Formtracer SV-C3200 / SV-C4500

SERIES 525 — Surface Roughness / Contour Measuring System

SV-C3200S4 with personal computer system and software

FEATURES

- Dramatically increased drive speed (X axis: 3.1"/s (80mm/s), Z2 axis column: 1.2"/s (30mm/s) further reduces total measurement time.
- In order to maintain the traverse linearity specification for an extended period of time, Mitutoyo has adopted highly rigid ceramic guides that combine the characteristics of smallest secular change and remarkable resistance to abrasion.
- The drive unit (X-axis) and column (Z2-axis) are equipped with a high-accuracy linear encoder (ABS type on Z2-axis). This improves reproducibility of continuous automatic measurement of small holes in the vertical direction and repeated measurement of parts which are difficult to position.

Automatic Measurement

- A wide range of optional peripherals are available to support quick and easy CNC operation.

Y-axis Table

Rotary Table θ1

Rotary Table θ2

Surface Roughness Measurement

- Traverse linearity: (2+1L)µin (±(0.05+0.001L) µm*)
  Designed to handle workpieces calling for high accuracy.
  *S4, H4, W4 types, L = Drive length inch (mm)
- Compliant with JIS '82/'94/'01, ISO, ANSI, DIN, VDA, and other international surface roughness standards.
- Equipped with a standard high accuracy detector (0.75mN/4mN measuring force) providing a resolution down to 0.004µin (0.0001µm).

Contour Drive Measurement

- X axis accuracy: ± (31.5+10L)µin (±(0.8+0.01L)µm*)
  Z1-axis accuracy: ± (31.5+l20Hl)µin (±(0.8+l2Hl/100)µm*)
  Designed to handle workpieces calling for high accuracy.
  * SV-C4500S4, H4, W4 types, L = Drive length, H = Measurement height inch (mm)
- The contour drive unit of SV-C4500 series instruments can continuously measure in the upward and downward directions without the need to change the arm orientation or reset the workpiece, when combined with the double cone-end stylus (a new product with contact points in the upward and downward directions).

Technical Data: Common

Base size (W x H):	23.6 x 17.7" (600 x 450mm) or 39.4 x 17.7" (1000 x 450mm)
Base material:	Granite
Mass	
Main unit:	308 lbs (140kg) (S4), 330 lbs (150kg) (H4), 485 lbs (220kg) (W4) 308 lbs (140kg) (S8), 330 lbs (150kg) (H8), 485 lbs (220kg) (W8)
Controller Unit:	31 lbs (14kg)
Remote Control Box:	2 lbs (0.9kg)
Power supply:	100 – 240VAC ±10%, 50/60Hz
Power consumption:	400W (main unit only)

Technical Data: Contour Measurement

X-axis	
Measuring range:	4" (100mm) or 8" (200mm)
Resolution:	1.97µin (0.05µm)
Measurement method:	Reflective-type linear encoder
Drive speed:	3.1"/s (80mm/s) and manual
Measuring speed:	0.00078 - 0.2"/s (0.02 - 5mm/s)
Measuring direction:	Forward/backward
Traverse linearity:	32µin/4"(0.8µm/100mm) 79µin/8" (2µm/200mm) *with the X axis in horizontal orientation
Linear displacement:	±(32+10L)µin (±0.8+0.01L) µm (SV-C3200S4, H4, W4)
accuracy (at 20°C)	±(32+10L)µin (±0.8+0.01L)µm (SV-C4500S4, H4, W4) ±(32+20L)µin (±0.8+0.02L)µm (SV-C3200S8, H8, W8) ±(32+20L)µin (±0.8+0.02L)µm SV-C4500S8, H8, W8) * L = Drive length inch (mm)
Inclination range:	±45°
Z2-axis (column)	
Vertical travel:	12"(300mm) or 20"(500mm)
Resolution:	39.4µin (1µm)
Measurement method:	ABSOLUTE linear encoder
Drive speed:	0 - 1.2"/s (0 - 30mm/s) and manual
Z1-axis (detector unit)	
Measuring range:	±1.2" (±30mm)
Resolution:	1.57µin (0.04µm) (SV-C3200 series), .78µin (0.02µm) (SV-C4500 series)
Measurement method:	Linear encoder (SV-C3200 series), Laser hologage (SV-C4500 series)
Linear displacement:	±(63+l20lH) µin (±(1.6+l2Hl/100)µm) (SV-C3200 series)
accuracy (at 20°C)	±(31.5+l20Hl) µin (±(0.8+l2Hl/100)µm) (SV-C4500 series) *H: Measurement height from the horizontal position (mm)
Stylus up/down operation:	Arc movement
Face of stylus:	Upward/downward (SV-C3200) Upward/downward (Direction switch by Formtracepak) (SV-C4500)
Measuring force:	30mN (SV-C3200) 10, 20, 30, 40, 50mN (SV-C4500) * As for SV-C4500, set the measurement force with Formtracepak.
Traceable angle:	Ascent: 77°, descent: 83° (using the standard stylus provided and depending on the surface roughness)
Stylus tip	Radius: 25µm, carbide tip

Technical Data: Surface Roughness Measurement

X1-axis	
Measuring range:	4" (100mm) or 8" (200mm)
Resolution:	1.97µin (0.05µm)
Measurement method:	Linear encoder
Drive speed:	3.1"/s (80mm/s)
Traversing direction:	Backward
Traverse linearity:	(2+1L) µin (0.05+1L/1000)µm (S4, H4, W4 types) 20µin/8"(0.5µm/200mm) (S8, H8, W8 types)
Z2-axis (column)	
Vertical travel:	12" (300mm) or 20" (500mm)
Resolution:	39.4 µin (1µm)
Measurement method:	ABSOLUTE linear encoder
Drive speed:	0 - 1.2"/s (0 - 30mm/s) and manual
Detector	
Range / resolution:	32000 µin / .4 µin, 3200µin / .04µin, 320 µin / .004µin (up to 96000 µin with an optional stylus) {800µm / 0.01µm, 80µm / 0.001µm, 8µm / 0.0001µm (up to 2400µm with an optional stylus)}
Detecting method:	Skidless / skid measurement
Measuring force:	0.75mN (low force type)
Stylus tip:	Diamond 60°/2µmR (low force type)
Skid radius of curvature:	1.57" (40mm)
Detecting method:	Differential inductance

Formtracer SV-C3200 / SV-C4500

SERIES 525 — Surface Roughness / Contour Measuring System

MiCAT
Mitutoyo Intelligent Computer Aided Technology
the standard in world metrology software
FORM

SPECIFICATIONS

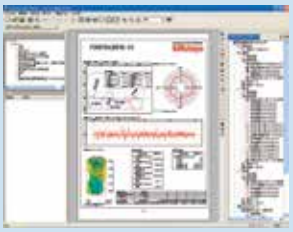
Model No.	SV-C3200S4	SV-C3200H4	SV-C3200W4
Order No. (inch)	**525-491A-1**	**525-492A-1**	**525-493A-1**
Model No.	SV-C4500S4	SV-C4500H4	SV-C4500W4
Order No. (inch)	**525-451A-1**	**525-452A-1**	**525-453A-1**
X1-axis measuring range	4" (100mm)	4" (100mm)	4" (100mm)
Measuring force of detector	0.75mN	0.75mN	0.75mN
Vertical travel	12" (300mm) power column	20" (500mm) power column	20" (500mm) power column
Granite base size (WxD)	23.6 x 17.7" (600 x 450mm)	23.6 x 17.7" (600 x 450mm)	39.4 x 17.7" (1000 x 450mm)
Dimensions (main unit, WxDxH)	39.2 x 22.6 x 38.0" (996 x 575 x 966mm)	39.2 x 22.6 x 46.3" (996 x 575 x 1176mm)	55.4 x 22.6 x 46.3" (1396 x 575 x 1176mm)
Mass (main unit)	308 lbs (140kg)	330 lbs (150kg)	485 lbs (220kg)

Model No.	SV-C3200S8	SV-C3200H8	SV-C3200W8
Order No. (inch)	**525-496A-1**	**525-497A-1**	**525-498A-1**
Model No.	SV-C4500S8	SV-C4500H8	SV-C4500W8
Order No. (inch)	**525-456A-1**	**525-457A-1**	**525-458A-1**
X1-axis measuring range	8" (200mm)	8" (200mm)	8" (200mm)
Measuring force of detector	0.75mN	0.75mN	0.75mN
Vertical travel	12" (300mm) power column	20" (500mm) power column	20" (500mm) power column
Granite base size (WxD)	23.6 x 17.7" (600 x 450mm)	23.6 x 17.7" (600 x 450mm)	39.4 x 17.7" (1000 x 450mm)
Dimensions (main unit, WxDxH)	39.6 x 22.6 x 38.0" (1006 x 575 x 966mm)	39.6 x 22.6 x 46.3" (1006 x 575 x 1176mm)	55.4 x 22.6 x 46.3" (1406 x 575 x 1176mm)
Mass (main unit)	308 lbs (140kg)	330 lbs (150kg)	485 lbs (220kg)

Optional Software

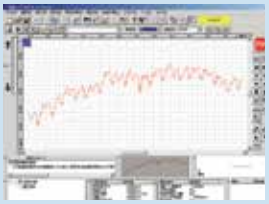
FORMTRACEPAK V5

Enables control of the optional motor-driven Y-axis table and rotary table for realizing efficient measurement automation. You can also perform contour evaluation that allows free analysis of level differences, angle, pitch, area and other characteristics based on surface roughness data. In addition, analysis results can be saved in the "html", "mhtml" or pdf format which allows Internet Explorer or MS-Word compatibility, allowing PC without layout editing programs to view analysis results.



Contour Measurement Screen

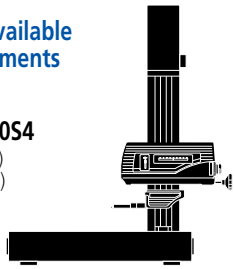
Surface Roughness Measurement Screen



A variety of models available for measuring requirements

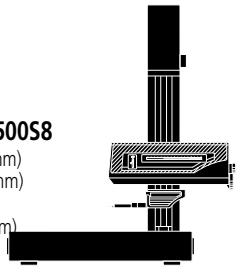
SV-C3200S4 / SV-C4500S4

Traverse range: 4" (100mm)
Vertical travel: 12" (300mm)
Base size (W x D):
23.6" x 17.7" (600 x 450mm)
Base material: Granite



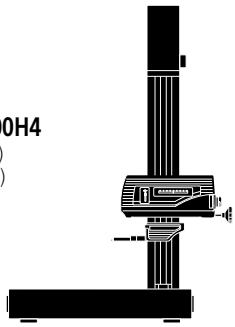
SV-C3200S8 / SV-C4500S8

Traverse range: 8" (200mm)
Vertical travel: 12" (300mm)
Base size (W x D):
23.6" x 17.7" (600 x 450mm)
Base material: Granite



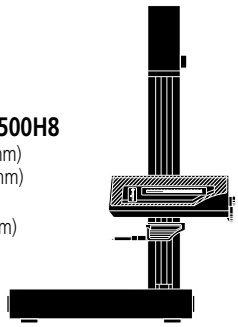
SV-C3200H4 / SV-C4500H4

Traverse range: 4" (100mm)
Vertical travel: 20" (500mm)
Base size (W x D):
23.6" x 17.7" (600 x 450mm)
Base material: Granite



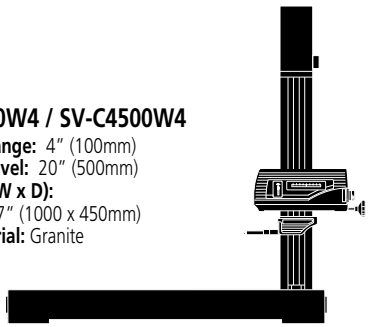
SV-C3200H8 / SV-C4500H8

Traverse range: 8" (200mm)
Vertical travel: 20" (500mm)
Base size (W x D):
23.6" x 17.7" (600 x 450mm)
Base material: Granite



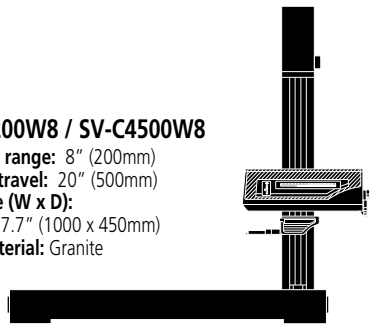
SV-C3200W4 / SV-C4500W4

Traverse range: 4" (100mm)
Vertical travel: 20" (500mm)
Base size (W x D):
39.4" x 17.7" (1000 x 450mm)
Base material: Granite



SV-C3200W8 / SV-C4500W8

Traverse range: 8" (200mm)
Vertical travel: 20" (500mm)
Base size (W x D):
39.4" x 17.7" (1000 x 450mm)
Base material: Granite



Mitutoyo

Formtracer Extreme SV-C4500CNC

SERIES 525 — Surface Roughness/Form Measuring Instrument

SV-C4500CNC with recommended machine vibration stand

* PC stand not included

Surface roughness detector

Contour Z-axis detector

FEATURES

- High-accuracy CNC Surface Roughness/ Form Measuring Instrument that allows both measurement of surface roughness and form/contour with one unit.
- Each axes has the maximum drive speed of 7.87"/s (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.
- For models with the α axis, it is possible to perform continuous measurement over horizontal and inclined surfaces by power-tilting the detector unit.
- 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.
- When combined with the double cone-end stylus (a new product with diametrically opposed contact points), the instrument can continuously measure in the upward and downward directions without the need to change the arm orientation or reset the workpiece fixturing.
- The measuring force can be switched among five levels (upward and downward) from the data-processing program (Formtracepak).
- Enables inclined plane measurements through 2-axis simultaneous control in the X- and Y-axis directions.
- When the detector for form/contour measurement is replaced with that for surface roughness measurement, or vice versa, it is a simple, one-touch replacement without re-routing of the connecting cables.
- Since the Z1-axis detector incorporates an anti-collision safety device, the detector unit will automatically stop even if its main body collides with a workpiece or fixture.
- Supplied with an easy-to-operate Remote Box. The user can make any movement by selecting the required axis using the two joysticks. The current axis selection is easily identified by the icon on the key top.
- Communication with the Data Processing/ Analysis section is via USB.

Technical Data: Common

Base size (W x H):	31 x 39.4" (800 x 1000mm) Type S 34 x 47.2" (800 x 1200mm) Type H
Base material:	Granite
Mass:	529 lbs (240kg) Type S 551 lbs (250kg) Type H
Power supply:	100 – 120VAC ±10%, 50/60Hz
Power consumption:	500W (main unit only)

Technical Data: Contour Measurement

X1-axis

Measuring range:	8" (200mm)
Resolution:	1.97µin (0.05µm)
Measurement method:	Reflective-type linear encoder
Drive speed:	7.87"/s (200mm/s) (max., CNC) 0 - 2"/s (0 - 50mm/s) (joystick)
Measuring speed:	0.00078" – 0.08"/s (0.02 - 2mm/s)
Measuring direction:	Push/Pull
Traverse linearity:	80µin / 8"(2µm/200mm) *with the X axis in horizontal orientation
Linear displacement accuracy (at 20°C):	±(0.8+4L/200)mm) * L = Drive length (mm)

α-axis

Inclination angle:	-45° to +10°
Resolution:	0.000225°
Rotating speed:	1rpm

Z2-axis (column)

Vertical travel:	12" or 20" (300mm or 500mm)
Resolution:	1.97µin (0.05µm)
Measurement method:	Reflective-type linear encoder
Drive speed:	7.87"/s (200mm/s) (max., CNC) 0 - 2."/s (0 - 50mm/s) (joystick)

Z1-axis (detector unit)

Measuring range:	±1.2" (±30mm)
Resolution:	.787µin (0.02µm)
Measurement method:	Reflective Type detector unit
Linear displacement:	
Accuracy (at 20°C)	±(32+110H)µin (±(0.8+I2HI/100)µm) *H: Measurement height from the horizontal position (mm) w/o α-axis: ±(1.5+10HI/1000)µm
Stylus up/down operation:	Arc movement
Face of stylus:	Downward
Measuring force:	10, 20, 30, 40, 50mN
Traceable angle:	Ascent: 70°, descent: 70° (using the standard stylus provided and depending on the surface roughness)
Stylus tip	Radius: 25µm, carbide tip

Technical Data: Surface Roughness Measurement

X1-axis

Measuring range:	8" (200mm)
Resolution:	1.97µin (0.05µm)
Measurement method:	Reflective-type linear encoder
Drive speed:	7.87"/s (200mm/s) (max., CNC) 0 - 2"/s (0 - 50mm/s) (joystick)
Measuring speed:	0.00078" - 0.08"/s (0.02 - 2mm/s)
Traversing direction:	Pulling
Traverse linearity:	20µin/8" (0.5µm/200mm)

α-axis

Inclination angle:	-45° to +10°
Resolution:	0.000225°
Rotating speed:	1rpm

Z2-axis (column)

Vertical travel:	12" or 20" (300mm or 500mm)
Resolution:	1.97µin (0.05µm)
Measurement method:	Reflective-type linear encoder
Drive speed:	7.87"/s (200mm/s) (max., CNC) 0 - 2"/s (0 - 50mm/s) (joystick)

Detector (optional)

Range / resolution:	32000 µin / .4 µin, 3200µin / .04µin, 320 µin / .004µin (up to 96000 µin with an optional stylus) {800µm / 0.01µm, 80µm / 0.001µm, 8µm / 0.0001µm (up to 2400µm with an optional stylus)}
Detecting method:	Skidless / skid measurement
Measuring force:	0.75mN
Stylus tip:	60°/2µmR
Skid radius of curvature:	1.57" (40mm)
Detecting method:	Differential inductance

Formtracer Extreme SV-C4500CNC

SERIES 525 — Surface Roughness/Form Measuring Instrument

Optional Accessories

Machine vibration stand: 12AAE032

Vibration isolation mechanism: Diaphragm air spring
Natural frequency : 2.5 - 3.5Hz
Damping mechanism: Orifice
Leveling mechanism: Automatic control with mechanical valves
Air supply pressure: 0.4Mpa
Allowable loading capacity: 772 lbs (350kg)
Dimensions (W x D x H): 39.4 x 35.2 x 28.1" (1000 x 895 x 715mm)
Mass: 617 lbs (280kg)

Y-axis table unit

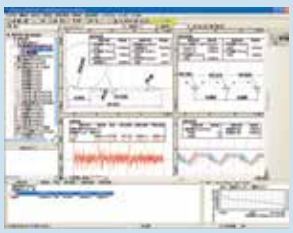
Measuring range: 8" (200mm)
Minimum reading : 1.97µin (0.05µm)
Scale unit: Reflective-type Linear Encoder
Drive speed: 200mm/s (max., CNC)
0 - 2"/s (0 - 50mm/s) (joystick)
Maximum loading capacity: 44 lbs (20kg)
Traverse linearity 20µin/8" (0.5µm/200mm)Surface roughness 80µin/8" (2µm/200mm) contour
Linear displacement accuracy (at 20°C):
± (80+20L)µin
{± (2+2L/100) µm}, contour mode
L: Dimension between two measured points (mm)
Table size: 7.8 x 7.8"(200 x 200mm)
Dimensions (W x D x H): 2.6 x 25.4 x 4.1" (320 x 646 x 105mm)
Mass: 77 lbs (35kg)

MiCAT
Mitutoyo Intelligent Computer Aided Technology
the standard in world metrology software
FORM

Optional Software

FORMTRACEPAK V5

Enables control of the optional motor-driven Y-axis table and rotary table for realizing efficient measurement automation. You can also perform contour evaluation that allows free analysis of level differences, angle, pitch, area and other characteristics based on surface roughness data. In addition, analysis results can be saved in the "html", "mhtml" or pdf format which allows Internet Explorer or MS-Word compatibility, allowing PC without layout editing programs to view analysis results.



Contour Measurement and Surface Roughness Measurement Screen

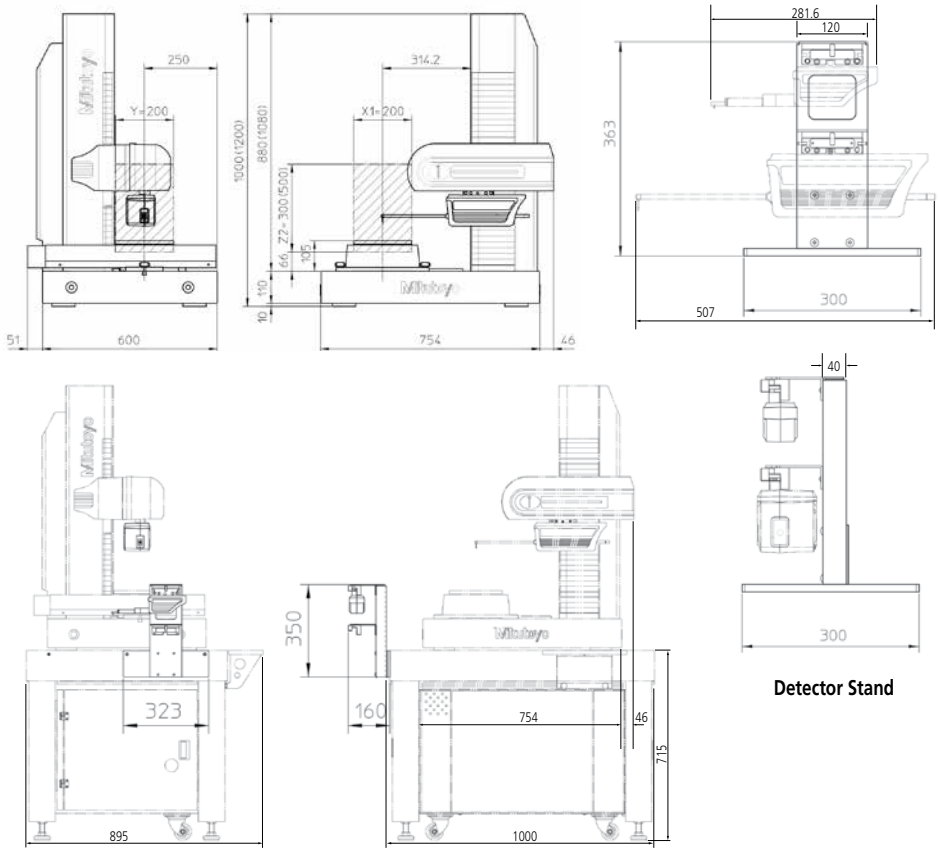
Report Layout Screen

SPECIFICATIONS

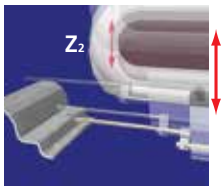
Model No.	SV-C4500S CNC	SV-C4500H CNC
Order No. (100V - 120V)	**525-674-1**	**525-694-1A**
X1-axis measuring range	8" (200mm)	8" (200mm)
Z2-axis vertical travel	12" (300mm)	20"(500mm)
Y-axis table unit	Installed	Installed
α-axis unit	Installed	Installed
Granite base size (WxD)	29.5 x 23.6"(750 x 600mm)	29.5 x 23.6"(750 x 600mm)
Dimensions (main unit, WxDxH)	31.5 x 24.4 x 39.4"(800 x 620 x 1000mm)	31.5 x 24.4 x 47.2"(800 x 620 x 1200mm)
Mass (main unit)	529 lbs (240kg)	551 lbs (250kg)

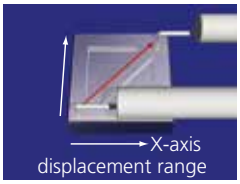
DIMENSIONS

Unit: mm



Detector Stand





Mitutoyo

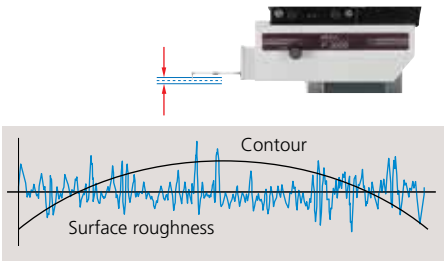
Formtracer CS-3200

SERIES 525 — Form Measuring Instruments

CS-3200S4 with personal computer system and software
* PC stand not included.

FEATURES

- Highest measurement accuracy in its class.
  X axis: ±(1+0.01L)µm
  Z1 axis: ±(1.5+l2Hl/100)µm
- To detect surface roughness and contour in a single measurement the Z1-axis detector unit of CS-3200S4 has a wide measuring range and high resolution of 5mm / 0.08µm to 0.05mm / 0.0008µm.



- In order to maintain the traverse linearity specification for an extended period of time, Mitutoyo has adopted highly rigid ceramic guides that combine the characteristics of smallest secular change and remarkable resistance to abrasion.
- Drastically increased drive speed further reduces total measurement time.
  X axis: 80mm/s, Z2 axis: 20mm/s
- To enhance safety during fast traverse, the Z-axis detector unit incorporates a safety device (Automatic Stop-On-Collision Mechanism).
- The detector unit can be extended to avoid interference between the drive unit and workpiece. The measuring range is shifted to the left by 2.76" (70mm).

- Incorporation of an ABS scale in the Z2 axis eliminates the need for origin point re-setting conventionally required for every step of repeated measurements over step or multiple sections.
- Small holes and inclined planes can be efficiently measured using the inclined X-axis drive unit and fine-feed handles on the X and Z2 axes.
- All detector and drive unit cables are housed inside the main unit to eliminate any risk of abrasion and guarantee trouble free, high-speed operation.
- Orientation of the drive unit can be inclined by ±45°. This allows CS-3200 to measure an inclined surface quickly.

ABSOLUTE®
Absolute System Patented by MITUTOYO

Technical Data: Contour Measurement

X1-axis
- Measuring range: 4" (100mm)
- Resolution: 1.97µin (0.05µm)
- Measurement method: Reflective-type linear encoder
- Drive speed: 0 - 3.1"/s (0 - 80mm/s) and manual
- Measuring speed: 0.00078 - 0.00787"/s (0.02 - 0.2mm/s) (surface roughness) 0.00078 - 0.0787"/s (0.02 - 2mm/s) (contour)
- Measuring direction: (Push/Pull)
- Traverse linearity: 8µin/4" (16µin/4") [0.2µm/100mm (0.4µm/100mm)] ( ): at the protruded detector position *with the X axis in horizontal orientation
- Linear displacement accuracy (at 20°C): ± (32+10L)µin {±(0.8+0.01L)µm} * L = Drive length (mm)
- Inclination range: ±45°

Z2-axis (column)
- Vertical travel: 12" (300mm)
- Resolution: 39.4µin (1µm)
- Measurement method: ABSOLUTE linear encoder
- Drive speed: 0 - 0.78"/s (0 - 20mm/s) and manual

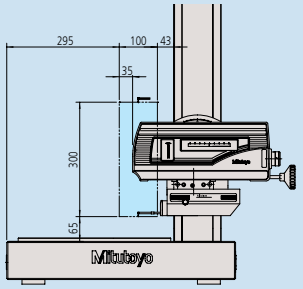
Z1-axis (detector unit)
- Measuring range / resolution: 3µin/.2", .3µin/.02", .03µin/.002" (0.08µm/5mm, 0.008µm/0.5mm, 0.0008µm/0.05mm)
- Measurement method: Differential inductance method
- Linear displacement Accuracy (at 20°C): ±(60+20H)µin ±(1.5+2H/100)µm *H: Measurement height from the horizontal position (mm)
- Stylus up/down operation: Arc movement
- Face of stylus: Downward
- Measuring force: 0.75mN
- Traceable angle: Ascent: 65°, descent: 65° (using the standard stylus provided and depending on the surface roughness)

- Stylus tip: Radius: 2µm, diamond
- Base size (W x H): 23.6 x 17.7" (600 x 450mm)
- Base material: Granite
- Mass: 309 lbs (140kg) (main unit)
- Power supply: 100 – 240VAC ±10%, 50/60Hz
- Power consumption: 400W (main unit only)

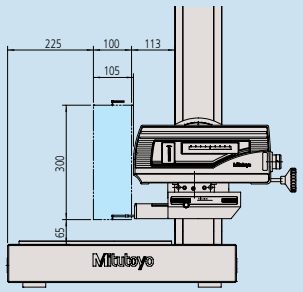
Protrusion of Detector Position

Normal detector position

Unit: mm



When detector is maximally extended
(Extended by 70mm from normal position)



Formtracer CS-3200

SERIES 525 — Form Measuring Instruments

MiCAT
Mitutoyo Intelligent Computer Aided Technology
the standard in world metrology software
FORM

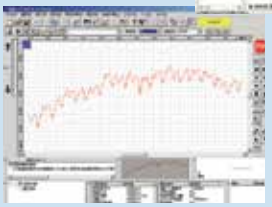
Optional Software

FORMTRACEPAK-6000

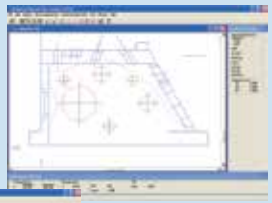
Enables control of the optional motor-driven Y-axis table and rotary table for realizing efficient measurement automation. You can also perform contour evaluation that allows free analysis of level differences, angle, pitch, area and other characteristics based on surface roughness data. In addition, you can create an original inspection certificate by setting the print format to suit your particular requirements.

Measuring instrument control

Contour analysis



Surface roughness analysis



Design data creation (CAD file import)

Contour verification

Inspection certificate creation

Main Unit Startup System

This machine incorporates a startup system (relocation detection system), which disables operation when an unexpected vibration is applied or the machine is relocated. Be sure to contact your nearest Mitutoyo prior to relocating this machine after initial installation.

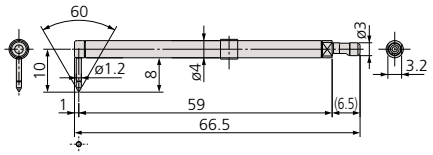
SPECIFICATIONS

Model No.	CS-3200S4
Order No. (inch)	**525-411A**
X1-axis measuring range	4" (100mm)
Z2-axis vertical travel	12" (300mm)

Stylus

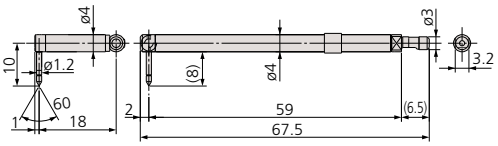
(Unit: inch (mm))

Standard stylus: No. 12AAD554
Tip radius: 2 µm
Tip angle: 60° cone
Tip material: Diamond



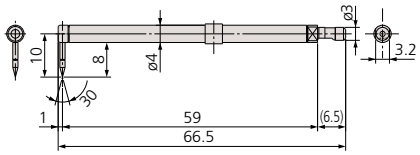
For contour/surface roughness measurement
Measurable depth: .28" (7mm) max.

Eccentric stylus: No. 12AAD558
Tip radius: 2 µm
Tip angle: 60° cone
Tip material: Diamond



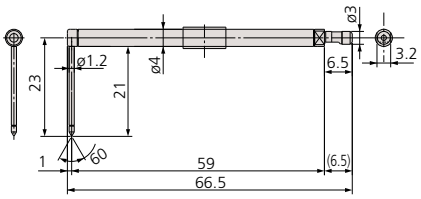
For contour/surface roughness measurement
Measurable offset length: .60" (15mm)

Cone stylus: No. 12AAD552
Tip radius: 25 µm
Tip angle: 30° cone
Tip material: Sapphire



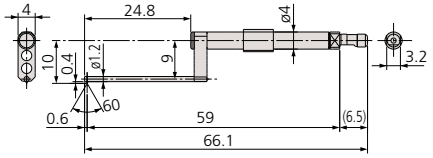
For contour measurement
Measurable depth: .28" (7mm) max.

Deep Groove stylus: No. 12AAD560
Tip radius: 2 µm
Tip angle: 60° cone
Tip material: Diamond



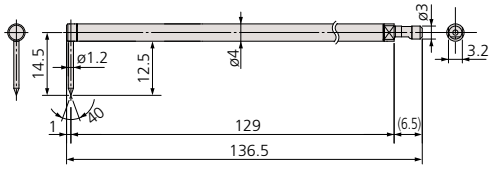
For contour/surface roughness measurement
Measurable depth: .79" (20mm) max.

Small hole stylus: No. 12AAD556
Tip radius: 2 µm
Tip angle: 60° cone
Tip material: Diamond

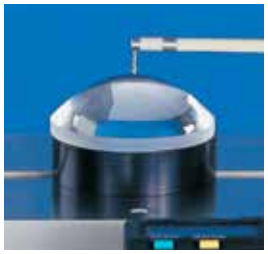


For contour/surface roughness measurement
Applicable hole: ø0.08" (ø2mm) min.

2x-long stylus: No. 12AAD562
Tip radius: 5 µm
Tip angle: 40° cone
Tip material: Diamond



For contour/surface roughness measurement
Measurable depth: .39" (10mm) max.



Measuring lens

Measuring ball screw

Measuring bearing ring

Mitutoyo

Formtracer Extreme CS-5000CNC / CS-H5000CNC

SERIES 525 — CNC Form Measuring Instruments

CS-5000CNC with personal computer system and software

* PC stand not included

Remote box

Wide range detector employing active control technology

FEATURES

- High-accuracy stylus type CNC Surface Measuring Instrument that allows simultaneous measurement of surface roughness and form/contour.
- The X1 axis has a maximum drive speed of 1.57"/s (40 mm/s) and Z2 axis has a maximum drive speed of 7.87"/s (200 mm/s). This permits high-speed positioning that may result in a large increase in the throughput of multiple-profile / multiple-workpiece measurement tasks.
- A Mitutoyo Laser Holoscale is incorporated in the X1 axis and Z1 axis so that high resolution (X1 axis: 6.25nm, Z1 axis: 4nm/8nm) 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 even if its main body collides with 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.
- 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.
- Supplied with the easy-to-operate Remote Box, the user can make any movement by selecting the required axis using the two joysticks. The current axis selection is easily identified by the icon on the key top.
- Uses USB for communicating with the Data Processing / Analysis Unit (optional).

Technical Data:

X1 axis

Measuring range:	8" (200mm)
Resolution:	0.25µin (0.00625µm)
Measurement method:	Laser Holoscale
Drive speed:	Max. 1.57"/s (40mm/s) (in CNC mode) 0 - 1.57"/s (0 - 40mm/s) (in joystick control mode)
Measuring speed:	0.0008 - 0.008"/s (0.02 - 0.2mm/s) (surface roughness) 0.0008 - 0.08"/s (0.02 - 2mm/s) (form/contour)
Measuring direction:	Push / Pull
Traverse linearity:	(4+1.5L)µin {(0.1+0.0015L)µm} with standard stylus (8+1.5L)µin {(0.2+0.0015L)µm} with 2X-long stylus
*Traverse linearity:	(2+3L)µin {(0.05+0.0003L)}µm with standard stylus (4+1.5L)µin {(0.1+0.0015L)}µm with 2X-long stylus
Linear displacement accuracy ±(20°C):	±(12+2L)µin {±(0.3+0.002L)µm}
*Linear displacement accuracy ±(20°C):	±(2.8+6.3+L)µin {±(0.16+0.001L)µm} L = Measured length inch (mm)

Z1 axis

Measuring range:	0.47" (12mm) (with standard stylus) 0.94" (24mm) (with 2X-long stylus)
Resolution:	0.16µin (0.004µm) (with standard stylus) 0.32µin (0.008µm) (with 2X-long stylus)
*Resolution:	0.03µin (0.0008µm) (with standard stylus) 0.06µin (0.0016µm) (with 2X-long stylus)
Stylus up/down:	Arc movement
Measurement method:	Laser Holoscale
Linear displacement accuracy (20°C):	±(12+120H)µin {±(0.3+I0.02HI)µm}
*Linear displacement accuracy (20°C):	±(2.8+120H)µin {±(0.07+I0.02HI)µm} H = Measured height inch (mm)
Measuring force:	4mN (with standard stylus) 0.75mN (with 2X-long stylus)
Traceable angle:	60° for ascent, 60° for descent (Depending on the workpiece surface condition)
Stylus tip: (ball stylus)	Radius: 5µm, angle: 40°, diamond (Radius: 0.25mm, sapphire)
Face of stylus:	Downward

Z2 axis (column unit)

Measuring range:	12" (300mm) (20" (500mm) high column type)
Resolution:	1.97µin (0.05µm)
Measurement method:	Reflective-type linear encoder
Drive speed:	Max. 7.87"/s (200mm/s) (in CNC mode) 0 - 1.97"/s (0 - 50mm/s) (in joystick control mode)
Base size (W x D):	29.5 x 23.6" (750 x 600mm)
Base material:	Granite
Dimension (W x D x H):	31.5 x 24.4 39.4" (800 x 620 x 1000mm) 31.5 x 24.4 x 47.2" (800 x 620 x 1200mm: high column type)
Mass:	529 lbs (240kg) 551 lbs (250kg): high column type))

*CS-H5000CNC model in red.

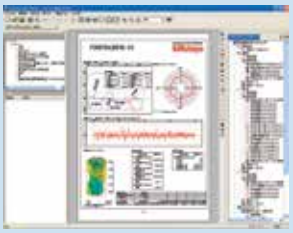
MiCAT
Mitutoyo Intelligent Computer Aided Technology
the standard in world metrology software
FORM

Optional Software

FORMTRACEPAK V5
Enables control of the optional motor-driven Y-axis table and rotary table for realizing efficient measurement automation. You can also perform contour evaluation that allows free analysis of level differences, angle, pitch, area and other characteristics based on surface roughness data. In addition, analysis results can be saved in the "html", "mhtml" or pdf format which allows Internet Explorer or MS-Word compatibility, allowing PC without layout editing programs to view analysis results.

Contour Measurement and Surface Roughness Measurement Screen

Report Layout Screen



ASLPAK
Aspherical lens analysis program
Recommended to be used with CS-H5000CNC and CS-5000CNC models. To make full use of software functions, optional accessories such as y-axis table, 3DALT and theta θ-1 table are required. The functions can be restricted without the optional accessories.

Formtracer Extreme CS-5000CNC / CS-H5000CNC

SERIES 525 — CNC Form Measuring Instruments

SPECIFICATIONS

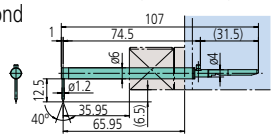
Model No.	CS-5000CNC	CS-5000CNC	CS-5000CNC	CS-5000CNC
Order No. (100V - 120V)	**525-721-1**	**525-722-1**	**525-723-1**	**525-724-1**
X1-axis measuring range	8" (200mm)	8" (200mm)	8" (200mm)	8" (200mm)
Z2-axis vertical travel	12" (300mm)	12" (300mm)	12" (300mm)	12" (300mm)
Y-axis table unit	—	—	Installed	Installed
α-axis unit	—	Installed	—	Installed

Model No.	CS-5000CNC	CS-5000CNC	CS-5000CNC	CS-5000CNC
Order No. (100V - 120V)	**525-741-1**	**525-742-1**	**525-743-1**	**525-744-1**
X1-axis measuring range	8" (200mm)	8" (200mm)	8" (200mm)	8" (200mm)
Z2-axis vertical travel	20" (500mm)	20" (500mm)	20" (500mm)	20" (500mm)
Y-axis table unit	—	—	Installed	Installed
α-axis unit	—	Installed	—	Installed

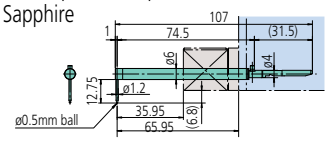
Model No.	CS-H5000CNC	CS-H5000CNC
Order No. (100V - 120V)	**525-761-1**	**525-763-1**
X1-axis measuring range	8" (200mm)	8" (200mm)
Z2-axis vertical travel	12" (300mm)	12" (300mm)
Y-axis table unit	—	Installed

Stylus

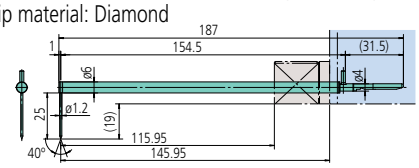
12AAD543*1**:** Standard-length stylus (tip radius: 5µm)
12AAJ037*2**:** For CS-H5000CNC (tip radius: 5µm)
Tip material: Diamond



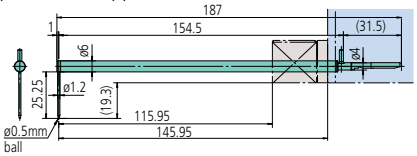
12AAD544*1*2**:** Standard-length ball stylus (tip radius: 5µm)
Tip material: Sapphire



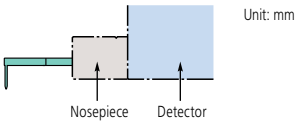
12AAD545*1**:** Double-length stylus (tip radius: 5µm)
12AAJ039*2**:** For CS-H5000CNC (tip radius: 5µm)
Tip material: Diamond



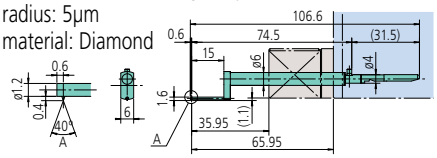
12AAD546*1*2**:** Double-length ball stylus
Tip material: Sapphire



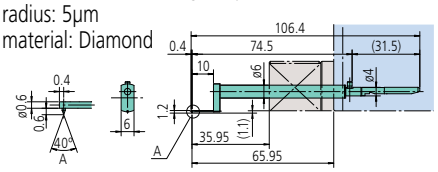
*1: Standard accessory of CS-5000CNC
*2: Standard accessory of CS-H5000CNC



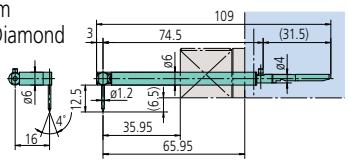
12AAD651: Standard-length stylus for small hole
Tip radius: 5µm
Tip material: Diamond



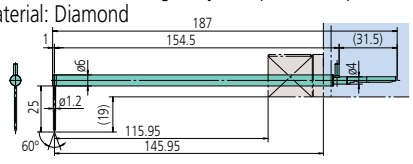
12AAD652: Standard-length stylus for extra-small hole
Tip radius: 5µm
Tip material: Diamond



12AAD653: Standard-length eccentric stylus
Tip radius: 5µm
Tip material: Diamond



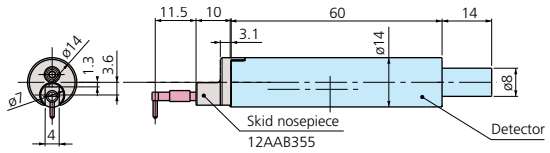
12AAJ041*2**:** Double-length stylus (tip radius: 2µm)
Tip material: Diamond



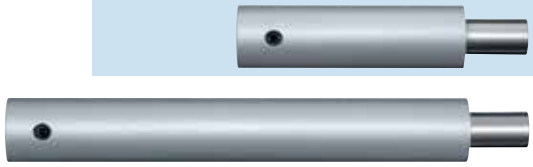
Mitutoyo

Optional Styli for Surface Roughness Measurement

Compatible with SJ-410, SJ-500, SV-2100, SV-3100, SV-3000CNC, SV-M3000CNC, SV-C3200, SV-C4500 Series



Detector (0.75mN): **178-396-2**
Detector (4mN): **178-397-2**

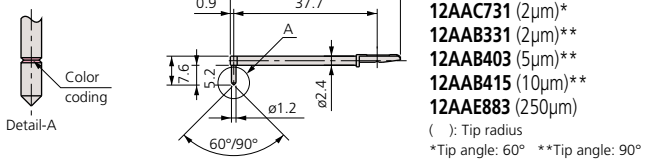


Extension rods
(12AAG202: 50mm, 12AAG203: 100mm)

Styli

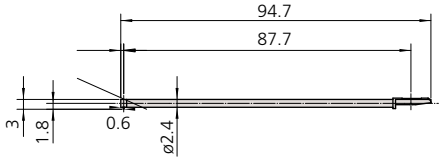
Unit: mm

Standard stylus



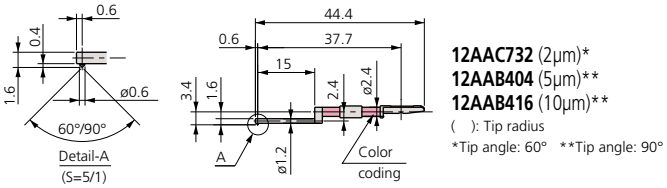
12AAE882 (1µm)*
12AAE924 (1µm)**
12AAC731 (2µm)*
12AAB331 (2µm)**
12AAB403 (5µm)**
12AAB415 (10µm)**
12AAE883 (250µm)
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

2X long for deep hole



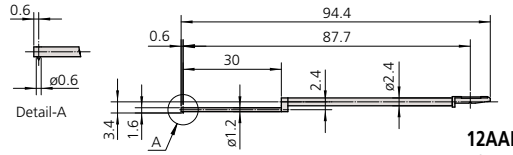
12AAE898 (2µm)*
12AAE914 (5µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For small hole



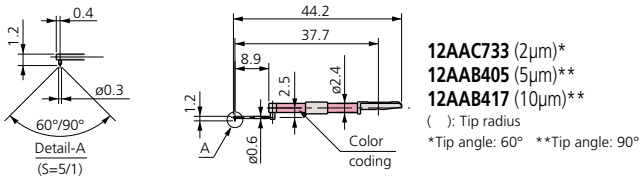
12AAC732 (2µm)*
12AAB404 (5µm)**
12AAB416 (10µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For small hole/2X long for deep hole



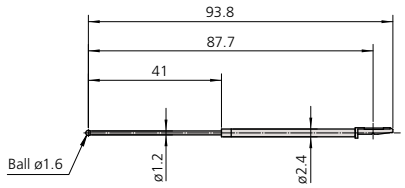
12AAE892 (2µm)*
12AAE908 (5µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For extra small hole



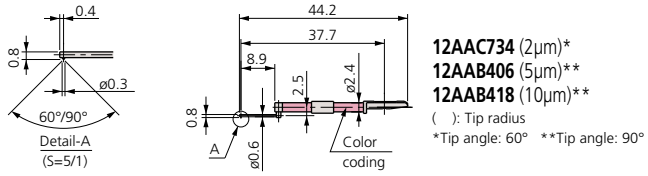
12AAC733 (2µm)*
12AAB405 (5µm)**
12AAB417 (10µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For small hole*2



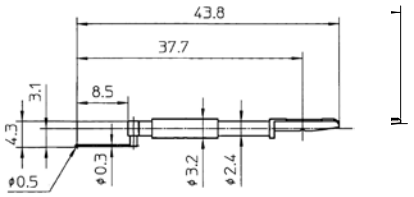
12AAE884 (0.8mm)
( ): Tip radius

For extra minute hole



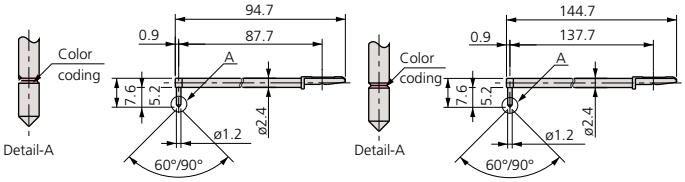
12AAC734 (2µm)*
12AAB406 (5µm)**
12AAB418 (10µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For ultra small hole *1*2



12AAJ662 (0.25mm)
( ): Tip radius

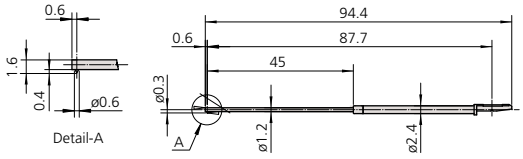
For deep hole (2X long and 3X long)



2X stylus
12AAC740 (2µm)*
12AAB413 (5µm)**
12AAB425 (10µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

3X stylus
12AAC741 (2µm)*
12AAB414 (5µm)**
12AAB426 (10µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For small slotted hole



12AAE938 (2µm)*
12AAE940 (5µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

*1: For downward-facing measurement only
*2: Used for calibration, a standard step gauge (No.178-611, option) is also required.

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

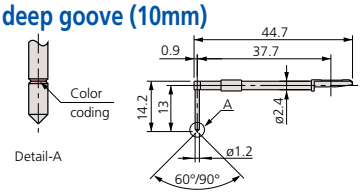
Optional Styli for Surface Roughness Measurement

Compatible with SJ-410, SJ-500, SV-2100, SV-3200, SV-3000CNC, SV-M3000CNC, SV-C3200, SV-C4500 Series

Styli

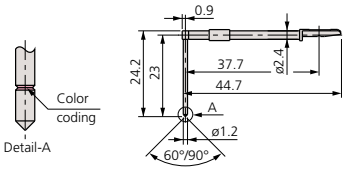
Unit: mm

For deep goove (10mm)



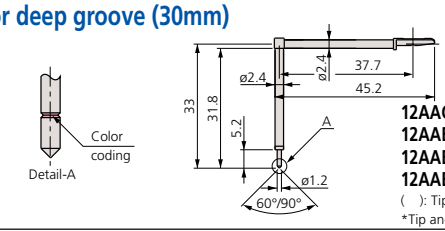
12AAC735 (2µm)*
12AAB409 (5µm)**
12AAB421 (10µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For deep groove (20mm)



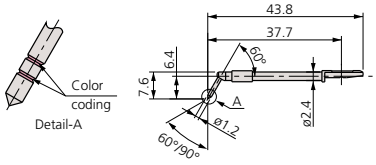
12AAC736 (2µm)*
12AAB408 (5µm)**
12AAB420 (10µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For deep groove (30mm)



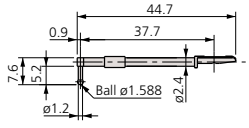
12AAC737 (2µm)*
12AAB335 (2µm)**
12AAB407 (5µm)**
12AAB419 (10µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For gear tooth



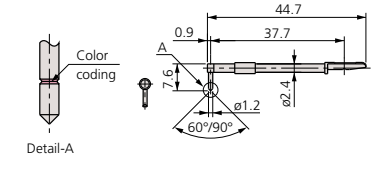
12AAB339 (2µm)*
12AAB410 (5µm)**
12AAB422 (10µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For rolling circle waviness surface*2



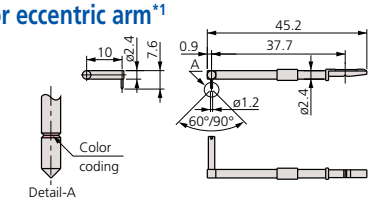
12AAB338 (0.8mm)
( ): Tip radius

For knife-edge detector



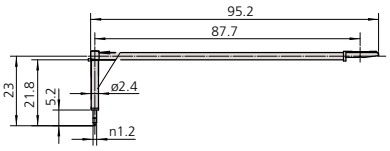
12AAC738 (2µm)*
12AAB411 (5µm)**
12AAB423 (10µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For eccentric arm*1



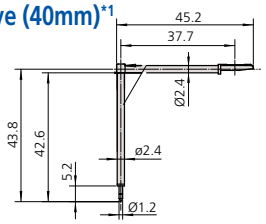
12AAC739 (2µm)*
12AAB412 (5µm)**
12AAB424 (10µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For deep groove (20mm)*1/2X Long for deep hole



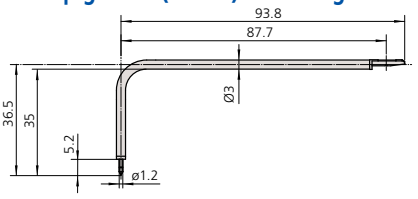
12AAE893 (2µm)*
12AAE909 (5µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For deep groove (40mm)*1



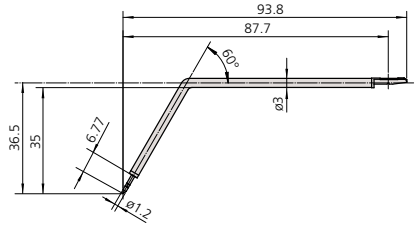
12AAE895 (2µm)*
12AAE911 (5µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For deep groove (30mm)*1/2X Long for deep hole



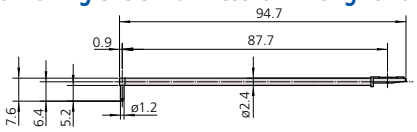
12AAE894 (2µm)*
12AAE910 (5µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For gear tooth*1/2X Long for deep hole



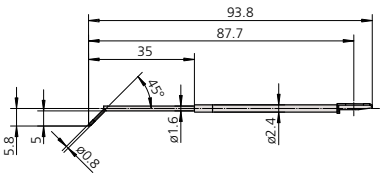
12AAE896 (2µm)*
12AAE912 (5µm)**
( ): Tip radius

For rolling circle waviness*1/2X Long for deep hole*2



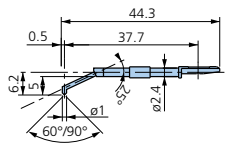
12AAE886 (0.25mm)
( ): Tip radius

For corner hole*1/2X Long for deep hole



12AAM601 (2µm)*
12AAM603 (5µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

For bottom surface



12AAE899 (2µm)*
12AAE915 (5µm)**
( ): Tip radius
*Tip angle: 60° **Tip angle: 90°

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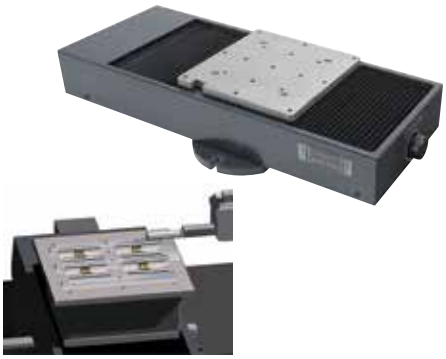
Optional Accessories for Automatic Measurement

Compatible with SV-3200, SV-C3200, SV-C4500, CS-3200 and CNC Models

Y-axis table*: 178-097

Enables efficient, automatic measurement of multiple aligned workpieces and multiple points on a single measurement surface.

* only for SV/CV/SV-C, CS model (non CNC model).



Travel range	8" (200mm)
Resolution	1.97µin (0.05µm)
Positioning accuracy	±3µm
Drive speed	Max. 3.15"/s (80mm/s)
Maximum load	110 lbs (50kg)
Mass	62 lbs (28kg)

θ2-axis table: 178-078*

You can measure multiple points on a cylindrical workpiece and automate front/rear-side measurement.

* θ2-axis mounting plate (**12AAE718**) is required when directly installing on the base of the SV-3100.

Displacement	360°
Resolution	0.0072°
Maximum load (loading moment)	8.8 lbs (4kg) (343 N•cm or less)
Rotational speed	Max. 18°/s
Mass	11 lbs (5kg)

Quick chuck: 211-032

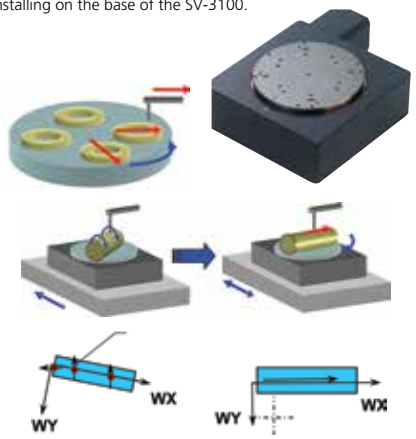
This chuck is useful when measuring small workpieces. You can easily clamp them with its knurled ring.

Retention range	Inner latch	OD: ø 0.04" - 1.42" (1 - 36mm)
	Inner latch	ID: ø 0.55" - 2.76" (14 - 70mm)
	Outer latch	OD: ø 0.04" - 2.95" (1 - 75mm)
Dimensions		ø 4.65" x 1.61" (118 x 41mm)
Mass		2.6 lbs (1.2kg)

θ1-axis table: 12AAD975*

For efficient measurement in the axial/transverse directions. When measuring a cylindrical workpiece, automatic alignment can be performed in combination with the Y-axis table.

* θ1-axis mounting plate (**12AAE630**) is required when directly installing on the base of the SV-3100.



Displacement	360°
Resolution	0.004°
Maximum load	26.5 lbs (12kg)
Rotational speed	Max. 10°/s
Mass	15 lbs (7kg)

Auto-leveling table: 178-087

This is a stage that performs fully automatic leveling as measurement starts, freeing the user from this troublesome operation. Fully automatic leveling can be done quickly by anyone. In addition, the operation is easy and reliable.

Inclination adjustment angle	±2°
Maximum load	15 lbs (7kg)
Table dimensions	5.1" x 3.9"(130 x 100mm)
Mass	7.7 lbs (3.5kg)

Micro-chuck: 211-031

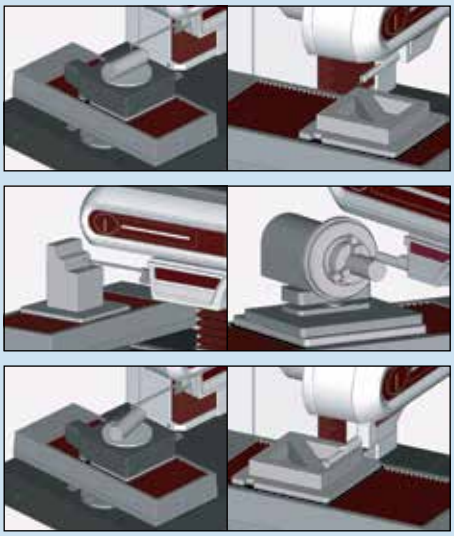
This chuck is suitable for clamping extra-small diameter workpieces (ø1mm or less), which cannot be retained with the centering chuck.

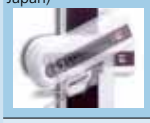
Retention range	OD: ø 0 - 0.06" (0 - 1.5mm)
Dimensions	ø 4.65" x 1.9" (118 x 48.5mm)
Mass	1.3 lbs (0.6kg)

Examples of optimal combinations of accessories for CNC models

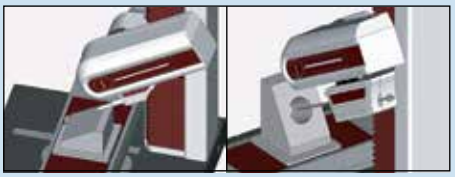
Optional accessory / Function	Y-axis Table	θ1 Table	θ2 Table
Automatic leveling	—	—	—
Automatic alignment (Patent registered: Japan)	●	●	—
Multiple workpiece batch measurement	▲	—	—
Measurement in the Y-axis direction	●	—	—
Oblique measurement of XY plane **	●	—	—
Outside 3D surface roughness measurement/evaluation **	●	—	—
Multiple-piece measurement in the Y-axis direction (Positioning in the Y-axis direction)	●	—	—
Multiple-piece measurement in the radius direction (Positioning in the rotating direction of XY plane)	▲	●	—
Tracking measurement in the Z-axis direction *	—	—	—
Inclined surface measurement in the X-axis direction	▲	—	—
Inclined hole inside measurement in the X-axis direction	▲	—	—
Multiple cylinder generatrix line measurement	▲	—	●
Measurement of both top and bottom surfaces	▲	—	●
Rotary positioning of large workpiece ***	—	—	—
Upward/downward and frontward/backward measurement of large workpiece ***	—	—	—

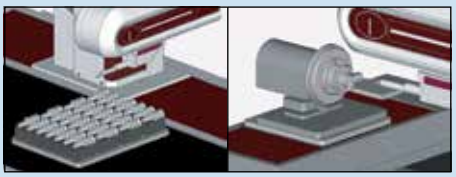
* : Applicable only to form/contour measurement
** : Applicable only to surface roughness measurement
*** : Applicable only for SV-M3000CNC



Drive unit tilting function (Patent pending: Japan)	Large θ Table	Rotary-type detector holder
		
●	—	—
▲	—	—
—	—	—
—	—	—
—	—	—
▲	—	—
—	—	—
—	—	—
—	—	—
●	—	—
●	—	—
—	—	—
—	—	—
—	●	—
—	—	●

●: Essential ▲: Better to provide with
—: Not necessary



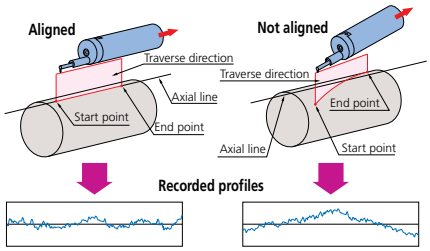


Optional Accessories for Surftest / Formtracer

Compatible with Desktop Models of Surftest and Formtracer

3-axis adjustment table

This table helps make the alignment adjustments required when measuring cylindrical surfaces. The corrections for the pitch angle and the swivel angle are determined from a preliminary measurement and the Digimatic micrometers are adjusted accordingly. A flat-surfaced workpiece can also be leveled with this table.



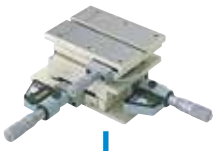
178-047
(V-block not included)

Leveling table

178-043-1 (mm), **178-053-1** (inch)
- Table top: 130 x 100mm
- Leveling range: ±1.5°
- XY travel: ±12.5mm

Digital leveling table

178-042-1 (mm)
178-052-1 (inch)
- Table top: 130 x 100mm
- Leveling range: ±1.5°
- XY travel: ±12.5mm



Leveling table

178-016
- Table top: 130 x 100mm
- Leveling range: ±1.5°
- Height: 40mm

Calibration stand *1

12AAM100

Calibration stand *2

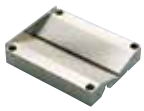
12AAG175

Calibration stand *3

12AAM309

V-block

998291
- Workpiece diameter: 1mm to 160mm
- Can be mounted on a leveling table



Precision vise

178-019
- Max. workpiece size: 36mm
- Can be mounted on a leveling table.

Cross-travel table

218-001 (mm),
218-011 (inch)
- Table top: 280 x 180mm
- XY travel: 100 x 50mm

Cross-travel table

218-041 (mm),
218-051 (inch)
- Table top: 280 x 152mm
- XY travel: 50 x 25mm

Rotary vise

218-003
- Two-slide jaw type.
- Max. workpiece size: ø60mm
- Minimum reading: 1°

Center support

172-142
- Max. workpiece dia.: 120mm
- 60mm riser is optional

Center support riser

172-143
- Used with a center support.
- Max. workpiece dia.: 240mm

Swivel center support

172-197
- Max. workpiece dia.: 80mm*
  *65mm when swiveled 10°
- Max. workpiece length: 140mm

Holder with clamp

176-107
- Used with a cross-travel table or rugged table.
- Max. workpiece height: 35mm

V-block with clamp

172-234, 172-378
- Used with a cross-travel table or rugged table.
- Max. workpiece dia.:
  50mm (**172-234**),
  25mm (**172-378**)

*1: Required for calibrating upward measurement of **CV-3200** series.
*2: Required for calibrating in bulk by mounting straight arm/small-hole stylus arm without using cross-travel table and Y-axis table.
*3: Required for calibrating in bulk by mounting straight arm/eccentric arm/small-hole stylus arm without using cross-travel table and Y-axis table.

Mitutoyo

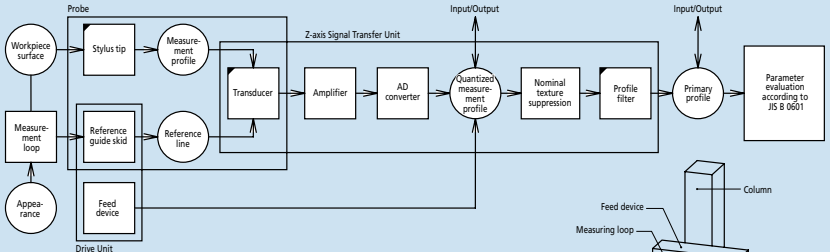
Quick Guide to Precision Measuring Instruments

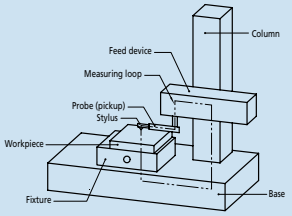
Surftest (Surface Roughness Testers)

- JIS B 0601:2001 Geometric Product Specifications (GPS) –Surface Texture: Profile method– Terms, definitions, and surface texture parameters
- JIS B 0632:2001 Geometric Product Specifications (GPS) –Surface Texture: Profile method– Metrological characterization of phase-correct filters
- JIS B 0633:2001 Geometric Product Specifications (GPS) –Surface Texture: Profile method– Rules and procedures for the assessment of surface texture
- JIS B 0651:2001 Geometric Product Specifications (GPS) –Surface Texture: Profile method– Nominal characteristics of contact (stylus) instruments

Nominal Characteristics of Contact (Stylus) Instruments

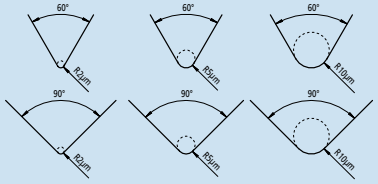
JIS B 0651: 2001 (ISO 3274: 1996)





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
Taper angle of cone: 60°, 90°
In typical surface roughness testers, the taper 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) Note 1	0.2
10		

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

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 Note 1	0.5
2.5	8	300	5 Note 2	1.5
8	25	300	10 Note 2	5

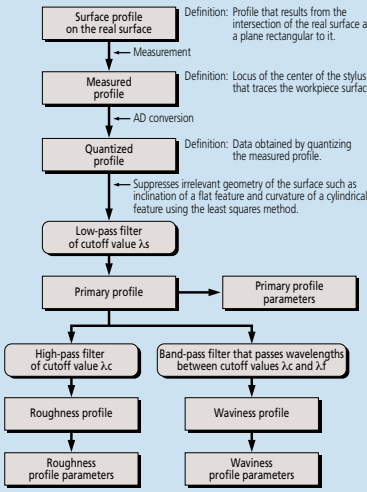
Note 1: For a surface with Ra>0.5µm or Rz>3µm, a significant error will not usually occur in a measurement even if r_{tip}= 5µm.
Note 2: If a cutoff value λs is 2.5µm or 8µm, attenuation of the signal due to the mechanical filtering effect of a stylus with the recommended tip radius appears outside the 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.

Metrological Characterization of Phase Correct Filters

JIS B 0632: 2001 (ISO 11562: 1996)

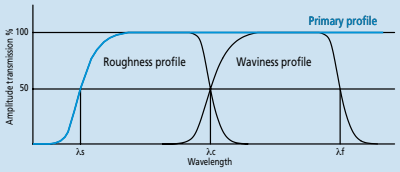
A profile filter is a phase-correct filter without phase delay (cause of profile distortion dependent on wavelength).
The weight function of a phase-correct filter shows a normal (Gaussian) distribution in which the amplitude transmission is 50% at the cutoff wavelength.

Data Processing Flow



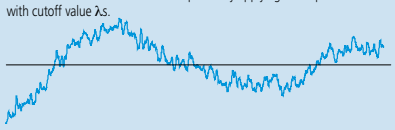
Surface Profiles

JIS B 0601: 2001 (ISO 4287: 1997)



Primary Profile

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

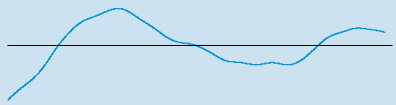


Roughness Profile

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.



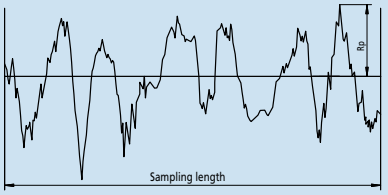
Definition of Parameters

JIS B 0601 : 2001 (ISO 4287 : 1997)

Amplitude Parameters (peak and valley)

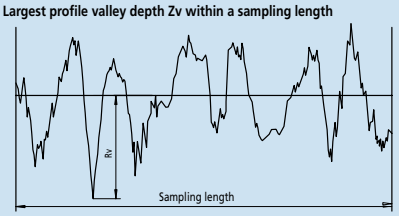
Maximum peak height of the primary profile Pp
Maximum peak height of the roughness profile Rp
Maximum peak height of the waviness profile Wp

Largest profile peak height Zp within a sampling length



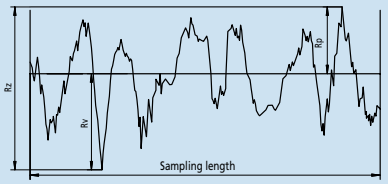
Maximum valley depth of the primary profile Pv
Maximum valley depth of the roughness profile Rv
Maximum valley depth of the waviness profile Wv

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

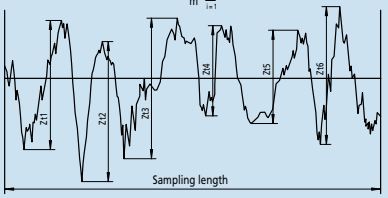


In Old JIS and ISO 4287-1: 1984, Rz was used to indicate the "ten point height of irregularities". Care must be taken because differences between results obtained according to the existing and old standards are not always negligibly small. (Be sure to check whether the drawing instructions conform to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

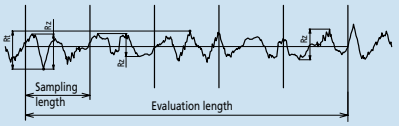
Mean value of the profile element heights Zt within a sampling length

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



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

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

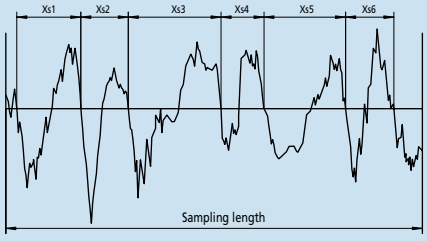
The above equation defines Rku. Pku and Wku are defined in a similar manner. Pku, Rku, and Wku are measures of the sharpness of the probability density function of the ordinate values.

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

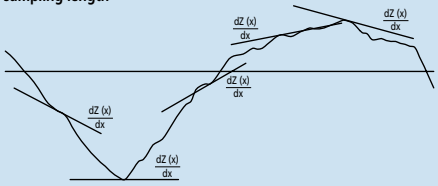
$$PSm, RSm, WSm = \frac{1}{m}\sum_{i=1}^{m} X_{si}$$



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

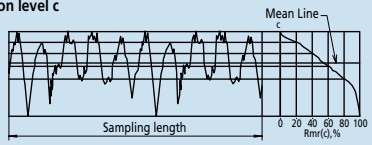
Root mean square value of the ordinate slopes dZ/dX within a sampling length



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)

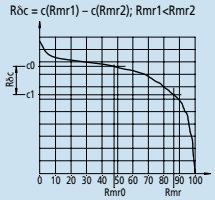
Ratio of the material length of the profile elements Ml(c) at a given level c to the evaluation length

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

Section height difference of the primary profile Pdc
Section height difference of the roughness profile Rdc
Section height difference of the waviness profile Wdc

Vertical distance between two section levels of a given material ratio

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



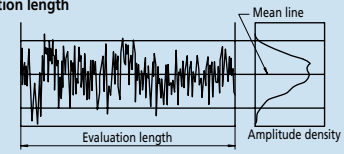
Relative material ratio of the primary profile Pmr
Relative material ratio of the roughness profile Rmr
Relative material ratio of the waviness profile Wmr

Material ratio determined at a profile section level Rδc (or Pδc or Wδc), related to the reference section level c0

Pmr, Rmr, Wmr = Pmr(c1), Rmr(c1), Wmr(c1)
where c1 = c0 – Rδc(Rδc, Wδc)
c0 = 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

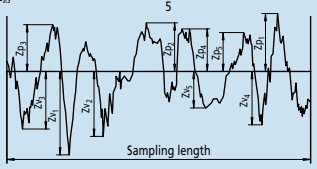


JIS Specific Parameters

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
RzJIS82	Surface profile as measured
RzJIS94	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.

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

Sampling Length for Surface Roughness Parameters

JIS B 0633: 2001 (ISO 4288: 1996)

Table 1: Sampling lengths for aperiodic profile roughness parameters (Ra, Rq, Rsk, Rku, RΔq), 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) Rzlmax only used for measurement of Rzlmax, Rvlmax, Rplmax, and Rclmax.

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

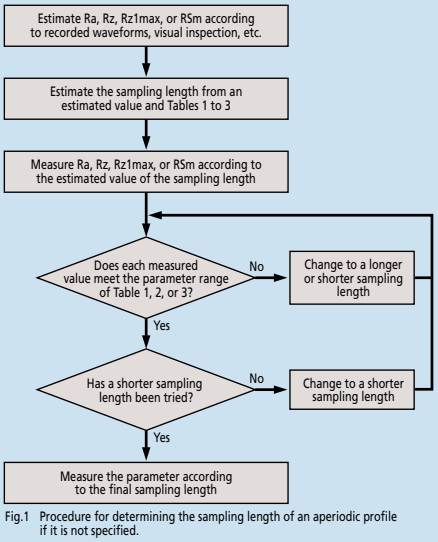


Fig.1 Procedure for determining the sampling length of an aperiodic profile if it is not specified.

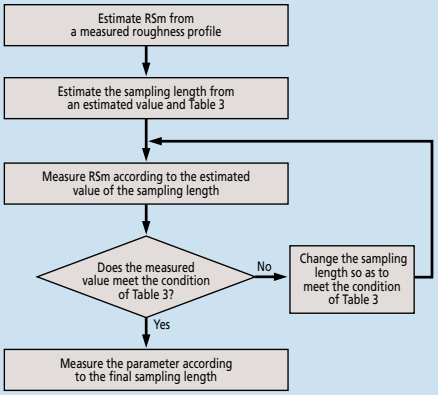


Fig.2 Procedure for determining the sampling length of a periodic profile if it is not specified.

Mitutoyo