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Surftest SJ-210
SERIES 178 — Portable Surface Roughness Tester

FEATURES
• The 2.4-inch color graphic LCD provides excellent readability and an intuitive display that is easy to negotiate. The LCD also includes a backlight for improved visibility in dark environments.
• The Surftest SJ-210 can be operated easily using the buttons on the front of the unit and under the sliding cover.
• Up to 10 measurement conditions and one measured profile can be stored in the internal memory.
• An optional memory card can be used as an extended memory to store large quantities of measured profiles and conditions.

SPECIFICATIONS/CONFIGURATION

<table>
<thead>
<tr>
<th>Model No.</th>
<th>SJ-210</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive unit</td>
<td>Standard type (178-230-2)</td>
</tr>
<tr>
<td>Detector</td>
<td>0.75mN type (178-296)</td>
</tr>
<tr>
<td>Display unit</td>
<td>Compact type (178-253A)</td>
</tr>
<tr>
<td>Detector: Tip angle</td>
<td>60°</td>
</tr>
<tr>
<td>Stylus tip radius</td>
<td>2μm</td>
</tr>
<tr>
<td>Detector measuring force</td>
<td>0.75mN</td>
</tr>
</tbody>
</table>

Standard accessories
- 12BAK699 Roughness specimen (Ra 3.00μm)
- 12BAK700 Carrying case
- 12BAK892 Protective sheets for display
- AC Adapter
- Operation manual
- Quick reference manual
- Warranty

DIMENSIONS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive unit inside display unit (Standard detector installed in drive unit) SJ-210 series</td>
<td></td>
</tr>
<tr>
<td>Sliding cover: Closed</td>
<td></td>
</tr>
<tr>
<td>Drive unit not stored inside display unit (Standard detector installed in drive unit) SJ-210 series</td>
<td></td>
</tr>
<tr>
<td>Standard drive unit</td>
<td></td>
</tr>
<tr>
<td>Sliding cover: Open</td>
<td></td>
</tr>
</tbody>
</table>

FUNCTION: SJ-210
Customization: Desired parameters can be selected for calculation and display.
GO/NG judgment: By max value / 16% / Standard deviation
Storage of measurement condition: Save the conditions at power OFF
Storage: Internal memory: Measurement condition (10sets), Measured profile (1set)
Memory card (Option): 500 measurement conditions, 10000 measured profiles, 5000 display images
Text file (Measurement conditions / Measured profile / Assessed profile / Bearing area curve / Amplitude distribution curve)
Calibration: Auto-calibration with the entry of numerical value / Average calibration with multiple measurement (Max.5 times) is available
Surftest SJ-310
SERIES 178 — Portable Surface Roughness Tester

FEATURES
• The data processing unit offers large 5.7-inch color graphic LCD touch-panel for superior readability and operability. The LCD also includes a backlight for improved visibility in dark environments.
• The excellent user interface provides intuitive and easy-to-understand operability.

SPECIFICATIONS/CONFIGURATION

<table>
<thead>
<tr>
<th>Model No.</th>
<th>SJ-310</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td></td>
</tr>
<tr>
<td>[inch/mm]</td>
<td></td>
</tr>
<tr>
<td>178-571-01A</td>
<td>178-571-02A</td>
</tr>
<tr>
<td>178-573-01A</td>
<td>178-573-02A</td>
</tr>
<tr>
<td>178-575-01A</td>
<td>178-575-02A</td>
</tr>
</tbody>
</table>

Drive unit
- Standard type (178-230-2)
- Retractable type (178-235)
- Transverse tracing type (178-387)

Detector
- 0.75μm type (178-296)
- 4μm type (178-307)
- 0.75μm type (178-296)
- 4μm type (178-307)
- 0.75μm type (178-296)
- 4μm type (178-307)

Display unit
- Standard type with printer

Display unit, Drive unit

DIMENSIONS

<table>
<thead>
<tr>
<th>Standard accessories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecting cable</td>
</tr>
<tr>
<td>Connecting cable</td>
</tr>
<tr>
<td>Connecting cable</td>
</tr>
<tr>
<td>Connecting cable</td>
</tr>
</tbody>
</table>

Carrying case

Roughness reference specimen (Ra 3μm), AC adapter, Phillips screwdriver, Strap for stylus pen, Operation manual, Quick reference manual, Warranty

Standard accessories

Connecting cable
Point-contact adapter
V-type adapter
Calibration stage
Stylus pen
Protection stage
Printer paper (5 pieces)
Carrying case
Roughness reference specimen (Ra 3μm), AC adapter, Phillips screwdriver, Strap for stylus pen, Operation manual, Quick reference manual, Warranty

Function: SJ-310
Customization: Desired parameters can be selected for calculation and display.
Statistical processing: Maximum value, minimum value, mean value, standard deviation, pass rate, histogram of each parameter
Go/NoGo judgment: maximum value rule, 16% rule, average value rule, standard deviation (1σ, 2σ, 3σ)
Storage: Internal memory: Measurement condition (10 sets)
Memory card (Option): 500 measurement conditions, 10000 measured profiles, 500 display images, Text file (Measurement conditions / Measured profile / Assessed profile / Bearing area curve / Amplitude distribution curve), 500 statistical data, etc.
Calibration: Auto-calibration with the entry of numerical value (Average calibration with multiple measurement (Max. 12 times) is available.)
Power saving function: Auto-sleep-function, Auto light-off of Backlight by ECO mode.
**Detectors**

**SJ-Printer for SJ-210**

Assessed profiles and calculation results and curves can be printed out by connecting the SJ-210-dedicated printer, which is palm sized (WxDxH: 93x125x70mm) and can run on an internal battery.

- Power supply can be selected. (AC adapter or battery pack)
- Printable items: Measurement conditions, calculation results, assessed profile, bearing area curve (BAC), amplitude distribution curve (ADC), and environment settings.

**DP-1VR**

It is possible to process Digimatic data output from the Surftest SJ series with the DP-1VR. This compact, hand-held device can provide printouts of measurement data and various statistical analyses results such as histograms, D-charts, and X bar R control charts. With optional output cables, DP-1VR is also capable of RS-232C output of measurement data to a PC (cable 09EAA084) and GO/NG condition output (cable 965516).
Free Communication Software
SJ-Tools
This program can be downloaded for FREE from the Mitutoyo website: http://www.mitutoyo.com
Output software based on Microsoft-Excel* for controlling the devices and reproducing and storing the measurement data.
* Microsoft-Excel is not included in the scope of supply.
Complete with exclusive accessories.
• Measurement device control
• Definition of measurement variables
• Graphic representation of the profile
• Storage of measurement records
• Documentation of measurement results
• Connecting cable
Optional cables are required.
12AA1068: USB PC connecting cable (USB cable) for SJ-210
12AADS10: USB PC connecting cable (USB cable) for SJ-310/410
12AAL067: RS-232C cable for SJ-210
12AAAB22: RS-232C cable for SJ-310/410
12AAH490: USB PC connecting cable for SJ-500/SV-210

Optional Accessories
12AA272: SJ-210 Replacement Battery Pack
12AA046: SJ-310 Replacement Battery Pack
12BA820: SJ-210 Display Protection Sheet (1pc.)
12AA1066: SJ-210 Display Protection Sheet (5pcs.)
12BA1402: SJ-310 Display Protection Sheet (1pc.)
12AAAN040: SJ-310 Display Protection Sheet (10pcs.)
178-601: Precision Reference Specimen (Ra 3.00 µm)
178-602: Precision Reference Specimen (Ra 3.19 µm / 3.00 µm)
178-603: Precision Reference Specimen – 2 values (GAR)
178-604: Precision Reference Specimen – 2 Values (MIT)
178-606: Precision Reference Specimen for Transverse Drive (Ra 0.039 µm / 0.30 µm)
178-029: Manual Column Stand

SJ-Tools input mask for Surftest SJ series

SJ-Tools output record from MS-Excel

Nosepiece, Adapter
Nosepiece for flat surfaces
12AA217
• SJ-210/210R optional accessory.
• SJ-310/310R standard accessory.
• Not available for the transverse tracing drive unit.

V-type adapter
12AA664
• SJ-210/310 Transverse tracing type standard accessory.
• Dedicated to the transverse tracing drive unit.

Extension rod (50mm)
12AA210
• Not available for the transverse tracing drive unit.
(Note: Only one rod can be used.)

Magnetic stand adapter
12AA221 (ø8mm)
12AA220 (ø9.5mm)

Vertical positioning adapter
12AA219
• Not available for the transverse tracing drive unit.

Support feet set
12AA216
• SJ-210/210R optional accessory.
• SJ-310/310R standard accessory.
• Not available for the detector side of the transverse tracing drive unit.

Extension cable (1m)
12BAAA303
• Only one cable can be used.

Height gage adapter
12AA222 (9mm x 9mm)
12AA233 (1/4" x 1/2")

No. 178-033
V-type for measuring in the cylinder axis direction

The V-width is adjustable to the cylinder diameter facilitating axial measurement of a wide range of cylinder diameters.
• Adjustable range: ø 5 - 150mm

No. 178-034
Setting attachment: Magnetic slider type

The magnet attached to the bottom surface of the frame allows hands-free measurements to be made.

Greatly facilitates measurement of internal wall surfaces of, for example, cylinder-block bores.
• Applicable diameter: ø75 - ø95mm
• Accessible depth: 30 - 135mm

No. 178-035
Setting attachment: Inside diameter type

No. 178-033
V-type for measuring in the cylinder axis direction

The V-width is adjustable to the cylinder diameter facilitating axial measurement of a wide range of cylinder diameters.
• Adjustable range: ø 5 - 150mm

No. 178-034
Setting attachment: Magnetic slider type

The magnet attached to the bottom surface of the frame allows hands-free measurements to be made.

Greatly facilitates measurement of internal wall surfaces of, for example, cylinder-block bores.
• Applicable diameter: ø75 - ø95mm
• Accessible depth: 30 - 135mm

No. 178-035
Setting attachment: Inside diameter type

Nosepiece for cylindrical surfaces
12AA218
• SJ-210/210R optional accessory.
• SJ-310/310R standard accessory.
• Not available for the transverse tracing drive unit.
• ø30mm or smaller workpiece
Surftest SJ-410
SERIES 178 — Portable Surface Roughness Tester

FEATURES
- Both skidded and skidless measurement are possible with this series. Equipped with 46 roughness parameters that conform to the latest ISO, DIN, ANSI, and JIS standards.
- A wide-range, high-resolution detector and a drive unit provide superior high-accuracy measurement in its class.

Detector
- Measuring range: 800µm
- Resolution: 0.000125µm (at 8µm range)

Drive unit
- Straightness/traverse length
  SJ-411: 0.3µm/25mm
  SJ-412: 0.5µm/50mm

- A skidless detector and a curved surface compensation function provide efficient evaluation of cylinder roughness.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>SJ-411</th>
<th>SJ-411</th>
<th>SJ-412</th>
<th>SJ-412</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No. (inch/mm)</td>
<td>178-581-01A</td>
<td>178-581-02A</td>
<td>178-583-01A</td>
<td>178-583-02A</td>
</tr>
<tr>
<td>Detector measuring force</td>
<td>0.75mN</td>
<td>4mN</td>
<td>0.75mN</td>
<td>4mN</td>
</tr>
<tr>
<td>Evaluation range</td>
<td>25mm</td>
<td>25mm</td>
<td>50mm</td>
<td>50mm</td>
</tr>
<tr>
<td>Stylist tip</td>
<td>2µm</td>
<td>5µm</td>
<td>2µm</td>
<td>5µm</td>
</tr>
</tbody>
</table>

Technical Data: X axis (drive unit)
- Measuring range: 1”(25mm)(SJ-411), 2”(50mm)(SJ-412)
- Measuring speed: .002, .004, .008, .02, .04”/s
- Return speed: .02, .04, .08”/s (0.5, 1.0, 2.0mm/s)
- Traversing direction: Pulling
- Traverse linearity: 0.7µm/1”(0.3µm/25mm)(SJ-411), 2µm/2”(0.5µm/50mm)(SJ-412)
- Positioning: ±1.5° (tilting), 10mm (up/down)

- A wide-range, high-resolution detector and a drive unit provide superior high-accuracy measurement in its class.
- The handheld data processing unit and the 5.7-inch color graphic LCD touch-panel provides superior readability and operability. The LCD also includes a backlight for improved visibility in dark environments.
- The excellent user interface provides intuitive and easy-to-understand operability.
- Measured data can be output to a PC with optional RS-232C or USB cable.
- Digital filter function for non-distorted roughness profiles.
- GO/NG judgment function.
- Auto-calibration function.
- The display interface supports 16 languages, which can be freely switched.
- Simplified contour analysis function supports the four types of measurement: step, level change, area and coordinate difference.
- Access to each feature can be password-protected, which prevents unintended operations and allows you to protect your settings.
- The optional attachments for mounting on a column stand significantly increase the operability.
Surftest SJ-410
SERIES 178 — Portable Surface Roughness Tester

Free Communication Software
SJ-Tools
This program can be downloaded for FREE from the Mitutoyo website. http:www.mitutoyo.com
Output software based on Microsoft-Excel® for controlling the devices and reproducing and storing the measurement data.
*Microsoft-Excel is not included in the scope of supply.
Complete with exclusive accessories.
• Measurement device control
• Definition of measurement variables
• Graphic representation of the profile
• Storage of measurement results
• Documentation of measurement results
Optional cables are required.
12AAD510: USB PC connecting cable (USB cable)
12AAA882: RS-232C connecting cable
Optional Accessories
178-611: Step gage (2µm, 10µm)
178-612: Step gage (2µm, 10µm, 79µin, 394µin)
178-610: Step gage (step: 1µm, 2µm, 5µm, 10µm)
12AAM556: Height/tilt adjustment unit for SJ-410
178-039: Manual column stand (granite base)
178-010: Auto-set unit for 178-039
178-020: X-axis adjustment unit for 178-039
178-030: Tilting adjustment unit (inclination adjustment unit) for 178-039
12AAB358: Cylindrical surface adapter
(workpiece dia.: 15 - 60mm)
178-016: Levelling table
(tilt: ±1.5°, max. loading: 15kg)
178-048: Levelling table with D.A.T function (mm)
(tilt: ±1.5°, max. loading: 15kg)
178-058: Levelling table with D.A.T function (inch)
(tilt: ±1.5°, max. loading: 15kg)
178-043-1: XY levelling table (25 x 25mm)
(tilt: ±1.5°, max. loading: 15kg, swiveling: ±3°)
178-053-1: XY levelling table (1” x 1”)
(tilt: ±1.5°, max. loading: 15kg, swiveling: ±3°)
178-042-1: Digital XY levelling table (25 x 25mm)
(tilt: ±1.5°, max. loading: 15kg, swiveling: ±3°)
178-052-1: Digital XY levelling table (1” x 1”)
(tilt: ±1.5°, max. loading: 15kg, swiveling: ±3°)
178-049: Digital XY levelling table (25 x 25mm)
(max. loading: 15kg)
178-059: Digital XY levelling table (1” x 1”)
(max. loading: 15kg)
178-019: Precision vise for XY levelling table
(jaw opening: 36mm)
998291: Precision V-block for XY levelling table
(workpiece dia.: 1 - 160mm)
12AA841: Memory card
965014: SPC cable (2m)
264-012-10: Input tool (USB type)
264-504-5A: DP-1VR
Detectors, Styli, and nosepieces
Consumables
12AA040: LCD protective sheet (10 sheets/set)
12AA876: Durable printer paper (25m, 5 roll/set)
270732: Printer paper (5 pack)
12AA046: Replacement battery
12AA088: Footswitch
Carrying case is a standard accessory.

DIMENSIONS

MEASUREMENT APPLICATIONS

Fine contour measurement with an auto leveling table
Deep groove measurement
Upside down measurement
Cylinder measurement with a support foot

Manual column stand
178-039

With optional accessories.
178-010: Auto-set unit
178-020: X-axis adjustment unit
178-030: Tilting adjustment unit

Surftest SJ-500/P, SV-2100
SERIES 178 — with Dedicated Control / PC System / Display Unit

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

FEATURES
- User-friendly display and simple operation equipped with a highly visible color 7.5-inch TFT LCD.
- Easy positioning
  A joy stick built in the dedicated control unit allows easy and quick positioning. Fine positioning of a small stylus, required for measuring the inner side of a small hole, can be easily made using the manual knob.

**Technical Data: SJ-500**
- X-axis (drive unit)
  - Measuring range: 1.97” (50mm)
  - Resolution: 1.97µin (0.05µm)
- Measurement method: Linear encoder
- Drive speed: 0 - 0.78”/s (0 - 20mm/s)
- Measuring speed: 0.00078 - 0.197”/s (0.02 - 5mm/s)
- Traverse direction: Pull
- Traverse linearity: 0.0078µin/1.97” (0.2µm / 50mm)
- Positioning: ±1.5° (tilting, with DAT function)
- 1.18” (30mm) (up/down)
- Detector resolution / Range: 0.4µin/32000µin, 0.04µin/3200µin
- Stylus tip: Diamond, 90º / 5µmR
- Skid radius of curvature: 1.57” (40mm)
- Detecting method: Skidless / skid measurement
- Measuring force: 4mN or 0.75mN (low force type)
- Control unit Display: 7.5” color TFT with backlight
- Printer: Built-in thermal printer
- Magnification: Horizontal: X10 to X500,000, Auto
  Vertical: X0.5 to X10,000, Auto
- Drive unit control: Joystick operation with manual knob

**Technical Data: SV-2100**
- X-axis (drive unit)
  - Measuring range: 3.94” (100mm)
  - Resolution: 1.97µin (0.05µm)
- Measurement method: Linear encoder
- Drive speed: 0 - 1.57”/s (0 - 40mm/s)
- Measuring speed: 0.00078 - 0.197”/s (0.02 - 5mm/s)
- Traverse direction: Pull
- Traverse linearity: 6µin/4” (0.15µm / 100mm)
- Z2-axis (column) Type: Manual operation or power drive
  - Vertical travel: 13.8” or 21.6” (350mm or 550mm*)
  - Resolution*: 1µm
  - Measurement method*: Rotary encoder
- Drive speed*: 0 - 0.78”/s (0 - 20mm/s)
  *Only for power drive type
- Detector resolution / Range : 0.4µin/32000µin, 0.04µin/3200µin, 0.004µin/320µin
- Measuring force: 4mN or 0.75mN (low force type)
- Stylus tip: Diamond, 90º / 5µmR
- Skid radius of curvature: 1.57” (40mm)
- Detecting method: Differential inductance

**Evaluation Capability**
- Cutoff length
  - ls: 0.25µm, 0.8µm, 2.5µm, 8µm, 25µm, 250µm, no filter
  - lc*: 0.025mm, 0.08mm, 0.25mm, 0.8mm, 2.5mm, 8mm, 25mm
  *Arbitrary length can be specified in the range from 0.02mm to 50mm.
- Sampling length (L)*
  - 0.025mm, 0.08mm, 0.25mm, 0.8mm, 2.5mm, 8mm, 25mm, 80mm (SV-2100 only)
- Data compensation functions
  - Parabola compensation, hyperbola compensation, ellipse compensation, R-plane (curved surface) compensation, conic compensation, tilt compensation

**SURFPAK-EZ: Easy-to-use task-focused software**
User-friendly graphical display and button layout allows intuitive operation. Simplified fine-contour analysis provided as standard, including step, area, angle, and circle calculation.

**Measurement and results display screen**

**High durable Printer Paper (5 Rolls/set)**

**Technical Data: SJ-500P**
- X-axis (drive unit)
  - Measuring range: 1.97” (50mm)
  - Resolution: 1.97µin (0.05µm)
- Measurement method: Linear encoder
- Drive speed: 0 - 0.78”/s (0 - 20mm/s)
- Measuring speed: 0.00078 - 0.2”/s (0.02 - 5mm/s)
- Traverse direction: Pull
- Traverse linearity: 0.0078µin/1.97” (0.2µm / 50mm)
- Positioning: ±1.5° (tilting, with DAT function)
- 1.18” (30mm) (up/down)
- Detector resolution / Range: 0.4µin/32000µin, 0.04µin/3200µin
- Stylus tip: Diamond, 90º / 5µmR
- Skid radius of curvature: 1.57” (40mm)
- Detecting method: Skidless / skid measurement
- Measuring force: 4mN or 0.75mN (low force type)
- Control unit Display: 7.5” color TFT with backlight
- Printer: Built-in thermal printer
- Magnification: Horizontal: X10 to X500,000, Auto
  Vertical: X0.5 to X10,000, Auto
- Drive unit control: Joystick operation with manual knob

**Evaluation Capability**
- Cutoff length
  - ls: 0.25µm, 0.8µm, 2.5µm, 8µm, 25µm, 250µm, no filter
  - lc*: 0.025mm, 0.08mm, 0.25mm, 0.8mm, 2.5mm, 8mm, 25mm
  *Arbitrary length can be specified in the range from 0.02mm to 50mm.
- Sampling length (L)*
  - 0.025mm, 0.08mm, 0.25mm, 0.8mm, 2.5mm, 8mm, 25mm, 80mm (SV-2100 only)
- Data compensation functions
  - Parabola compensation, hyperbola compensation, ellipse compensation, R-plane (curved surface) compensation, conic compensation, tilt compensation

**12AAA876**: High durable Printer Paper (5 Rolls/set)
**270732**: Standard type printer paper (5pcs.)
### Surftest SJ-500/P, SV-2100

#### SERIES 178 — with Dedicated Control / PC System / Display Unit

<table>
<thead>
<tr>
<th>Model no.</th>
<th>SJ-500P</th>
<th>SJ-500</th>
<th>SV-2100M4</th>
<th>SV-2100S4</th>
<th>SV-2100H4</th>
<th>SV-2100W4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Data processing</td>
<td>PC System</td>
<td>Dedicated Data Processor</td>
<td>Dedicated Data Processor</td>
<td>Dedicated Data Processor</td>
<td>Dedicated Data Processor</td>
<td>Dedicated Data Processor</td>
</tr>
<tr>
<td>Order No. (inch)</td>
<td>178-531-02A</td>
<td>178-533-02A</td>
<td>178-637-01A</td>
<td>178-681-01A</td>
<td>178-683-01A</td>
<td>178-685-01A</td>
</tr>
<tr>
<td>Measuring force of detector</td>
<td>4mN</td>
<td>4mN</td>
<td>0.75mN</td>
<td>0.75mN</td>
<td>0.75mN</td>
<td>0.75mN</td>
</tr>
<tr>
<td>X-axis measuring range</td>
<td>2” (50mm)</td>
<td>2” (50mm)</td>
<td>4” (100mm)</td>
<td>4” (100mm)</td>
<td>4” (100mm)</td>
<td>4” (100mm)</td>
</tr>
<tr>
<td>Vertical travel</td>
<td>Optional stand</td>
<td>13.8” (350mm) manual column</td>
<td>13.8” (350mm) power column</td>
<td>21.6” (550mm) power column</td>
<td>21.6” (550mm) power column</td>
<td>21.6” (550mm) power column</td>
</tr>
<tr>
<td>Granite base size (WxD)</td>
<td>Optional stand</td>
<td>23.6” x 17.7” (600 x 450mm)</td>
<td>23.6” x 17.7” (600 x 450mm)</td>
<td>23.6” x 17.7” (600 x 450mm)</td>
<td>23.6” x 17.7” (600 x 450mm)</td>
<td>23.6” x 17.7” (600 x 450mm)</td>
</tr>
<tr>
<td>PC I/F Unit</td>
<td>12.7” x 10.4” x 3.4” (350 x 263 x 86mm)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Dimensions (main unit, WxDxH)</td>
<td>16.7” x 3.7” x 6.3” (425 x 94 x 160mm)</td>
<td>28.2” x 17.7” x 34” (716 x 450 x 863mm)</td>
<td>28.2” x 17.7” x 38” (716 x 450 x 966mm)</td>
<td>28.2” x 17.7” x 46” (716 x 450 x 1166mm)</td>
<td>44” x 17.7” x 46.3” (1116 x 450 x 1176mm)</td>
<td></td>
</tr>
<tr>
<td>Main unit Mass</td>
<td>5.9 lbs. (2.7 kg)</td>
<td>308.6 lbs. (140 kg)</td>
<td>308.6 lbs. (140 kg)</td>
<td>308.6 lbs. (140 kg)</td>
<td>485 lbs (220 kg)</td>
<td></td>
</tr>
</tbody>
</table>

#### Assessed profiles

- Dedicated data processor type: P (primary profile), R (roughness profile), WC, envelope residual profile, roughness motif, waviness motif
- PC system type: P (primary profile), R (roughness profile), WC, WCA, WE, DIN4776 profile, E (envelope residual profile), roughness motif, waviness motif

#### Evaluation parameters

- Dedicated data processor type: Ra, Rc, Ry, Rq, Rt, Rmax, Rp, Rz, Sm, S, Pc, mr (c), δc, mr, tp, Htp, Lo, It, Ppi, HSC, Δa, Δq, Ku, Sk, Rpk, Rvk, Rk, Mr1, Mr2, A1, A2, Vo, λa, λq, R, AR, Rx, W, AW, Wx, Wte, (43 parameters), Customization
- PC system type: Pa, Pq, Psk, Pku, Pp, Px, Pt, Pc, P5, P2, P2a, Prm (c), Pmr, Poc, Rq, Rs, Rk, Rp, Rz, Rx, Rct, Rsm, RΔq, Rmr (c), Rmr, Rσc, Wa, Wq, Wsk, Wku, Wp, Wx, Wz, Wl, Wc, Wsm, WΔq, Wmr (c), Wmr, WOc, Ro, Rp, Rsk, Rpt, Rm1, Rm2, A1, A2, Rx, AR, R, Wx, AW, W, Wte, Ry, RyDIN, RzDIN, Rz3, S, HSC, Lo, It, Δa, λa, λq, Vo, Htp, NR, NCRX, CPM, SR, SAR, NW, SW, SAW

#### Analysis graphs

- Dedicated data processor type: ADC, BAC, power spectrum graph
- PC system type: ADC, BAC Graph, power spectrum graph, auto-correlation graph, Walsh power spectrum graph, Walsh auto-correlation graph, slope distribution graph, local peak distribution graph, parameter distribution graph

#### Curved surface compensation

- Dedicated data processor type: Parabolic compensation, Hyperbolic compensation, Elliptical compensation, Circular compensation
- PC system type: Parabolic compensation, Hyperbolic compensation, Elliptical compensation, Circular compensation, Conic compensation, Inclination (Entire, Arbitrary), Polynomial compensation

#### Contour analysis

- Dedicated data processor type: Area, Circle, Angle, Coordinate difference, Step, Inclination
- PC system type (SURFPAK-EZ): Area, Circle, Angle, Coordinate difference, Step, Inclination

#### Filters

- Dedicated data processor type: 2CR-75%, 2CRPC-75%, Gaussian, Robust-spline
- PC system type: 2CR-75%, 2CR-50%, 2CRPC-75%, 2CRPC-50%, Gaussian, Robust-spline

---

### Manual column stand options: 178-085 and 178-089 (for SJ-500)

- Suitable for desktop use in inspection rooms and such.
- **No.178-085** Except measuring unit
  - Vertical adjustment range: 11.8” (300mm)
  - Dimension (W x D x H): 23.6” x 17.7” x 28”
  - Measuring force of detector: 4mN
  - Weigh: 242 lbs (110kg)
- **No.178-089** Except measuring unit
  - Vertical adjustment range: 9.8” (250mm)
  - Dimension (W x D x H): 15.7” x 9.8” x 2.4”
  - Measuring force of detector: 4mN
  - Weight: 44 lbs (20kg)


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

- Inclination adjustment angle: ±2°
- Maximum load: 15.4 lbs (7kg)
- Table dimensions: 5.12” x 3.94” (130 x 100mm)
- Mass: 7.7 lbs (3.5kg)
SURFTEST SV-3200 SERIES 178 — Surface Roughness Testers

**FEATURES**

- Mitutoyo’s SurfTest SV-3200 Series provide high-accuracy, high-level analysis, and multi-functionality in measurement of surface roughness.
- Peripheral devices such as the auto-leveling guide is required. No lubrication of the anti-abrasive property, is used as the X-axis drive unit guide. No lubrication of the Z2-axis (column, resolution: 39.4µin (1µm) to insure high-accuracy positioning.
- Ceramic, which is known for its superb anti-abrasive property, is used as the X-axis drive unit guide. No lubrication of the guide is required.
- Ceramic, which is known for its superb anti-abrasive property, is used as the X-axis drive unit guide. No lubrication of the guide is required.
- High-accuracy glass scales are built-in on X-axis (resolution: 1.97µin (0.05µm) and ZZ-axis (column, resolution: 39.4µin (1µm)) to insure high-accuracy positioning.

The SurfTest SV-3200 Series provide high-accuracy, high-level analysis, and multi-functionality in measurement of surface roughness.

The SV-3200 series manifest high-reliability especially in the horizontal roughness parameters (S, Sm), that require high-accuracy of the X-axis travel.

- When equipped with high accuracy Y-axis table and 3D surface analysis software MCubeMap, this offers CNC type capabilities usually performed on Extreme series machines.
- Various optional detector holders such as Crank Rotary type and Manual Rotary type make this versatile for many different applications.
- New optional Digital Automatic Tilt (DAT) function is best suited for workpieces that are too large for leveling tables.

### Technical Data

**X-axis**
- Measuring range: 4” or 8” (100mm or 200mm)
- Resolution: 1.97µin (0.05µm)
- Measurement method: Linear encoder
- Drive speed: 0 - 3.1”/s (0 - 80mm/s)
- Measuring speed: 0.0078 - 0.2”/s (0.02 - 5mm/s)
- Traversing direction: Pull
- Traverse linearity: 4”: (2+L)µin (0.05+0.001L)µm* 8”: 20µin / 8” (0.5µm/200mm)
- Z2-axis (column)
  - Vertical travel: 12” or 20” (300mm or 500mm) power drive
  - Resolution: 39.4µin (1µm)
  - Measurement method: ABSOLUTE linear encoder
  - Drive speed: 0 - 1.2”/s (0 - 30mm/s)
- Detector Range / resolution: 32000 µin / .4 µin, 3200µin / .04µin, 320µin / .04µin
- Drive speed: 0 - 3.1”/s (0 - 80mm/s)
- Measurement method: Linear encoder
- Resolution: 1.97µin (0.05µm)
- Measuring range: 4” or 8” (100mm or 200mm)

### Evaluation Capability: FORMTRACEPAK V5

- Assessed profiles
  - P (primary profile), R (roughness profile), WC, WCA, WE, WEA
  - DIN4776 profile, envelope residual profile, roughness motif, waviness motif
- Evaluation parameters
  - Ra, Rq, Rz, Rmax, Rmin, Rv, Rmax, Rmin, Rv, Rmax, Rmin
  - Rsk, Rku, Rlo, Rsk, Rku, Rlo, Rsk, Rku, Rlo
- Waviness motif parameters: Wte, Wx, W, AW, SW, SAW, NW
- Roughness motif parameters: Rx, R, AR, SR, SAR, NR, NCRX, CP
- Waviness motif parameters: Wte, Wx, W, AW, SW, SAW, NW
- Analysis graphs
  - ADC, BAC1, BAC2, power spectrum chart, auto-correlation chart, Walsh power spectrum chart, Walsh auto-correlation chart, slope distribution chart, local peak distribution chart, parameter distribution chart
- Digital filter
  - 2CR-75%, 2CR-50%, 2CR-75% (phase corrected), 2CR-50% (phase corrected), Gaussian-50% (phase corrected)
- Cutoff length
  - c: .001, .003, .01, .03, .1, .3, 1”
  - (0.025mm, 0.08mm, 0.25mm, 0.8mm, 2.5mm, 8mm, 25mm)
  - l: .001, .003, .01, .03, .1, .3, 1”
  - (0.025mm, 0.08mm, 0.25mm, 0.8mm, 2.5mm, 8mm, 25mm)
- Sampling length (L)*: .001, .003, .01, .03, .1, .3, 1”
  - (0.025mm, 0.08mm, 0.25mm, 0.8mm, 2.5mm, 8mm, 25mm)
- Data compensation functions
  - Tilt compensation, R-plane (curved surface) compensation, ellipse compensation, parabola compensation, hyperbola compensation, quadratic curve automatic compensation, polynomial compensation, polynomial automatic compensation

*Arbitrary length can be specified in the range from .001* (0.025mm) to the maximum traverse length.
Optional Accessories
A wide range of peripherals are available to support various challenging measurement needs.

**Digital Auto Tilting Unit**
178-040
*Contact Sales Rep for details. Recommend to be installed in manufacturer's facility. (See page J-25 for more accessories.)

**3D-Auto Leveling Table**
178-077
*Used together with 178-096

**308 lbs (140kg)**
**330 lbs (150kg)**
**485 lbs (220kg)**

**A variety of models available for measuring requirements**

**SV-3200S4**
- 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-3200S8**
- 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-3200H4**
- 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-3200H8**
- 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-3200W4**
- 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-3200W8**
- Traverse range: 8” (200mm)
- Vertical travel: 20” (500mm)
- Base size (W x D): 39.4” x 17.7” (1000 x 450mm)
- Base material: Granite

**Model No.**
- SV-3200S4
- SV-3200S8
- SV-3200H4
- SV-3200H8
- SV-3200W4
- SV-3200W8

**Order No. (inch)**
- 178-424A-1
- 178-425A-1
- 178-426A-1
- 178-427A-1
- 178-428A-1
- 178-429A-1
- 178-444A-1
- 178-445A-1
- 178-446A-1
- 178-447A-1
- 178-448A-1
- 178-449A-1

**Measuring force of detector**
- 0.75mN

**X-axis measuring range**
- 4” (100mm)

**Vertical travel**
- power column 20” (500mm)

**Granite base size (WxD)**
- 23.6 x 17.7” (600 x 450mm)

**Mass (main unit)**
- 308 lbs (140kg)

**Models without X-axis inclination function**
Surftest Extreme SV-3000CNC / SV-M3000CNC
SERIES 178 — CNC Surface Measuring Instruments

FEATURES
• High-accuracy CNC Surface Roughness Measuring Instrument that allows surface roughness measurement in both axes.
• Each axes has the 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.
• For models with the α-axis, it is possible to perform continuous measurement over horizontal and inclined surfaces by power-tilting the drive 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.
• Using optional rotary table ø1 and ø2 designed to use with the CNC models enables it to expand the CNC measurement application range.
• Inclined plane measurements is possible through 2-axis simultaneous control in the X- and Y-axis directions.
• Since the detector unit incorporates an anti-collision safety device, the detector unit will automatically stop even if its main body collides with a workpiece or fixture.
• Communication with the Data Processing/Analysis section is via USB.

Technical Data: SV-3000CNC
X1-axis
Measuring range: 8” (200mm)
Resolution: 1.9µm (0.05μm)
Measurement method: Reflective-type linear encoder
Drive speed: 7.87"/s (200mm/s) (max., CNC)
0 - 2.4"/s (0 - 60mm/s) (joystick)
Measuring speed: 0.0078" - 0.78"/s (0.2 - 2mm/s)
Traversing direction: Backward
 Traverse linearity: 20µin (0.5µm/200mm)

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

Z2-axis (column)
Vertical travel: 12" (300mm) 20" (500mm)
Resolution: 1.9µm (0.05μm)
Measurement method: Reflective-type linear encoder
Drive speed: 7.87"/s (200mm/s) (max., CNC)
0 - 2.4"/s (0 - 60mm/s) (joystick)
Base size (W x H): 29.5 x 23.6" (750 x 600mm)
Base material: Granite
Detector Range / resolution: 32000 µin / .4µin, 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)
Measuring force: 4mN or 0.75mN (low force type)
Stylus tip: Diamond, 90º /5µm (60º / 2µm, low force type)

Order No. (100V - 120V) 178-521-1 178-541-1 178-522-1 178-542-1 178-523-1 178-543-1 178-524-1 178-544-1
X1-axis measuring range 8" (200mm) 8" (200mm) 8" (200mm) 8" (200mm) 8" (200mm) 8" (200mm) 8" (200mm) 8" (200mm)
Z2-axis vertical travel 12" (300mm) 20" (500mm) 12" (300mm) 20" (500mm) 12" (300mm) 20" (500mm) 12" (300mm) 20" (500mm)
Y-axis table unit — — Installed Installed Installed Installed Installed Installed
α-axis unit — — Installed Installed Installed Installed Installed Installed
Optional Accessories
Vibration isolation stand
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)

PC stand is not included, isolation stand is optional
Surftest Extreme SV-3000CNC / SV-M3000CNC
SERIES 178 — CNC Surface Measuring Instruments

FEATURES

• CNC Surface Roughness Tester that covers measurement of large/heavy workpieces such as engine blocks, crankshafts, etc.
• In combination with the surfaceness detector rotating unit, S-3000AR (optional), it can perform continuous measurement over the bottom, top and side surfaces of a workpiece.
• Suitable for automatic surfaceness measurement on large and heavy workpieces.
• Provides 31.5° (800mm) of Y-axis stroke. This makes it possible to measure multiple profiles on large workpieces.
• Load table has a self-contained structure to ensure that various size workpieces, jigs, auto-feed devices, etc., are easily accommodated and can be specified, if required, by special order.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>SV-M3000CNC</th>
</tr>
</thead>
</table>

Order No. (100V - 120V) 178-549-1

<table>
<thead>
<tr>
<th>XI-axis range</th>
<th>Width (8”/200mm)</th>
</tr>
</thead>
</table>

Drive speed: 7.87”/s (200mm/s) (max., CNC)
0 - 1.97”/s (0 - 50mm/s) (joystick)

Measuring speed: 0.00078” - 0.08”/s (0.02 - 2mm/s)

Traverse linearity:
- 20µin/” (0.5µm/200mm)
- 28µin/” (0.7µm/200mm)

α-axis

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

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 surfaceness data. In addition, analysis results can be saved in the “.htm”, “.mhtml” or pdf format which allows Internet Explorer or MS-Word compatibility, allowing PC without layout editing programs to view analysis results.

Contour Measurement & Surfroughness Measurement Screen

Report Layout Screen

Surfactest Extreme SV-3000CNC / SV-M3000CNC
FEATURES

- Dramatically increased drive speed (X axis: 3.1"/s (80mm/s), Z 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 automatic measurement of small holes improves reproducibility of continuous linear encoder (ABS type on Z2-axis). This axis) are equipped with a high-accuracy specification for an extended period (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 (0.75µm/4µm measuring force) providing a resolution down to 0.004µm (0.0001µm).

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 (0.75µm/4µm measuring force) providing a resolution down to 0.004µm (0.0001µm).

Contour Drive Measurement

- X axis accuracy: ± (31.5+10L)µin (±(0.8+0.01L)µm) (SV-C4500 series, H4, W4 types, L = Drive length, HI = Measurement height inch (mm))
- Z1-axis accuracy: ± (31.5+20HI/100)µin (±(0.8+2HI/100)µm) (SV-C4500 series)
  - Designed to handle workpieces calling for high accuracy.
  - * S4, H4, W4 types, L = Drive length 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, W4), 485 lbs (220kg) (W8)
  - 330 lbs (150kg) (S8), 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: 0.00076 - 0.2"/s (0.02 - 5mm/s)
  - Measuring direction: Forward/backward
  - Traverse linearity: ±(32+10L)µin (±0.8+0.02L)µm (SV-C4500S4, H4, W4)
  - Linear displacement: ±(32+10L)µin (±0.8+0.02L)µm (SV-C4500S8, H8, W8, W8)
- Z1-axis (detector unit)
  - Measuring range: ±1.2" (±30mm)
  - Resolution: 1.5µin (0.004µm) (SV-C3200 series), 78µin (0.02µm) (SV-C4500 series)
  - Measurement method: Linear encoder (SV-C3200 series), Laser holography (SV-C4500 series)
  - Linear displacement: ±(32+20HI/100)µin (±(1.6+2HI/1000)µm) (SV-C4500 series)
  - accuracy (at 20°C): ±(32+20HI/100)µin (±(1.6+2HI/1000)µm)
- Z2-axis (column)
  - Vertical travel: 12" (300mm) or 20" (500mm)
  - Resolution: 0 - 1.2" (0 - 30mm) and manual
  - Measurement method: ABSOLUTE linear encoder
  - Drive speed: 0 - 1.2"/s (0 - 30mm/s) and manual
  - Measuring range: ±(32+20HI/100)µin (±(1.6+2HI/1000)µm) (SV-C3200 series)
  - Linear displacement: ±(63+|20|H)µin (±(1.6+|2H|/100)µm) (SV-C4500 series)
- Z-axis (column)
  - Vertical travel: 12" (300mm) or 20" (500mm)
  - Resolution: 0 - 1.2" (0 - 30mm) and manual
  - Measurement method: Linear encoder (SV-C3200 series), Laser holography (SV-C4500 series)
  - Linear displacement: ±(32+20HI/100)µin (±(1.6+2HI/1000)µm) (SV-C4500 series)
  - accuracy (at 20°C): ±(32+10HI/100)µin (±(0.8+0.02L)µm) (SV-C4500 series, H8, W8)
  - *L = Drive length inch (mm)
  - Inclination range: ±45º
  - ZZ-axis (column)
  - Vertical travel: 12" (300mm) or 20" (500mm)
  - Resolution: 39µin (1µm)
  - Measurement method: ABSOLUTE linear encoder
  - Drive speed: 0 - 1.2"/s (0 - 30mm/s) and manual
  - Measuring range: ±(32+20HI/100)µin (±(1.6+2HI/1000)µm) (SV-C4500 series)
  - Linear displacement: ±(63+|20|H)µin (±(1.6+|2H|/100)µm) (SV-C4500 series)
  - accuracy (at 20°C): ±(32+10HI/100)µin (±(0.8+0.02L)µm) (SV-C4500 series, H8, W8, W8)
  - *L = Drive length inch (mm)

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)
  - Traverse linearity: ±(2+1L)µin (±(0.05+0.001L)µm) (SV-C3200 series)
  - Face of stylus: Arc movement
  - Stylus tip: Diamond
  - Resolution: 39.4µin (1µm)
  - Measuring speed: 0.00078 - 0.2"/s (0.02 - 5mm/s)
  - Measurement method: Linear encoder (SV-C3200 series), Reflective-type linear encoder (SV-C4500 series)
  - Linear displacement: ±(32+20HI/100)µin (±(1.6+2HI/1000)µm) (SV-C4500 series)
  - Measuring height: ±(31.5+10L)µin (±(0.8+0.01L)µm) (SV-C4500 series, H4, W4)
  - Vertical travel: 12" (300mm) or 20" (500mm)
  - Resolution: 0 - 1.2" (0 - 30mm) and manual
  - Measurement method: Linear encoder (SV-C3200 series), Laser holography (SV-C4500 series)
  - Linear displacement: ±(32+20HI/100)µin (±(1.6+2HI/1000)µm) (SV-C4500 series)
  - accuracy (at 20°C): ±(31.5+10HI/100)µin (±(0.8+0.01L)µm) (SV-C4500 series, H4, W4)
- Z-axis (column)
  - Vertical travel: 12" (300mm) or 20" (500mm)
  - Resolution: 39.4µin (1µm)
  - Measurement method: Linear encoder (SV-C3200 series), Laser holography (SV-C4500 series)
  - Linear displacement: ±(32+20HI/100)µin (±(1.6+2HI/1000)µm) (SV-C4500 series)
  - accuracy (at 20°C): ±(31.5+10HI/100)µin (±(0.8+0.01L)µm) (SV-C4500 series, H4, W4)
  - *L = Drive length inch (mm)
  - Inclination range: ±45º
  - ZZ-axis (column)
  - Vertical travel: 12" (300mm) or 20" (500mm)
  - Resolution: 39µin (1µm)
  - Measurement method: ABSOLUTE linear encoder
  - Drive speed: 0 - 1.2"/s (0 - 30mm/s) and manual
  - Measuring range: ±(32+20HI/100)µin (±(1.6+2HI/1000)µm) (SV-C4500 series)
  - Linear displacement: ±(63+|20|H)µin (±(1.6+|2H|/100)µm) (SV-C4500 series)
  - accuracy (at 20°C): ±(32+10HI/100)µin (±(0.8+0.02L)µm) (SV-C4500 series, H8, W8, W8)
  - *L = Drive length inch (mm)
Formtracer SV-C3200 / SV-C4500
SERIES 525 — Surface Roughness / Contour Measuring System

SPECIFICATIONS

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

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

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-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-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-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-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-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

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.
FEATURES

- High-accuracy CNC Surface Roughness/Form Measuring Instrument that allows both measurement of surface roughness and form/contour with one unit.
- Each axis 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: 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)
- Measuring speed: 0.00078" – 0.08"/s (0.02 – 2mm/s)
- Measuring direction: Pull/Pull
- Traverse linearity: 20µin/8" (0.5µm/200mm)
- Measuring speed: 0.00078" – 0.08"/s (0.02 – 2mm/s)
- Drive speed: 7.87"/s (200mm/s) (max., CNC)
- Z1-axis (detector unit):
  - Measuring range: ±1.2" (±30mm)
  - Resolution: 7.8µin (0.2µm)
  - Measurement method: Reflective Type detector unit
  - Linear displacement:
    - Accuracy (at 20°C): ±32µin/110µin/µin (±0.84/3.6/0.1µm)
  - *L = Drive length (mm)
- Inclination angle:
  - α-axis:
    - Orientation: -45° to +10°
    - Resolution: 0.000225°
    - Rotating speed: 1rpm
  - Z2-axis (column):
    - Vertical travel: 12" or 20" (300mm or 500mm)
    - Resolution: 19.9µin (0.05µm)
    - Measurement method: Reflective linear encoder
    - Drive speed: 7.87"/s (200mm/s) (max., CNC)
    - Measuring speed: 0 – 2"/s (0 – 50mm/s) (joystick)
    - Traverse linearity: 80µin/8" (0.2µm/200mm)
- Stylus up/down operation:
  - Arc movement
  - Stylus tip: Radius: 25µm, carbide tip

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)
- Measuring speed: 0 – 2"/s (0 – 50mm/s) (joystick)
- Drive speed: 7.87"/s (200mm/s) (max., CNC)
- Z1-axis (detector unit):
  - Measuring range: ±4° (±100µm)
  - Resolution: 7.8µin (0.2µm)
  - Measurement method: Reflective Type detector unit
  - Linear displacement:
    - Accuracy (at 20°C): ±32° + 110µin/µin (±0.84/3.6/0.1µm)
  - *H: Measurement height from the horizontal position (mm) / vs α-axis:
    - ±1° + 10Hµin/µin (±0.05° + 0.01µm)
  - Stylus up/down operation:
    - Pulling
  - Traverse linearity: 20µin/8" (0.5µm/200mm)
- Inclination angle:
  - α-axis:
    - Orientation: +45° to +10°
    - Resolution: 0.000225°
    - Rotating speed: 1rpm
  - Z2-axis (column):
    - Vertical travel: 12° or 20° (300mm or 500mm)
    - Resolution: 19.9µin (0.05µm)
    - Measurement method: Reflective linear encoder
    - Drive speed: 7.87"/s (200mm/s) (max., CNC)
    - Measuring speed: 0 – 2"/s (0 – 50mm/s) (joystick)
- Skid radius of curvature:
  - 1.57" (40mm)

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)
- Measuring speed: 0.00078" – 0.08"/s (0.02 – 2mm/s)
- Drive speed: 7.87"/s (200mm/s) (max., CNC)
- Z1-axis (detector unit):
  - Measuring range: ±1.2" (±30mm)
  - Resolution: 7.8µin (0.2µm)
  - Measurement method: Reflective Type detector unit
  - Linear displacement:
    - Accuracy (at 20°C): ±32µin/110µin/µin (±0.84/3.6/0.1µm)
  - *L = Drive length (mm)
- Inclination angle:
  - α-axis:
    - Orientation: -45° to +10°
    - Resolution: 0.000225°
    - Rotating speed: 1rpm
  - Z2-axis (column):
    - Vertical travel: 12" or 20" (300mm or 500mm)
    - Resolution: 19.9µin (0.05µm)
    - Measurement method: Reflective linear encoder
    - Drive speed: 7.87"/s (200mm/s) (max., CNC)
    - Measuring speed: 0 – 2"/s (0 – 50mm/s) (joystick)
- Stylus up/down operation:
  - Arc movement
  - Stylus tip: Radius: 25µm, carbide tip

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)
- Measuring speed: 0 – 2"/s (0 – 50mm/s) (joystick)
- Drive speed: 7.87"/s (200mm/s) (max., CNC)
- Z1-axis (detector unit):
  - Measuring range: ±4° (±100µm)
  - Resolution: 7.8µin (0.2µm)
  - Measurement method: Reflective Type detector unit
  - Linear displacement:
    - Accuracy (at 20°C): ±32° + 110µin/µin (±0.84/3.6/0.1µm)
  - *H: Measurement height from the horizontal position (mm) / vs α-axis:
    - ±1° + 10Hµin/µin (±0.05° + 0.01µm)
  - Stylus up/down operation:
    - Pulling
  - Traverse linearity: 20µin/8" (0.5µm/200mm)
- Inclination angle:
  - α-axis:
    - Orientation: +45° to +10°
    - Resolution: 0.000225°
    - Rotating speed: 1rpm
  - Z2-axis (column):
    - Vertical travel: 12° or 20° (300mm or 500mm)
    - Resolution: 19.9µin (0.05µm)
    - Measurement method: Reflective linear encoder
    - Drive speed: 7.87"/s (200mm/s) (max., CNC)
    - Measuring speed: 0 – 2"/s (0 – 50mm/s) (joystick)
- Skid radius of curvature:
  - 1.57" (40mm)
Formtracer Extreme SV-C4500CNC
SERIES 525 — Surface Roughness/Form Measuring Instrument

SPECIFICATIONS

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

DIMENSIONS

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 mode: L: Dimension between two measured points (mm)
- Linear displacement accuracy (at 20°C):
  - ± (80+20L)µin
  - ± (2+2L/100) µin
- 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)

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)

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.
**Formtracer CS-3200**

**FEATURES**

- Highest measurement accuracy in its class.
  - X axis: ±(1+0.01L)µm
  - Z1 axis: ±(1.5+|2H|/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.

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**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: ±(32+10L)µin ±(0.8+0.01L)µm
  - L = Drive length (mm)

**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: ±(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)

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

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Formtracer CS-3200 SERIES 525 — Form Measuring Instruments
Formtracer CS-3200
SERIES 525 — Form Measuring Instruments

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>CS-320054</th>
</tr>
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<tbody>
<tr>
<td>Order No. (inch)</td>
<td>525-411A</td>
</tr>
<tr>
<td>X1-axis measuring range</td>
<td>4&quot; (100mm)</td>
</tr>
<tr>
<td>Z2-axis vertical travel</td>
<td>12&quot; (300mm)</td>
</tr>
</tbody>
</table>

Stylus

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

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

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

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

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

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

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

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.

Measuring instrument control
Contour analysis
Surface roughness analysis
Design data creation (CAD file import)
Contour verification
Inspection certificate creation

Main Unit Startup System

Measuring lens
Measuring ball screw
Measuring bearing ring

UNIT: inch (mm)
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:

<table>
<thead>
<tr>
<th>X1 axis</th>
<th>Z1 axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range: 8&quot; (200mm)</td>
<td>Measuring range: 0.47&quot; (12mm) (with standard stylus)</td>
</tr>
<tr>
<td>Resolution: 0.25µin (0.00625µm)</td>
<td>Resolution: 0.16µin (0.004µm) (with standard stylus)</td>
</tr>
<tr>
<td>Measurement method: Laser Holoscale</td>
<td>Measurement method: Laser Holoscale</td>
</tr>
<tr>
<td>Drive speed: Max. 1.57&quot;/s (40mm/s) (in CNC mode) 0 - 1.57&quot;/s (0 - 40mm/s) (in joystick control mode)</td>
<td>Drive speed: Max. 0.75µin (0.019µm) (in CNC mode) 0 - 0.75µin (0 - 19µm) (in joystick control mode)</td>
</tr>
<tr>
<td>Measuring speed: 0.0008 - 0.08&quot;/s (0.02 - 2mm/s) (surface roughness) 0.0008 - 0.8&quot;/s (0.02 - 20mm/s) (form/contour)</td>
<td>Measuring speed: 0.0008 - 0.008&quot;/s (0.02 - 0.2mm/s) (surface roughness) 0.0008 - 0.08&quot;/s (0.02 - 20mm/s) (form/contour)</td>
</tr>
<tr>
<td>Measuring direction: Push / Pull</td>
<td>Stylus up/down: Arc movement</td>
</tr>
<tr>
<td>Traverse linearity: (4+1.5L)µin {(0.1+0.0015L)µm} with standard stylus (8+3L)µin {(0.2+0.003L)µm} with 2X-long stylus</td>
<td>Linear displacement accuracy (20°C): ±(12+120H)µin {(0.3+0.02HI)µm}</td>
</tr>
<tr>
<td>Linear displacement accuracy (20°C): ±(2.8+6.3+L)µin {(0.16+0.001L)µm}</td>
<td>Linear displacement accuracy (20°C): ±(2.8+6.3+L)µin {(0.16+0.001L)µm}</td>
</tr>
<tr>
<td>Measuring force: 4mN (with standard stylus)</td>
<td>Stylus tip: Radius: 5µm, angle: 40°, diamond (ball stylus) (Radius: 0.25mm, sapphire)</td>
</tr>
<tr>
<td>Traceable angle: 60° for ascent, 60° for descent (Depending on the workpiece surface condition)</td>
<td>Face of stylus: Downward</td>
</tr>
<tr>
<td>Base size (W x D): 29.5 x 23.6&quot; (750 x 600mm)</td>
<td>Base material: Granite</td>
</tr>
<tr>
<td>Mass: 529 lbs (240kg)</td>
<td>Dimension (W x D x H): 31.5 x 24.4 x 39.4&quot; (800 x 620 x 1000mm)</td>
</tr>
<tr>
<td>(high column type)</td>
<td>(800 x 620 x 1200mm: high column type)</td>
</tr>
</tbody>
</table>
| *CS-H5000CNC model in red.
Formtracer Extreme CS-5000CNC / CS-H5000CNC

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>CS-5000CNC</th>
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<th>CS-5000CNC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No. (100V - 120V)</td>
<td>525-721-1</td>
<td>525-722-1</td>
<td>525-723-1</td>
<td>525-724-1</td>
</tr>
<tr>
<td>X1-axis measuring range</td>
<td>8&quot; (200mm)</td>
<td>8&quot; (200mm)</td>
<td>8&quot; (200mm)</td>
<td>8&quot; (200mm)</td>
</tr>
<tr>
<td>Z2-axis vertical travel</td>
<td>12&quot; (300mm)</td>
<td>12&quot; (300mm)</td>
<td>12&quot; (300mm)</td>
<td>12&quot; (300mm)</td>
</tr>
<tr>
<td>Y-axis table unit</td>
<td>—</td>
<td>—</td>
<td>Installed</td>
<td>Installed</td>
</tr>
<tr>
<td>α-axis unit</td>
<td>—</td>
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<tr>
<td>Order No. (100V - 120V)</td>
<td>525-741-1</td>
<td>525-742-1</td>
<td>525-743-1</td>
<td>525-744-1</td>
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<tr>
<td>X1-axis measuring range</td>
<td>8&quot; (200mm)</td>
<td>8&quot; (200mm)</td>
<td>8&quot; (200mm)</td>
<td>8&quot; (200mm)</td>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Order No. (100V - 120V)</td>
<td>525-761-1</td>
<td>525-763-1</td>
</tr>
<tr>
<td>X1-axis measuring range</td>
<td>8&quot; (200mm)</td>
<td>8&quot; (200mm)</td>
</tr>
<tr>
<td>Z2-axis vertical travel</td>
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<td>12&quot; (300mm)</td>
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<td>Y-axis table unit</td>
<td>—</td>
<td>Installed</td>
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</table>

Stylus

12AAD543*: Standard-length stylus (tip radius: 5µm)
12AAU037**: For CS-H5000CNC (tip radius: 5µm)
Tip material: Diamond

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

12AAD545*: Double-length stylus (tip radius: 5µm)
12AAU039**: For CS-H5000CNC (tip radius: 5µm)
Tip material: Diamond

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

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.

Report Layout Screen

Contour Measurement and Surface Roughness Measurement 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.

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FORMTRACEPAK V5
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Report Layout Screen

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### 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

#### Standard Stylus

- **For small hole**
  - 12AAE882 (1µm)*
  - 12AAE924 (1µm)**
  - 12AAC731 (2µm)*
  - 12AAE883 (2µm)**
  - 12AAE884 (5µm)*
  - 12AAE925 (5µm)**

- **For extra small hole**
  - 12AAC732 (2µm)*
  - 12AAE884 (5µm)**
  - 12AAE926 (5µm)**

- **For extra minute hole**
  - 12AAC733 (2µm)*
  - 12AAE885 (5µm)**
  - 12AAE927 (5µm)**

- **For deep hole (2X long and 3X long)**
  - 12AAC740 (2µm)*
  - 12AAE938 (5µm)**
  - 12AAE940 (5µm)**

- **For small slotted hole**
  - 12AAC741 (2µm)*
  - 12AAE939 (5µm)**
  - 12AAE941 (5µm)**

#### 2X long for deep hole

- **For small hole**
  - 12AAE898 (2µm)*
  - 12AAE914 (5µm)**

- **For small hole/2X long for deep hole**
  - 12AAC740 (2µm)*
  - 12AAE938 (5µm)**

- **For ultra small hole**
  - 12AAC741 (2µm)*
  - 12AAE939 (5µm)**

- **For small hole*2**
  - 12AAE884 (0.8mm)

#### Extension rods

- 12AAG202: 50mm, 12AAG203: 100mm

### Color Coding

- White
- Black
- No color
- Yellow
- No notch or color

---

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

**For deep groove (10mm)**
- 12AAC735 (2µm)*
- 12AAE409 (5µm)**
- 12AAE421 (10µm)**
  - Tip radius
  - Tip angle: 60° **Tip angle: 90°

**For deep groove (20mm)**
- 12AAC736 (2µm)*
- 12AAE408 (5µm)**
- 12AAE420 (10µm)**
  - Tip radius
  - Tip angle: 60° **Tip angle: 90°

**For deep groove (30mm)**
- 12AAC737 (2µm)*
- 12AAE407 (5µm)**
- 12AAE419 (10µm)**
  - Tip radius
  - Tip angle: 60° **Tip angle: 90°

**For gear tooth**
- 12AAE339 (2µm)*
- 12AAE410 (5µm)**
- 12AAE422 (10µm)**
  - Tip radius
  - Tip angle: 60° **Tip angle: 90°

**For rolling circle waviness surface**
- 12AAE338 (0.8mm)
  - Tip radius

**For knife-edge detector**
- 12AAC738 (2µm)*
- 12AAE411 (5µm)**
- 12AAE423 (10µm)**
  - Tip radius
  - Tip angle: 60° **Tip angle: 90°

**For eccentric arm**
- 12AAC739 (2µm)*
- 12AAE412 (5µm)**
- 12AAE424 (10µm)**
  - Tip radius
  - Tip angle: 60° **Tip angle: 90°

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

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

**For deep groove (20mm)**
- 12AAC738 (2µm)*
- 12AAE411 (5µm)**
- 12AAE423 (10µm)**
  - Tip radius
  - Tip angle: 60° **Tip angle: 90°

**For deep groove (30mm)**
- 12AAC739 (2µm)*
- 12AAE412 (5µm)**
- 12AAE424 (10µm)**
  - Tip radius
  - Tip angle: 60° **Tip angle: 90°

**For rolling circle waviness surface**
- 12AAE338 (0.8mm)
  - Tip radius

**For knife-edge detector**
- 12AAC738 (2µm)*
- 12AAE411 (5µm)**
- 12AAE423 (10µm)**
  - Tip radius
  - Tip angle: 60° **Tip angle: 90°

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- 12AAE412 (5µm)**
- 12AAE424 (10µm)**
  - Tip radius
  - Tip angle: 60° **Tip angle: 90°

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

**For bottom surface**
- 12AAE895 (2µm)*
- 12AAE911 (5µm)**
  - Tip radius
  - Tip angle: 60° **Tip angle: 90°
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/C/SV-C, CS model (non CNC model).

<table>
<thead>
<tr>
<th>Function</th>
<th>Y-axis Table</th>
<th>B-Table</th>
<th>R-Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic leveling</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Automatic alignment</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Rotation speed</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Mass</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**Q1-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.

* Only for mounting plate (12AAD630) is required when directly installing on the base of the SV-3100.

<table>
<thead>
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<th>Function</th>
<th>Y-axis Table</th>
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</tr>
<tr>
<td>Automatic alignment</td>
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<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Multiple workpiece batch</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Measurement in the Y-axis</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Oblique measurement of X'Y' plane</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Outside 3D surface roughness measurement/evaluation</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Multiple-piece measurement in the Y-axis direction</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Multiple-piece measurement in the radius direction (Positioning in the rotating direction of X'Y' plane)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Inclined surface measurement in the X-axis direction</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Inclined hole inside measurement in the X-axis direction</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Multiple cylinder generatrix line measurement</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Measurement of both top and bottom surfaces</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Rotary positioning of large workpiece ***</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**Q2-axis table**: 178-078*

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

* Q2-axis mounting plate (12AAE718) is required when directly installing on the base of the SV-3100.

**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.

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</tbody>
</table>

**Quick chuck**: 211-032

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

<table>
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<tr>
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</table>

**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.

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**Examples of optimal combinations of accessories for CNC models**

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</tr>
<tr>
<td>Inclined surface measurement in the X-axis direction</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Inclined hole inside measurement in the X-axis direction</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Multiple cylinder generatrix line measurement</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Measurement of both top and bottom surfaces</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Rotary positioning of large workpiece ***</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Upward/downward and frontward/backward measurement of large workpiece ***</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

* : Applicable only to form/contour measurement
** : Applicable only to surface roughness measurement
*** : Applicable only for SV-M3000/CNC
### 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.

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

- **178-042-1** (mm), **178-052-1** (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

**Leveling table**
- **178-047**
  - Table top: 130 x 100mm
  - Leveling range: ±1.5°
  - Height: 50mm

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

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

- **178-047** (V-block not included)

---

**V-block**
- **980291**
  - 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.

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

**Calibration stand**
- **12AAM100**
  - For calibrating upward measurement of CV-3200 series.

- **12AAAG175**
  - For calibrating in bulk by mounting straight arm/eccentric arm/small-hole stylus arm without using cross-travel table and Y-axis table.

- **12AAM309**
  - For calibrating in bulk by mounting straight arm/small-hole stylus arm without using cross-travel table and Y-axis table.

---

**Drive unit tilting function**
(Patent pending: Japan)

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

---

*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.
Stylus Shape
A stylus is a stylus and is conical with a spherical tip. Tip radius: $r_1 = 2 \mu m$, $5 \mu m$ or $10 \mu m$ Taper angle: $90^\circ$ In typical surface roughness testers, the taper angle of the stylus is $60^\circ$ unless otherwise specified.

Static Measuring Force

Relationship between Cutoff Value and Stylus Tip Radius
The following table lists the relationship between the roughness profile cutoff value $R_c$, stylus tip radius $r_1$, and cutoff ratio $\lambda$.

<table>
<thead>
<tr>
<th>$r_1$ (µm)</th>
<th>$\lambda$ (µm)</th>
<th>$R_c$ (µm)</th>
<th>$r_1$ (µm)</th>
<th>$\lambda$ (µm)</th>
<th>$R_c$ (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.75</td>
<td>0.025</td>
<td>8</td>
<td>5</td>
<td>0.012</td>
</tr>
<tr>
<td>2</td>
<td>0.75</td>
<td>0.025</td>
<td>8</td>
<td>5</td>
<td>0.012</td>
</tr>
</tbody>
</table>

Note 1: The maximum value of static measuring force at the average position of a stylus is to be defined. The static measuring force should be specified as a function of parameter value calculated from measurements, as shown in Table 1.

Note 2: If a cutoff value $\lambda$ is specified (in addition to the parameter value), the maximum value of static measuring force for a stylus with the recommended tip radius appears outside the roughness profile pass band. Therefore, the maximum value of static measuring force is to be specified in the form of a function of parameter value calculated from measurements, as shown in Table 1.

Maximum measuring force at the average position of a stylus is to be defined. The maximum value of static measuring force should be specified as a function of parameter value calculated from measurements, as shown in Table 1.

Surftest (Surface Roughness Testers)
Amplitude Parameters (average of ordinates)
Arithmetical mean deviation of the primary profile $P_a$
Arithmetical mean deviation of the roughness profile $R_a$
Arithmetical mean deviation of the waviness profile $W_a$
Arithmetic mean of the absolute value of the ordinates $Z(x)$ within a sampling length
$$P_a, R_a, W_a = \frac{1}{l} \int_{X_s1}^{X_s2} |Z(x)| dx$$
with $l$ as $l_p$, $l_r$, or $l_w$ according to the case.

Root mean square deviation of the primary profile $P_q$
Root mean square deviation of the roughness profile $R_q$
Root mean square deviation of the waviness profile $W_q$
Root mean square value of the ordinate values $Z(x)$ within a sampling length
$$P_q, R_q, W_q = \frac{1}{l} \int_{X_s1}^{X_s2} Z^2(x) dx$$
with $l$ as $l_p$, $l_r$, or $l_w$ 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 cubic value of the ordinate values $Z(x)$ and the cube of $P_q$, $R_q$, or $W_q$ respectively within a sampling length
$$Rsk = \frac{1}{l} \int_{X_s1}^{X_s2} \left( \frac{Z(x)^3}{P_q^3} \right) dx$$

The above equations define $Psk$, $Rsk$, and $Wsk$. $Psk$ 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 $Rku$
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 $P_q$, $R_q$, or $W_q$ respectively within a sampling length
$$Rku = \frac{1}{l} \int_{X_s1}^{X_s2} \left( \frac{Z(x)^4}{P_q^4} \right) dx$$

The above equations define $Rku$, $Rku$, and $Wku$. $Rku$, $Rku$, 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 $X_s$ within a sampling length
$$Psm, Rsm, Wsm = \frac{1}{l} \sum_{i=0}^{n} X_{si}$$

Hybrid Parameters
Root mean square slope of the primary profile $P\alpha_q$
Root mean square slope of the roughness profile $R\alpha_q$
Root mean square slope of the waviness profile $W\alpha_q$
Root mean square value of the ordinate slopes $dZ/dX$ within a sampling length
$$P\alpha_q, R\alpha_q, W\alpha_q = \frac{1}{l} \int_{X_s1}^{X_s2} \left( \frac{dZ}{dX} \right)^2 dx$$

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 $c$
$$Pmr(c) = \frac{1}{l} \int_{X_s1}^{X_s2} \left[ \frac{Z(x)}{Ml(c)} \right] dx$$

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
$$Pmr(c), Rmr(c), Wmr(c) = \frac{1}{l} \int_{X_s1}^{X_s2} \left( \frac{Z(x)}{Ml(c)} \right) dx$$

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 section
$$Pdc = Pmr(c1) - Pmr(c2); c1 > c2$$

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 $Rmr(c)$, related to the reference section level $c0$
$$Pmr, Rmr, Wmr = \frac{1}{l} \int_{X_s1}^{X_s2} \left( \frac{Z(x)}{Ml(c)} \right) dx$$

Material density function
Profile height amplitude distribution curve
Sample probability density function of the ordinate $Z(x)$ within the evaluation length
$$R_{z[JIS]} = \frac{1}{5} \sum_{i=0}^{n} |Z_{si}|$$

JIS Specific Parameters
Ten-point height of irregularities, $R_{z[JIS]}$
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 high-pass filter
$$R_{z[JIS]} = \frac{1}{5} \sum_{i=0}^{n} \left( Z_{pi} - Z_{pi-4} \right)$$

Hybrid Parameter $P\alpha_q$
Root mean square slope of the primary profile $P\alpha_q$
Arithmetical mean of the absolute values of the profile deviations from the mean line within the sampling length of the roughness profile $W\alpha_q$
Arithmetic mean of the absolute slopes $dZ/dX$ within a sampling length
$$R_{\alpha_q} = \frac{1}{l} \int_{X_s1}^{X_s2} \left( \frac{dZ}{dX} \right) dx$$

Sampling Length for Surface Roughness Parameters

Table 1: Sampling lengths for aperiodic profile roughness parameters ($R_a$, $R_q$, $R_ku$, $R_{\alpha_q}$, $R_{sm}$, $R_{z[JIS]}$), material ratio curve, probability density function, and related parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sampling length $l \text{ mm}$</th>
<th>Evaluation length $l \text{ mm}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.006-0.010$</td>
<td>$0.04$</td>
<td>$0.04$</td>
</tr>
<tr>
<td>$0.011-0.050$</td>
<td>$0.25$</td>
<td>$1.25$</td>
</tr>
<tr>
<td>$0.051-0.040$</td>
<td>$0.8$</td>
<td>$12.5$</td>
</tr>
<tr>
<td>$0.041-0.100$</td>
<td>$2.5$</td>
<td>$40$</td>
</tr>
</tbody>
</table>

Table 2: Sampling lengths for aperiodic profile roughness parameters ($R_z$, $R_v$, $R_p$, $R_c$, $R_t$) and Related Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sampling length $l \text{ mm}$</th>
<th>Evaluation length $l \text{ mm}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.006-0.010$</td>
<td>$0.04$</td>
<td>$0.4$</td>
</tr>
<tr>
<td>$0.011-0.050$</td>
<td>$0.25$</td>
<td>$1.25$</td>
</tr>
<tr>
<td>$0.051-0.100$</td>
<td>$0.8$</td>
<td>$4$</td>
</tr>
<tr>
<td>$0.101-0.200$</td>
<td>$2.5$</td>
<td>$12.5$</td>
</tr>
<tr>
<td>$0.201-0.500$</td>
<td>$8$</td>
<td>$40$</td>
</tr>
</tbody>
</table>

Table 3: Sampling lengths for measurement of periodic roughness profile parameters ($R_m$, $R_{sm}$) and periodic or aperiodic profile parameter $R_{sm}$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sampling length $l \text{ mm}$</th>
<th>Evaluation length $l \text{ mm}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.006-0.010$</td>
<td>$0.04$</td>
<td>$0.4$</td>
</tr>
<tr>
<td>$0.011-0.050$</td>
<td>$0.25$</td>
<td>$1.25$</td>
</tr>
<tr>
<td>$0.051-0.100$</td>
<td>$0.8$</td>
<td>$4$</td>
</tr>
<tr>
<td>$0.101-0.400$</td>
<td>$2.5$</td>
<td>$12.5$</td>
</tr>
<tr>
<td>$0.401-0.500$</td>
<td>$8$</td>
<td>$40$</td>
</tr>
</tbody>
</table>

Procedure for determining a sampling length if it is not specified

- Estimate $R_a$, $R_q$, $R_{sm}$, or $R_{z[JIS]}$ according to recorded waveforms, visual inspection, etc.

- Estimate the sampling length from an estimated value $l$ within $l_{[1:5]}$

- Measure $R_a$, $R_q$, $R_{sm}$, or $R_{z[JIS]}$ according to the estimated value of the sampling length

- Does each measured value meet the parameter range of Table 1, 2, or 3?

- Measure the parameter according to the final sampling length

- Has a shorter sampling length been tried?

- Does the measured value meet the condition of Table 2?

- Estimate $R_{sm}$ from a measured roughness profile

- Estimate the sampling length from an estimated value of $R_{sm}$

- Does the measured value meet the condition of Table 2?

- Change the sampling length so as to meet the condition

- Measure the parameter according to the final sampling length

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.
Contracer CV-2100
SERIES 218 — Contour Measuring Instruments

FEATURES
• Newly designed high precision digital ARC scale improves the Z-axis accuracy and resolution.
• Quick release grip handle allows for rapid traverse in column Z-axis for CV-2100M4.
• Key operation buttons are now mounted onto the X-axis drive unit eliminating wired remote box.
• X-axis traverse speed has been greatly improved to 20mm/s allowing quick positioning and set-up time.
• New added function for automatic stylus up/down means high volume repetitive measurements are now capable with part programming.
• Z-axis detector measuring range has been improved to 50mm for both models.
• CV-2100N4 model can be mounted to optional manual column stand or custom fixture supplied by end-user.

Connected to a personal computer, the FORMTRACEPAK V5 contour analysis program provides various modes of measurement and analysis. *Printer not included

Centralized front control panel Quick-vertical-motion handle X-axis jog shuttle

Technical Data
X1-axis
Measuring range: 4” (100mm) (CV-2100)
Resolution: 3.93µin (0.1µm)
Measurement method: Digital arc scale
Drive speed: 0-0.79”/s (0-20mm/s)
Linear displacement: ±(100+20L)µin ±(2.5+2L/100)µm
Accuracy (at 20°C)*: Measurement height from the horizontal position within ±1” ±(2.5mm)
Inclining range: ±45°

Z2-axis (column)
Column type: Manual (M4 type)
Vertical travel: 13.8” (350mm) (M4 type)

CV-2100N4 with personal computer system and software

Highly accurate arc scale

This scale directly tracks the arc trajectory of the stylus tip so that the most accurate compensation can be applied to the scale output, which leads to higher accuracy and resolution.

*1: If the CV-2100N4 is operated without the dedicated manual stand, the measuring range of the Z-axis might be reduced, depending on the installation conditions. If you are considering using the CV-2100N4 without the stand, contact your local Mitutoyo sales office for advice.
*2: Optional accessory 218-042 manual column stand
**Optional Accessories**

- **218-042**: Column stand for CV-2100N4 (vertical travel: 250mm, inclination: ±45°)
- **218-001**: Cross-travel table (XY range: 100 x 50mm)
- **218-011**: Cross-travel table (XY range: 4” x 2”)
- **218-041**: Cross-travel table (XY range: 50 x 25mm)
- **218-051**: Cross-travel table (XY range: 2” x 1”)
- **218-003**: Rotary vise (heavy-duty type)
- **172-197**: Swivel center support
- **172-142**: Center support
- **172-143**: Center support riser
- **998862**: Pin gage unit for calibration (mm)
- **998861**: Pin gage unit for calibration (inch)
- **176-107**: Holder with clamp
- **172-144**: Rotary vise
- **172-144**: Rotary vise
- **172-378**: V-block with clamp (Max. workpiece dia.: 50mm)
- **172-234**: V-block with clamp (Max. workpiece dia.: 25mm)
- **172-197**: Swivel center support
- **172-142**: Center support
- **172-143**: Center support riser
- **12AAG175**: Calibration table
- **178-047**: 3-axis adjustment table
- **218-044**: Calibration kit (inch)

**Contracer CV-2100**

**SERIES 218 — Contour Measuring Instruments**

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Model</th>
<th>CV-2100M4</th>
<th>CV-2100N4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Order No.</strong></td>
<td>218-643A</td>
<td>218-623A</td>
</tr>
<tr>
<td><strong>Measurement range</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-axis</td>
<td>4&quot; (100mm)</td>
<td>2&quot; (50mm)</td>
</tr>
<tr>
<td>Z1-axis (detector unit)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z2-axis (column)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>X-axis inclination angle</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-axis</td>
<td>±45°</td>
<td></td>
</tr>
<tr>
<td>Z1-axis</td>
<td>±45°</td>
<td></td>
</tr>
<tr>
<td>Z2-axis</td>
<td>±45°</td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-axis</td>
<td>±(100+20L) µin [±(2.5+0.02L) µm]</td>
<td></td>
</tr>
<tr>
<td>Z1-axis</td>
<td>±(100+100H) µin [±(2.5+0.1H) µm]</td>
<td></td>
</tr>
<tr>
<td>Z2-axis (column)</td>
<td>Manual (quick-up-and-down motion, fine feed)</td>
<td></td>
</tr>
<tr>
<td><strong>Measuring speed</strong></td>
<td>0.00078 - 0.2 in/sec (0.02 - 5 mm/s)</td>
<td></td>
</tr>
<tr>
<td><strong>Linearity accuracy (X-axis horizontal orientation)</strong></td>
<td>98.4µin/4in (2.5µm/100mm)</td>
<td></td>
</tr>
<tr>
<td><strong>Drive method</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-axis</td>
<td>Motorized drive 0 - 0.79in/s (0 - 20mm/s)</td>
<td></td>
</tr>
<tr>
<td>Z1-axis (column)</td>
<td>Manual (quick-up-and-down motion, fine feed)</td>
<td></td>
</tr>
<tr>
<td><strong>Measuring surface direction</strong></td>
<td>Push / pull</td>
<td></td>
</tr>
<tr>
<td><strong>Measuring surface direction</strong></td>
<td>Downward</td>
<td></td>
</tr>
<tr>
<td><strong>Measuring force</strong></td>
<td>(3gf) (30±10mN)</td>
<td></td>
</tr>
<tr>
<td><strong>Stylus traceable angle (Standard accessory stylus)</strong></td>
<td>Ascent 77°, Descent 87° (Depends on the surface condition)</td>
<td></td>
</tr>
<tr>
<td><strong>External dimensions (W×D×H)</strong></td>
<td>29.3”x17.7”x34.8” (745x450x885mm)</td>
<td>25.6”x5.63”x5.45” (651x143x138.5mm)</td>
</tr>
<tr>
<td><strong>Mass</strong></td>
<td>321.43 lbs (145.8 kg)</td>
<td>12.78 lbs (5.8 kg)</td>
</tr>
</tbody>
</table>

**DIMENSIONS**

---

Optional Manual Column Stand for CV-2100N4
**Contracer CV-3200 / CV-4500**

**SERIES 218 — Contour Measuring Instruments**

**FEATURES**

- Dramatically increased drive speed (X axis: 80 mm/s, Z2 axis: 20 mm/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.
- With the support for a wide range of optional peripherals designed for use with the CNC models enables simplified CNC measurement.
- The drive unit (X-axis) and column (Z2-axis) are equipped with a high-accuracy linear encoders (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.
- A newly designed straight arm has reduced interference on the workpiece and expanded the measurement range in the Z1 axis (height) direction.
- One-touch mounting and removal of the arm.

With the addition of a new function for continuously measuring top and bottom faces, the variable measuring force function has become more useful, enabling a wide variety of efficient, high-precision measurements.

- 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).
- High-precision and high-speed drive has been achieved, significantly improving measurement efficiency.
- A newly designed straight arm has reduced interference on the workpiece and expanded the measurement range in the Z1 axis (height) direction.
- One-touch mounting and removal of the arm.

---

**Technical Data**

**X-axis**
- Measuring range: 4" (100mm) or 8" (200mm)
- Resolution: 1.97µm (0.05µm)
- Measurement method: Reflective-type linear encoder
- Drive speed: 3.15"/s (80mm/s) and manual
- Measuring speed: 0.0008" - 0.02"/s (0.02 - 5mm/s)
- Measuring direction: Push / Pull
- Traverse linearity: \(32\mu m/4", 80\mu m/8"\)
- Linear displacement: \((31.5 + 10L)\mu m\) \((CV-3200S4, H4, W4)\)
- Accuracy (at 20°C): \(63 + 20H\mu m\) \((CV-3200S4, H4, W4)\)
- Stylus up/down operation: Arc movement
- Face of stylus: Radius: 25µm, carbide tip
- Measuring force: 30mN (CV-3200), 100 – 240VAC ±10%, 50/60Hz
- Power consumption: 400W (main unit only)

**Z2-axis (column)**
- Vertical travel: 10" (300mm) or 20" (500mm)
- Resolution: 39.4µin (1µm)
- Measurement method: ABSOLUTE linear encoder
- Drive speed: 0 - 1.2"/s (0 - 30mm/s) and manual
- Measuring range: ±1.2" (±30mm)
- Resolution: 1.57µin (.04µm) (CV-3200 series), .78µin (0.02µm) (CV-4500 series)
- Measurement method: Rotory arc encoder (CV-3200 series), (CV-4500 series)
- Linear displacement: \((31.5 + 20L)\mu m\) \((CV-3200S8, H8, W8)\)
- Accuracy (at 20°C): \(32 + 20L\mu m\) \((CV-3200S8, H8, W8)\)

**Stylus tip radius**
- Ascent: 77°, descent: 83° (using the standard stylus provided and depending on the surface roughness)

**Base material**
- Granite

**Mass**
- Main unit: 309lbs (140kg) (S4), 331lbs (150kg) (H4), 485lbs (220kg) (W4)
- Controller Unit: 31lbs (14kg)
- Remote Control Box: 2lbs (0.9kg)
- Power supply: 100 – 240VAC ±10%, 50/60Hz
- Power consumption: 400W (main unit only)

**Collective Calibration Function**
- A dedicated calibration gage enables the user to calibrate the instrument for Z-axis gain, symmetry, stylus-tip radius, etc, in a single procedure.

**Calibration kit for CV-4500 series**
- CV-4500: 12AAQ491
- CV-3200: 12AAQ489 (not shown)
**Contracer CV-3200 / CV-4500**

**SERIES 218 — Contour Measuring Instruments**

### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>CV-3200S4</th>
<th>CV-3200H4</th>
<th>CV-3200W4</th>
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</thead>
<tbody>
<tr>
<td>Order No. (inch)</td>
<td>218-491A</td>
<td>218-492A</td>
<td>218-493A</td>
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<td>Model No.</td>
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<td>CV-4500H4</td>
<td>CV-4500W4</td>
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<td>218-452A</td>
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<thead>
<tr>
<th>Function</th>
<th>Report Creation Function</th>
<th>Automatic Circle Line Application Function</th>
<th>Data Composition Function</th>
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<table>
<thead>
<tr>
<th>X1-axis measuring range</th>
<th>4&quot; (100mm)</th>
<th>4&quot; (100mm)</th>
<th>4&quot; (100mm)</th>
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<tbody>
<tr>
<td>Vertical travel</td>
<td>12&quot; power column</td>
<td>20&quot; power column</td>
<td>20&quot; power column</td>
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<tr>
<td>Granite base size (WxD)</td>
<td>23.6 x 17.7&quot; (600 x 450mm)</td>
<td>23.6 x 17.7&quot; (600 x 450mm)</td>
<td>23.6 x 17.7&quot; (600 x 450mm)</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Dimensions (main unit, WxDxH)</th>
<th>X1-axis measuring range</th>
<th>Vertical travel</th>
<th>Base size (W x D)</th>
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<tbody>
<tr>
<td></td>
<td>4&quot; (100mm)</td>
<td>12&quot; (300mm)</td>
<td>23.6 x 17.7&quot; (600 x 450mm)</td>
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<tr>
<td>Base material</td>
<td>Granite</td>
<td>Granite</td>
<td>Granite</td>
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</table>

| Mass (main unit)               | 309 lbs (140kg) | 331 lbs (150kg) | 485 lbs (220kg) |

### A variety of models available for measuring requirements

**CV-3200S4 / CV-4500S4**

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

**CV-3200H4 / CV-4500H4**

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

**CV-3200W4 / CV-4500W4**

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

**Optional Software**

FORMTRACEPAK V5

- Measurement Control Screen
- Profile Analysis Screen
- Report Creation Function
- Automatic Circle Line Application Function

**Data Composition**

- Data Composition Function
  - Data 1
  - Data 2
  - Data composition
Optional Arms and Styli for Contour Measurement

For CV-2100

**List of Applicable Arms**

<table>
<thead>
<tr>
<th>Arm name</th>
<th>Order No.</th>
<th>Compatible stylus height</th>
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<tr>
<td></td>
<td>935113</td>
<td>H = 20mm</td>
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<td></td>
<td>935114</td>
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<td>935115</td>
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<td>Eccentric type</td>
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<td></td>
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<tr>
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<tr>
<td>Small hole</td>
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<td>H = 0.4, 1, 2.5mm</td>
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**List of Applicable Styli**

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<thead>
<tr>
<th>Stylus name</th>
<th>Order No.</th>
<th>Stylus height</th>
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<td>354883</td>
<td>H = 12mm</td>
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</tr>
<tr>
<td></td>
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<tr>
<td>Cross-ground stylus carbide-tipped</td>
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<td></td>
<td>354888</td>
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<tr>
<td></td>
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</tr>
<tr>
<td>Cone stylus carbide-tipped tip angle 30°</td>
<td>12AAE865</td>
<td>H = 6mm</td>
</tr>
<tr>
<td></td>
<td>12AAE866</td>
<td>H = 12mm</td>
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<td></td>
<td>12AAE867</td>
<td>H = 20mm</td>
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<td>12AAE868</td>
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<td>12AAE869</td>
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<tr>
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### List of Applicable Styli

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<td>Cone stylus carbide-tipped tip angle 30°</td>
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<td></td>
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</table>

**Optional Styli for Contour Measurement**

**CV-2100, CV-3200, CV-4500, SV-C3200, SV-C4500 and SV-C4500CNC**

- **Single bevel**
  - Tip angle: 12°
  - Tip radius: 25µm
  - Tip material: Carbide

- **Intersecting Cut**
  - Tip angle: 20°
  - Tip radius: 25µm
  - Tip material: Carbide

- **Cone**
  - Tip angle: 30°/50°*
  - Tip radius: 25µm
  - Tip material: Carbide, Sapphire, Diamond*

- **Knife edge**
  - Tip angle: 20°
  - Tip radius: 25µm
  - Tip material: Carbide

- **Ball**
  - Ball dia: 1mm
  - Tip material: Carbide

- Any specified arm and stylus other than above listed can be custom-made to special order.
Optional Arms and Styli for Contour Measurement
For CV-3200, CV-4500, SV-C3200, SV-C4500 and SV-C4500CNC

### List of Applicable Styli

<table>
<thead>
<tr>
<th>Stylus Name</th>
<th>Order No.</th>
<th>H (mm)</th>
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<td>32</td>
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<td>354886</td>
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<td>Cross-ground stylus carbide-tipped</td>
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### List of Applicable Arms

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<th>Arm Name</th>
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*1: Standard accessory  
*2: Stylus for CV-4500 series  
*3: One-sided cut stylus SPH-71 (standard accessory) mounting

Arm stylus (integrated arm and stylus) only for CV-4500

<table>
<thead>
<tr>
<th>Arm stylus name</th>
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<tr>
<td>Double small-hole arm stylus</td>
<td>12AAM110</td>
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</table>

*8: Arm Stylus for CV-4500 series
Optional Accessories for Automatic Measurement

Compatible with CV-3200, CV-4500 and CNC Models

1) Y-axis table: 178-097
Enables efficient, automatic positioning of multiple aligned workpieces and multiple points on a single measurement surface.

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

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<tr>
<th>Function</th>
<th>Y-axis Table</th>
<th>θ Table</th>
<th>φ Table</th>
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<tr>
<td>Multiple-piece measurement</td>
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<td>▲</td>
<td>—</td>
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<td>Tracking measurement in the</td>
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<td>Z-axis direction</td>
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<td>Inclined surface measurement</td>
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<td>(Measuring in X-axis direction)</td>
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<td>Inclined hole inside measurement</td>
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<td>(X-axis direction)</td>
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<td>Multiple cylinder generatrix</td>
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<td>measurement</td>
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<td>Measurement of both top and</td>
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<td>bottom surfaces</td>
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<td>Rotary positioning of large</td>
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<td>workpiece **</td>
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<td>Tracking measurement in the</td>
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<td>(Positioning in the Y-axis</td>
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<td>Automatic-leveling table: 178-087</td>
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<td>(SV, CV, CS3200)</td>
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<td>Quick chuck: 211-032</td>
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<td>This quick chuck is useful when</td>
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<td>measuring small workpieces.</td>
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<td>You can easily clamp them with</td>
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<tr>
<td>its knurled ring.</td>
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</tbody>
</table>

2) Micro-chuck: 211-031
This chuck is suitable for clamping extra-small diameter workpieces (ø1 mm or less), which cannot be retained with the centering chuck.

Retention range
OD: ø0-0.06” (0-1.5mm)
Dimensions: ø 4.65” x 1.95” (118 x 48.5mm)
Mass: 1.32 lbs (0.6kg)
Optional Accessories for Contracer / Formtracer
Compatible with Desktop Models of Contracer and Formtracer

Cross-travel table
- Table top: 11” x 7” (280 x 180mm)
- XY travel: 3.94” x 1.97” (100 x 50mm)
- Max. load 110 lbs (50kg)

V-block with clamp
- Used with a cross-travel table or rugged table.
- Max. workpiece diameter: 1.97” (50mm)
- Max. workpiece diameter: .98” (25mm)

Precision vise
- Max. workpiece size: 1.42” (36mm)
- Can be mounted on a leveling table.

Holder with clamp
- Used with a cross-travel table or rugged table.
- Max. workpiece height: 1.38” (35mm)

Rotary vise
- Two-slide jaw type.
- Max. workpiece size: ø 2.36” (60mm)
- Minimum reading: 1°

Leveling table
- Table top: 5.12” x 3.94” (130 x 100mm)
- Leveling range: ±1.5°
- XY travel: .49” ± (12.5mm)

Swivel center support
- Max. workpiece diameter: 3.15” (80mm)*
- Max. workpiece diameter: 2.56” (65mm) when swiveled 10°
- Max. workpiece length: 5.51” (140mm)

Center support
- Max. workpiece diameter: 4.72” (120mm)
- Max. workpiece diameter: 2.36” (60mm) riser is optional (172-143)
- Center support riser
- Used with a center support.
- Max. workpiece diameter: 9.45” (240mm)

V-block with clamp
- Workpiece diameter: 0.039” to 6.3” (1mm to 160mm)
- Can be mounted on a leveling table

Precision vise
- Max. workpiece size: 1.42” (36mm)
- Can be mounted on a leveling table.

Holder with clamp
- Used with a cross-travel table or rugged table.
- Max. workpiece height: 1.38” (35mm)

Rotary vise
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- Max. workpiece diameter: 2.36” (60mm) riser is optional (172-143)
- Center support riser
- Used with a center support.
- Max. workpiece diameter: 9.45” (240mm)

Three-axis adjustment table
- Table top: 5.11 x 3.94” (130 x 100mm)
- Workpiece weight: 33lbs. (15kg) at max.
- Workpiece diameter: 0.04” – 6.3” (1 - 160mm)
- Leveling range: ±1.5°
- Swivel range: ±2°
- Y-axis adjustment: ±0.5° (± 12.5mm)
- Height: 6” (152.5mm)
- Maxi: 19.8lbs. (9kg)
- Remarks: V-block (998291) is provided

Three-axis adjustment table
Order No. 178-047
Table top: 5.11 x 3.94” (130 x 100mm)
Workpiece weight: 33lbs. (15kg) at max.
Workpiece diameter: 0.04 – 6.3” (1 - 160mm)
Leveling range: ±1.5°
Swivel range: ±2°
Y-axis adjustment: ±0.5° (± 12.5mm)
Height: 6” (152.5mm)
Maxi: 19.8lbs. (9kg)
Remarks: V-block (998291) is provided
Quick Guide to Precision Measuring Instruments

■ Traceable Angle

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

For model CV-3200/4500, the same type of stylus (SPH-71: one-sided sharp stylus with a tip angle of 12°) can trace a maximum 77° of up slope and a maximum 83° of down slope.

■ Compensating for Stylus Tip Radius

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

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

■ Compensating for Arm Rotation

The stylus is carried on a pivoted arm so it rotates as the surface is traced and the contact tip does not track purely in the Z direction. Therefore it is necessary to apply compensation in the X direction to ensure accuracy. There are three methods of compensating for arm rotation.

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

■ Accuracy

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

■ Overload Safety Cutout

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

For model CV-3200/4500, a safety device functions if the arm comes off the detector mount.

■ Simple or Complex Arm Guidance

In the case of a simple pivoted arm, the locus that the stylus tip traces during vertical movement (Z direction) is a circular arc that results in an unwanted offset in X, for which compensation has to be made. The larger the arc movement, the larger is the unwanted X displacement (δ) that has to be compensated. (See figure, lower left.) The alternative is to use a complex mechanical linkage arrangement to obtain a linear translation locus in Z, and therefore avoid the need to compensate in X.

■ Z axis Measurement Methods

Though the X axis measurement method commonly adopted is by means of a digital scale, the Z axis measurement divides into analog methods (using a differential transformer, etc.) and digital scale methods.

Analog methods vary in Z axis resolution depending on the measurement magnification and measuring range. Digital scale methods have fixed resolution. Generally, a digital scale method provides higher accuracy than an analog method.
Contour analysis methods

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

Data processing section and analysis program

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

Tolerancing with Design Data

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

Best-fitting

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

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

Data Combination

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

Measurement Examples

- Aspheric lens contour
- Internal gear teeth
- Male thread form
- Female thread form
- Inner/outer ring contour of a bearing
- Gage contour
Roundtest RA-120 / 120P
SERIES 211 — Roundness Measuring Instruments

The Roundtest RA-120 / 120P are a compact, affordable, and simple-to-use device for measuring part geometry on the shop floor. It also provides such superb data analysis capabilities as required with laboratory roundness measuring instruments and has a ±1000µm wide range detector and precision turn table with excellent rotation accuracy.

The RA-120 is a dedicated processor based model which controls all operations via the control panel incorporated in the main unit.

The RA-120P is a PC based model which controls all operations via ROUNDPAK software (optional).

**Specifications**

<table>
<thead>
<tr>
<th>Model No.</th>
<th>RA-120</th>
<th>RA-120D</th>
<th>RA-120P</th>
<th>RA-120PD</th>
</tr>
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<tbody>
<tr>
<td>Order No.</td>
<td>211-544A</td>
<td>211-543A</td>
<td>211-547A</td>
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</tr>
</tbody>
</table>

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Large color LCD display for RA-120 models

**Roundtest RA-120 / 120P**

**Optical X-axis stop**

**Vertical column (Z-axis)**
- Vertical travel: 11" (280mm)
- Feeding: 1.18" (30mm)/rev. (coarse), 0.039" (1mm)/rev. (fine)
- Maximum probing depth: 3.94" (100mm) (min. ID: 1.18" (30mm)
- Maximum workpiece weight: 55 lbs (25kg)

**Horizontal arm (X-axis)**
- Horizontal travel: 65" (165mm) (Including a protrusion of 1" (25mm) the turntable rotation center)

**Probe and stylus**
- Measuring range: ±1000µm
- Measuring force: 100mN±30mN
- Standard stylus: 12AAL021, carbide ball, ø1.6mm
- Measuring direction: Two directional
- Stylus angle adjustment: ±45° (with graduations)

**Data analysis unit**
- Processing unit: Built-in (PC with Roundpak)*
- Data sampling points: 3,600 points/rotation
- Data analysis items:
  - Roundness, Coaxiality, Concentricity, Flatness, Circular runout (radial), Circular runout (axial), Squareness (against axis), Squareness (against plane), Thickness deviation, Parallelism
- Reference circles for roundness evaluation:
  - LSC, M2C, MIC, MCC
- Recording device:
  - Built-in thermal line printer (optional external printer)*
- Recording magnification:
  - X5 to X200,000, Auto (X1 to X500,000)*
- Roughness component reduction:
  - Low pass filter, band pass filter
- Cutoff value:
  - 15upr, 30upr, 50upr, 100upr, 15-30upr, 15-50upr, 15-100upr, 50-100upr, Manual setting* 
- Number of measuring sections:
  - Max. 5-section (100-section)*

*RA-120P

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Large color LCD display for RA-120 models
Roundtest RA-120 / 120P
SERIES 211 — Roundness Measuring Instruments

DAT (Digital Adjustment Table) function
The turntable digitally displays the centering and leveling adjustments, turning what used to be a difficult and finicky task into one that is simple enough for even untrained operator to perform.

1. Preliminary measurement of two cross sections “A” and “B”.

2. Following preliminary measurement, the centering and leveling adjustment values are displayed on the monitor.

3. Manipulate the digital micrometer heads of the rotary table so that the adjustment values displayed on the monitor are realized.

4. Centering and leveling are complete.
   Centering range: ±3mm
   Leveling (inclination) range: ±1°

DIMENSIONS

 functions
- Notched workpiece measurement
- Recalculation of datum/measured data
- Limaçon function compensates for eccentricity
- Rotation of 3D display**
- Real-time display**
- Simplified layout (divided layout)**
- Hair line, auxiliary line, hidden line, fill line**
- Color setting of measured data**
- Offsetting of recorded profile generation**
- Zooming of recorded profile**
- Data deletion**
- Graph analysis (displacement/angle between measured points)**
- Power spectrum analysis**
- Gear tooth analysis**
- Harmonic analysis**
- Test data output (via CSV format)**
- Function of ROUNDPAK software

Air supply
- Air pressure: 390kPa
- Air consumption: 30L/min.
- Power supply: 100V AC - 240V AC, 50/60Hz
- Dimensions (W x D x H): 17.7” x 14.2” x 25”
  (450 x 360 x 636mm)
- Mass: 70.5 lbs (32kg) (main unit), 4.4 lbs (2kg) (air regulator)

Optional Accessories
- 211-032: Quick chuck (OD: 1 - 79mm, ID: 16 - 69mm)
- 211-014: Three-Jaw chuck (OD: 2 - 78mm, ID: 25 - 68mm)
- 211-031: Micro-chuck (OD: 1.5mm max.)
- 356038: Auxiliary stage for a low-height workpiece
- 211-016: Reference hemisphere
- 211-045: Magnification checking gage
- 997090: Gage block set for calibration
- 12AAH320: X-axis stop
- 211-013: Vibration damping stand
  - Interchangeable styli (See page J-49.)

CONSUMABLE PARTS
- 12AAH181: Printer paper 10 rolls/set
- 358592: Element for air filter 1 pc/set
- 358593: Element for air regulator 10 pcs/set

Roundtest RA-120 / 120P
SERIES 211 — Roundness Measuring Instruments
Roundtest RA-1600 / RA-1600M
SERIES 211 — Roundness/Cylindricity Measuring System

A new PC-compliant roundness and cylindrical-form measuring instrument with extensive analysis features to enable measurement of a wide variety of workpieces.

**Technical Data**

**Turntable**
- Rotational accuracy (radial): (0.02+6H/10000)µm (RA-1600)
- Rotational accuracy (angular): (0.02+6X/10000)µm (RA-1600M)
- Rotational accuracy (axial): (0.03+6X/10000)µm (RA-1600M)
- Rotational speed: 4, 6, 10rpm
- Table top diameter: ø5.9” (150mm)
- Centering range: ±3mm (with DAT function)
- Leveling range: ±1° (with DAT function)
- Maximum probing diameter: ø11” (ø280mm)
- Maximum workpiece diameter: ø22” (ø560mm)
- Maximum table loading: 55lbs (25kg)

**Vertical column (Z-axis)**
- Vertical travel: 11.8” (300mm)
- Straightness (in narrow range): 0.20µm / 100mm (RA-1600)
- Straightness (in entire range): 0.30µm / 300mm (RA-1600)
- Straightness (in narrow range): 0.20µm / 100mm (RA-1600M)
- Straightness (in entire range): 0.30µm / 300mm (RA-1600M)
- Parallelism with turntable axis: 1.5µm / 300mm
- Positioning speed: Max. 15mm/s
- Measuring speed: 0.5, 1, 2, 5mm/s
- Maximum probing depth (ID/OD): 3.6” (over ø1.26”) (91mm (over ø32))
- Maximum probing height (ID/OD): 6.5” (165mm) (from table axis)
- Measuring range: ±400µm / ±40µm / ±4µm
- Measuring force: 15–50mN (5 level switching)
- Standard stylus: 12AAL021, carbide ball, ø1.6mm
- Probing direction: Bi-directional
- Stylus angle adjustment: ±45° (with graduations)
- Air supply:
  - Air pressure: 0.35MPa (4kgf/cm²)
  - Air consumption: 22L/min.
- Power supply: 100V AC – 240V AC, 50/60Hz
- Dimensions (W x D x H): 35 x 19.3 x 33” (890 x 490 x 840mm)
- Mass: 375lbs (170kg)

*1 Use an optional auxiliary stage for measuring a workpiece whose height is 20mm or less.

**Spiral Measurement/Analysis**
The spiral-mode measurement function combines table rotation and rectilinear action allowing cylindricity, coaxiality, and other measurement data to be loaded as a continuous data set.

**Continuous internal/external diameter measurement**
Continuous internal/external diameter measurement is possible without changing the detector position.

**Safety mechanism provided as a standard feature**
A collision-sensing function has been added to the detector unit (when it is in the vertical orientation) to prevent collision in the Z-axis direction. Additionally, an accidental collision prevention function, which stops the system when the detector displacement exceeds its range, has been added. When an accidental touch is detected, the dedicated analysis software (ROUNDPAK) senses the error and automatically stops the system.
Roundtest RA-1600 / RA-1600M
SERIES 211 — Roundness/Cylindricity Measuring System

* Centering and Leveling function
The turntable displays centering and leveling adjustments digitally, making this challenging task simple enough for even an untrained operator to perform.
1. Preliminary measurement of two cross sections “A” and “B”.
2. Following preliminary measurement, the centering and leveling adjustment values are displayed on the monitor.
3. By adjusting the micrometer heads for the rotary table, the adjustment values or level meter displayed on the monitor can be achieved.
4. Centering and leveling are complete.
   Centering range: ±3mm
   Leveling (inclination) range: ±1°

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>RA-1600</th>
<th>RA-1600M</th>
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<tbody>
<tr>
<td>Order No. (inch/mm)</td>
<td>211-733A</td>
<td>211-724A</td>
</tr>
<tr>
<td>Mic Heads</td>
<td>Digimatic</td>
<td>Mechanical</td>
</tr>
</tbody>
</table>

DIMENSIONS

Optional Accessories

- 350850: Cylindrical square
- 356038: Auxiliary stage for a low-height workpiece
- 12AAF203: 2x extension detector holder
- 12AAF204: Auxiliary detector holder for a large-diameter workpiece
- 12AA090: Sliding detector holder
- 211-045: Magnification checking gage
- 211-032: Chuck (OD: ø12 - 78mm, ID: ø25 - 68mm)
- 211-031: Quick chuck (OD: ø11 - 78mm, ID: 16 - 69mm)
- 178-025: Vibration isolator (Desk type)
- 644B213: Vibration isolation workstation

Sliding detector-unit holder (Option) 12AA090
The detector-unit holder is equipped with a sliding mechanism, enabling one-touch measurement of a workpiece with a deep hole having a thick wall, which has been difficult with the conventional standard arm.

* See this page for details about the continuous ID and OD measuring function.
## Technical Data

**Turntable**
- **Rotational accuracy (radial):** \(1.8 + 35H/\mu\text{in} (0.02 + 3.5H/1000\mu\text{m})\)
- **Rotational accuracy (axial):** \(1.8 + 35H/\mu\text{in} (0.02 + 3.5H/1000\mu\text{m})\)
- **Rotating speed:** 2, 4, 6, 10rpm
- **Table top diameter:** ø9.2", (235mm) AS / AH models
- **ø7.9", (200mm) DS / DH models**
- **Centering range:** ±3mm (ø5mm: DS / DH models)
- **Leveling range:** ±1°
- **Maximum probing diameter:** ø11.8", (300mm)
- **Maximum workpiece diameter:** ø22.8", (590mm)
- **Maximum workpiece weight:** 66 lbs (30kg)

**Vertical column (Z-axis)**
- **Vertical travel:** 11.8" (300mm) (22.8" (590mm): AH / DH models)
- **Straightness (x,y,z):** 0.10μm / 100mm, 0.15μm / 300mm (0.25μm / 500mm: AH / DH models)
- **Parallelism with rotating axis:** 0.7μm / 300mm (1.2μm / 500mm: AH / DH models)
- **Positioning speed:** Max. 50㎜/s
- **Measuring speed:** 0.5, 1, 2, 5㎜/s
- **Maximum probing height:** 11.8" (300mm) (ø7 / ø0: 30mm)
- **Maximum probing depth:** over ø32: 85mm (ø50mm: standard styli)

**Horizontal arm (X-axis)**
- **Horizontal travel:** 6.9" (175mm) (Including a protrusion of 1" (25mm) the turntable rotation center)
- **Straightness (x2):** 0.7μm / 150mm
- **Squareness with rotating axis:** 1.0μm / 150mm
- **Positioning speed:** Max. 30mm/s with joystick operation
- **Measuring speed:** 0.5, 1, 2, 5mm/s

**Probes and stylus**
- **Measuring range:** ±400μm / ±40μm / ±4μm
- **Measuring force:** 10mN-50mN (in 5 steps)
- **Standard styli:** 12AAL021, carbide ball, ø1.6mm

**Data analysis system**
- **Analysis software:** Roundpak
- **Filter type:** 2CRPC-75%, 2CRPC-50%, 2CR-75% (non-phase corrected), 2CR-50% (non-phase corrected), Gaussian, filter OFF
- **Cutoff value:** 15μpr, 50μpr, 150μpr, 500μpr, 1500μpr, 15-500μpr, 50-500μpr, 50-1500μpr, 150-1500μpr, Manual setting
- **Reference circles for roundness evaluation:** LSC, MZC, MIC, MCC

**Air supply**
- **Air pressure:** 390kPa (4kgf/cm²)
- **Air consumption:** 30L/min.
- **Power supply:** 100V AC ~ 240V AC, 50/60Hz
- **Dimensions (W x D x H):** 26.3 x 20 x 35.4" (667 x 510 x 900mm)
- **Mass:** 396 lbs (180kg), 440 lbs (200kg) / AH / DH models

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## Roundtest RA-2200AS / DS / AH / DH

**SERIES 211 — Roundness / Cylindricity Measuring System**

The RA-2200 provides a high accuracy, high speed and high performance in roundness measurement. The fully-automatic or a DAT (Digital Adjustment Table) function aided manual workpiece centering and leveling turns what used to be a difficult and finicky task into one that is simple enough for even untrained users to perform. This facilitates substantial reductions in overall measurement time. The RA-2200 system comes complete with powerful data analysis software ROUNDPAK which requires only simple manipulation using a mouse and icon, achieving enhanced functionality and ease of operation.

**RA-2200AS with personal computer system and software**

* Shown with optional vibration isolator and side table for PC

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**Round accuracy**

**Easy-to-use turntable**

With extremely high rotational accuracy, both in the radial and axial directions, the turntable allows high accuracy flatness testing to be performed in addition to roundness and cylindricity measurements.

Incorporating an automatic centering/leveling turntable (A.A.T.), the top-of-the-line RA-2200AS/AH models relieve the operator of the bothersome task of workpiece centering and leveling.

A guidance system (D.A.T.) is incorporated into the turntables on the RA-2200DS/DH models to help the operator perform manual centering and leveling smoothly and simply.

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### Technical Data

**Turntable**

- **Rotational accuracy (radial):** \(1.8 + 35H/\mu\text{in} (0.02 + 3.5H/1000\mu\text{m})\)
- **Rotational accuracy (axial):** \(1.8 + 35H/\mu\text{in} (0.02 + 3.5H/1000\mu\text{m})\)
- **Rotating speed:** 2, 4, 6, 10rpm
- **Table top diameter:** ø9.2", (235mm) AS / AH models
- **ø7.9", (200mm) DS / DH models**
- **Centering range:** ±3mm (ø5mm: DS / DH models)
- **Leveling range:** ±1°
- **Maximum probing diameter:** ø11.8", (300mm)
- **Maximum workpiece diameter:** ø22.8", (590mm)
- **Maximum workpiece weight:** 66 lbs (30kg)

**Vertical column (Z-axis)**

- **Vertical travel:** 11.8" (300mm) (22.8" (590mm): AH / DH models)
- **Straightness (x,y,z):** 0.10μm / 100mm, 0.15μm / 300mm (0.25μm / 500mm: AH / DH models)
- **Parallelism with rotating axis:** 0.7μm / 300mm (1.2μm / 500mm: AH / DH models)
- **Positioning speed:** Max. 50㎜/s
- **Measuring speed:** 0.5, 1, 2, 5㎜/s
- **Maximum probing height:** 11.8" (300mm) (ø7 / ø0: 30mm)
- **Maximum probing depth:** over ø32: 85mm (ø50mm: standard styli)

**Horizontal arm (X-axis)**

- **Horizontal travel:** 6.9" (175mm) (Including a protrusion of 1" (25mm) the turntable rotation center)
- **Straightness (x2):** 0.7μm / 150mm
- **Squareness with rotating axis:** 1.0μm / 150mm
- **Positioning speed:** Max. 30mm/s with joystick operation
- **Measuring speed:** 0.5, 1, 2, 5mm/s

**Measuring system**

- **Probes and stylus**
  - **Measuring range:** ±400μm / ±40μm / ±4μm
  - **Measuring force:** 10mN-50mN (in 5 steps)
  - **Standard styli:** 12AAL021, carbide ball, ø1.6mm

**Data analysis system**

- **Analysis software:** Roundpak
- **Filter type:** 2CRPC-75%, 2CRPC-50%, 2CR-75% (non-phase corrected), 2CR-50% (non-phase corrected), Gaussian, filter OFF
- **Cutoff value:** 15μpr, 50μpr, 150μpr, 500μpr, 1500μpr, 15-500μpr, 50-500μpr, 50-1500μpr, 150-1500μpr, Manual setting

**Reference circles for roundness evaluation:** LSC, MZC, MIC, MCC

**Air supply**

- **Air pressure:** 390kPa (4kgf/cm²)
- **Air consumption:** 30L/min.
- **Power supply:** 100V AC ~ 240V AC, 50/60Hz
- **Dimensions (W x D x H):** 26.3 x 20 x 35.4" (667 x 510 x 900mm)
  - 26.3 x 20 x 43.3" (667 x 510 x 1100mm: AH / DH models)
- **Mass:** 396 lbs (180kg), 440 lbs (200kg) / AH / DH models

**Printout**

- **Users to perform. This facilitates substantial reductions in overall measurement time.**
- **The RA-2200 system comes complete with powerful data analysis software ROUNDPAK which requires only simple manipulation using a mouse and icon, achieving enhanced functionality and ease of operation.**

---

**Roundtest RA-2200AS / DS / AH / DH**

**SERIES 211 — Roundness / Cylindricity Measuring System**

The RA-2200 provides a high accuracy, high speed and high performance in roundness measurement. The fully-automatic or a DAT (Digital Adjustment Table) function aided manual workpiece centering and leveling turns what used to be a difficult and finicky task into one that is simple enough for even untrained users to perform. This facilitates substantial reductions in overall measurement time. The RA-2200 system comes complete with powerful data analysis software ROUNDPAK which requires only simple manipulation using a mouse and icon, achieving enhanced functionality and ease of operation.**
Roundtest RA-2200AS / DS / AH / DH
SERIES 211 — Roundness / Cylindricity Measuring System

Greater productivity by continuous measurement
Both the OD and ID of a workpiece* can be measured in succession without the need for changing the traverse direction of the stylus.
*Inside diameter up to 50 mm.

Unique design allows system upgrading
The system can be upgraded to CNC operation by replacing and adjusting the detector unit. (This task should be performed by a Mitutoyo technician.)

Surface roughness measurement function (Surface roughness unit: option)
A surface roughness detector, compliant with the relevant International Standards, can be mounted in place of the roundness measuring detector. This creates a multiple sensor system that can not only test the geometrical roundness/cylindricity of a surface but also the roughness of that surface as well.

Highly repeatable measurements with high-accuracy scales Mitutoyo linear scales are used in the X/Z drive unit to guarantee the high precision positioning so vital for repetitive measurement.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>RA-2200AS</th>
<th>RA-2200DS</th>
<th>RA-2200AH</th>
<th>RA-2200DH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>211-511A</td>
<td>211-514A</td>
<td>211-512A</td>
<td>211-516A</td>
</tr>
<tr>
<td>Effective table diameter</td>
<td>9.25” (235mm)</td>
<td>8” (200mm)</td>
<td>9.25” (235mm)</td>
<td>8” (200mm)</td>
</tr>
<tr>
<td>Centering range</td>
<td>±0.118” (±3mm)</td>
<td>±0.197” (±5mm)</td>
<td>±0.118” (±3mm)</td>
<td>±0.197” (±5mm)</td>
</tr>
<tr>
<td>Column travel</td>
<td>12” (300mm) (standard column)</td>
<td>20” (500mm) (high column)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic unit mass</td>
<td>396 lbs. (180kg)</td>
<td>440 lbs. (200kg)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DIMENSIONS

![Diagram of Roundtest RA-2200AS / DS / AH / DH]

Optional Accessories
- 350850: Cylindrical square
- 356038: Auxiliary stage for a low-height workpiece
- 12AAK110: Vibration isolator
- 12AAK120: Monitor arm
- 12AAL019: Side table for PC
- 211-032: Sliding detector-unit holder (Standard) 12AAL090
  The detector-unit holder is equipped with a sliding mechanism, enabling one-touch measurement of a workpiece with a deep hole having a thick wall, which has been difficult with the conventional standard arm.

Sliding distance: 4.4” (112mm)
The detector-unit holder can be stopped at a position sufficiently higher than the workpiece along the Z-axis, and then lowered and positioned to make measurements. Furthermore, internal/external diameters can be easily measured with the continuous internal/external diameter measurement function*.

* See this page for details about the continuous ID and OD measuring function.
**Roundtest RA-H5200AS / AH**

**SERIES 211 — Roundness / Cylindricity Measuring System**

RA-H5200AS / AH, a roundness/cylindricity measuring system developed to combine world-class accuracy with maneuverability/high analysis capability.

Enhanced detector safety functions such as accidental touch and collision detection is installed to minimize damage to both machine and workpieces.

**Technical Data**

**Turntable**
- Rotational accuracy (radial): $(0.8+3.5H)/10000$ μm
- Rotational accuracy (axial): $(0.8+3.5X)/10000$ μm
- H: Probing height (mm), X: Distance from the turntable axis (mm)
- Rotating speed: 2, 4, 6, 10rpm (20rpm: auto-centering)
- Table top diameter: φ11.8 (300mm)
- Centering range: ±1.5mm
- Leveling range: ±1°
- Maximum probing diameter: φ15.7 (400mm)
- Maximum workpiece diameter: φ26.8 (680mm)
- Maximum workpiece weight: 176 lbs (80kg)
- 143 lbs (65kg): auto-centering

**Vertical column (Z-axis)**
- Vertical travel: 13.8” (350mm), 21.7” (550mm): AH model
- Straightness ( İç × 2.5): 0.05μm / 100mm, 0.14μm / 350mm
- Parallelism with rotating axis: 0.2μm / 350mm
- Positioning speed: Max. 60mm/s
- Measuring speed: 0.5, 1, 2, 5mm/s
- Maximum probing height: 13.8” (350mm) (OD / ID)
- Maximum probing depth: over φ32, 85mm (without standard stylus)
- over φ7, 58mm (with standard stylus)

**Horizontal arm (X-axis)**
- Horizontal travel: 8.9” (225mm)
- Straightness ( İç × 2.5): 0.4μm / 200mm
- Squireness with rotating axis: 0.5μm / 200mm
- Positioning speed: Max. 50mm/s
- Measuring speed: 0.5, 1, 2, 5mm/s

**Probe and stylus**
- Measuring range: ±400μm (±5mm: tracking range)
- Measuring force: 10mN~50mN (in 5 steps)
- Standard stylus: 12AAL021, carbide ball, φ1.6mm
- Measuring direction: Two directional
- Stylus angle adjustment: ±45° (with graduations)

**Data analysis system**
- Analysis software: Roundpak
- Filter type: 2CRPC-75%, 2CRPC-50%, 2CR-75% (non-phase corrected), 2CR-50% (non-phase corrected), Gaussian, filter OFF
- Cutoff value: 15μm, 50μm, 150μm, 500μm, 1500μm
- Reference circles for roundness evaluation: LSC, MZC, MIC, MCC

**Air supply**
- Air pressure: 390kPa (4kgf/cm²)
- Air consumption: 45L/min.
- Power supply: 100V AC – 240V AC, 50/60Hz
- Dimensions (W x D x H): 49.6 x 28.0 x 74.8” (1260 x 710 x 1900mm)
- Mass: Main unit: 1433lbs. (650kg)
- Vibration isolator: 375 lbs (170kg)

**High-accuracy automatic centering/leveling turntable**

A highly accurate, highly rigid turntable has been achieved through exceptional manufacturing accuracy of the critical components, such as the rotor and stator, in addition to an air-bearing incorporating a complex aperture that provides superior rigidity and uniform pressure distribution. As a result, the rotational accuracy (radial), which is the heart of the roundness/cylindricity measuring system, is a world-class $(0.02 + 3.5H)/10000$ μm.

**Automatic continuous OD/ID measurement**

Automatic measurement can be performed continuously from external diameter to internal diameter without having to change the probe position. This not only reduces measurement time but eliminates the error factors otherwise involved in changing the probe position, greatly facilitating high-accuracy measurement.

The automatic centering/leveling mechanism incorporates a high-precision glass scale on each axis of the turntable. This allows feedback to be generated that prevents positioning errors from affecting centering/leveling adjustments. The high-speed, automatic, centering/leveling capability achieved greatly contributes to reducing the total measurement time from workpiece setting to workpiece measurement.
Roundtest RA-H5200AS / AH
SERIES 211 — Roundness / Cylindricity Measuring System

X-axis tracking measurement
Because of the linear scale incorporated into the X-axis, measurement can be performed
by tracking the workpiece surface (tracking range: ±5mm). This function is effective for
measuring a workpiece with a displacement that exceeds the detection range of the probe in
measuring roundness/cylindricity or a taper that is determined with slider/column movement.

Surface roughness measurement function
(Surface roughness unit: option)
A surface roughness detector, compliant with the relevant International Standards, can be
mounted in place of the roundness measuring detector. This creates a multiple sensor system
that can not only test the geometrical roundness/cylindricity of a surface but also the roughness of
that surface as well.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>RA-H5200AS</th>
<th>RA-H5200AH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>211-531A</td>
<td>211-532A</td>
</tr>
</tbody>
</table>

**Column travel**
13.77" (350mm) (standard column) 21.65" (550mm) (high column)

DIMENSIONS

Sliding detector-unit holder(Standard) 12AAL090
The detector-unit holder is equipped with a sliding mechanism, enabling one-touch measurement of
a workpiece with a deep hole having a thick wall, which has been difficult with the conventional
standard arm.

Sliding distance: 4.4" (112mm)
The detector-unit holder can be stopped at a position sufficiently higher than the workpiece
along the Z-axis, and then lowered and positioned to make measurements. Furthermore, internal/external
diameters can be easily measured with the continuous internal/external diameter measurement function*.

* See this page for details about the continuous ID and OD measuring function.
Roundtest Extreme
RA-2200CNC / RA-H5200CNC
SERIES 211 — CNC Roundness, Cylindricity and Surface Roughness Measuring System

Mitutoyo offers innovative roundness/cylindricity measuring systems capable of automated measurement with independent/simultaneous multi-axis CNC control. In addition to high measuring accuracy and reliability, these CNC models provide excellent inspection productivity. Roundness and surface roughness measurements are both available from a single measuring system so workpiece resetting for roughness measurement is not required. Roughness measurement is possible in the axial and circumferential directions.

Technical Data: RA-2200CNC
Turntable
- Rotational accuracy (radial): (8.4 ± 35µm) / (0.02 ± 3.5µm / 10000µm)
- Rotational accuracy (axial): (8.4 ± 35µxµm) / (0.02 ± 3.5µm / 10000µm)

- Probing height (mm), X: Distance from the turntable axis (mm)
- Rotating speed: 2, 4, 6, 10rpm
- Table top diameter: ø300mm
- Centering range: ±5mm
- Leveling range: ±1°
- Maximum probing diameter: ø14” (356mm)
- Maximum workpiece diameter: ø26.8” (680mm)
- Maximum workpiece weight: 176 lbs (80kg) [143 lbs (65kg): auto-centering]
- Vertical column (Z-axis)
  - Vertical travel: 13.7” (350mm) 21.7” (550mm): H5200H model
  - Straightness (λ2.5): 0.1µm / 100mm, 0.14µm / 350mm (0.2µm / 550mm: H5200H model)
  - Parallelism with rotating axis: 0.2µm / 350mm (0.32µm / 550mm: H5200H model)
  - Positioning speed: Max. 60mm/s
  - Measuring speed: 0.5, 1, 2, 5mm/s
  - Maximum probing height: 13.7” (350mm) (OD / ID)
  - Maximum probing depth: over ø32: 104mm (w/standard stylus)
  - over ø12.7: 26mm (w/standard stylus)

- Horizontal arm (X-axis)
  - Horizontal travel: 8.8” (225mm)
  - Straightness (λ2.5): 0.4µm / 200mm
  - Squareness with rotating axis: 0.5µm / 200mm
  - Positioning speed: Max. 50mm/s
  - Measuring speed: 0.5, 1, 2, 5mm/s
  - Probe and stylus
    - Measuring range: ±400µm (±5mm: tracking range)
    - Measuring force: 40mN (in 5 steps)
    - Standard stylus: 12AAA301, carbide ball, ø1.6mm
    - Measuring direction: one direction
    - Stylus angle adjustment: ±45° (with graduations)
  - Air supply
    - Air pressure: 390kPa (4kgf/cm²)
    - Air consumption: 45L/min.
  - Power supply: 100V AC – 240V AC, 50/60Hz
  - Dimensions (W x D x H): 49.6 x 28.0 x 66.9”
    - 49.6 x 28.0 x 74.8”: H5200H model
  - Mass: Main unit: 1433 lbs (650kg)
    - 1477 lbs (670kg): H5200H model
    - Vibration isolator: 375 lbs (170kg)

* Shown with optional vibration isolator and side table for PC.

Technical Data: RA-H5200CNC
Turntable
- Rotational accuracy (radial): (8.4 ± 35µm) / (0.02 ± 3.5µm / 10000µm)
- Rotational accuracy (axial): (8.4 ± 35µm) / (0.02 ± 3.5µm / 10000µm)

- Probing height (mm), X: Distance from the turntable axis (mm)
- Rotating speed: 2, 4, 6, 10rpm
- Table top diameter: ø300mm
- Centering range: ±5mm
- Leveling range: ±1°
- Maximum probing diameter: ø14” (356mm)
- Maximum workpiece diameter: ø26.8” (680mm)
- Maximum workpiece weight: 176 lbs (80kg)
  - 143 lbs (65kg): auto-centering
- Vertical column (Z-axis)
  - Vertical travel: 13.7” (350mm) 21.7” (550mm): H5200H model
  - Straightness (λ2.5): 0.1µm / 100mm, 0.14µm / 350mm (0.2µm / 550mm: H5200H model)
  - Parallelism with rotating axis: 0.2µm / 350mm (0.32µm / 550mm: H5200H model)
  - Positioning speed: Max. 60mm/s
  - Measuring speed: 0.5, 1, 2, 5mm/s
  - Maximum probing height: 13.7” (350mm) (OD / ID)
  - Maximum probing depth: over ø32: 104mm (w/standard stylus)
  - over ø12.7: 26mm (w/standard stylus)

- Horizontal arm (X-axis)
  - Horizontal travel: 8.8” (225mm)
  - Straightness (λ2.5): 0.4µm / 200mm
  - Squareness with rotating axis: 0.5µm / 200mm
  - Positioning speed: Max. 50mm/s
  - Measuring speed: 0.5, 1, 2, 5mm/s
  - Probe and stylus
    - Measuring range: ±400µm (±5mm: tracking range)
    - Measuring force: 40mN (in 5 steps)
    - Standard stylus: 12AAA301, carbide ball, ø1.6mm
    - Measuring direction: one direction
    - Stylus angle adjustment: ±45° (with graduations)
  - Air supply
    - Air pressure: 390kPa (4kgf/cm²)
    - Air consumption: 45L/min.
  - Power supply: 100V AC – 240V AC, 50/60Hz
  - Dimensions (W x D x H): 49.6 x 28.0 x 66.9”
    - 49.6 x 28.0 x 74.8”: H5200H model
  - Mass: Main unit: 1433 lbs (650kg)
    - 1477 lbs (670kg): H5200H model
    - Vibration isolator: 375 lbs (170kg)

* Shown with optional side table for PC.
Roundtest Extreme
RA-2200CNC / RA-H5200CNC

SERIES 211 — CNC Roundness, Cylindricity and Surface Roughness Measuring System

ROUNDPAK
Off-line measurement procedure programming function
On-screen virtual 3D simulation measurements can be performed with the incorporated off-line teaching function that allows a part program (measurement procedure) to be created without an objective workpiece. The probe and the holder unit of the Roundtest Extreme can be precisely represented and an alarm can be raised to indicate that there is a collision risk predicted by the simulation.

3D simulation screens (work-view windows) can be generated after entering CAD data (in IGES, DXF form) and text data.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model No.</th>
<th>EXTREME RA-2200S CNC</th>
<th>EXTREME RA-2200H CNC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>211-517A</td>
<td>211-518A</td>
</tr>
<tr>
<td>Column travel</td>
<td>11.8” (300mm) (standard column)</td>
<td>19.7” (500mm) (high column)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model No.</th>
<th>EXTREME RA-H5200S CNC</th>
<th>EXTREME RA-H5200H CNC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>with vibration isolating stand</td>
<td>211-533A</td>
</tr>
<tr>
<td>Column travel</td>
<td>15.77” (350mm) (standard column)</td>
<td>21.65” (550mm) (high column)</td>
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</table>

DIMENSIONS

<table>
<thead>
<tr>
<th>RA-H5200S CNC / RA-H5200H CNC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit: mm</td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Optional Accessories

- 350850: Cylindrical square
- 211-045: Magnification calibration gage
- 211-014: Chuck (OD: 1 - 78mm, ID: 25 - 68mm)
- 211-032: Quick chuck (OD: 1 - 79mm, ID: 16 - 69mm)
- 211-031: Micro-chuck (OD: 0.1~1.5mm max.)
- 12AAB598: Protective shield (RA-H5200 only)
- Interchangeable styli (See page J-54.)
- 12AAK110: Vibration isolator (RA-2200 only)
- 12AAK120: Monitor arm (RA-2200 only)
- 12AAL019: Side table for PC
- 12AAG419: Surface roughness detector for RA-CNC

Dimensions

Overall: 32” w x 24”d x 33”h
CPU Holder: Adjusts from 6- ½” – 11- ¾”w
CPU Tower Height: 16” when keyboard tray is set at 25”h
18” when keyboard tray is set at 27”h
20” when keyboard tray is set at 29”h
Cord Bin: 4-1/2”d x 10”h x 30”w
Keyboard Tray: 30” w x 22-3/4”d, pulls out 9”

Cart is constructed of steel and rolls easily on casters. A keyboard drawer can be placed at the perfect height for nearly any user. A CPU tower can be placed on the lower shelf.
### Optional Styli for Roundtest

**Interchangeable Styli for RA-120, RA-120P, RA-1600/M, RA-2200, RA-H5200**

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Application/Type</th>
<th>Stylus tip</th>
<th>Dimensions (mm)</th>
<th>Stylus tip</th>
<th>Dimensions (mm)</th>
<th>Stylus tip</th>
<th>Dimensions (mm)</th>
<th>Stylus tip</th>
<th>Dimensions (mm)</th>
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</thead>
<tbody>
<tr>
<td>12AAL021*</td>
<td>Standard (Standard accessory)</td>
<td>ø0.5 mm tungsten carbide</td>
<td>66.7</td>
<td>ø0.5 mm tungsten carbide</td>
<td>66.7</td>
<td>ø0.5 mm tungsten carbide</td>
<td>66.7</td>
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<td></td>
</tr>
<tr>
<td>12AAL022</td>
<td>Notch</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12AAL023</td>
<td>Deep groove</td>
<td>ø4.5 mm sapphire</td>
<td>66</td>
<td>ø4.5 mm sapphire</td>
<td>66</td>
<td>ø4.5 mm sapphire</td>
<td>66</td>
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<tr>
<td>12AAL024</td>
<td>Corner</td>
<td>ø1.5 mm tungsten carbide</td>
<td>66</td>
<td>ø1.5 mm tungsten carbide</td>
<td>66</td>
<td>ø1.5 mm tungsten carbide</td>
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<tr>
<td>12AAL025</td>
<td>Cutter mark</td>
<td>ø6.7 mm tungsten carbide</td>
<td>66</td>
<td>ø6.7 mm tungsten carbide</td>
<td>66</td>
<td>ø6.7 mm tungsten carbide</td>
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<tr>
<td>12AAL026</td>
<td>Small hole (ø0.8)</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
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<td></td>
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<tr>
<td>12AAL027</td>
<td>Small hole (ø1.5)</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
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<tr>
<td>12AAL027</td>
<td>Small hole (ø1.6)</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
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<tr>
<td>12AAL028</td>
<td>Small hole (ø1.6)</td>
<td>ø1.6 mm tungsten carbide</td>
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<td>ø1.6 mm tungsten carbide</td>
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<td>ø1.6 mm tungsten carbide</td>
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<tr>
<td>12AAL029</td>
<td>Extra small hole (Depth 3mm)</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
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<tr>
<td>12AAL030</td>
<td>ø1.6 mm ball</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
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<td>ø1.6 mm tungsten carbide</td>
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<tr>
<td>12AAL031</td>
<td>2X-long type deep groove**</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
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<tr>
<td>12AAL032</td>
<td>2X-long type corner**</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
<td>66</td>
<td>ø1.6 mm tungsten carbide</td>
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<td>12AAL033</td>
<td>2X-long type cutter mark**</td>
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* 12AAL021 is a standard accessory for all Roundtest models.
** Not available for RA-10, RA-120P, and RA-220

New design for holding styli is not shown in above illustrations.

Customized special interchangeable styli are available on request. Please contact any Mitutoyo office for more information.

New styli for RA-2200 / HS200 are compatible with old RA-2100 / HS100 detectors.
Old styli for RA-2100 / HS100 are NOT compatible with new RA-2200 / HS200 detectors.
### Optional Styli for Roundtest

#### Interchangeable Styli for RA-2200 CNC, RA-H5200 CNC

<table>
<thead>
<tr>
<th>Application/Type</th>
<th>Groove</th>
<th>Flat surface</th>
<th>General purpose</th>
<th>Notch</th>
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<td>12AAE302</td>
<td>12AAE301</td>
<td>12AAE309</td>
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<td>ø1.6 mm tungsten carbide</td>
<td>ø1.6 mm tungsten carbide</td>
<td>ø3 mm tungsten carbide</td>
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<tr>
<td>Dimensions (mm)</td>
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<td><img src="image2.png" alt="Diagram" /></td>
<td><img src="image3.png" alt="Diagram" /></td>
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<table>
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<tr>
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<th>ø1.6 mm ball</th>
<th>ø0.8 mm ball</th>
<th>ø0.5 mm ball</th>
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<td>12AAE304</td>
<td>12AAE305</td>
<td>12AAE308</td>
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<td>Dimensions (mm)</td>
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<td><img src="image6.png" alt="Diagram" /></td>
<td><img src="image7.png" alt="Diagram" /></td>
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<table>
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<tr>
<th>Application/Type</th>
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<th>Deep hole B</th>
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<tr>
<td>Dimensions (mm)</td>
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<td><img src="image10.png" alt="Diagram" /></td>
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#### Usage examples of styli

- **Cutter mark**
- **Corner**
- **Small hole**
- **Flatness measurement**
- **Notched workpiece measurement**
- **ID measurement**

---

**Analyzing items**

<table>
<thead>
<tr>
<th>Models</th>
<th>RA-H5200CNC/RA-H5200</th>
<th>RA-2200CNC/RA-2200</th>
<th>RA-1600</th>
<th>RA-1600M</th>
<th>RA-120P</th>
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</table>
Optional Accessories for Roundtest

Centering chuck (ring operated) 211-032
Suitable for holding small parts with easy-to-operate knurled-ring clamping.
• Holding capacity:
  - Internal jaws: OD = 1-36 mm, ID = 14-70 mm.
  - External jaws: OD = 30-80 mm.
• External dimensions: ø157 x 34 mm
• Mass: 1.2kg

Micro-chuck 211-031
Used for clamping a workpiece (less than ø1 mm dia.) that the centering chuck cannot handle.
• Holding capacity: up to ø1.5 mm
• External dimensions: ø118x48.5 mm
• Mass: 0.8kg

Centering chuck (key operated) 211-014
Suitable for holding longer parts and those requiring a relatively powerful clamp.
• Holding capacity:
  - Internal jaws: OD = 1 - 35 mm, ID = 33 - 85 mm
  - External jaws: OD = 1-75 mm.
• External dimensions: ø157 x 76mm
• Mass: 3.8kg

Vibration Isolated frame with work surface

Magnification calibration gage 211-045
Used for normalizing detector magnification by calibrating detector travel against displacement of a micrometer spindle.
• Maximum calibration range: 400µm
• Graduation: 0.2µm
• Mass: 4kg

Auxiliary workpiece stand 356038
• Used for measuring a workpiece whose diameter is 20mm or shorter and whose height is 20mm or lower.

Code No. Dimensions Load Capacity
64AAB357 30 x 48 x 30" 1300 lbs

Cylindrical square 350850
• Used for checking and aligning table rotation axis parallel to the Z-axis column.
• Squareness: 3µm
• Straightness: 1µm
• Cylindricity: 2µm
• Roundness: 0.5µm
• Mass: 7.5kg

Magnification checking kit* 997090
• A combination of gage blocks and an optical flat.
  * Standard accessory for RA-2200, RA-2200CNC, RA-H5200 and RA-H5200CNC

Origin-point gage* 998382
• A gage for zero setting of the R-axis and Z-axis.
  * Standard accessory for RA-2200 and RA-H5200

Reference Hemisphere 211-016
### Eco-Fix Kit Form-S

**Mitutoyo ECO-FIX Kit Fixture Systems**

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</tr>
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<td>K551025</td>
<td>1</td>
<td>Location pin ø 12 X 25mm</td>
<td>K550261</td>
<td>2</td>
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</tr>
<tr>
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<td>1</td>
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<td>K550250</td>
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<tr>
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<td>Location pin ø 12 X 100mm</td>
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<td>1</td>
<td>Back square mini</td>
</tr>
<tr>
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<td>Location pin ø 20 X 13mm</td>
<td>K550888</td>
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<td>Straight pin Ø 6mm x 20mm</td>
</tr>
<tr>
<td>K551029</td>
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<td>K550889</td>
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<td>Straight pin Ø 6mm x 30mm</td>
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<td>K550890</td>
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<td>K551050</td>
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**Kit Part No.** K551133

### Eco-Fix Kit Form-L

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**Kit Part No.** K551134
The effectiveness of this function can be seen in the graph below. Some roundness testers support accurate measurement with a limaçon error correction function. Therefore the workpiece should be centered (axes made coincident) before measurement. The larger the eccentricity, the larger is the error in calculated roundness. A displacement offset (eccentricity) between the Roundtest’s rotary table axis and that of the workpiece results in distortion of the measured form (limaçon error) and consequently produces an error in the calculated roundness value. The effectiveness of this function can be seen in the graph below.
Effect of Filter Settings on the Measured Profile

Roundness values as measured are greatly affected by variation of filter cutoff value. It is necessary to set the filter appropriately for the evaluation required.

Evaluating the Measured Profile Roundness

Roundness testers use the measurement data to generate reference circles whose dimensions define the roundness value. There are four methods of generating these circles, as shown below, and each method has individual characteristics so the method that best matches the function of the workpiece should be chosen.

- **Least Square Circle (LSC) Method**
  - A circle is fitted to the measured profile such that the sum of the squares of the departure of the profile data from this circle is a minimum. The roundness figure is then defined as the difference between the maximum departures of the profile from this circle (highest peak to the lowest valley).

- **Minimum Zone Circles (MZC) Method**
  - Two concentric circles are positioned to enclose the measured profile such that their radial difference is a minimum. The roundness figure is then defined as the radial separation of these two circles.

- **Minimum Circumscribed Circle (MCC) Method**
  - The smallest circle that can enclose the measured profile is created. The roundness figure is then defined as the maximum departure of the profile from this circle. This circle is sometimes referred to as the ‘ring gage’ circle.

- **Maximum Inscribed Circle (MIC) Method**
  - The largest circle that can be enclosed by the profile data is created. The roundness figure is then defined as the maximum departure of the profile from this circle. This circle is sometimes referred to as the ‘plug gage’ circle.

Undulations Per Revolution (UPR) data in the roundness graphs

A 1 UPR condition indicates eccentricity of the workpiece relative to the rotational axis of the measuring instrument. The amplitude of undulation components depends on the leveling adjustment.

A 2 UPR condition may indicate: (1) insufficient leveling adjustment on the measuring instrument; (2) circular runout due to incorrect mounting of the workpiece on the machine tool that created its shape; (3) the form of the workpiece is elliptical by design as in, for example, an IC-engine piston.

A 3 to 5 UPR condition may indicate: (1) Deformation due to over-tightening of the holding chuck on the measuring instrument; (2) Relaxation deformation due to stress release after unloading from the holding chuck on the machine tool that created its shape.

- A 5 to 15 UPR condition often indicates unbalance factors in the machining method or processes used to produce the workpiece.

- A 15 (or more) UPR condition is usually caused by tool chatter, machine vibration, coolant delivery effects, material non-homogeneity, etc., and is generally more important to the function than to the fit of a workpiece.