Roundtest RA-120 / 120P

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 turntable 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).

Large color LCD display for RA-120 models

Z-axis scale unit

Optional X-axis stop

SPECIFICATIONS

Model No. RA-120 RA-120D RA-120P RA-120PD
Order No. 211-544A 211-543A 211-547A 211-546A

* Does not include Z-axis scale unit.

RA-120P
Order No.: 211-547A (with mechanical mic-heads)
Order No.: 211-546A (with DAT function, inch/mm)
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 task into one that is simple enough for even new operators 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

External dimensions

Unit: mm

Turntable top view

Installation floor plan

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
- 12AAH433: 2-axis scale unit for RA-120

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

A 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±6)(H10000)μm (RA-1600)
- Rotational accuracy (axial): (0.02±6)(X10000)μm (RA-1600)
- Rotational accuracy (radial): (0.03±6H10000)μm (RA-1600M)
- Rotational accuracy (axial): (0.03±6X10000)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): 0.40μm / 100mm (RA-1600M)
- Straightness (in entire range): 0.80μm / 100mm (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): 11.8"(300mm) *1
- Maximum probing depth (radial): 1.97"(over ø0.27") (RA-1600M)

**Horizontal arm (X-axis)**
- Horizontal travel: 6.5"(165mm) (from table axis -1±5.5"
- Positioning speed: Max. 15mm/s
- Measuring speed: 0.5, 1, 2, 5mm/s
- X-axis straightness: 2.7μm/140mm (RA-1600)
- Maximum parallelism to turntable axis: 0.6μm/140mm (RA-1600)
- Probe and stylus
  - Measuring range: 400μm / 40μm / ±4μm
  - Measuring force: 10–50mN (5 level switching)
  - Standard stylus: 12AL021, carbide ball, ø1.6mm
  - Measuring direction: Bi-directional
  - Stylus angle adjustment: ±45° (with graduations)
- Air supply
  - Air pressure: 0.39MPa (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 auxiliary auxiliary for measuring a workpiece whose height is 25mm or less.

**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.

**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.

**Measurement Through X-axis Tracking**
Measurement while tracing is possible through a built-in linear scale in the X-axis. This type of measurement is useful when displacement due to form variation exceeds the measuring range of the detector, and X-axis motion is necessary to maintain contact with the workpiece surface.

**Continuous Internal/External Diameter Measurement**
Continuous internal/external diameter measurement is possible without changing the detector position.
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 a new 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>
</tr>
</thead>
<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

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>350850</td>
<td>Cylindrical square</td>
</tr>
<tr>
<td>356038</td>
<td>Auxiliary stage for a low-height workpiece</td>
</tr>
<tr>
<td>12AAF203</td>
<td>2x extension detector holder</td>
</tr>
<tr>
<td>12AAF204</td>
<td>Auxiliary detector holder for a large-diameter workpiece</td>
</tr>
<tr>
<td>12AAL090</td>
<td>Sliding detector holder</td>
</tr>
<tr>
<td>211-045</td>
<td>Magnification checking gage</td>
</tr>
<tr>
<td>211-014</td>
<td>Chuck (OD: ø2 - 78mm, ID: ø25 - 68mm)</td>
</tr>
<tr>
<td>211-032</td>
<td>Quick chuck (OD: ø1 - 78mm, ID: 16 - 69mm)</td>
</tr>
<tr>
<td>211-031</td>
<td>Micro-chuck (OD: ø0.1 - 1.5mm max.)</td>
</tr>
<tr>
<td>178-025</td>
<td>Vibration isolator (Desktop type)</td>
</tr>
<tr>
<td>211-045</td>
<td>Side table for PC</td>
</tr>
</tbody>
</table>

Sliding detector-unit holder (Option) 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.

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 page 41 for details about the continuous ID and OD measuring function.
Roundtest RA-2200AS / DS / AH / DH
SERIES 211 — Roundness / Cylindricity Measuring System

The RA-2200 provides high accuracy, high speed and high performance in roundness measurement. The fully-automatic, or DAT (Digital Adjustment Table), function-aided manual workpiece centering and leveling turns what used to be a difficult task into one that is simple enough for even new 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 icons, achieving enhanced functionality and ease of operation.

Highly accurate and 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.
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.

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

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 page 41 for details about the continuous ID and OD measuring function.

Optional Accessories
350850: Cylindrical square
356038: Auxiliary stage for a low-height workpiece
12AAL024: Extension probe holder (2X higher)
12AAL026: Auxiliary probe holder for a large diameter workpiece
211-014: Chuck (OD: 1 - 85mm, ID: 33 - 85mm)
211-032: Quick chuck (OD: 1 - 75mm, ID: 14 - 70mm)
178-025: Vibration isolator
178-024: Stand for vibration isolator Interchangeable styl
12AAK110: Vibration isolator Interchangeable styl
12AAK120: Monitor arm
12AAP019: Side table for PC
12AAL053: Surface roughness detector holder
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.

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.

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

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.

Technical Data

Turntable
Rotational accuracy (radial): (0.02+3.5H/10000)µm
Rotational accuracy (axial): (0.02+3.5V/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: ø11.8” (300mm)
Centering range: ±5mm
Leveling range: ±1°
Maximum probing diameter: ø15.7” (400mm)
Maximum workpiece diameter: ø26.8” (680mm)
Maximum workpiece weight: 176 lbs (80kg)

Dimensions (W x D x H):
143 lbs (65kg): auto-centering
1477 lbs. (670kg): AH model

Vertical column (Z-axis)
Vertical travel: 13.8” (350mm), (21.7” (550mm): AH model)
Straightness (Xx2.5): 0.05µm / 100mm, 0.14µm / 350mm
Parallelism with rotating axis: ø2µm / 350mm
Positioning speed: Max. 60mm/s
Measuring speed: 0.5, 1, 2, 5mm/s
Maximum probing height: 13.8” (350mm) (OD / ID)
(21.7” (550mm): AH model)
Maximum probing depth: over ø32, 85mm (w/standard stylus)
over ø7: 50mm (w/standard stylus)

Horizontal arm (X-axis)
Horizontal travel: 8.9” (225mm)
Straightness (Xx2.5): 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: 10mN-50mN (in 5 steps)
Standard stylus: 12AA021, carbide ball, ø1.6mm
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:
15upr, 50upr, 150upr, 500upr, 1500upr,
15-150upr, 15-500upr, 15-1500upr, 50-500upr, 50-1500upr, 150-1500upr, Manual setting
Reference circles for roundness evaluation:
LSC, M2C, M1C, MCC

Air supply
Air pressure: 45psi
Power supply: 100V AC – 240V AC, 50/60Hz
Dimensions (W x D x H):
49.6 x 28.0 x 74.8”
49.6 x 28.0 x 170mm
49.6 x 28.0 x 74.8”
49.6 x 28.0 x 170mm
49.6 x 28.0 x 190mm: AH model
Mass: Main unit: 143lbs (650kg)
2CR
147lbs (670kg): AH model
Vibration isolator: 375 lbs (170kg)
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.

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>
<tr>
<td>Column travel</td>
<td>13.77&quot; (350mm) (standard column)</td>
<td>21.65&quot; (550mm) (high column)</td>
</tr>
</tbody>
</table>

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.

Optional Accessories

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>350850</td>
<td>Cylindrical square</td>
</tr>
<tr>
<td>12AAF203</td>
<td>Extension probe holder (2X higher)</td>
</tr>
<tr>
<td>12AAF205</td>
<td>Extension probe holder (3X higher)</td>
</tr>
<tr>
<td>12AAF204</td>
<td>Auxiliary probe holder for a large diameter workpiece</td>
</tr>
<tr>
<td>211-045</td>
<td>Magnification calibration gage</td>
</tr>
<tr>
<td>211-014</td>
<td>Chuck (OD: 2 - 78mm, ID: 25 - 68mm)</td>
</tr>
<tr>
<td>211-032</td>
<td>Quick chuck (OD: 1 - 79mm, ID: 16 - 69mm)</td>
</tr>
<tr>
<td>211-031</td>
<td>Micro-chuck (OD: 0.1~1.5mm max.)</td>
</tr>
<tr>
<td>12AAB598</td>
<td>Protective shield</td>
</tr>
<tr>
<td>12AAL019</td>
<td>Interchangeable styli (See page J-49.)</td>
</tr>
</tbody>
</table>

* See page 41 for details about the continuous ID and OD measuring function.
Roundtest Extreme RA-2200CNC / RA-H5200CNC

Mitutoyo offers innovative roundness/cylinder and surface roughness 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): 0.02+3.5H/10000µm
- Rotational accuracy (axial): 0.02+3.5X/10000µm
- H: Probing height (mm), X: Distance from the turntable axis (mm)
- Rotating speed: 2, 4, 6, 10rpm
- Tabletop diameter: ø25mm
- Centering range: ±3mm
- Leveling range: ±1°
- Maximum probing diameter: ø10.1" (256mm)
- Maximum workpiece diameter: ø22.8" (580mm)
- Maximum workpiece weight: 86 lbs (30kg)

**Vertical column (Z-axis)**
- Vertical travel: 11.8" (300mm) 19.7" (500mm: 2200H model)
- Straightness (c2.5): 0.10µm / 100mm, 0.15µm / 300mm
- Parallelism with rotating axis: 0.7µm / 300mm
- Positioning speed: Max. 30mm/s
- Measuring speed: ±1, 2, 5mm/s
- Maximum probing height: 11.8" (300mm) (OD / ID)
- Maximum probing depth: over ø32: 104mm (w/standard stylus)

**Horizontal arm (X-axis)**
- Horizontal travel: 6.9" (175mm) (including a protrusion of 1" (25mm) the turntable rotation center)
- Straightness (c2.5): 0.7µm / 150mm
- Squareness with rotating axis: ±1µm / 150mm
- Positioning speed: Max. 30mm/s
- Measuring speed: ±1, 2, 5mm/s
- Probe and stylus
  - Measuring range: ±400µm±40µm±4µm (±5mm: tracking range)
  - Measuring force: 40N (not adjustable)
  - Standard stylus: E301, carbide ball, φ1.6mm
  - Measuring direction: one direction
  - Stylus angle adjustment: ±45° (with graduations)

**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): 2200H model
- Mass: 397 lbs (180kg)

**Technical Data: RA-H5200CNC**

**Turntable**
- Rotational accuracy (radial): 1.8+35H/10000µm
- Rotational accuracy (axial): 1.8+35X/10000µm
- H: Probing height (mm), X: Distance from the turntable axis (mm)
- Rotating speed: 2, 4, 6, 10rpm (20rpm: auto-centering)
- Tabletop 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 (63kg): auto-centering

**Vertical column (Z-axis)**
- Vertical travel: 13.7" (350mm) 21.7" (550mm): H5200H model
- Straightness (c2.5): 0.15µm / 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: 13.7" (350mm) (OD / ID)
- Maximum probing depth: over ø32: 104mm (w/standard stylus)

**Horizontal arm (X-axis)**
- Horizontal travel: 8.8" (225mm)
- Straightness (a2c2.5): 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±40µm±4µm (±5mm: tracking range)
  - Measuring force: 40N (not adjustable)
  - Standard stylus: E301, carbide ball, φ1.6mm
  - Measuring direction: one direction
  - Stylus angle adjustment: ±45° (with graduations)

**Air supply**
- Air pressure: 390kPa (4kgf/cm²)
- Air consumption: 450L/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 1100mm): 2200H model
- Mass: 397 lbs (180kg)

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

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-49.)
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: 36 x 30 x 24-32" (W x D x H)
Cord Bin: 4"h x 5-3/8"d (width is 10" less than table width)
Distance From Front Edge to Cord Bin: 30"d table – 15-1/2"d
Distance Between Legs: 10" less than the overall table width
Work surface feature a 1", 45 lb density, furniture board substrate with attractive Gray laminate tabletop brimmed with bullnose edge band in Quartz gray color. Work surface is height adjustable in one inch increments from 24" to 32".
Tabletop incorporates metal threaded inserts on the underside to affix the leg assemblies for added strength and durability. Table comes with 4" casters with two as locking type for stationary placement.

*Laptop PC not included with table.
## Optional Styli for Roundtest

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

<table>
<thead>
<tr>
<th>Application/Type</th>
<th>Standard (Standard accessory)</th>
<th>Notch</th>
<th>Deep groove</th>
<th>Corner</th>
<th>Cutter mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>12AAL021*</td>
<td>12AAL022</td>
<td>12AAL023</td>
<td>12AAL024</td>
<td>12AAL025</td>
</tr>
<tr>
<td>Stylus tip</td>
<td>ø1.6 mm tungsten carbide</td>
<td>ø3 mm tungsten carbide</td>
<td>SR0.25mm sapphire</td>
<td>SR0.25mm sapphire</td>
<td>tungsten carbide</td>
</tr>
<tr>
<td>Dimensions (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ø1.6 tungsten carbide</td>
<td>ø3 tungsten carbide</td>
<td>5.5mm</td>
<td>5.5mm</td>
<td>tungsten carbide</td>
</tr>
<tr>
<td></td>
<td>Included in 5-pcs. styli set No. 12AAL020</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Application/Type</th>
<th>Small hole (ø0.8)</th>
<th>Small hole (ø1.0)</th>
<th>Small hole (ø1.5)</th>
<th>Extra small hole (Depth 3mm)</th>
<th>ø1.6 mm ball</th>
</tr>
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<tbody>
<tr>
<td>Order No.</td>
<td>12AAL026</td>
<td>12AAL027</td>
<td>12AAL028</td>
<td>12AAL029</td>
<td>12AAL030</td>
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<tr>
<td>Stylus tip</td>
<td>ø0.8 mm tungsten carbide</td>
<td>ø1 mm tungsten carbide</td>
<td>ø1.5 mm tungsten carbide</td>
<td>ø0.5 mm tungsten carbide</td>
<td>ø1.6 mm ball</td>
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<td>Dimensions (mm)</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>ø0.8 tungsten carbide</td>
<td>ø1 tungsten carbide</td>
<td>ø1.5 tungsten carbide</td>
<td>ø0.5 tungsten carbide</td>
<td>ø1.6 tungsten carbide</td>
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<table>
<thead>
<tr>
<th>Application/Type</th>
<th>Disk</th>
<th>Crank (ø0.5)</th>
<th>Crank (ø1.0)</th>
<th>Flat surface</th>
<th>2X-long type**</th>
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<tbody>
<tr>
<td>Order No.</td>
<td>12AAL031</td>
<td>12AAL032</td>
<td>12AAL033</td>
<td>12AAL034</td>
<td>12AAL035</td>
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<td>Stylus tip</td>
<td>ø12 mm tungsten carbide</td>
<td>ø5 mm tungsten carbide (Depth 2.5 mm)</td>
<td>ø1 mm tungsten carbide (Depth 5.5 mm)</td>
<td>tungsten carbide</td>
<td>ø1.6 mm tungsten carbide</td>
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<td>Dimensions (mm)</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>ø12 mm tungsten carbide</td>
<td>ø5 mm tungsten carbide</td>
<td>ø1 mm tungsten carbide</td>
<td>tungsten carbide</td>
<td>ø1.6 mm tungsten carbide</td>
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<table>
<thead>
<tr>
<th>Application/Type</th>
<th>2X-long type notch**</th>
<th>2X-long type deep groove**</th>
<th>2X-long type corner**</th>
<th>2X-long type cutter mark**</th>
<th>2X-long type Small hole**</th>
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<tbody>
<tr>
<td>Order No.</td>
<td>12AAL036</td>
<td>12AAL037</td>
<td>12AAL038</td>
<td>12AAL039</td>
<td>12AAL040</td>
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<td>Stylus tip</td>
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<td>SR0.25mm sapphire</td>
<td>SR0.25mm sapphire</td>
<td>tungsten carbide</td>
<td>ø1 mm tungsten carbide</td>
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<td>Dimensions (mm)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ø3 mm tungsten carbide</td>
<td>SR0.25mm sapphire</td>
<td>SR0.25mm sapphire</td>
<td>tungsten carbide</td>
<td>ø1 mm tungsten carbide</td>
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<td>Included in 5-pcs. styli set No. 12AAL020</td>
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<table>
<thead>
<tr>
<th>Application/Type</th>
<th>3X-long type***</th>
<th>3X-long type deep groove***</th>
<th>Stylus shank</th>
<th>Stylus shank (standard groove)</th>
<th>Stylus shank (2X-long groove)**</th>
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<tbody>
<tr>
<td>Order No.</td>
<td>12AAL041</td>
<td>12AAL042</td>
<td>12AAL043</td>
<td>12AAL044</td>
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<td>SR0.25mm sapphire</td>
<td>For mounting CMM styli (mounting thread M2)</td>
<td>For mounting CMM styli (mounting thread M2)</td>
<td>For mounting CMM styli (mounting thread M2)</td>
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<tr>
<td>Dimensions (mm)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ø1.6 mm tungsten carbide</td>
<td>SR0.25mm sapphire</td>
<td>For mounting CMM styli (mounting thread M2)</td>
<td>For mounting CMM styli (mounting thread M2)</td>
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### 5 pc. Stylus set: 12AAL020

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Part Description</th>
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<tbody>
<tr>
<td>12AAL022</td>
<td>Stylus for notched workpiece</td>
</tr>
<tr>
<td>12AAL023</td>
<td>Stylus for deep groove</td>
</tr>
<tr>
<td>12AAL027</td>
<td>Stylus for small hole (1.0mm)</td>
</tr>
<tr>
<td>12AAL030</td>
<td>1.6mm ball stylus</td>
</tr>
<tr>
<td>12AAL035</td>
<td>2X-long type stylus</td>
</tr>
</tbody>
</table>

### M2 CMM stylus with ruby ball tip

- **K651276**: D = ø0.5, d = ø0.34, L = 3.0, Mass = 0.3g
- **K651236**: D = ø0.7, d = ø0.5, L = 4.0, Mass = 0.3g
- **K651012**: D = ø1.0, d = ø0.7, L = 4.5, Mass = 0.3g

- **K651013**: 
  - D = ø1.5, d = ø0.7, l = 4.5, Mass = 0.3g
  - Unit: mm

- **K651014**: 
  - D = ø2.0, d = ø1.0, l = 6.0, Mass = 0.3g

- **K651016**: 
  - D = ø3.0, d = ø1.5, l = 7.5, Mass = 0.4g

- **K651017**: 
  - D = ø4.0, d = ø1.5, l = 10.0, Mass = 0.4g

- **K651018**: 
  - D = ø6.0, d = ø2.5, R = 10.0, Mass = 0.7g

- **K651024**: 
  - D = ø8.0, d = ø2.5, R = 10.0, Mass = 0.9g

- **K651025**: 
  - D = ø8.0, d = ø2.5, R = 11.0, Mass = 1.5g

### Notes:
- * 12AAL021 is a standard accessory for all Roundtest models.
- ** Not available for RA-10, RA-120P and RA-220
- Measuring is only in the vertical direction. Measuring magnification of 20000X is available using the 2X-long styli.
- Customized special interchangeable styli are available on request. Please contact any Mitutoyo office for more information.
- * New design for holding styli is not shown in above illustrations.
- 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.

---

*Image and text information from a Mitutoyo document.*
### Optional Styli for Roundtest

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

<table>
<thead>
<tr>
<th>Application/Type</th>
<th>Order No.</th>
<th>Groove</th>
<th>Flat surface</th>
<th>General purpose</th>
<th>Notch</th>
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<tr>
<td><strong>Styli tip</strong></td>
<td></td>
<td>ø1.6 mm tungsten carbide</td>
<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><strong>Dimensions (mm)</strong></td>
<td></td>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
<td><img src="image3" alt="Diagram" /></td>
<td><img src="image4" alt="Diagram" /></td>
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</table>

<table>
<thead>
<tr>
<th>Application/Type</th>
<th>Order No.</th>
<th>ø1.6 mm ball</th>
<th>ø0.8 mm ball</th>
<th>ø0.5 mm ball</th>
<th>Deep groove</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Styli tip</strong></td>
<td></td>
<td>ø1.6 mm tungsten carbide</td>
<td>ø0.8 mm tungsten carbide</td>
<td>ø0.5 mm tungsten carbide</td>
<td>ø1.6 mm tungsten carbide</td>
</tr>
<tr>
<td><strong>Dimensions (mm)</strong></td>
<td></td>
<td><img src="image5" alt="Diagram" /></td>
<td><img src="image6" alt="Diagram" /></td>
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<table>
<thead>
<tr>
<th>Application/Type</th>
<th>Order No.</th>
<th>Deep hole A</th>
<th>Deep hole B</th>
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<tbody>
<tr>
<td><strong>Styli tip</strong></td>
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<td>ø1.6 mm tungsten carbide</td>
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<tr>
<td><strong>Dimensions (mm)</strong></td>
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<td><img src="image9" alt="Diagram" /></td>
<td><img src="image10" alt="Diagram" /></td>
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</table>

### Usage examples of styli

- **Roundness**
- **Cylindricity**
- **Concentricity**
- **Coaxiality**
- **Flatness**
- **Parallelism**
- **Perpendicularity**
- **Runout**
- **Total runout**
- **Straightness**
- **Inclination**
- **Taper**

#### Analysis options

<table>
<thead>
<tr>
<th>Analysis options</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>
<th>RA-120</th>
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<tr>
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<td>✓</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
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<td>✓</td>
<td>✶</td>
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<tr>
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<td>✓</td>
<td>✓</td>
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<td>Straightness</td>
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<td>—</td>
</tr>
<tr>
<td>Inclination</td>
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<td>✓</td>
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<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>•</td>
<td>—</td>
</tr>
</tbody>
</table>

- ✶ Full measurement capability
- • Limited measurement capability; R-Axis must be stationary.
Optional Accessories for Roundtest

### Centering chuck (key operated)
**211-014**
Suitable for holding longer parts and those requiring a relatively powerful clamp.
- **Holding capacity:**
  - Internal jaws: OD = 1-35mm, ID = 14-70 mm.
  - External jaws: OD = 1-75 mm.
- **External dimensions:** ø118x41 mm
- **Mass:** 1.2kg

### 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 = 30-80mm.
- **External dimensions:** ø157 x 76mm
- **Mass:** 3.8kg

### Micro-chuck
**211-031**
Used for clamping a workpiece (less than ø1 mm dia.) that the centering chuck cannot handle.
- **Holding capacity:**
  - Internal jaws: OD = 1-36 mm, ID = 14-70 mm.
  - External jaws: OD = 1-75 mm.
- **External dimensions:** ø118x48.5 mm
- **Mass:** 0.8kg

### 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

### Vibration isolated frame with work surface

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

### 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-HS200CNC

### Origin-point gage*
**998382**
- A gage for zero setting of the R-axis and Z-axis.
* Standard accessory for RA-2200 and RA-HS200

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211-016
Reference Hemisphere

### Code No. | Dimensions | Load Capacity
--- | --- | ---
64AAB357 | 30 x 48 x 30” | 1300 lbs

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J-51
# Eco-Fix Kit Form-S

**Mitutoyo ECO-FIX Kit Fixture Systems**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Qty.</th>
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<td>1</td>
<td>Adaptor plate ø 150mm</td>
<td>K551069</td>
<td>1</td>
<td>Flat top ø 12mm</td>
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<tr>
<td>K551024</td>
<td>1</td>
<td>Location pin ø 12 X 13mm</td>
<td>K550026</td>
<td>1</td>
<td>V-block mini</td>
</tr>
<tr>
<td>K551025</td>
<td>1</td>
<td>Location pin ø 12 X 25mm</td>
<td>K550026</td>
<td>1</td>
<td>Cone receiver mini</td>
</tr>
<tr>
<td>K551026</td>
<td>1</td>
<td>Location pin ø 12 X 50mm</td>
<td>K550250</td>
<td>1</td>
<td>Stopper element mini</td>
</tr>
<tr>
<td>K551027</td>
<td>1</td>
<td>Location pin ø 12 X 100mm</td>
<td>K550247</td>
<td>1</td>
<td>Back square mini</td>
</tr>
<tr>
<td>K551028</td>
<td>1</td>
<td>Location pin ø 20 X 13mm</td>
<td>K550888</td>
<td>2</td>
<td>Straight pin Ø 6mm x 20mm</td>
</tr>
<tr>
<td>K551029</td>
<td>1</td>
<td>Location pin ø 20 X 25mm</td>
<td>K550889</td>
<td>2</td>
<td>Straight pin Ø 6mm x 30mm</td>
</tr>
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<td>Location pin ø 20 X 50mm</td>
<td>K550890</td>
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<td>Straight pin Ø 6mm x 40mm</td>
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<td>K551051</td>
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<tr>
<td>K551040</td>
<td>1</td>
<td>Adjustable location pin ø 20mm</td>
<td>K551053</td>
<td>1</td>
<td>Allen key 5mm</td>
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<td>K551041</td>
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<td>Adjustable location pin ø 12mm</td>
<td>K551054</td>
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<td>Double open ended spanner 10-17</td>
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<td>K551042</td>
<td>3</td>
<td>Location pin ø 12mm with bore ø 6mm</td>
<td>K550591</td>
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<td>Washer ø 6.4mm / ø 17mm</td>
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<tr>
<td>K551044</td>
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<td>K550110</td>
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<td>Cylinder head screw M6 x 20mm</td>
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<tr>
<td>K550279</td>
<td>1</td>
<td>Spring clip, d= 8mm, L= 60mm</td>
<td>K550563</td>
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<td>Cylinder head screw M6 x 25mm</td>
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# Eco-Fix Kit Form-L

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<td>Back square mini</td>
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<td>K551024</td>
<td>1</td>
<td>Location pin ø 12 X 13mm</td>
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<td>V-block</td>
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<td>Location pin ø 12 X 100mm</td>
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<td>1</td>
<td>Back square</td>
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<tr>
<td>K551028</td>
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<td>Location pin ø 20 X 13mm</td>
<td>K550888</td>
<td>2</td>
<td>Straight pin Ø 6mm x 20mm</td>
</tr>
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<td>K551029</td>
<td>2</td>
<td>Location pin ø 20 X 25mm</td>
<td>K550889</td>
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<td>Straight pin Ø 6mm x 30mm</td>
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<td>Location pin ø 20 X 50mm</td>
<td>K550890</td>
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<td>Straight pin Ø 6mm x 40mm</td>
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<td>Straight pin Ø 8mm x 95mm</td>
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<td>Slotted Nut for receiver bracket h=12mm</td>
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<td>Slotted Nut for receiver bracket h=15mm</td>
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<td>Allen key 2mm</td>
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<td>Allen key 3mm</td>
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<td>Allen key 4mm</td>
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<td>Receiver bracket L=120, ø 20mm</td>
<td>K551053</td>
<td>1</td>
<td>Allen key 5mm</td>
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<td>Spring clip, d= 8mm, L= 60mm</td>
<td>K550591</td>
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<td>Washer ø 6.4mm / ø 17mm</td>
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<td>K550110</td>
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<td>Cylinder head screw M6 x 20mm</td>
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<td>Cone receiver mini</td>
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**Quick Guide to Precision Measuring Instruments**

**Roundtest (Roundform Measuring Instruments)**

- JIS B 7451-1997: Roundness measuring instruments
- JIS B 0621-1984: Definition and notation of geometric deviations

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

**Notation example**

- Verification example using a roundness measuring instrument

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

**Notation example**

- Verification example using a roundness measuring instrument

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

**Notation example**

- Verification example using a roundness measuring instrument

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

**Notation example**

- Verification example using a roundness measuring instrument

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

**Notation example**

- Verification example using a roundness measuring instrument

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

**Notation example**

- Verification example using a roundness measuring instrument

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

**Notation example**

- Verification example using a roundness measuring instrument

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

**Notation example**

- Verification example using a roundness measuring instrument

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### Adjustment prior to Measurement

#### Centering
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 larger the eccentricity, the larger is the error in calculated roundness.

Therefore the workpiece should be centered (axes made coincident) before measurement. Some roundness testers support accurate measurement with a limaçon error correction function. The effectiveness of this function can be seen in the graph below.

**Effect of eccentricity compensation function**

- Data table

**Notation example**

- Verification example using a roundness measuring instrument

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

**Inclination versus elliptic error**

- Data table

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**J-53**
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 departure 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.