unit	Measuring range		200 mm	
	Resolution		0.05 µm	
	Scale unit		Reflective-type linear encoder	
	Drive speed	CNC mode	Max. 200 mm/s	
		Joystick control mode	0 to 50 mm/s	
	Maximum loading capacity		20 kg (the center of gravity should be placed within ø100 mm from the table center)	
	Straightness		0.5 µm/200 mm	
	Linear displacement accuracy (at 20 °C, contour mode)		$\pm(2+2L/100)$ µm L: Dimension between two measured points (mm)	
	Table size		200×200 mm	
	External dimensions (W×D×H)		320×646×105 mm	
	Mass		35 kg	
Z₂ axis (column)	Travel range		300 mm	500 mm
	Resolution		0.05 µm	
	Scale unit		Reflective-type linear encoder	
	Drive speed	CNC mode	Max. 200 mm/s	
		Joystick control mode	0 to 50 mm/s	
	Accuracy (20 °C)	Model without α axis	$\pm(1.5+|10H|/1000)$ µm H: Z₂ axis measurement height (mm)	
		Model with α axis	–	
	Base size (W×D)		750×600 mm	
	Base material		Granite	
Measurement analysis			Refer to the FORMTRACEPAK surface roughness measurement/analysis on page 23.	
External dimensions (W×D×H)			800×620×1000 mm	
Mass (excluding Y-axis table unit and Vibration Insulating Stand)			240 kg	
Operating temperature and humidity ranges			15 to 25 °C, 20 to 80 % RH (non-condensing)	
Storage temperature and humidity ranges			-10 to 50 °C, 5 to 90 % RH (non-condensing)	

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.

■ α-axis unit (for α-axis installed model)

Inclination angle	-45° (counterclockwise), +10° (clockwise)
Rotating speed under inclined condition	1 rpm
Resolution of inclination angle	0.000225°
Mass	9 kg

■ Vibration Insulating Stand (Required Option)

Vibration insulating mechanism	Diaphragm air spring
Natural frequency	2.5 to 3.5 Hz
Damping mechanism	Orifice
Leveling mechanism	Automatic control with mechanical valves
Air supply pressure	0.4 MPa
Allowable loading capacity	350 kg
External dimensions (W×D×H)	1000×895×715 mm
Mass	280 kg

Mitutoyo

CNC Surface Roughness Measuring Instrument
Surftest Extreme SV-M3000CNC

■ Features

- A CNC Surface Roughness Measuring Instrument that covers measurement of large/heavy workpieces such as engine blocks, crankshafts, etc.
- The X_1, Y and Z_2 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.
- A highly accurate instrument featuring column (Z_2 axis) CNC drive. This allows comprehensive surface roughness measurement on large and heavy workpieces that cannot otherwise be tested except by using a compact surface roughness tester (handy-type).
- The following three types of detector holder are available to suit the intended use.
  1. Standard type (downward facing)
  2. Long type (downward facing, particularly suitable for measurement of deep holes, etc.)
  3. Rotary type (orientation indexable for downward, upward, forward and backward facing.)
- A large rotary table (option) with a loading capacity of 100 kg is available by special order.
- Measuring force for the Z_1-axis detector is selectable from 4 mN or 0.75 mN.

1. Standard-type detector holder

2. Long-type detector holder

Measurement example for long-type detector holder

3. Rotary-type detector holder (downward facing)

3. Rotary-type detector holder (upward facing)

Measurement example for rotary-type detector holder (backward facing)
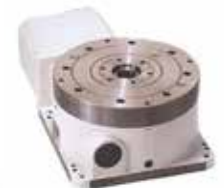
Large θ-axis table (Option)

SV-M3000CNC
(Y-axis column moving type Surface Roughness Measuring Instrument)
(Picture above is special specification)

Specifications

■ SV-M3000CNC

X₁ axis	Measuring range		200 mm
	Resolution		0.05 µm
	Scale unit		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200 mm/s
		Joystick control mode	0 to 50 mm/s
	Measuring speed		0.02 to 2 mm/s
	Straightness	Using standard-type detector	0.5 µm/200 mm
		Using long-type detector	0.7 µm/200 mm
		Using rotary-type detector — Up/down direction	0.5 µm/200 mm
		Using rotary-type detector — Forward/backward direction	0.7 µm/200 mm
	System noise Rz*	Using standard-type detector	Rz<0.1 µm
		Using long-type detector	Rz<0.2 µm
		Using rotary-type detector	Up/down direction: Rz<0.2 µm Forward/backward direction: Rz<0.4 µm
Z₂ axis (column)	Measuring range		500 mm
	Resolution		0.05 µm
	Scale unit		Reflective-type linear encoder
	Measuring force	CNC mode	Max. 200 mm/s
		Joystick control mode	0 to 50 mm/s
Y axis	Measuring range		800 mm
	Resolution		0.05 µm
	Scale unit		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200 mm/s
		Joystick control mode	0 to 50 mm/s
	Measuring speed		0.02 to 2 mm/s
	Straightness	Using standard-type detector — Narrow range	0.5 µm/50 mm
		Using standard-type detector — Wide range	2 µm/800 mm
		Using long-type detector — Narrow range	0.7 µm/50 mm
		Using long-type detector — Wide range	3 µm/800 mm
		Using rotary-type detector (up/down direction) — Narrow range	0.7 µm/50 mm
		Using rotary-type detector (up/down direction) — Wide range	3 µm/800 mm
	System noise Rz*	Using standard-type detector	Rz<0.2 µm
		Using long-type detector	Rz<0.3 µm
		Using rotary-type detector	Rz<0.3 µm
Measurement analysis			Refer to the FORMTRACEPAK surface roughness measurement/analysis on page 23.
Base unit	Base size (W×D)		600×1500 mm
	Base material		Steel
	Allowable loading capacity		300 kg
Vibration isolating unit	Air supply pressure		0.4 MPa
	Vibration insulating mechanism		Diaphragm air spring
	Natural frequency		4.0 to 5.0 Hz
	Damping mechanism		Orifice & Oil damper
	Leveling mechanism		Automatic control with mechanical valves
External dimensions (W×D×H)			1085×1695×1922 mm
Mass (including the vibration isolating unit)			1600 kg
Operating temperature and humidity ranges			15 to 25 °C, 20 to 80 % RH (non-condensing)
Storage temperature and humidity ranges			-10 to 50 °C, 5 to 90 % RH (non-condensing)

* System noise Rz is determined when measuring the glass optical flat under condition below: (1) X₁ axis is horizontal (2) Measuring speed: 0.5 mm/sec (3) λ c: 0.8 (4) Number of intervals: 5 (ISO 4287 1997)

■ α-axis unit (for α-axis installed model)

Inclination angle	-45° (counterclockwise), +10° (clockwise)
Rotating speed under inclined condition	1 rpm
Resolution of inclination angle	0.000225°
Mass	9 kg

Mitutoyo

CNC Surface Roughness / Contour Measuring Instrument

Formtracer Extreme SV-C4500CNC HYBRID

■ Features

- A Surface Roughness/Contour Measuring Instrument that allows measurement of surface roughness and form/contour with one unit through detector replacement.
- CNC Surface Roughness/Contour Measuring Instrument equipped with a non-contact type detector as well as a contact type surface roughness contour measuring detector.
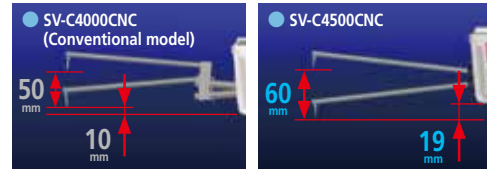
[Contour measuring function]

- Equipped with a new, more-powerful detector (specific to contour measurement).
  1. The measuring range has increased by 10 mm (compared to the previous model).
  2. The use of a magnet joint on the arm mount allows speedy replacement of an arm.
  3. Upward and downward facing surfaces can be continuously measured in combination with a dual-sided cone stylus.
  4. The measuring force can be specified (in 5 steps) from the software interface (FORMTRACEPAK).

[Surface roughness testing function]

- Compliant with JIS 1982/1994/2001, ISO, ANSI, DIN, VDA, and other international surface roughness standards.
- Equipped with the Z_1-axis detector (0.75 mN measuring force) as standard.
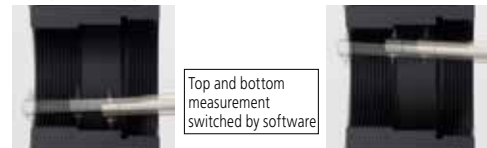
[Common specifications]

- The X_1, Y and Z_2 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.
- It is possible to perform inclined plane measurements through 2-axis simultaneous control in the Y-axis direction.
- It is possible to expand the measuring range for multiple workpieces, etc., through positioning in Y.
- The non-contact detector is selectable between CPS2525 and CPS0517.

● SV-C4000CNC (Conventional model) 50 mm / 10 mm
● SV-C4500CNC 60 mm / 19 mm

1. **Detector measurement range expanded by 10 mm**
(When using the **SPH-71** one-sided cut stylus)

● SV-C4000CNC (Conventional model) — Screw fixing
● SV-C4500CNC

Removable unit (arm)
2. Magnetic joint
Removal unit (detector)

Lower direction measurement (Bottom surface)
Upper direction measurement (Top surface)
Top and bottom measurement switched by software

Effective diameter
Plain-section diameter
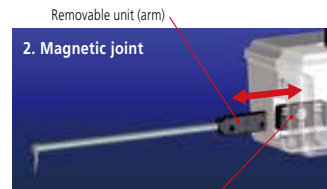
3. Continuous top-bottom measurement function

Detector stand

SV-C4500CNC HYBRID (Contour measuring detector shown mounted)

SV-C4500CNC HYBRID (Surface roughness measuring detector shown mounted)

Specifications

■ SV-C4500CNC HYBRID

X₁ axis (drive unit)	Measuring range		200 mm
	Resolution		0.05 µm
	Scale unit		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200 mm/s
		Joystick control mode	0 to 50 mm/s
	Measuring speed		0.02 to 2 mm/s
	Form/contour mode	Measuring direction	Forward/backward
		Straightness	2 µm/200 mm
		Accuracy (20 °C)	±(0.8+4L/200) µm L: Measurement length (mm)
	Surface roughness mode	Measuring direction	Backward
		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 (detector unit)	Form/contour mode	Measuring range	60 mm (±30 mm from the horizontal plane)
		Resolution	0.02 µm
		Measuring direction	Upward/downward direction (Direction can be switched by FORMTRACEPAK)
		Stylus up/down operation	Arc movement
		Scale unit	Arc scale
		Accuracy (20 °C)	±(0.8+|2H|/100) µm H: Measurement height from the horizontal position (mm)
		Measuring force	10, 20, 30, 40, 50 mN (Can be switched by software)
		Traceable angle	70° for ascent, 70° for descent (depending on the surface texture)
		Stylus tip	30° cone, Carbide
	Surface roughness mode	Measuring range	800 µm/80 µm/8 µm
		Resolution	0.01 µm/0.001 µm/0.0001 µm
		Measuring force	0.75 mN
	Non-contact type detector CPS2525*	Measuring range	1.2 mm
		Resolution	25 nm
	Non-contact type detector CPS0517*	Measuring range	0.1 mm
		Resolution	5 nm
Z₂ axis (column)	Travel range		500 mm
	Resolution		0.05 µm
	Scale unit		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200 mm/s
		Joystick control mode	0 to 50 mm/s
	Accuracy (20 °C)		±(3.5+15H/1000) µm H: Z₂ axis measurement height (mm)
Base size (W×D)			750×600 mm
Base material			Granite
Measurement analysis			Refer to page 23.

* 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.

Mitutoyo

CNC Surface Roughness / Contour Measuring Instrument
Formtracer Extreme SV-C4500CNC

■ **Features**
- A Surface Roughness / Contour Measuring Instrument that allows measurement of surface roughness and form / contour with one unit through detector replacement.
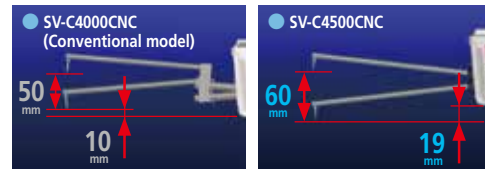
[Contour measuring function]
- Equipped with a new, more-powerful detector (specific to contour measurement).
  1. The measuring range has increased by 10 mm (compared to the previous model).
  2. The use of a magnet joint on the arm mount allows speedy replacement of an arm.
  3. Upward and downward facing surfaces can be continuously measured in combination with a dual-sided cone stylus.
  4. The measuring force can be specified (in 5 steps) from the software interface (FORMTRACEPAK).

[Surface roughness testing function]
- Compliant with JIS 1982 / 1994 / 2001, ISO, ANSI, DIN, VDA, and other international surface roughness standards.
- Equipped with the Z_1-axis detector (0.75 mN measuring force) as standard.

[Common specifications]
- The X_1, Y and Z_2 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.
- For models with the Y-axis table, it is possible to perform inclined plane measurements through 2-axis simultaneous control in the X- and Y-axis directions.
- For models with the α axis, it is possible to perform continuous measurement over horizontal and inclined surfaces by power-tilting the X_1 axis.
- For models with the Y-axis table, it is possible to expand the measuring range for multiple workpieces, etc., through positioning in Y.
- Mitutoyo's lineup of CNC Surface Roughness Measuring Instruments offers 8 models that cover all possible combinations of standard and high column types, α-axis drive and Y-axis drive to suit every application.
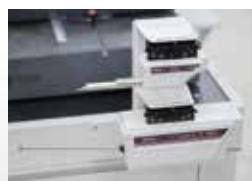
● SV-C4000CNC (Conventional model) 50 mm 10 mm
● SV-C4500CNC 60 mm 19 mm

1. **Detector measurement range expanded by 10 mm**
(When using the **SPH-71** one-sided cut stylus)

● SV-C4000CNC (Conventional model) Screw fixing
● SV-C4500CNC

Removable unit (arm)

2. Magnetic joint

Removal unit (detector)

Lower direction measurement (Bottom surface)
Upper direction measurement (Top surface)

Top and bottom measurement switched by software

Effective diameter
Plain-section diameter
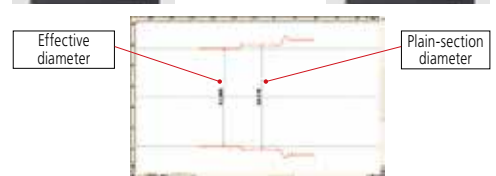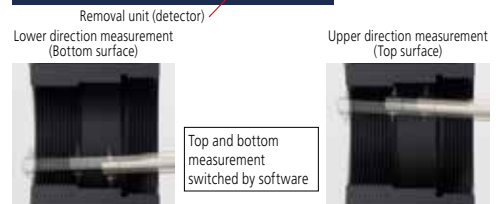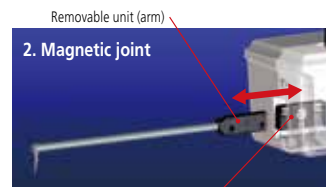
3. Continuous top-bottom measurement function

Detector stand

SV-C4500CNC (Contour measuring detector shown mounted)

SV-C4500CNC (Surface roughness measuring detector shown mounted)

Specifications

■ SV-C4500CNC

Column type			Standard column type	High column type
X₁ axis (drive unit)	Measuring range		200 mm	
	Resolution		0.05 μm	
	Scale unit		Reflective-type linear encoder	
	Drive speed	CNC mode	Max. 200 mm/s	
		Joystick control mode	0 to 50 mm/s	
	Measuring speed		0.02 to 2 mm/s	
	Form/contour mode	Measuring direction	Forward/backward	
		Straightness	2 μm/200 mm	
		Accuracy (20 °C)	±(0.8+4L/200) μm L: Measurement length (mm)	
	Surface roughness mode	Measuring direction	Backward	
		Straightness	0.5 μm/200 mm	
Y axis		Measuring range	200 mm	
		Resolution	0.05 μm	
		Maximum table loading	20 kg	
Z₁ axis (detector unit)	Form/contour mode	Measuring range	60 mm (±30 mm from the horizontal plane)	
		Resolution	0.02 μm	
		Measuring direction	Upward/downward (Direction can be switched by FORMTRACEPAK)	
		Stylus up/down operation	Arc movement	
		Scale unit	Arc scale	
		Accuracy (20 °C)	±(0.8+|2H|/100) μm H: Measurement height from the horizontal position (mm)	
		Measuring force	10, 20, 30, 40, 50 mN (Can be switched by software)	
		Traceable angle	70° for ascent, 70° for descent (depending on the surface texture)	
		Stylus tip	30° cone, Carbide	
	Surface roughness mode	Measuring range	800 μm/80 μm/8 μm	
		Resolution	0.01 μm/0.001 μm/0.0001 μm	
		Measuring force	0.75 mN	
Z₂ axis (column)	Travel range		300 mm	500 mm
	Resolution		0.05 μm	
	Scale unit		Reflective-type linear encoder	
	Drive speed	CNC mode	Max. 200 mm/s	
		Joystick control mode	0 to 50 mm/s	
	Accuracy (20 °C)	Model without α axis	±(1.5+10H/1000) μm H: Z₂ axis measurement height (mm)	
		Model with α axis	–	
	Base size (W×D)		750×600 mm	
	Base material		Granite	
Measurement analysis			Refer to page 23.	

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.

■ α-axis unit (for α-axis installed model)

Inclination angle	-45° (counterclockwise), +10° (clockwise)
Rotational speed under inclined condition	1 rpm
Resolution of inclination angle	0.000225°
Mass	9 kg

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CNC Surface Texture Measuring Instrument
Formtracer Extreme
CS-5000CNC/CS-H5000CNC

■ Features

- High-accuracy stylus type CNC Surface Measuring Instrument that allows batch measurement of surface roughness and form/contour.
- The X_1 and Z_2 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.
- A Mitutoyo Transmission type linear encoder is incorporated in the X_1 and Z_1 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 Z_1-axis detector to implement a wide-range measurement capability wherein the variation in dynamic measuring force is restricted.
- It is possible to perform inclined plane measurements through 2-axis simultaneous control in the X- and Y-axis directions.
- The Z_1-axis detector incorporates an anti-collision safety device to automatically stop the machine if the detector body touches a workpiece or jig.

- For models with the axis, it is possible to perform continuous measurement over horizontal and inclined surfaces by power-tilting the X_1 axis. (**CS-5000CNC** only)
- For models with the Y-axis table, it is possible to expand the measuring range for multiple workpieces, etc., through positioning in the Y-axis direction.
- This system has a track record in an application to measure an aspheric lens to a high level of accuracy.
  The system is being well received because of its options (Y-axis Table and 3D Auto-leveling Table) that allow easy and automatic workpiece setting (inclination and peak/valley-point detection) and the dedicated software (ASLPAK: refer to page 24) that allows easy part-program creation and analysis in addition to the high-accuracy main unit.

Wide range detector employing active control technology

CS-H5000CNC
(Pictured with Y-axis table, 3D Auto-leveling Table, and θ_1 axis)

Specifications

■ CS-5000CNC / CS-H5000CNC

Model			CS-5000CNC		CS-H5000CNC	
Column type			Standard column type	High column type	Standard column type	High column type
X₁ axis	Measuring range		200 mm			
	Resolution		0.005 μm			
	Scale unit		Transmitted-type linear encoder			
	Drive speed	CNC mode	Max. 40 mm/s			
		Joystick control mode	0 to 40 mm/s			
	Measuring speed		0.02 to 0.2 mm/s (surface roughness), 0.02 to 2 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)		$\pm(0.3+0.002L)$ μm L: traverse length (mm)		$\pm(0.16+0.001L)$ μm L: traverse length (mm)	
α axis	Inclination angle		-45° (counterclockwise), +10° (clockwise)		–	
Z₁ axis (detector unit)	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		Transmitted-type linear encoder			
	Accuracy (20 °C)		$\pm(0.3+|0.02H|)$ μm H: probing height (mm)		$\pm(0.07+|0.02H|)$ 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 tip			
		Standard ball stylus	Tip ball radius: 0.25 mm, Sapphire			
		2X-long stylus	Tip radius: 5 μm, Tip angle: 40°, Diamond tip			
		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		300 mm	500 mm	300 mm	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 size (W×D)		750×600 mm			
	Base material		Granite			
Measurement analysis			Refer to page 23.			

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.

■ Y-axis table unit (for Y-axis installed model)

|		
Measuring range		200 mm
Minimum reading		0.05 μm
Scale unit		Reflective-type linear encoder
Drive speed	CNC mode	Max. 200 mm/s
	Joystick control mode	0 to 50 mm/s
Maximum loading capacity		20 kg (the center of gravity should be placed within 50 mm from the table center)
Straightness		0.5 μm/200 mm
Accuracy (20 °C, contour mode)		$\pm(2+2L/100)$ μm L: Dimension between two measured points (mm)
Table size		200×200 mm
External dimensions (W×D×H)		320×646×105 mm
Mass		35 kg

Mitutoyo

Surface Roughness / Contour Analysis Program
FORMTRACEPAK

FORMTRACEPAK functions offer total support for measurement system control, surface roughness analysis, contour analysis, contour tolerancing, and inspection report creation.
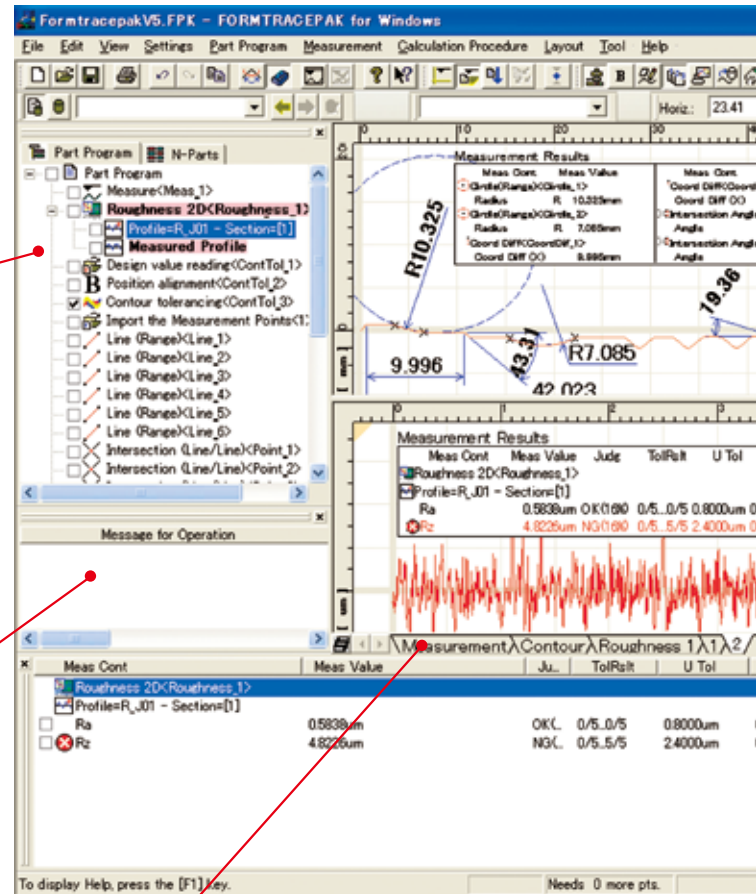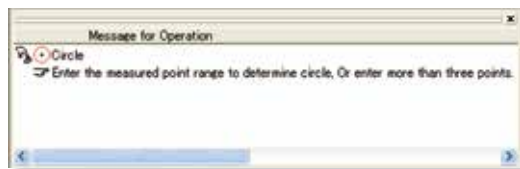
Editing measurement procedures

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.
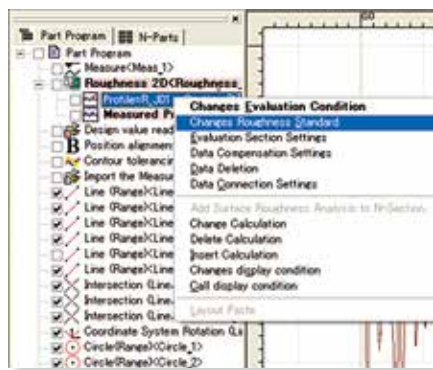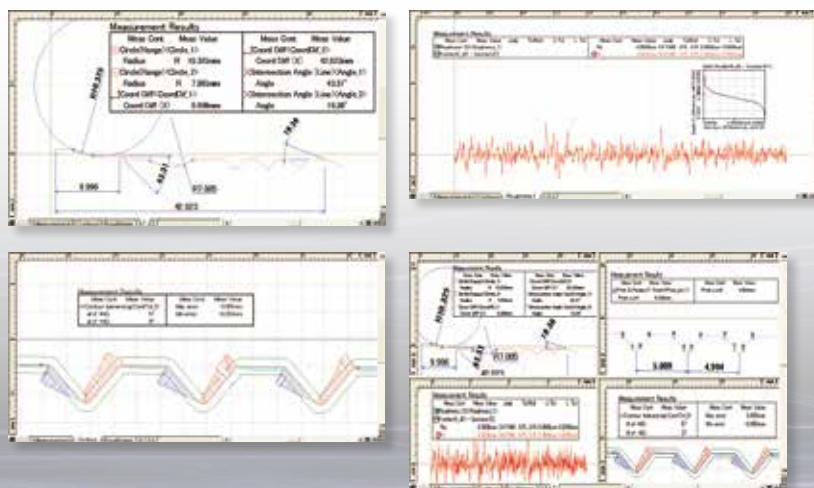
Operation messaging

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

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.

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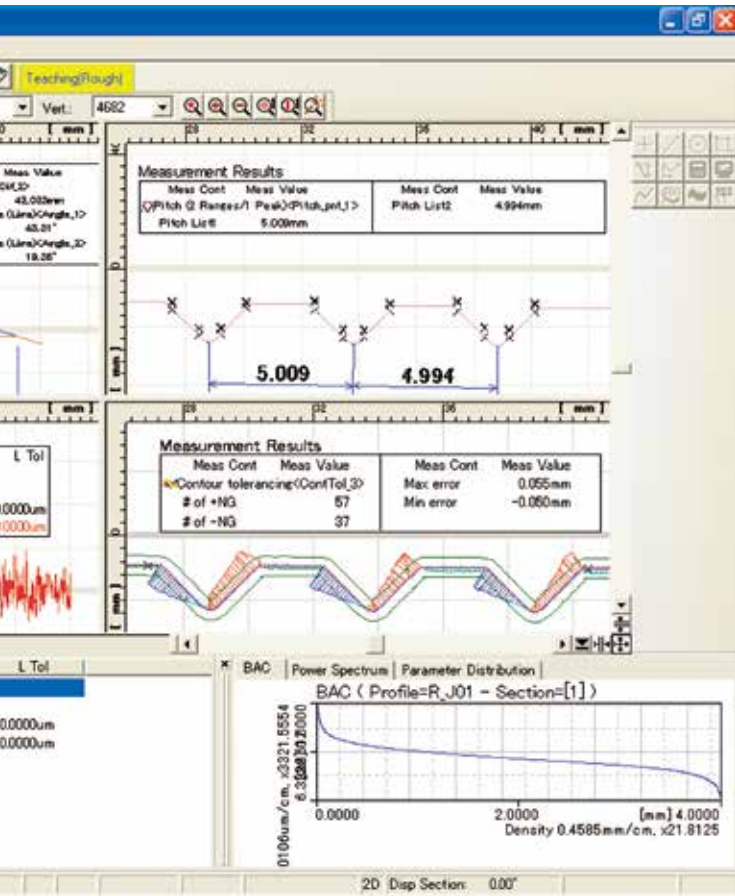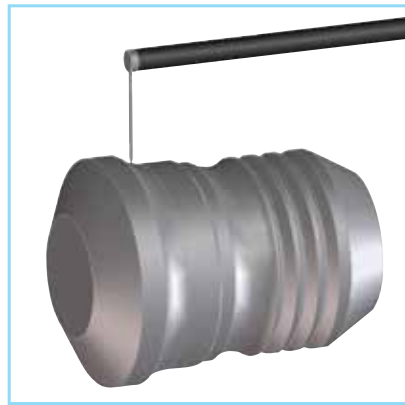
Measurement control

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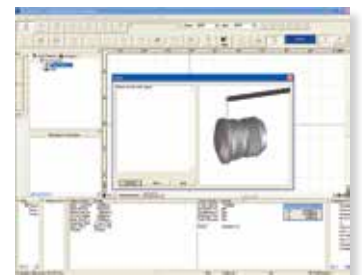
To make immediate measurements, you can use the pull-down menu to easily select and call up the desired operating procedure.
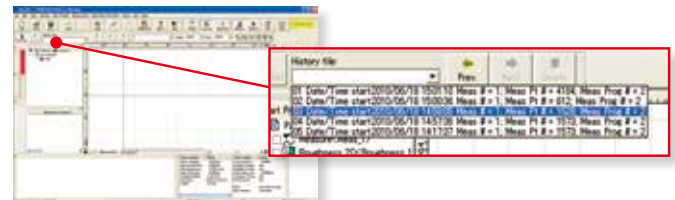
Online help functions*

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.
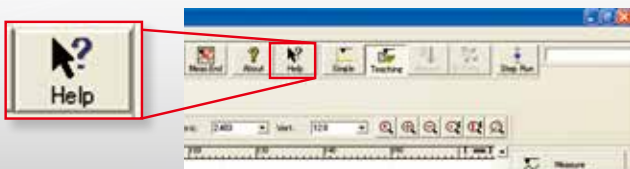
* Online help function supports only Japanese and English.

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.
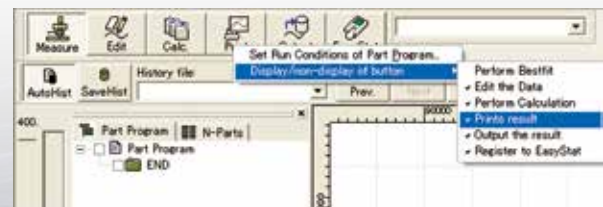
17 languages

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.

* Supported languages: Japanese, English, German, French, Italian, Spanish, Polish, Hungarian, Swedish, Czech, Chinese (simplified characters), Chinese (traditional characters), Korean, Turkish, Portuguese, Russian, Dutch.

Simple statistical commands

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

FORMTRACEPAK
Contour Analysis

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● **Contour analysis function**

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

● **Contour-tolerancing function as a standard feature**

Patent registered in Japan

The best-fit processing function that moves the coordinate values of the design data and measurement data to the optimum positions is provided as a standard feature. Since the tolerancing results can be visually displayed as graphics, displayed as tolerance values and tolerance expansions in each coordinate, or output as a text file, they can be utilized as feedback data for machining systems.
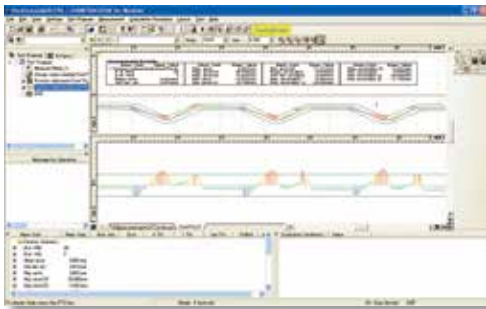
Example of contour-tolerancing result

● **Calculation command repetition setting**   Patent registered in Japan

When identical shapes have the same pitch, you can analyze all of the shapes in a batch by specifying a single analysis location and the pitch.

Repeat
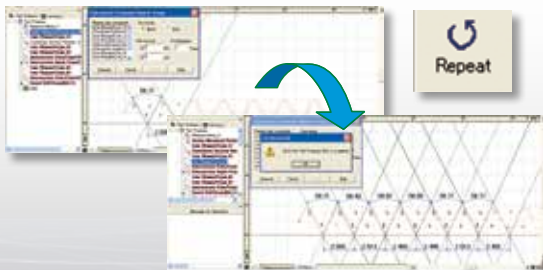
● **Circle and line automatic determination function**

Using the circle/line auto-fitting command, you can automatically calculate all circles and lines contained in the data without having to click the command button each time.
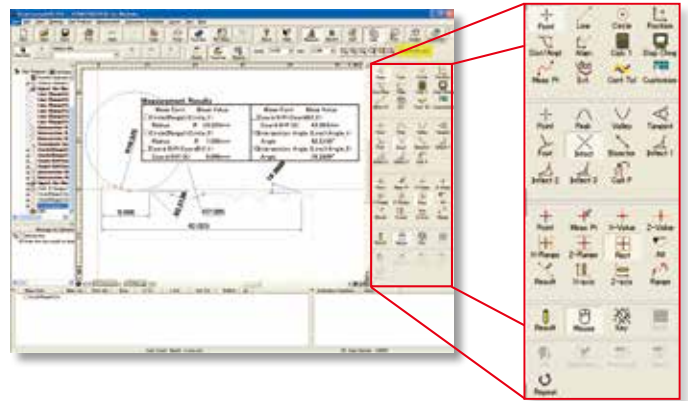
● **Best-fit processing function for measurement point strings**

This function tries to fit the measurement points to the pre-registered reference data on the same coordinate system. It can eliminate the effects of a shift that may occur when setting the workpiece during automatic analysis.
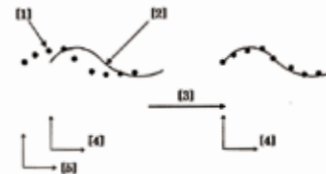
[1]Measured Points/[2]Bestfit Reference Data/[3]Bestfit/[4]Reference Coordinate System/[5]Measurement Coordinate System
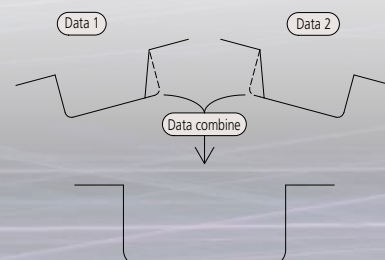
● **Data superimposition command**

You can superimpose two sets of data by detecting their characteristic points. Use the mouse to drag and move the measurement point strings to the desired positions to be superimposed.

peak
end point
start point
origin point
valley
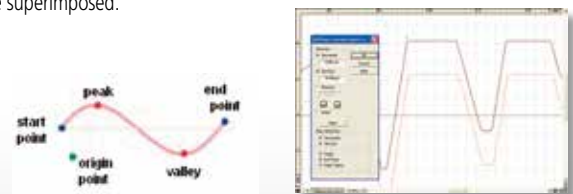
● **Data combination function**

You can combine partial data collected separately from a workpiece because of its external shape into a single graphic and analyze it.

Data 1   Data 2

Data combine

FORMTRACEPAK
Surface Roughness Analysis

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● **Surface Roughness analysis function**

FORMTRACEPAK can perform surface roughness analyses that conform to various standards such as ISO, JIS, ANSI, and VDA. For comparing the 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 R-surface, and a data deletion function.

● **Microscopic contour analysis function**

This function can calculate steps and surface areas from the roughness data. Furthermore, as with the contour analysis function, a rich set of calculation commands that combine various elements, such as points, lines, and circles, to calculate angles, pitches, and distances are provided as standard features.
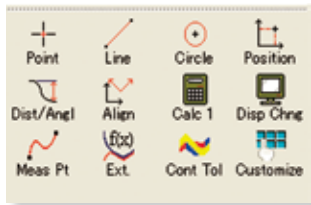
● **Simple input using drawing symbols**

You can easily set up cumbersome measurement conditions by simply entering data according to the drawing symbols of the ISO/JIS roughness standard.

Example of drawing symbol
Grinding

Ra 1.5

⊥ — *2.5 / Rzmax 6.7*

Example of entering data

U"X"0.08—0.8/Rz8max 3.3
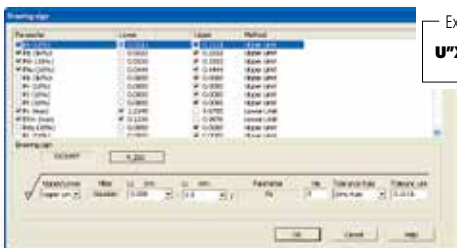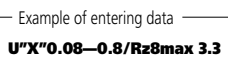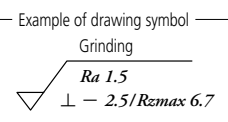
● **Multiple-point measurement function**

You can easily create a part program that measures multiple points by simply entering a shift.
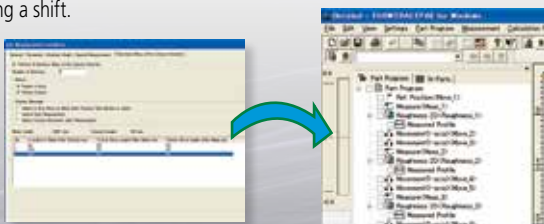
● **Analysis function using multiple-point measurements**

For a workpiece that cannot be measured over the evaluation distance specified by a standard, you can calculate the roughness parameter from the data obtained by measuring multiple points, and compare the measurement data with the tolerance limits using the 16 % rule, for example.
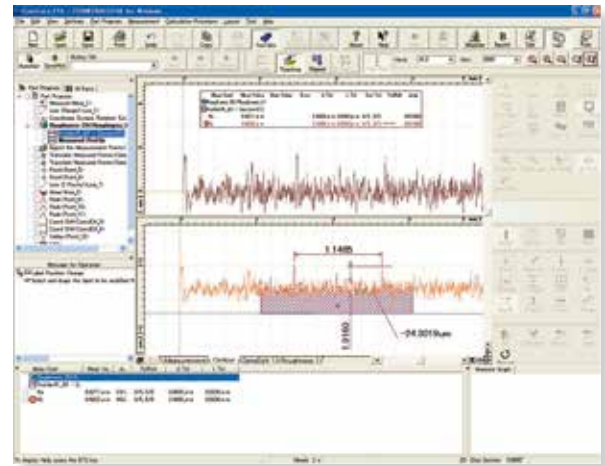
● **Reference length dialog box**

When setting up the reference length in a measurement condition, you can display the standard values defined by the ISO/JIS standards by selecting the applicable standard.
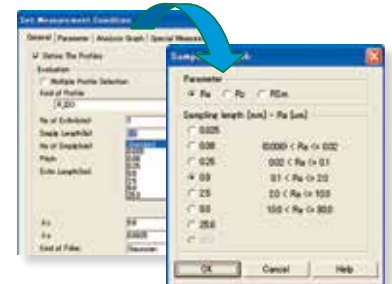
● **Analysis condition modification with a preview function**

You can easily modify various types of analysis conditions such as the standard to be used, curve type, and filter. Furthermore, before eliminating (compensating) shapes such as slopes, R-surfaces, and parabolas, the preview function allows you to check the impact on the spot.

Before compensation
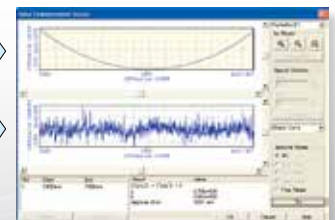
After compensation
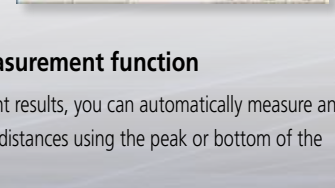
● **R-surface automatic measurement function**

Based on the preliminary measurement results, you can automatically measure an R-surface by allocating measurement distances using the peak or bottom of the R-surface as the reference.

Peak

Peak

FORMTRACEPAK
Layout program

Integrating Contour, Surface Roughness, and Roundness Measurement Results onto a Single Page!

You can use simple operations to lay out graphics obtained from measurements as well as measurement results for surface roughness, contour, and roundness* on a single page.

Furthermore, since the program now allows you to specify a saved file and paste it, you can easily paste results from multiple files.

* Note that the optional ROUNDPAK roundness/cylindricity analysis program is required. (Ver. 7 or higher)
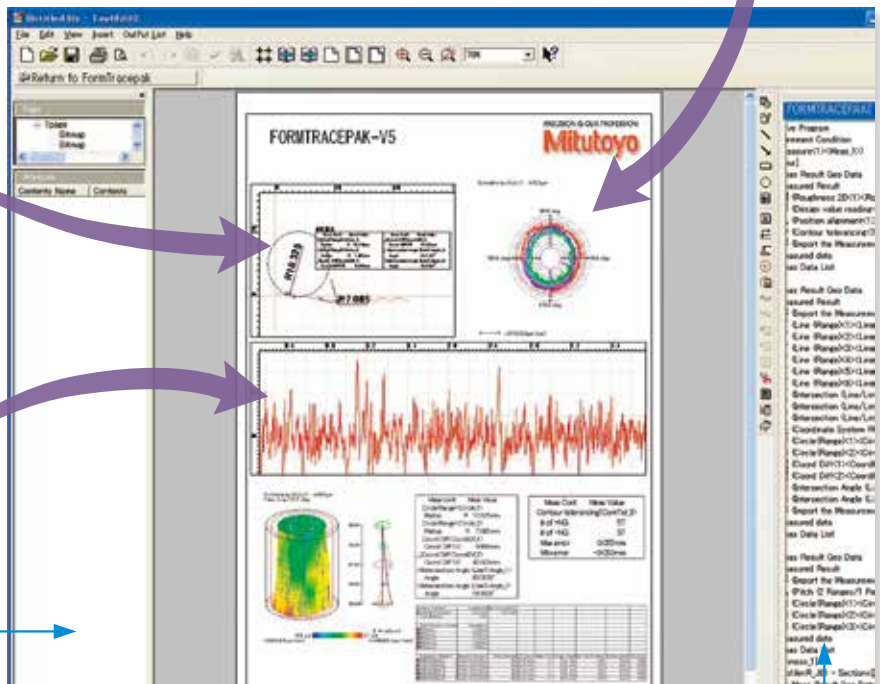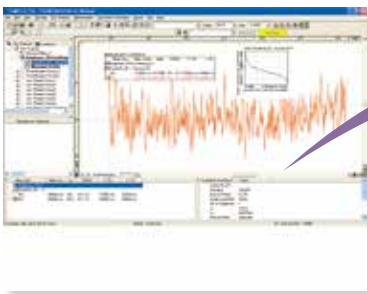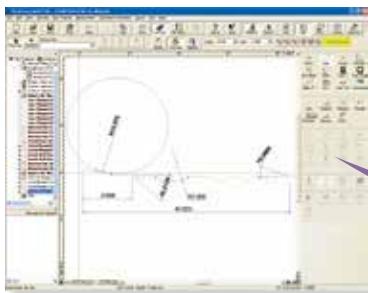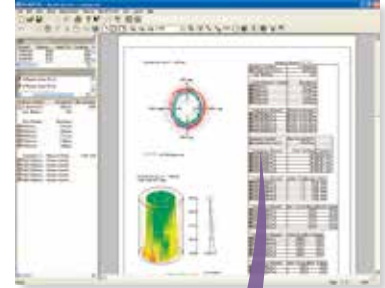
● Report creation function
You can freely assemble measurement results/conditions/graphics as well as comments/circles/lines/arrows, and print them out in a measurement result report. You can also save the created layout and use it again later for similar measurements.

● System layout printing
This function allows automatic layout and print of an inspection certificate with an easy operation just by selecting print items such as calculation result, measurement condition and measurement graphs. It also allows detailed setting of measurement graph size, measurement result, font, etc. Use this function for an easy print solution.

● Element insertion bar
Using the mouse to drag and drop the analysis content displayed in the element insertion bar, you can paste it into the layout.

● Saving the result as a web page
Since the measurement result report can be output as a PDF file or html format, you can check the result even on a PC in which no layoutediting program is installed.

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FORMTRACEPAK Contour Measurement/Analysis Specifications

Arithmetic processing	Point	Point, peak point, valley point, contact point, foot of a perpendicular, intersection point, midpoint, inflection point (distance), inflection point (angle), inflection point (angular variation), point readout
	Line	Line, tangent line, perpendicular line, parallel line, median line, line (point, angle), line readout
	Circle	Circle, circle (center - radius), circle (2 points), contact circle, contact circle (measurement point), circle (radius/center fixed), circle readout, ellipse (calculated with the quadratic curve command)
	Coordinate	Coordinate difference (X-axis coordinate difference, Z-axis coordinate difference, angular difference, radial difference), positional judgment
	Distance/angle	Distance, step height (mean, maximum, minimum), groove dimensions, pitch (pitch, pitch [between centers]), angle, travel distance
	Coordinate system	Origin setting of coordinate system, coordinate system rotation
	Arithmetic operations/compilation	Arithmetic operations (addition, subtraction, multiplication, division, absolute value, square root), statistics (mean, maximum value, minimum value, standard deviation, unbiased standard deviation, total sum), data entry, data deletion
	Measurement point compilation	Deletion, translation, rotation, inversion, positioning, segmentation, offset, idealization, fairing, filtering, scale handling of measurement points (polar coordinate spreading), combination
	Extended functions	Area, quadratic curve (ellipse, hyperbola, parabola), circle/line auto-determination command (automatically determines multiple circle/line features included in the specified area)
	Contouring tolerancing	Contour tolerancing, best-fitting, design value generation, design value reading, balloon display of arbitrarily-positioned data
	Other functions	Tolerancing, dimension display, simplified display
Calculation support		Auto-display of calculation command help (ON/OFF)
Measurement support function (common to contour/roughness measurement)		Peak/valley detection (manual), ball measurement, workpiece identification function, leveling, squareness alignment, straightness alignment, R-surface auto-measurement function (for roughness measurement only)
CNC measurement		Measurement part program, multiple parts
Statistical processing		Simplified statistical functions
Data file input/output		Output: text, design value, IGES, DXF Input: text, design value (IGES and DXF are loaded by the design value generation utility), data import from SJ-series
Coordinate control		Origin setting, coordinate system rotation, coordinate system configuration through workpiece identification, zero-setting or resetting of each axis
Stylus calibration		Auto-calibration with the batch calibration kit, manual calibration with GB, reference hemisphere or pin gauge Calibration history: Any stylus has no restriction on the number of events to be stored.
Straightness correction		Equipped with the straightness correction function
Sampling pitch		0.1 to 2000 μm (depending on the measuring machine)
Memory capacity		Up to 100,000 points (depending on the measuring machine)
Magnified display Vertical		Arbitrary value (in steps of 0.001), automatic and 0.001 to 10,000,000 times
Magnified display Horizontal		Arbitrary value (in steps of 0.001), automatic and 0.001 to 10,000,000 times

FORMTRACEPAK Surface Roughness Measurement/Analysis Specifications

Compliant roughness standards	JIS1982, JIS1994, JIS2001, ISO1997, ANSI, VDA, OLDMIX
Parameters	Ra, Rq, Sk, Ku, Rp, Rv, Ry, RyDIN, RzDIN, Rt, Rc, Rz, R3z, R3t, S, Δa, Δq, λa, λq, Lo, lr, Rk, Rpk, Rvk, Mr1, Mr2, A1, A2, Sm, Pc, HSC, mr, mrd, δc, Vo, Rx, AR, R, NR, NCRX, CPM, SR, SAR, Wx, AW, W, Wte, NW, SW, SAW (Area and height-related parameters are analyzable with the contour analysis command.)
GO/NG judgment methods	Mean or maximum value rule, 16 % rule
Assessed profiles	Primary (unfiltered) profile, roughness profile, filtered waviness profile, waviness profile, unfiltered rolling circle waviness profile, rolling circle waviness profile, envelope residual profile, DF profile (DIN4776/ISO13565-1), roughness motif profile (An envelope waviness profile is displayed at the time of motif assessment.)
Analysis graph	Material ratio curve (BAC), amplitude distribution curve (ADC), power spectrum, autocorrelation, Walsh power spectrum, Walsh autocorrelation, peak height distribution, tilt angle distribution, parameter distribution (As for abrasion amount or multilayer, area, etc. are analyzable through contour analysis.)
Form removal	Least square line, R-surface correction, elliptic correction, parabolic correction, hyperbolic correction, conic correction, polynomial correction (automatic or optional 2nd to 7th-order correction)
Filter type	Gaussian, 2CRPC75, 2CRPC50, 2CR75, 2CR50, robust spline
Cutoff wavelengths	(λc): 0.025, 0.08, 0.25, 0.8, 2.5, 8, 25, 80 mm optional (λs): 0.8, 2.5, 8, 25, 80, 250, 800 μm optional
Micro-contour analysis	Refer to Arithmetic processing in FORMTRACEPAK Contour Measurement/Analysis Specifications.
Statistical processing	Simplified statistical functions
Measurement support functions (common to contour/roughness measurement)	Peak/valley detection (manual), ball measurement, workpiece identification function, leveling, squareness alignment, straightness alignment, R-surface auto-measurement function (for roughness measurement only)
Measurement support functions	Simplified input according to drawing instruction marks, sampling length setting dialog box, N-points measuring function
Stylus calibration	Roughness specimen, step-gage (Calibration history: no restriction on the number of events that can be stored for any stylus)
Memory capacity	Up to 100,000 points
Magnified display Vertical	Arbitrary value (in steps of 0.001), automatic and 0.001 to 10,000,000 times
Magnified display Horizontal	Arbitrary value (in steps of 0.001), automatic and 0.001 to 10,000,000 times

Natural language selection	Japanese, English, German, French, Italian, Spanish, Polish, Hungarian, Swedish, Czech, Chinese (simplified characters), Chinese (traditional characters), Korean, Turkish, Portuguese, Russian, Dutch

Note: Online help is provided only in Japanese and English.

FORMTRACEPAK
Software

3D Data Analysis Program, FORMTRACEPAK-Pro (Option)

This software will analyze the three-dimensional surface roughness data collected from coordinate measurement with the Y-axis table.

It can offer various visual representation methods, such as shading display, mesh display, and contour-line display.

Thus, the user can analyze the target surface texture from various angles by making use of not only the 3D Roughness Parameter Calculation, Profile Analysis (area, volume), but also Bearing Area Curve (BAC), Amplitude Distribution Curve (ADC) and Power Spectrum Analysis, etc.
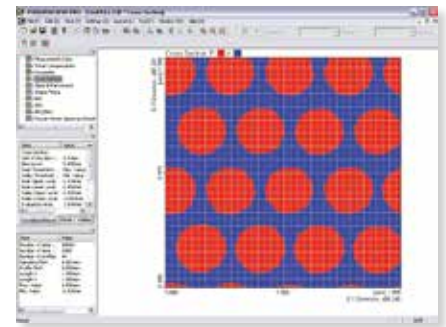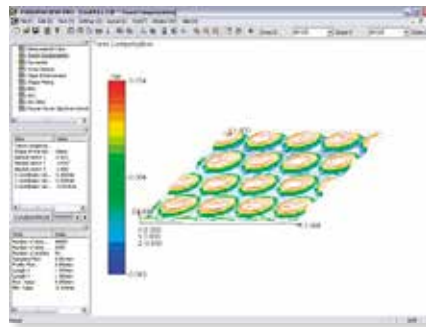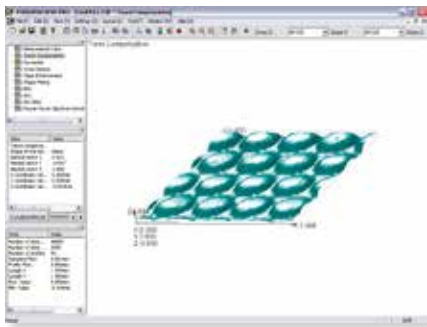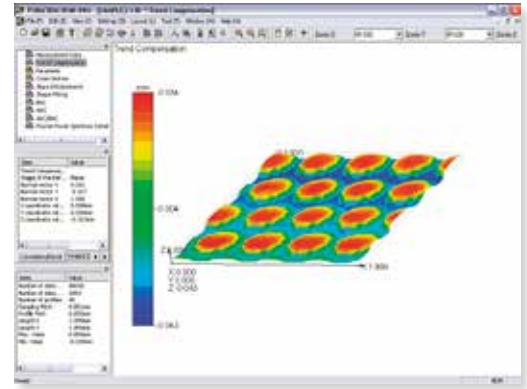
Aspheric Lens Analysis Program ASLPAK

This software allows you to create a part program for assessing an aspheric lens by merely entering the data of general that defines the aspheric surface and effective lens diameter. It allows not only analysis of designed R and best-fit R, but also easy determination of the pseudo roughness parameters for the aspheric surface from those results.

Aspheric Simple Program Creation Screen

Aspheric Pseudo Roughness Parameter Analysis

Aspheric Accuracy Assessed Values (F', A', S') Analysis

MiCAT

Mitutoyo Intelligent Computer Aided Technology

the standard in world
metrology software

FORM

3D Surface Texture Analysis Program MCubeMap (Option)

This software is a 3D surface texture analysis program oriented to CNC Surface Roughness Measuring Instruments and CNC Surface Texture Measuring Instruments.
Its abundant display functionality for measured data includes colored view, contour lines, 3D view, 3D view plus mesh plot, photomicrography, etc., allowing easy and clear recognition of surface features.
The software allows you to create a graphical report with analysis results presented in your own customized layout.
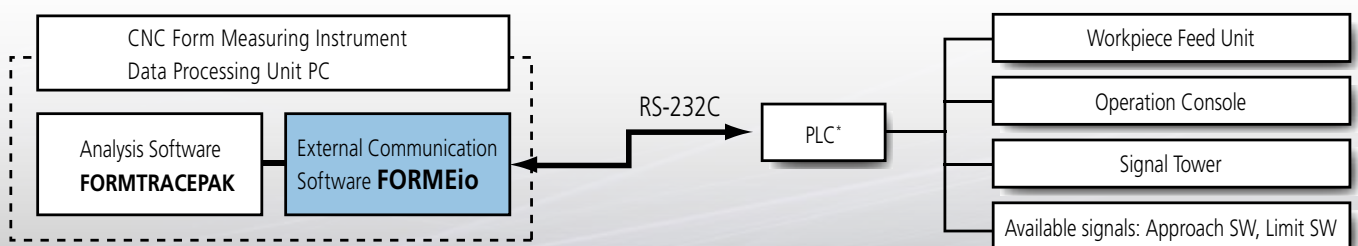(This software is compatible with the 3D Surface Texture Parameter Standard in the latest issue of ISO 25178-2.)
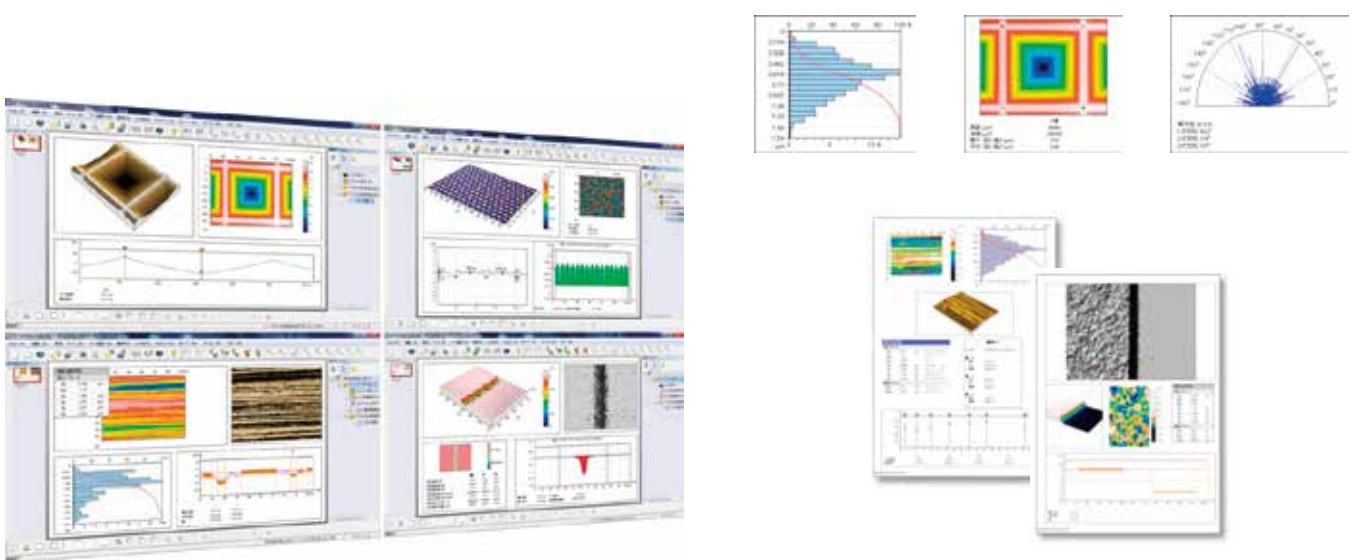
External Communication Program, FORMEio (Option)

This is optional software for installing the external control function in the CNC form measuring instrument.
With this function it is possible to monitor and control the measuring instrument conditions via RS-232C communication from the PLC.

* Programmable Logic Controller

Mitutoyo

Detectors / Styli (For Surface Roughness Measuring*)

* Except for **CS-5000CNC/CS-H5000CNC**.

Detectors
Unit: mm

Order No.	Measuring force	
178-396-2	0.75 mN	'97ISO and '01JIS compliant detectors
178-397-2	4 mN	Detectors that comply with previous standards, for general use, etc.

Skidless nosepiece (**12AAB355**)
Detector

Extension rods

● **12AAG202** Extension rod 50 mm

● **12AAG203** Extension rod 100 mm

Note: No more than one extension rod can be connected.

Styli
Unit: mm

Standard stylus

Color coding*³
Detail-A

12AAE882 (1 μm)*¹
12AAE924 (1 μm)
12AAC731 (2 μm)*¹
12AAB403 (5 μm)
12AAB415 (10 μm)
12AAE883 (250 μm)*⁴
（ ）: Tip radius

Double-length for deep hole*²

12AAE898 (2 μm)*¹
12AAE914 (5 μm)
（ ）: Tip radius

For small hole

Detail-A
(S=5/1)
Color coding*³

12AAC732 (2 μm)*¹
12AAB404 (5 μm)
12AAB416 (10 μm)
（ ）: Tip radius

For small hole / Double-length for deep hole*²

Detail-A

12AAE892 (2 μm)*¹
12AAE908 (5 μm)
（ ）: Tip radius

For extra-small hole

Detail-A
(S=5/1)
Color coding*³

12AAC733 (2 μm)*¹
12AAB405 (5 μm)
12AAB417 (10 μm)
（ ）: Tip radius

For small hole*²*⁴

Ball φ1.6

12AAE884 (φ1.6 mm)

For extra-minute hole

Detail-A
(S=5/1)
Color coding*³

12AAC734 (2 μm)*¹
12AAB406 (5 μm)
12AAB418 (10 μm)
（ ）: Tip radius

For ultra-small hole*⁴

Ball φ0.5
Detail-A

12AAJ662 (φ0.5 mm)

For deep hole (double-length and triple-length)*²

Color coding*³
Detail-A
2X stylus
12AAC740 (2 μm)*¹
12AAB413 (5 μm)
12AAB425 (10 μm)
（ ）: Tip radius

Color coding*³
Detail-A
3X stylus
12AAC741 (2 μm)*¹
12AAB414 (5 μm)
12AAB426 (10 μm)
（ ）: Tip radius

For small slotted hole*²

Detail-A

12AAE938 (2 μm)*¹
12AAE940 (5 μm)

*1 Tip angle 60°
*2 For downward-facing measurement only.

*3 Tip radius	1 μm	2 μm	5 μm	10 μm	250 μm
Color coding	White	Black	No color	Yellow	No notch or color

*4 Used for calibration, a standard step gauge (**178-611**, option) is also required.

Styli (For Surface Roughness Measuring*)

* Except for **CS-5000CNC / CS-H5000CNC**.

Styli	Unit: mm

For deep groove (10 mm)

Detail-A

12AAC735 (2 µm)*1
12AAB409 (5 µm)
12AAB421 (10 µm)
( ): Tip radius

For deep groove*2 (20 mm)

12AAE893 (2 µm)*1
12AAE909 (5 µm)
( ): Tip radius

For deep groove*2 (20 mm)

Detail-A

12AAC736 (2 µm)*1
12AAB408 (5 µm)
12AAB420 (10 µm)
( ): Tip radius

For deep groove*2 (40 mm)

12AAE895 (2 µm)*1
12AAE911 (5 µm)
( ): Tip radius

For deep groove*2 (30 mm)

Detail-A

12AAC737 (2 µm)*1
12AAB407 (5 µm)
12AAB419 (10 µm)
( ): Tip radius

For deep groove (30 mm) / Double-length for deep hole*2

12AAE894 (2 µm)*1
12AAE910 (5 µm)
( ): Tip radius

For gear tooth

Detail-A

12AAB339 (2 µm)*1
12AAB410 (5 µm)*1
12AAB422 (10 µm)*1
( ): Tip radius

For gear tooth / Double-length for deep hole*2

12AAE896 (2 µm)*1
12AAE912 (5 µm)*1
( ): Tip radius

For rolling circle waviness surface*4

12AAB338 (φ1.588)

For rolling circle waviness / Double-length for deep hole*2*4

12AAE886 (250 µm)

For knife-edge

Detail-A

12AAC738 (2 µm)*1
12AAB411 (5 µm)
12AAB423 (10 µm)
( ): Tip radius

For corner hole / Double-length for deep hole*2

12AAM601 (2 µm)*1
12AAM603 (5 µm)*1
( ): Tip radius

For eccentric arm*2

Detail-A

12AAC739 (2 µm)*1
12AAB412 (5 µm)
12AAB424 (10 µm)
( ): Tip radius

Hole-bottom cone stylus

12AAE899 (2 µm)*1
12AAE915 (5 µm)
( ): Tip radius

*1 Tip angle 60°
*2 For downward-facing measurement only.
Note: Customized special interchageable styli are available on request.
      Please contact any Mitutoyo sales office for more information.

*3

Tip radius	2 µm	5 µm	10 µm
Color coding	Black	No color	Yellow

*4 Used for calibration, a standard step gauge (**178-611**, option) is also required

Arms / Styli (For SV-C4500CNC Contour Measuring)

Arms

● Arm compatibility table

Description	Arm No.	Order No.	Applicable stylus No.
Straight arm	AB-31	12AAM101[*1]	SPH-5✳, 6✳, 7✳, 8✳, 9✳ SPHW[*2]-56, 66, 76
Eccentric arm	AB-37	12AAQ762[*3*4]	SPH-5✳, 6✳, 7✳, 8✳, 9✳ SPHW[*2]-56, 66, 76
Small-hole arm	AB-33	12AAM103[*3*4]	SPH-41, 42, 43

● Straight arm **AB-31**
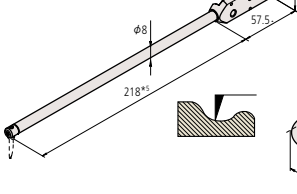
● Eccentric arm **AB-37**
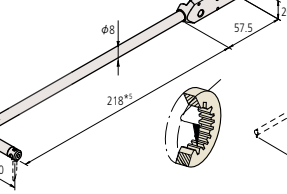
● Small-hole arm **AB-33**
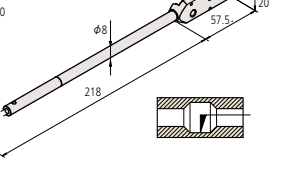
Styli

● Stylus compatibility table

Stylus name	Stylus No.	Order No.	Application arm No.	H (mm)
Double-sided conical stylus[*2]	SPHW-56	12AAM095[*6]	AB-31, AB-37	20
	SPHW-66	12AAM096[*4]	AB-31, AB-37	32
	SPHW-76	12AAM097[*4]	AB-31, AB-37	48
One-sided cut stylus	SPH-51	354882[*3*4]	AB-31, AB-37	6
	SPH-61	354883	AB-31, AB-37	12
	SPH-71	354884[*1]	AB-31, AB-37	20
	SPH-81	354885	AB-31, AB-37	30
	SPH-91	354886	AB-31, AB-37	42
Intersecting cut stylus	SPH-52	354887	AB-31, AB-37	6
	SPH-62	354888	AB-31, AB-37	12
	SPH-72	354889[*3*4]	AB-31, AB-37	20
	SPH-82	354890	AB-31, AB-37	30
	SPH-92	354891	AB-31, AB-37	42
Cone stylus Tip angle 30° Sapphire tipped	SPH-53	354892	AB-31, AB-37	6
	SPH-63	354893	AB-31, AB-37	12
	SPH-73	354894	AB-31, AB-37	20
	SPH-83	354895	AB-31, AB-37	30
	SPH-93	354896	AB-31, AB-37	42
Cone stylus Tip angle 30° Carbide-tipped	SPH-56	12AAA566	AB-31, AB-37	6
	SPH-66	12AAA567	AB-31, AB-37	12
	SPH-76	12AAA568[*3*4]	AB-31, AB-37	20
	SPH-86	12AAA569	AB-31, AB-37	30
	SPH-96	12AAA570	AB-31, AB-37	42
Cone stylus Tip angle 20° Carbide-tipped	SPH-57	12AAE865	AB-31, AB-37	6
	SPH-67	12AAE866	AB-31, AB-37	12
	SPH-77	12AAE867	AB-31, AB-37	20
	SPH-87	12AAE868	AB-31, AB-37	30
	SPH-97	12AAE869	AB-31, AB-37	42
Cone stylus Tip angle 50° Diamond tipped	SPH-79	355129	AB-31, AB-37	20
Knife edge stylus	SPH-54	354897	AB-31, AB-37	6
	SPH-64	354898	AB-31, AB-37	12
	SPH-74	354899	AB-31, AB-37	20
	SPH-84	354900	AB-31, AB-37	30
	SPH-94	354901	AB-31, AB-37	42
Ball stylus	SPH-55	354902	AB-31, AB-37	6
	SPH-65	354903	AB-31, AB-37	12
	SPH-75	354904	AB-31, AB-37	20
	SPH-85	354905	AB-31, AB-37	30
	SPH-95	354906	AB-31, AB-37	42
Small hole stylus[*7]	SPH-41	12AAM104[*3*4]	AB-33	2
	SPH-42	12AAM105	AB-33	4
	SPH-43	12AAM106[*3*4]	AB-33	6.5

*1 This is a standard accessory.
*2 Stylus for **SV-C4500** Series
*3 Arm stylus standard set (**12AAN461**) component.
*4 Arm stylus up/downward measurement set (**12AAN462**) component.
*5 When mounting one-sided cut stylus **SPH-71** (standard accessory)
*6 Standard accessory for **SV-C4500** Series
*7 Styli **SPH-21**, **22**, and **23** for **SV-C3100 / 4100** Series are not available.
*8 Arm stylus for **SV-C4500** Series

● Double-sided conical stylus

Tip angle: 30°
Tip radius: 25 μm
Carbide-tipped

● One-sided cut stylus

Tip angle: 12°
Tip radius: 25 μm
Carbide-tipped

● Intersecting cut stylus

Tip angle: 20°
Tip radius: 25 μm
Carbide-tipped

● Cone stylus

Tip angle: 30° (**SPH-79**: 50°)
Tip radius: 25 μm
Sapphire, Carbide-tipped
(**SPH-79**: Diamond tipped)

● Cone stylus

Tip angle: 20°
Tip radius: 25 μm
Carbide-tipped

● Knife edge stylus

Tip angle: 20°
Edge width: 3 mm
Tip radius: 25 μm
Carbide-tipped

● Ball stylus

Ball dia: 1 mm
Carbide-tipped

● Small hole stylus SPH-41

Tip shape: One-sided cut
Tip angle: 20°
Tip radius: 25 μm
Carbide-tipped

● Small hole stylus SPH-42

Tip shape: One-sided cut
Tip angle: 20°
Tip radius: 25 μm
Carbide-tipped

● Small hole stylus SPH-43

Tip shape: One-sided cut
Tip angle: 20°
Tip radius: 25 μm
Carbide-tipped

● Arm stylus (comprising an arm and stylus)

Arm stylus name	Stylus No.	Order No.	H (mm)
Double-sided small hole arm stylus[*8]	SPHW-21	12AAT469	2.4
	SPHW-31	12AAM108	2.4
	SPHW-22	12AAT470	5
	SPHW-32	12AAM109[*4]	5
	SPHW-33	12AAM110	9

● Double-sided small hole arm stylus SPHW-21/31

closeup of tip

Tip shape: Cone
Tip angle: 20°(**SPHW-21**)
30°(**SPHW-31**)
Tip radius: 25 μm
Carbide-tipped

● Double-sided small hole arm stylus SPHW-22/32

closeup of tip

Tip shape: Cone
Tip angle: 20°(**SPHW-22**)
30°(**SPHW-32**)
Tip radius: 25 μm
Carbide-tipped

● Double-sided small hole arm stylus SPHW-33

closeup of tip

Tip shape: Cone
Tip angle: 30°
Tip radius: 25 μm
Carbide-tipped

Styli (For CS-5000CNC / CS-H5000CNC)

Styli

Unit: mm

Standard-length stylus
12AAD543 [1]
12AAJ037 [2]

Stylus length: 12.5 mm
Tip material: Diamond
Tip shape: 40° cone
Tip radius: 5 μm
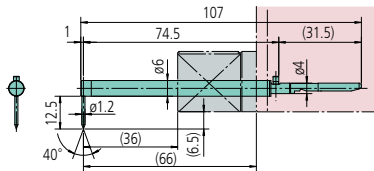
Standard-length stylus for small hole
12AAD651

Stylus length: 0.4 mm
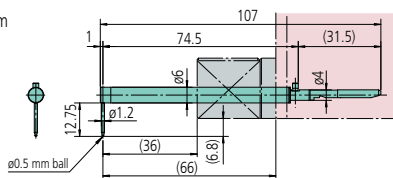Tip material: Diamond
Tip shape: 40° cone
Tip radius: 5 μm
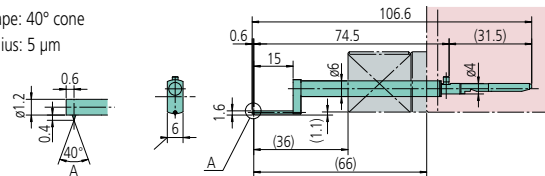
Standard-length ball stylus
12AAD544 [1][2]

Stylus length: 12.75 mm
Tip material: Sapphire
Tip ball radius: 0.25 mm

Standard-length stylus for extra-small hole
12AAD652

Stylus length: 0.6 mm
Tip material: Diamond
Tip shape: 40° cone
Tip radius: 5 μm
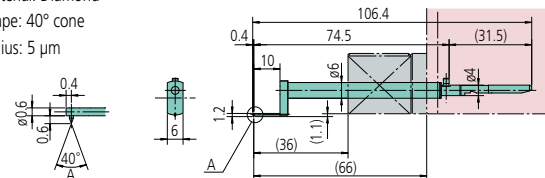
Double-length stylus
12AAJ041 [2]

Stylus length: 25 mm
Tip material: Diamond
Tip shape: 60° cone
Tip radius: 2 μm
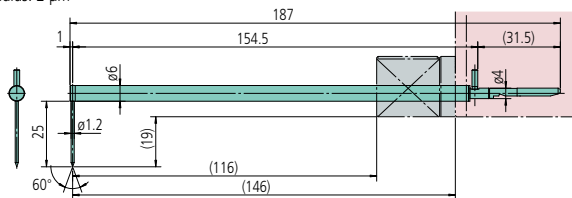
Standard-length eccentric stylus
12AAD653

Stylus length: 12.5 mm
Tip material: Diamond
Tip shape: 40° cone
Tip radius: 5 μm

Double-length stylus
12AAD545 [1]
12AAJ039 [2]

Stylus length: 25 mm
Tip material: Diamond
Tip shape: 40° cone
Tip radius: 5 μm

Nosepiece   Detector unit
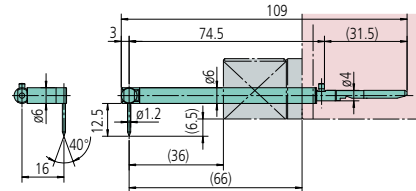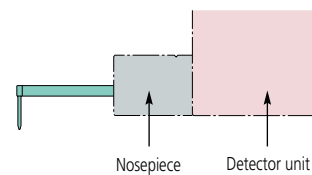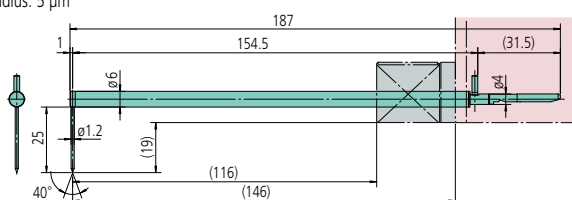
Double-length ball stylus
12AAD546 [1][2]

Stylus length: 25.25 mm
Tip material: Sapphire
Tip ball radius: 0.25 mm
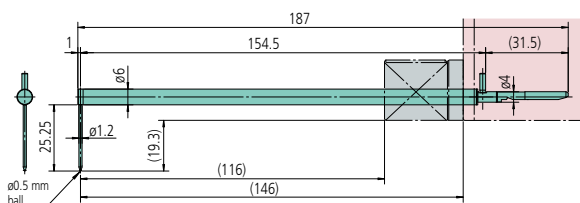
[1] Standard accessory for **CS-5000CNC**
[2] Standard accessory for **CS-H5000CNC**

Wide choice of functions expands the application range

Examples of optimal combinations of accessories

◯: Essential △: Recommended function —: Not necessary

Function / Item	Y-axis Table (mountable model only)	θ¹ Table (Option)	θ² Table (Option)	2D Auto levelling table (Option)	3D Auto levelling table (Option)	Drive unit tilting function (mountable model only)
Automatic leveling	—	—	—	◯	◯	◯
Automatic alignment	◯	◯	—	—	—	△
Multiple workpiece batch measurement	△	—	—	—	—	—
Measurement in the Y-axis direction	◯	—	—	—	—	—
Oblique measurement of XY plane*	◯	—	—	—	—	—
Outside 3D surface roughness measurement/evaluation*	◯	—	—	—	—	△
Multiple-piece measurement in the Y-axis direction (Positioning in the Y-axis direction)	◯	—	—	—	—	—
Multiple-piece measurement in the radial direction (Positioning in the rotating direction of XY plane)	△	◯	—	—	—	—
Inclined surface measurement in the X-axis direction	△	—	—	—	—	◯
Inclined hole inside measurement in the X-axis direction	△	—	—	—	—	◯
Multiple cylinder generatrices measurement	△	—	◯	—	—	—
Measurement of both top and bottom surfaces	△	—	◯	—	—	—

* Applicable only to surface roughness measurement

● Precision Vise

For use on a cross-travel stage, etc.

Fixing method	Double clamping method
Clamping range	51 mm
Jaw width	44 mm
Jaw depth	16 mm
Overall height	37 mm

178-019

● 3-axis Adjustment Table

The use of this 3-axis Adjustment Table allows simple straightness alignment and leveling by merely adjusting the table according to guidance from FORMTRACEPAK. This does not need any experience or intuitive ability.
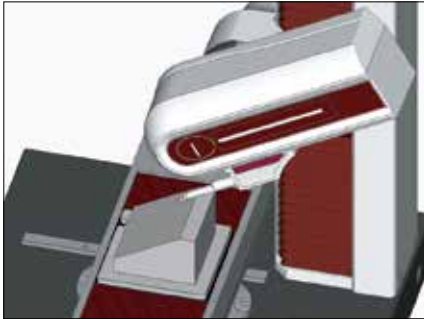
178-047

● Centering chuck (ring operated)

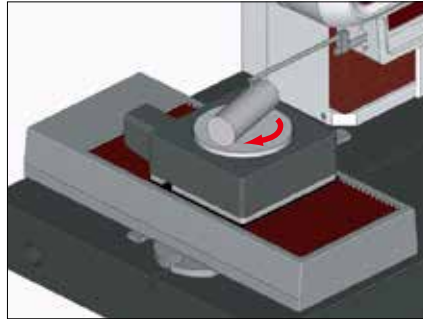This chuck is useful when measuring cylindrical workpieces, which are easily clamped by turning the knurled ring.

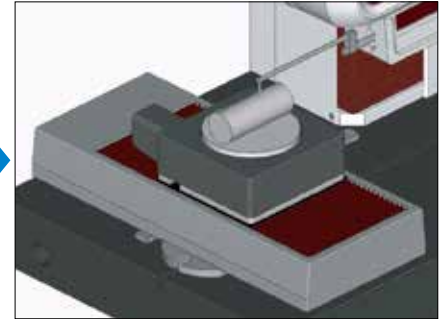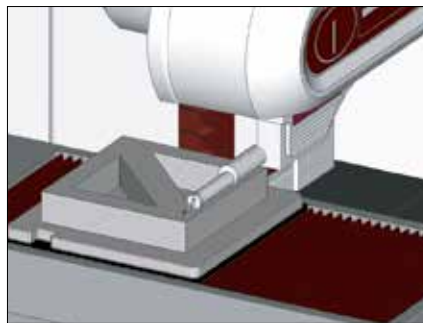| Clamping range	Jaws normal OD: ø1 to ø36 mm Jaws normal ID: ø16 to ø69 mm Jaws reversed OD: ø25 to ø79 mm
Dimensions	ø118×41 mm
Mass	1.2 kg

211-032

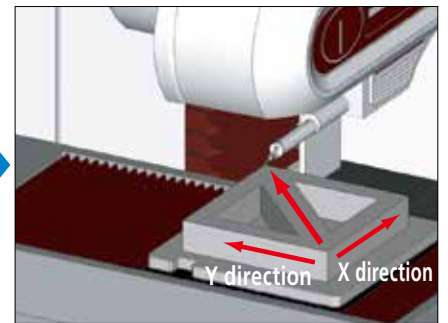Inclined surface measurement in the X-axis direction

Automatic alignment

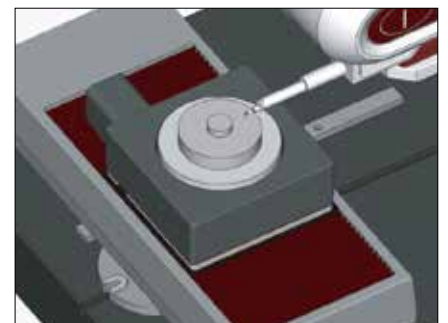Inclined hole inside measurement in the X-axis direction

Oblique measurement of XY plane
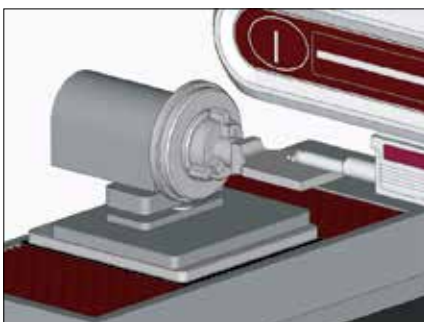

Y direction   X direction

Multiple workpiece batch measurement
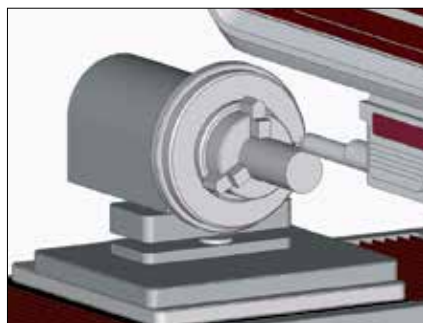
Multiple cylinder generatrices measurement

Multiple-piece measurement in the radial direction

Measurement of both top and bottom surfaces

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