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.

**Roundtest RA-120 / 120P**

**SERIES 211 — Roundness Measuring Instruments**

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).

### Technical Data

**Turntable**
- Rotational accuracy: (0.044+H/10000)µm
- Rotating speed: 6rpm
- Table top diameter: ø1.96" (150mm)
- Centering range: ±0.12" (3mm)
- Leveling range: ±1°
- Maximum probing diameter: ø11" (280mm)
- Maximum workpiece diameter: ø17.3" (440mm)
- Maximum workpiece weight: 55 lbs (25kg)
- Vertical column (Z-axis)
  - Vertical travel: 11" (280mm)
  - Feeding: 1.18" (30mm)/rev. (coarse), 0.039" (1mm)/rev. (fine)
- Maximum probing height: 11" (280mm) from the turntable top
- Maximum probing depth: 9.14" (100mm) (min. ID: 1.18" (30mm))
- 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: 12AA021, 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, MZC, MIC, MCC
  - Recording device:
    - Built-in thermal line printer (optional external printer)*
    - Recording magnification: X5 to X2000, 500 (Auto X1 to X500, 000)*
    - Roughness component reduction:
      - Low pass filter, band pass filter
    - Filter type:
      - 2CR-75%, 2CR-50%, 2CPRC-75% (phase corrected), 2CPRC-50% (phase corrected), Gaussian, filter OFF
    - Cutoff value:
      - 15upr, 50upr, 150upr, 500upr, 15-150upr, 50-500upr, Manual setting*
    - Number of measuring sections:
      - Max. 5-section (100-section)*
  - *RA-120P

### 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>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>211-544A</td>
<td>211-543A</td>
<td>211-547A</td>
<td>211-546A</td>
</tr>
</tbody>
</table>

Large color LCD display for RA-120 models
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

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

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±6µm/100mm (RA-1600)
- Rotational accuracy (axial): 0.06±6µm/100mm (RA-1600M)
- Rotational accuracy (radial): 0.03±6µm/100mm (RA-1600M)
- Rotational accuracy (axial): 0.03±6µm/100mm (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" (280mm)
- Maximum workpiece diameter: ø2.2" (560mm)
- Maximum table loading: 55lbs (25kg)

Vertical arm (X-axis)
- Measuring speed: 0.5, 1, 2, 5mm/sec
- Positioning speed: Max. 15mm/sec
- Maximum probing height (Z/D): 11.8" (300mm) ± 1.6µm/100mm
- X-axis parallelism to turntable axis: 1.5µm / 300mm
- X-axis straightness: 0.3µm / 140mm (RA-1600)
- X-axis straightness: 0.8µm / 100mm (RA-1600M)
- Parallelism with turntable axis: 5µm / 300mm

Horizontal arm (X-axis)
- Horizontal travel: 6.5" (165mm) (From table axis -1 to 5.5"
- Positioning speed: Max. 15mm/sec
- Measuring speed: 0.5, 1, 2, 5mm/sec
- X-axis straightness: 2.7µm / 140mm (RA-1600)
- X-axis parallelism to turntable axis: 1.6µm / 140mm (RA-1600)

Probes and stylus
- Measuring range: ±40µm / ±40µm / ±4µm
- Measuring force: 10–50mN (5 level switching)
- Standard stylus: 12AAL021, 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 optional auxiliary stage for measuring a workpiece whose height is 20mm or less.

ROUNDPACK
The latest roundness/cylindrical form analysis program

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.

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 (ROUNDPACK) senses the error and automatically stops the system.

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

1) : External diameter measurement
2) : Internal diameter measurement
3) : Displacement
4) : & inner diameter. Up to ø60 mm

J-41
**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.

**For RA-1600**

<table>
<thead>
<tr>
<th>Centering adjustment value</th>
<th>Leveling adjustment value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ø150</td>
<td>ø105</td>
</tr>
<tr>
<td>ø130</td>
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<td>ø0</td>
<td>ø105</td>
</tr>
<tr>
<td>ø0</td>
<td>ø105</td>
</tr>
</tbody>
</table>

**For RA-1600M**

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
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
12AA0L090: Sliding detector holder
211-045: Magnification checking gage
211-014: Chuck (OD: ø4 - 78mm, ID: ø25 - 68mm)
211-032: Quick chuck (OD: ø1 - 78mm, ID: ø16 - 69mm)
211-031: Micro-chuck (OD: ø0.1 - 1.5mm max.)
178-025: Vibration isolator (Desk top type)
64AA0B13: Vibration isolation workstation
12AA0L019: Side table for PC

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**Sliding detector-unit holder (Option) 12AA0L090**
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-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.

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.

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>
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</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>211-511A (mm/inch)</td>
<td>211-514A (inch)</td>
<td>211-512A (mm/inch)</td>
<td>211-516A (inch)</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>
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</tr>
</tbody>
</table>

DIMENSIONS

Optional Accessories
350850: Cylindrical square
356038: Auxiliary stage for a low-height workpiece
12AAF203: Extension probe holder (X2 higher)
12AAF204: Auxiliary probe holder for a large diameter workpiece
211-045: Magnification checking gage
211-014: Chuck (OD: 1 - 85mm, ID: 33 - 85mm)
211-032: Quick chuck (OD: 1 - 75mm, ID: 14 - 70mm)
211-031: Micro-chuck (OD: 1.5mm max.)
178-025: Vibration isolator
178-024: Stand for vibration isolator
12AAK110: Vibration isolator
12AAK120: Monitor arm
12AAL019: Side table for PC

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.

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.

Continuous measurement is possible as shown in steps (1) through (3) on the figure at the left, without having to switch the probe direction.

1) and 2) : OD measurement
3) : ID measurement
→ Movement
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. * with vibration isolating stand</td>
<td>211-531A</td>
<td>211-532A</td>
</tr>
<tr>
<td>Column travel</td>
<td>13.77” (350mm) (standard column)</td>
<td>21.65” (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.

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*.

Optional Accessories
350850: Cylindrical square
12AAF203: Extension probe holder (2X higher)
12AAF205: Extension probe holder (3X higher)
12AAF204: Auxiliary probe holder for a large diameter workpiece
211-045: Magnification calibration gage
211-014: Chuck (OD: 2 - 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
12AAL019: Side table for PC
## Technical Data: RA-2200CNC

### Turntable
- **Rotational accuracy (radial):** 1.8+35μm (±0.02+3.5X/10000μm)
- **Rotational accuracy (axial):** 1.8+35μm (±0.02+3.5X/10000μm)

### Power supply
- **Dimensions (W x D x H):** 26.3 x 20 x 35.4" (667 x 510 x 900mm)
- **Mass:** 397 lbs (180kg)

### Air supply
- **Air pressure:** 100V AC – 240V AC, 50/60Hz
- **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:** 397 lbs (180kg)

### Vertical column (Z-axis)
- **Vertical travel:** 13.7" (350mm) 21.7" (550mm)
- **Straightness (φ2.5):** 0.75µm / 100mm, 0.15µm / 300mm
- **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)
- **Maximum probing depth:** 104mm (w/standard stylus)
- **Stylus angle adjustment:** ±45° (with graduations)
- **Stylist:** 12AAE301, carbide ball, ø1.6mm
- **Measuring direction:** one direction

### Air supply
- **Air pressure:** 390kPa (4kgf/cm²)
- **Air consumption:** 30L/min.

### Horizontal arm (X-axis)
- **Horizontal travel:** 6.9" (175mm) (Including a protrusion of 1" (25mm) the turntable rotation center)
- **Straightness (φ2.5):** 0.75µm / 150mm
- **Squaringness with rotating axis:** 1.0µm / 150mm
- **Positioning speed:** Max. 30mm/s
- **Measuring speed:** 0.5, 1, 2, 5mm/s
- **Probe and stylus:** ±400μm / ±40μm / ±4µm (±5mm: tracking range)
- **Measuring force:** 400N
- **Standard stylus:** 12AAE301, carbide ball, ø1.6mm
- **Measuring direction:** one direction
- **Stylist angle adjustment:** ±45° (with graduations)

### Technical Data: RA-H5200CNC

### Turntable
- **Rotational accuracy (radial):** 8.5+35µm (±0.02+3.5X/10000μm)
- **Rotational accuracy (axial):** 8.5+35µm (±0.02+3.5X/10000μm)

### Power supply
- **Dimensions (W x D x H):** 26.8" (685mm) 39.0" (1000mm)
- **Mass:** 143 lbs (65kg)

### Air supply
- **Air pressure:** 390kPa (4kgf/cm²)
- **Air consumption:** 45L/min.

### Vertical column (Z-axis)
- **Vertical travel:** 10.1" (256mm) 14" (356mm)
- **Straightness (φ2.5):** 0.75µm / 100mm, 0.15µm / 300mm
- **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)
- **Maximum probing depth:** 104mm (w/standard stylus)
- **Stylus angle adjustment:** ±45° (with graduations)

### Air supply
- **Air pressure:** 390kPa (4kgf/cm²)
- **Air consumption:** 45L/min.

### Horizontal arm (X-axis)
- **Horizontal travel:** 8.5" (215mm) 13.7" (350mm) 21.7" (550mm)
- **Straightness (φ2.5):** 0.4µm / 200mm
- **Squaringness with rotating axis:** 0.5µm / 200mm
- **Positioning speed:** Max. 50mm/s
- **Measuring speed:** 0.5, 1, 2, 5mm/s
- **Probe and stylus:** ±400μm (±5mm: tracking range)
- **Measuring force:** 400N (in 5 steps)
- **Standard stylus:** 12AAE301, carbide ball, ø1.6mm
- **Measuring direction:** one direction
- **Stylist angle adjustment:** ±45° (with graduations)

### 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.
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)
- 12AAK110: Interchangeable styli (See page J-54.)
- 12AAK120: Vibration isolator (RA-2200 only)
- 12AAL019: Monitor arm (RA-2200 only)
- 12AAG419: Side table for PC
- 050165B: Surface roughness detector for RA-CNC

Dimensions

- Overall: 32" w x 24" d x 33" h
- CPU Holder: Adjusts from 6- 1/2" – 11- 3/4" 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>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>5R0.25 mm sapphire</td>
<td>5R0.25 mm sapphire</td>
<td>tungsten carbide</td>
</tr>
<tr>
<td>Dimensions (mm)</td>
<td></td>
<td></td>
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</table>

- Included in 5-pcs. styli set No. 12AAL020

<table>
<thead>
<tr>
<th>Application/Type</th>
<th>Small hole (ø0.8)</th>
<th>Small hole (ø1.0)</th>
<th>Small hole (ø1.6)</th>
<th>Extra small hole (Depth 3mm)</th>
<th>ø1.6 mm ball</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>12AAL026</td>
<td>12AAL027</td>
<td>12AAL028</td>
<td>12AAL029</td>
<td>12AAL030</td>
</tr>
<tr>
<td>Stylus tip</td>
<td>ø0.8 mm tungsten carbide</td>
<td>ø1.0 mm tungsten carbide</td>
<td>ø1.6 mm tungsten carbide</td>
<td>ø1.5 mm tungsten carbide</td>
<td>ø1.6 mm tungsten carbide</td>
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<td>Dimensions (mm)</td>
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- Included in 5-pcs. styli set No. 12AAL020

<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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</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>12AAL031</td>
<td>12AAL032</td>
<td>12AAL033</td>
<td>12AAL034</td>
<td>12AAL035</td>
</tr>
<tr>
<td>Stylus tip</td>
<td>ø1.2 mm tungsten carbide</td>
<td>ø0.5 mm tungsten carbide (Depth 2.5 mm)</td>
<td>ø1.0 mm tungsten carbide (Depth 5.5 mm)</td>
<td>tungsten carbide</td>
<td>tungsten carbide</td>
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<td>Dimensions (mm)</td>
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- Included in 5-pcs. styli set No. 12AAL020

<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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</thead>
<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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<tr>
<td>Stylus tip</td>
<td>ø3 mm tungsten carbide</td>
<td>5R0.25 mm sapphire</td>
<td>5R0.25 mm sapphire</td>
<td>tungsten carbide</td>
<td>tungsten carbide</td>
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<td>Dimensions (mm)</td>
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- Included in 5-pcs. styli set No. 12AAL020

<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>
</tr>
</thead>
<tbody>
<tr>
<td>Order No.</td>
<td>12AAL041</td>
<td>12AAL042</td>
<td>12AAL043</td>
<td>12AAL044</td>
<td>12AAL045</td>
</tr>
<tr>
<td>Stylus tip</td>
<td>ø1.6 mm tungsten carbide</td>
<td>5R0.25 mm sapphire</td>
<td>For mounting CMM stylus (mounting thread M2)</td>
<td>For mounting CMM stylus (mounting thread M2)</td>
<td>For mounting CMM stylus (mounting thread M2)</td>
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<td>Dimensions (mm)</td>
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</tr>
</tbody>
</table>

- Included in 5-pcs. styli set No. 12AAL020

* 12AAL021 is a standard accessory for all Roundtest models.

** Not available for RA-10, RA-120P and RA-220

* New design for holding styl 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.

---

#### M2 CMM stylus with ruby ball tip

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Stylus tip</th>
<th>Dimensions (mm)</th>
<th>Unit: mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>K651013</td>
<td>ø1.5, d = ø0.7, L = 4.5, Mass = 0.39</td>
<td>K651013</td>
<td>D = ø5.0, d = ø2.5, R = 10.0, Mass = 0.70</td>
</tr>
<tr>
<td>K651014</td>
<td>ø1.0, d = ø0.5, L = 6.0, Mass = 0.39</td>
<td>K651014</td>
<td>D = ø6.0, d = ø2.5, R = 10.0, Mass = 0.90</td>
</tr>
<tr>
<td>K651016</td>
<td>ø1.0, d = ø0.5, L = 7.5, Mass = 0.40</td>
<td>K651016</td>
<td>D = ø8.0, d = ø2.5, R = 11.0, Mass = 1.50</td>
</tr>
</tbody>
</table>

---

**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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<tr>
<td>Order No.</td>
<td>12AAE310</td>
<td>12AAE302</td>
<td>12AAE301</td>
<td>12AAE309</td>
</tr>
<tr>
<td>Stylus tip</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>
</tr>
<tr>
<td>Dimensions (mm)</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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</tbody>
</table>

<table>
<thead>
<tr>
<th>Application/Type</th>
<th>ø1.6 mm ball</th>
<th>ø0.8 mm ball</th>
<th>ø0.5 mm ball</th>
<th>Deep groove</th>
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<tbody>
<tr>
<td>Order No.</td>
<td>12AAE303</td>
<td>12AAE304</td>
<td>12AAE305</td>
<td>12AAE308</td>
</tr>
<tr>
<td>Stylus tip</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>Dimensions (mm)</td>
<td><img src="image5" alt="Diagram" /></td>
<td><img src="image6" alt="Diagram" /></td>
<td><img src="image7" alt="Diagram" /></td>
<td><img src="image8" alt="Diagram" /></td>
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<table>
<thead>
<tr>
<th>Application/Type</th>
<th>Deep hole A</th>
<th>Deep hole B</th>
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<tbody>
<tr>
<td>Order No.</td>
<td>12AAE306</td>
<td>12AAE307</td>
</tr>
<tr>
<td>Stylus tip</td>
<td>ø1.6 mm tungsten carbide</td>
<td>ø1.6 mm tungsten carbide</td>
</tr>
<tr>
<td>Dimensions (mm)</td>
<td><img src="image9" alt="Diagram" /></td>
<td><img src="image10" alt="Diagram" /></td>
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</table>

### Usage examples of styli

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

<table>
<thead>
<tr>
<th>Analyzing items</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>
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<td>✖️</td>
<td>—</td>
<td>—</td>
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<td>Concentricity</td>
<td>✖️</td>
<td>✖️</td>
<td>✖️</td>
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<td>Coaxiality</td>
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<td>Flattness</td>
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<tr>
<td>Parallelism</td>
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<tr>
<td>Perpendicularity</td>
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<td>✖️</td>
<td>✖️</td>
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<tr>
<td>Runout</td>
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<td>✖️</td>
<td>✖️</td>
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<tr>
<td>Total runout</td>
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<td>✖️</td>
<td>✖️</td>
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<tr>
<td>Straightness</td>
<td>—</td>
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<td>✖️</td>
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<tr>
<td>Inclination</td>
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<tr>
<td>Taper</td>
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<td>✖️</td>
<td>✖️</td>
<td>—</td>
</tr>
</tbody>
</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: φ118 x 48.5 mm
- Mass: 1.2 kg

**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 = 30 - 80 mm.
- External dimensions: φ157 x 76 mm
- Mass: 3.8 kg

**Vibration isolated frame with work surface**

**Micro-chuck**
*211-031*
Used for clamping a workpiece (less than φ1 mm dia.) that the centering chuck cannot handle.
- Holding capacity: up to φ1.5 mm
- External dimensions: φ118 x 48.5 mm
- Mass: 0.8 kg

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

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

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

**Reference Hemisphere**
*211-016*

**Magnification checking kit**
*997090*
- Standard accessory for RA-2200, RA-2200CNC, RA-H5200, and RA-H5200CNC

**Origin-point gage**
*999382*
- Standard accessory for RA-2200 and RA-H5200
## Eco-Fix Kit Form-S

**Mitutoyo ECO-FIX Kit Fixture Systems**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Qty</th>
<th>Part name</th>
<th>Part No.</th>
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<tr>
<td>K551038</td>
<td>1</td>
<td>Adaptor plate ø 150mm</td>
<td>K551069</td>
<td>1</td>
<td>Flat top ø 12mm</td>
</tr>
<tr>
<td>K551024</td>
<td>1</td>
<td>Location pin ø 12 X 13mm</td>
<td>K550262</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>K550261</td>
<td>2</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>
<tr>
<td>K551030</td>
<td>1</td>
<td>Location pin ø 20 X 50mm</td>
<td>K550890</td>
<td>2</td>
<td>Straight pin Ø 6mm x 40mm</td>
</tr>
<tr>
<td>K551031</td>
<td>1</td>
<td>Location pin ø 20 X 100mm</td>
<td>K551046</td>
<td>1</td>
<td>Slotted nut for receiver bracket h=12mm</td>
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<tr>
<td>K551035</td>
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<td>Receiver bracket small</td>
<td>K551050</td>
<td>1</td>
<td>Allen key 2mm</td>
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<tr>
<td>K551036</td>
<td>1</td>
<td>Receiver bracket large</td>
<td>K551051</td>
<td>1</td>
<td>Allen key 3mm</td>
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<td>K551040</td>
<td>1</td>
<td>Adjustable location pin ø 20mm</td>
<td>K551052</td>
<td>1</td>
<td>Allen key 4mm</td>
</tr>
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<td>K551041</td>
<td>1</td>
<td>Adjustable location pin ø 12mm</td>
<td>K551053</td>
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<td>Allen key 5mm</td>
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<td>K551042</td>
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<td>Location pin ø 12mm with bore ø 6mm</td>
<td>K551054</td>
<td>1</td>
<td>Double open ended spanner 10-17</td>
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<td>K551044</td>
<td>1</td>
<td>Receiver bracket L=90; ø 12mm</td>
<td>K550591</td>
<td>1</td>
<td>Washer ø 6,4mm / ø 17mm</td>
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<tr>
<td>K550716</td>
<td>1</td>
<td>Straight pin with thread</td>
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<td>8</td>
<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>
<td>6</td>
<td>Cylinder head screw M6 x 25mm</td>
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</table>

Kit Part No.  K551133

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## Eco-Fix Kit Form-L

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<td>Back square mini</td>
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<tr>
<td>K551024</td>
<td>1</td>
<td>Location pin ø 12 X 13mm</td>
<td>K550058</td>
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<td>V-block</td>
</tr>
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</tr>
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<td>Stopper element</td>
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<td>Location pin ø 12 X 100mm</td>
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Kit Part No.  K551134
Quick Guide to Precision
Measuring Instruments

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

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.

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

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

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

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

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.

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

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.

Adjustment prior to Measurement

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.
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 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.