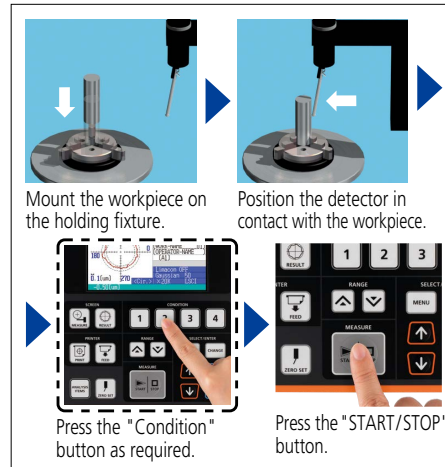


## Roundtest RA-10 SERIES 211 — Roundness Measuring Instrument



RA-10

### Simple measurement procedure



### SPECIFICATIONS

Model No.			RA-10
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.04 + 6H/10000) μm H: Probing height (mm)
		Axial direction	(0.04 + 6X/10000) μm X: distance from the center of rotation (mm)
	Maximum probing diameter		ø100 mm
	Maximum loading mass		10 kg
Vertical movement	Vertical travel		117 mm
X axis	Travel range		75 mm (-25 mm to 50 mm from the rotation center)
Detector*	Measuring range		±1000 μm

\* Only the standard length stylus is applicable to this detector. The long type cannot be used.

## Roundtest RA-120/120P SERIES 211 — Roundness Measuring Instruments



RA-120



RA-120P

The analysis capabilities for the various models (RA-120/120P/10) vary. For details, refer to page L-26.

### SPECIFICATIONS

Model No.			RA-120	RA-120P
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.04 + 6H/10000) μm H: Probing height (mm)	
		Axial direction	(0.04 + 6X/10000) μm X: distance from the center of rotation (mm)	
	Maximum probing diameter*1		ø280 mm (ø380 mm: for the vertical position when detector holder is installed reversely, the maximum probing height is up to 50 mm from the table top.)	
	Maximum loading mass		25 kg	
Vertical movement	Vertical travel		280 mm	
X axis	Travel range		165 mm (-25 mm to 140 mm from the rotation center)	
Detector*2	Measuring range		±1000 μm	

\*1 Auxiliary stage for a low-height workpiece (optional) is required for the measurement 20 mm or less in the radial direction from the center point of the table and 20 mm or less from the table top.

\*2 Only the standard length stylus is applicable to this detector. The long type cannot be used.

A cost-effective compact instrument that enables full-scale roundness evaluation.

- Offers easy operation for anyone. A large, simple key arrangement is used.
- User-friendly operation. Measurement results and recorded profiles are easy to view with the large LCD, and can then be printed by the built-in thermal line printer. Furthermore, optional functions to improve usability can be offered.

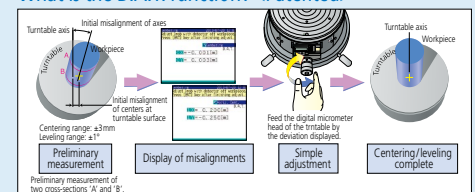


Refer to the Roundtest RA-10 Brochure (E15019) for more details.

Easy operation, compact and outstanding cost/performance ratio, designed for use on the shop-floor right beside the production line.

- D.A.T. (Digimatic Adjustment Table) function aids adjustments such as centering and leveling, and substantially reduces the time required for preliminary setup operations.

### What is the D.A.T. function? <Patented>



Dedicated analysis unit type (RA-120)

Data analysis by PC (RA-120P)

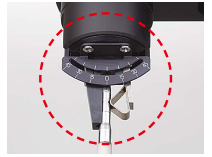
- Compact, lightweight design from incorporating electronic components inside the main unit.
- **ROUNDPAK**, a data analysis program employs Windows OS and archived higher level of analysis.



Refer to the Roundtest RA-120/120P Brochure (E15008) for more details.

## Roundtest RA-1600 SERIES 211 — Roundness/Cylindricity Measuring System

- Compact body and a wide measuring range assures precision that compares well with that of higher-grade models.
- D.A.T. (Digital Adjustment Table) function aids manual workpiece centering and leveling.
- Safety mechanism provided in the detection section as a standard feature.
- A sliding mechanism (optional sliding detector holder) can be installed in the detector holder. It enables one-touch measurement of a workpiece with a deep hole having a thick wall, which has been difficult with the standard detector.



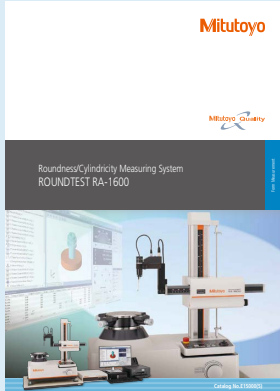
Detector safety mechanism



RA-1600

### SPECIFICATIONS

Model No.		RA-1600	
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.02 + 6H/10000) μm H: Probing height (mm)
		Axial direction	(0.02 + 6X/10000) μm X: Distance from the center of rotation (mm)
	Maximum loading mass		25 kg
	Maximum probing diameter		ø280 mm
Vertical movement (Z-axis column unit)	Vertical travel		300 mm
	X axis	Travel range	165 mm (-25 mm to +140 mm from the rotation center)
Detector	Measuring range	Standard	±400 μm/±40 μm/±4 μm
		Tracking	±5 mm



Refer to the Roundtest RA-1600 Brochure (E15000) for more details.

Achieved the world's highest level of accuracy for this class of machine. A high-performance automatic system equipped with a high-speed automatic centering/leveling function.

- High-speed automatic centering/leveling function contributes to a significant reduction in the man-hours required for setups.
- A fully automatic system which performs processing automatically from part program calling, centering/leveling, measurement, calculation, all the way through to printing.
- Capable of continuous inside/outside diameter measurement without changing the detector orientation (up to 50 mm ID).
- The automatic positioning function of the turntable enables automatic measurement in combination with table rotation and slider/column movement.
- Advanced graphical analysis such as power spectrum chart is available.
- A sliding mechanism is incorporated in the detector holder part.

## Roundtest RA-2200 SERIES 211 — Roundness/Cylindricity Measuring System



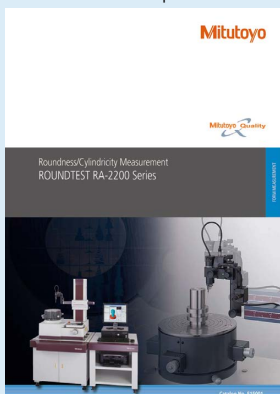
RA-2200AH  
System vibration isolator (with side table)



RA-2200AH  
System vibration isolator (monitor arm type)\*  
\* Printer table (provided by the customer) not shown.

### SPECIFICATIONS

Model No.		RA-2200AS	RA-2200DS	RA-2200AH	RA-2200DH
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.02 + 3.5H/10000) μm H: Probing height (mm)		
		Axial direction	(0.02 + 3.5X/10000) μm X: Distance from the center of rotation (mm)		
	Maximum loading mass		30 kg		
	Maximum probing diameter		ø300 mm		
Vertical movement (Z-axis column unit)	Vertical travel	300 mm		500 mm	
	X axis	Travel range	175 mm (-25 mm to +150 mm from the rotation center)		
Detector	Measuring range	Standard	±400 μm/±40 μm/±4 μm		
		Tracking	±5 mm		



Refer to the Roundtest RA-2200 Series Brochure (E15001) for more details.

## Roundtest RA-H5200 SERIES 211 — Roundness/Cylindricity Measuring System



RA-H5200AS  
with side table

### SPECIFICATIONS

Model No.		RA-H5200AS		RA-H5200AH	
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.02 + 3.5H/10000) μm H: Probing height (mm)		
		Axial direction	(0.02 + 3.5X/10000) μm X: Distance from the center of rotation (mm)		
	Maximum loading mass	80 kg (On auto-centering: 65 kg)			
	Maximum probing diameter	ø400 mm			
Vertical movement (Z-axis column unit)	Vertical travel	350 mm		550 mm	
X axis	Travel range	225 mm (-25 mm to +200 mm from the rotation center)			
Detector	Measuring range	Standard	±400 μm/±40 μm/±4 μm		
		Tracking	±5 mm		

## Roundtest RA-2200 PLUS SERIES 211 — Roundness/Cylindricity Measuring System



RA-2200AH PLUS  
System vibration isolator (with side table)

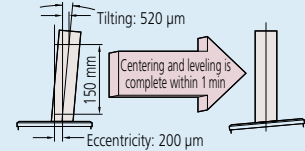


### SPECIFICATIONS

Model No.		RA-2200AS PLUS		RA-2200AH PLUS	
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction	(0.02 + 3.5H/10000) μm H: Probing height (mm)		
		Axial direction	(0.02 + 3.5X/10000) μm X: Distance from the center of rotation (mm)		
	Maximum loading mass	30 kg			
	Maximum probing diameter	ø256 mm			
Vertical movement (Z-axis column unit)	Vertical travel	300 mm		500 mm	
X axis	Travel range	175 mm (-25 mm to +150 mm from the rotation center)			
Detector	Measuring range	Standard	±400 μm/±40 μm/±4 μm		
		Tracking	±5 mm		

A high-performance automatic system equipped with a high-speed automatic centering/leveling function achieves the world's highest-level of accuracy.

- High-speed automatic centering/leveling function contributes to a significant reduction in the man-hours required for setups.



- A fully automatic system which performs processing automatically from part program calling, centering/leveling, measurement, calculation, all the way through to printing.
- Capable of continuous inside/outside diameter measurement without changing the detector orientation (up to 50 mm ID).
- The automatic positioning function of the turntable enables automatic measurement in combination with table rotation and slider/column movement.
- Advanced graphical analysis such as a power spectrum chart is available.
- A sliding mechanism is incorporated in the detector holder.

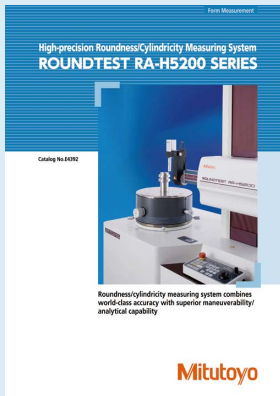
- The turntable with automatic centering and leveling function is equipped as standard, which frees operators from manual centering and leveling operations.
- Automatic control of holder arm posture (vertical/horizontal) and the rotation feature of the detector (rotates in 1° increments in the range of 0 to 270°) enables continuous measurement of various feature combinations, such as OD/ID and/or top/bottom plane measurements.
- A Mitutoyo linear scale is used in the X-axis drive unit to directly detect the position of the drive unit. It guarantees the highly precise positioning vital for automatic measurement.
- A roughness detector (optional) is supported.



Refer to the Roundtest RA-2200 Series Brochure (E15001) for more details.

A fully automated machine with highest-level accuracy that can greatly improve productivity and efficiency.

- The turntable with automatic centering and leveling function is equipped as standard, which frees operators from manual centering and leveling operations.
- Automatic control of holder arm posture (vertical/horizontal) and the rotation feature of the detector (rotates in 1° increments in the range of 0 to 270°) enables continuous measurement of various feature combinations, such as OD/ID and/or top/bottom plane measurements.
- A Mitutoyo linear scale is used in the X-axis drive unit to directly detect the position of the drive unit. It guarantees the highly precise positioning vital for automatic measurement.
- A roughness detector (optional) is supported.



Refer to the Roundtest RA-H5200 Series Brochure (E4392) for more details.

The best accuracy achieved in the class of large cylindricity measuring machine.

- Loading capacity is 350 kg, and the highest rotational accuracy in the class is achieved. Besides roundness and cylindricity, the flatness can be measured in high accuracy. The workpiece that requires high accuracy measurement such as large and heavy cylindrical parts can be measurement.
- For the ID measurement of a deep hole, such as a main shaft of machine tool, a deep hole measuring unit (specially made, without CNC functions) is available.
- A Mitutoyo linear scale is used in the X-axis drive unit to directly detect the position of the drive unit. It guarantees the highly precise positioning vital for automatic measurement.

## Roundtest RA-H5200 PLUS SERIES 211 — Roundness/Cylindricity Measuring System



RA-H5200AS PLUS  
with side table

### SPECIFICATIONS

Model No.		RA-H5200AS PLUS	RA-H5200AH PLUS
Turntable	Rotational accuracy (JIS B 7451-1997)	Radial direction (0.02 + 3.5H/10000) μm	H: Probing height (mm)
		Axial direction (0.02 + 3.5X/10000) μm	X: Distance from the center of rotation (mm)
	Maximum loading mass	80 kg (On auto-centering: 65 kg)	
	Maximum probing diameter	ø356 mm	
Vertical movement (Z-axis column unit)	Vertical travel	350 mm	550 mm
X axis	Travel range	225 mm (-25 mm to +200 mm from the rotation center)	
Detector	Measuring range	Standard	±400 μm/±40 μm/±4 μm
		Tracking	±5 mm

## Roundtest Extreme RA-6000 CNC SERIES 211 — CNC Roundness/Cylindricity Measuring System



RA-6000 CNC

### SPECIFICATIONS

Model No.		RA-6000 CNC
Turntable	Rotational accuracy *1*2 (JIS B 7451-1997)	Radial direction (0.05 + 6H/10000) μm H: Probing height (mm)
		Axial direction (0.05 + 6X/10000) μm X: Distance from the center of rotation (mm)
	Maximum loading mass	350 kg
	Maximum probing diameter	ø880 mm
Vertical movement (Z-axis column unit)	Vertical travel	1050 mm
X axis	Travel range	465 mm (-25 mm travel available from the rotation center)
Detector	Measuring range	±400 μm

\*1 The temperature at which the accuracy can be guaranteed is 20 °C.

\*2 The rotational accuracy has been obtained when load is applied to the rotation center.

## ROUNDTRACER EXTREME SERIES 211 — CNC Roundness/Cylindricity Measuring System



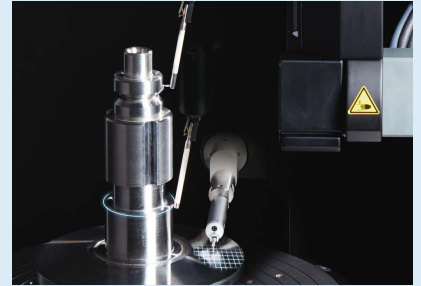
RTX-0605-A

### SPECIFICATIONS

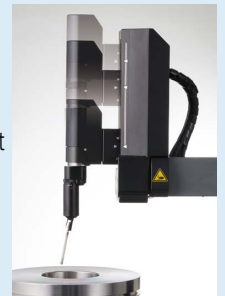
Model No.			RTX-0605-A
Turntable	Rotational accuracy (JIS B 7451:1997)	Radial direction	$(0.02 + 3.5H/10000) \mu\text{m}$ H: Probing height (mm)
		Axial direction	$(0.02 + 3.5R/10000) \mu\text{m}$ R: Measuring radius (mm)
	Maximum loading mass		60 kg
	Maximum probing diameter		$\varnothing 680 \text{ mm}$
Vertical movement (Z-axis column unit)	Travel range		550 mm
X axis	Travel range		197 mm (-33 mm to 164 mm from the rotation center)*
Detectors	Measuring range		$\pm 400 \mu\text{m} / \pm 40 \mu\text{m} / \pm 3.6 \mu\text{m}$

\* Value when the measuring system is mounted with a roundness detector and a standard stylus, and is in the outside diameter measuring position with the stylus at 0°.

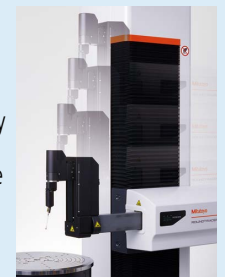
- ROUNDTRACER EXTREME models are triple-role CNC profile measuring systems that integrate the roundness and cylindricity measuring capabilities of our ROUNDTTEST models and the contour and surface roughness measuring capabilities of our hybrid, dual-role FORMTRACER models to measure surface roughness, contour, roundness, and cylindricity.



- Measurement repeatability is improved as a result of the newly developed centring mechanism and optimized slider structure.
- A detector holder with motorized sliding function enables continuous inside and upper surface measurement of thick workpieces.



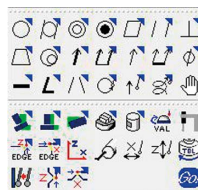
- Measurement throughput is improved as a result of the increased drive speeds of each axis and the addition of new functions and technologies.
- The incredibly high throughput is the result of reduced positioning time by CNC control, a highly rigid centring table, reduced waiting time until measurement start, and best-in-class drive speeds.



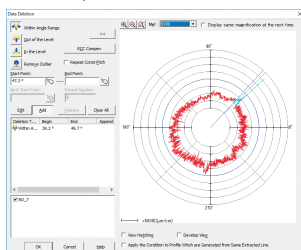
Refer to the ROUNDTRACER EXTREME Brochure (E15032) for more details.

## ROUNDPAK Roundness/Cylindricity measurement/Analysis software

- A wide variety of parameters including those for roundness/cylindricity, as well as flatness and parallelism, are provided as standard features. You can visually select these parameters using icons.

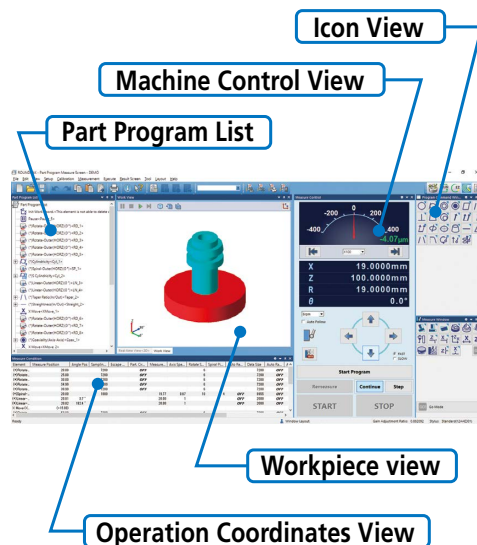


**ROUNDPAK** also comes with specialized functions, such as the design value best-fit analysis function, the harmonic analysis function, and a function for recording the peak or trough points on a circumference. Data that has already been collected can be easily used for re-calculation, or deleted.

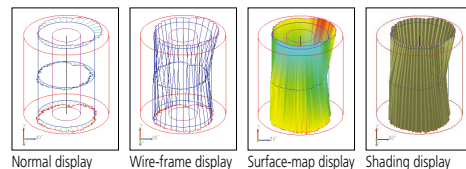


Data deletion

- The customer can create reports in custom formats by specifying how the analysis results will be displayed, as well as the sizes and positions of graphics. The analysis result window can be directly utilized as a layout window. Since the measurement procedure, including the layout information, is saved, the entire process, from measurement start, calculation, result saving, and finally to printing, can be automatically executed.



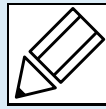
- Analysis results such as cylindricity and coaxiality can be visually expressed in 3D graphics.



- An offline teaching function is provided to create a part program (measurement procedure) without an actual measurement target, enabling the user to virtually execute the measurement operation in a 3D simulation window.

Analysis type		Model	RTX-0605-A	RA-2200 / H5200 RA-2200 PLUS / H5200 PLUS / 6000CNC	RA-1600	RA-120P	RA-120	RA-10
Roundness		○	✓	✓	✓	✓	✓	✓
Cylindricity		⊘	✓	✓	✓			
Concentricity		◎	✓	✓	✓	✓	✓	✓
Coaxiality	Axis element	⊙	✓	✓	✓	✓	✓	✓
	Axis	⊚	✓	✓	✓	✓	✓	✓
Flatness		□	✓	✓	✓	✓	✓	✓
Parallelism		//	✓	✓	✓	✓	✓	
Perpendicularity		⊥	✓	✓	✓	✓	✓	
Radial deviation		⊓	✓	✓	✓			
Thickness deviation		⊗	✓	✓	✓	✓	✓	
Radial runout		↗	✓	✓	✓	✓	✓	✓
Total runout		↘	✓	✓	✓			
Diameter measurement		∅	✓	✓	✓			
Straightness		—	✓	✓	✓			
Inclination		∟	✓	✓	✓			
Taper		∧	✓	✓	✓			
Diameter contour tolerancing		⊕	✓	✓	✓			
Rectilinear contour tolerancing		∩	✓	✓	✓			
Width measurement (only CNC)		■	✓	✓ (only PLUS and CNC)				
Power spectrum		▮	✓	✓	✓			
Harmonic analysis		⊕	✓	✓	✓	✓		
Profile operation		±	✓	✓	✓	✓		
Tapered surface analysis		⊖	✓	✓	✓			
Lead (twist) analysis		⊘	✓ (optional)					
3D surface property analysis		⊘	✓ (optional)					

# Quick Guide to Precision Measuring Instruments

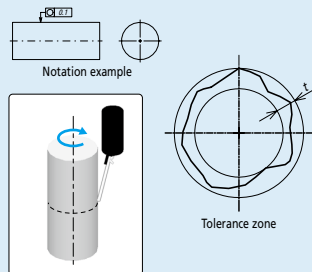


## Roundtest (Roundform Measuring Instruments)

### Geometrical tolerances ISO/DIS 1101: 1996\*1, ISO 5459\*2

#### ○ Roundness

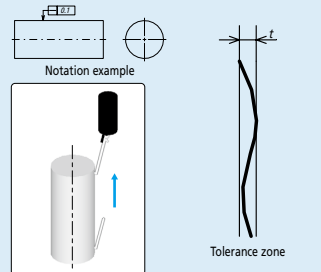
Any circumferential line must be contained within the tolerance zone formed between two coplanar circles with a difference in radii of  $t$



Verification example using a roundness measuring instrument

#### — Straightness

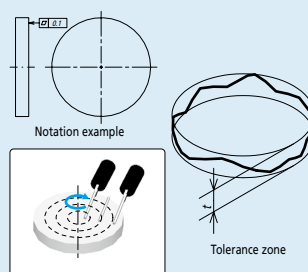
Any line on the surface must lie within the tolerance zone formed between two parallel straight lines a distance  $t$  apart and in the direction specified



Verification example using a roundness measuring instrument

#### □ Flatness

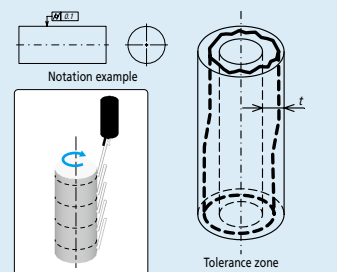
The surface must be contained within the tolerance zone formed between two parallel planes a distance  $t$  apart



Verification example using a roundness measuring instrument

#### ○/□ Cylindricity

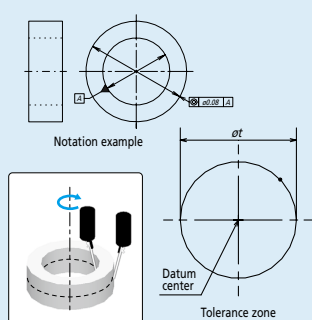
The surface must be contained within the tolerance zone formed between two coaxial cylinders with a difference in radii of  $t$



Verification example using a roundness measuring instrument

#### ◎ Concentricity

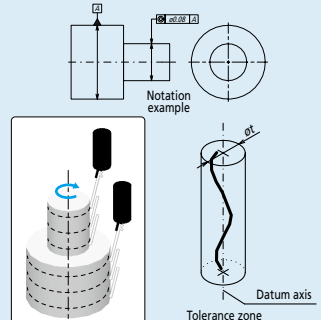
The center point must be contained within the tolerance zone formed by a cylinder of diameter  $t$  concentric with the datum



Verification example using a roundness measuring instrument

#### ◎ Coaxiality

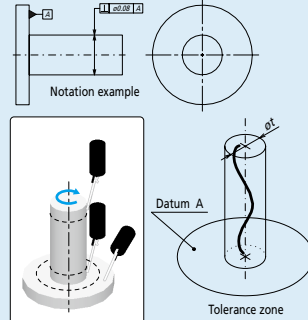
The axis must be contained within the tolerance zone formed by a cylinder of diameter  $t$  concentric with the datum



Verification example using a roundness measuring instrument

#### ⊥ Perpendicularity

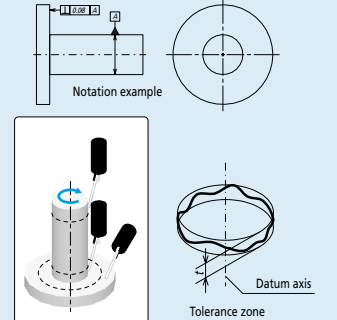
The line or surface must be contained within the tolerance zone formed between two planes a distance  $t$  apart and perpendicular to the datum



Verification example using a roundness measuring instrument

#### ⊥ Parallelism

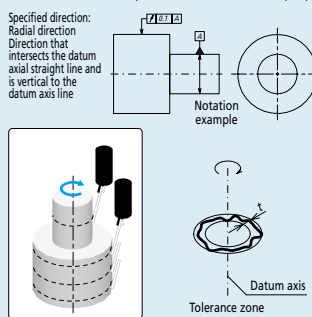
The line or surface must be contained within the tolerance zone formed between two parallel planes a distance  $t$  apart and parallel to the datum



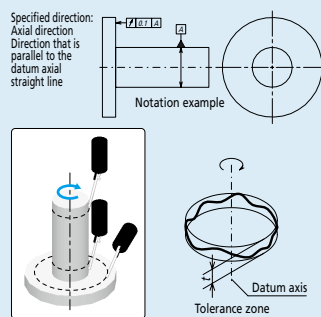
Verification example using a roundness measuring instrument

#### ↗ Circular Runout (Radial and Axial)

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



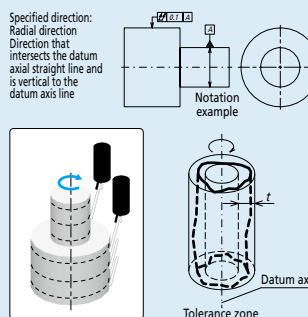
Verification example using a roundness measuring instrument



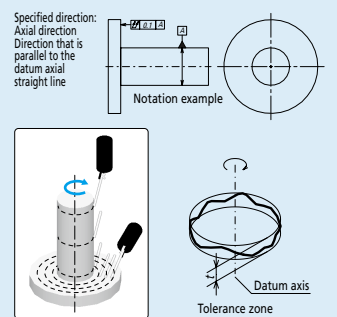
Verification example using a roundness measuring instrument

#### ↗ Total Runout (Radial and Axial)

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



Verification example using a roundness measuring instrument

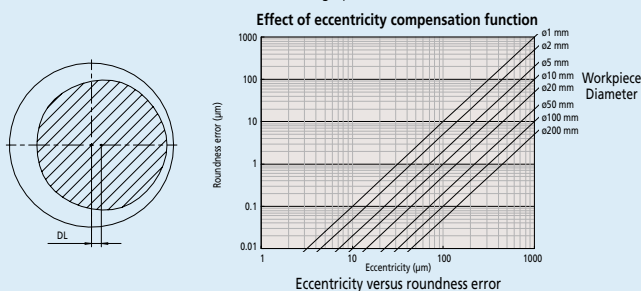


Verification example using a roundness measuring instrument

### Adjustment prior to Measurement ISO 4291: 1985\*3

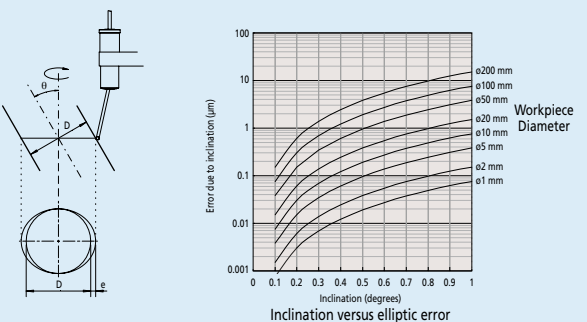
#### Centering

A displacement offset (eccentricity) between the Roundtest's turntable axis and that of the workpiece results in distortion of the measured form (limaçon error) and consequentially 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.



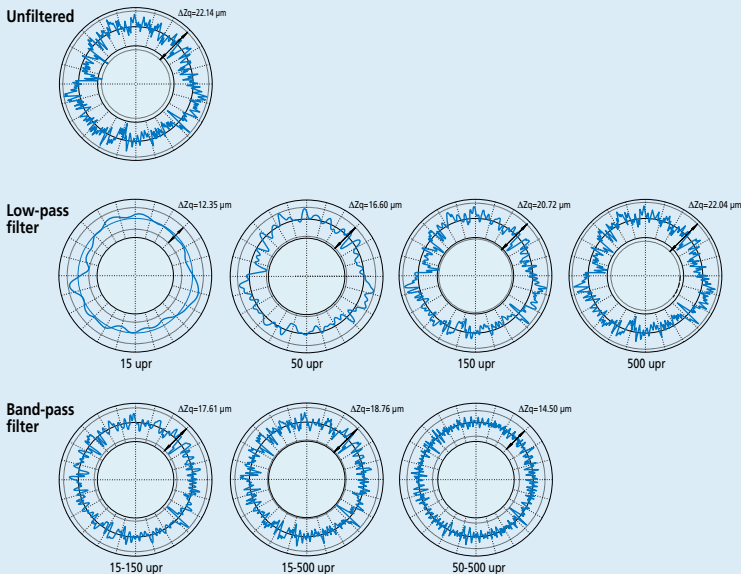
#### Leveling

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 ISO 12181-2: 2011\*4

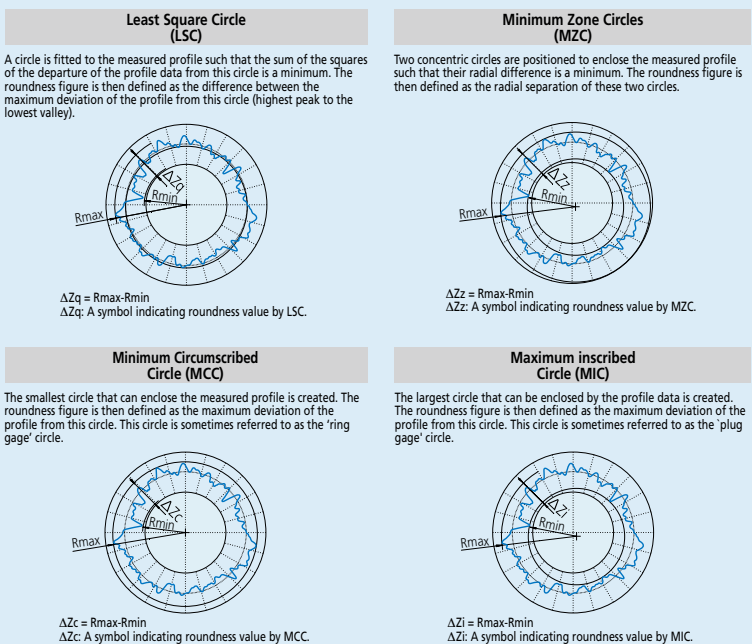
Profiles can be filtered in various ways to reduce or eliminate unwanted detail, with a cut-off value set in terms of undulations per revolution (upr). The effect of different upr settings is shown in the diagrams below, which illustrate how the measured roundness value decreases as lower upr settings progressively smooth out the line.



## Evaluating the Measured Profile Roundness ISO 12181-1: 2011\*5, ISO 4291: 1985\*3

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.

Each method results in a different center position for the reference circles and therefore affects the axial location of the circular feature measured.



\*1 ISO/DIS 1101: 1996 Geometrical Product Specifications (GPS) - Geometrical tolerancing - Tolerancing of form, orientation, location and run-out

\*2 ISO 5459 Technical drawings - Geometrical tolerancing - Datums and datum-systems for geometrical tolerances

\*3 ISO 4291: 1985 Methods for the assessment of departure from roundness - Measurement of variations in radius

\*4 ISO 12181-2: 2011 Geometrical Product Specifications (GPS) - Roundness - Part 2: Specification operators

\*5 ISO 12181-1: 2011 Geometrical Product Specifications (GPS) - Roundness - Part 1: Vocabulary and parameters of roundness

## Filtering

	2CR filter	Gaussian filter
Standard	ISO 4291: 1985*3	ISO 12181-1: 2011*5
Attenuation rate	75%	50%

## Terms and abbreviated terms ISO 12181-1: 2011\*5

Abbreviated terms	Terms
LSCI	Least squares reference circle
LSCY	Least squares reference cylinder
LSLI	Least squares reference line
LSPL	Least squares reference plane
LCD	Local cylindricity deviation
LFD	Local flatness deviation
LRD	Local roundness deviation
LSD	Local straightness deviation
MICI	Maximum inscribed reference circle
MICY	Maximum inscribed reference cylinder
MCCI	Minimum circumscribed reference circle
MCCY	Minimum circumscribed reference cylinder
MZCI	Minimum zone reference circles
MZCY	Minimum zone reference cylinder
MZLI	Minimum zone reference lines
MZPL	Minimum zone reference planes
UPR	Undulations per revolution

## Parameters and abbreviated terms ISO 12181-1: 2011\*5

Abbreviated terms	Parameter	Reference element*			
		Minimum zone	Least square	Minimum circumscribed	Minimum inscribed
CYLtt	Cylinder taper		✓		
STRsg	Generatrix straightness deviation		✓		
STRlc	Local generatrix straightness deviation		✓		
CYLp	Peak-to-reference cylindricity deviation		✓		
FLTp	Peak-to-reference flatness deviation		✓		
RONp	Peak-to-reference roundness deviation		✓		
STRp	Peak-to-reference straightness deviation		✓		
CYLt	Peak-to-valley cylindricity deviation	✓	✓	✓	✓
FLTt	Peak-to-valley flatness deviation	✓	✓		
RONt	Peak-to-valley roundness deviation	✓	✓	✓	✓
STRt	Peak-to-valley straightness deviation	✓	✓		
CYLv	Reference-to-valley cylindricity deviation		✓		
FLTv	Reference-to-valley flatness deviation		✓		
RONv	Reference-to-valley roundness deviation		✓		
STRv	Reference-to-valley straightness deviation		✓		
CYLq	Root-mean-square cylindricity deviation		✓		
FLTq	Root-mean-square flatness deviation		✓		
RONq	Root-mean-square roundness deviation		✓		
STRq	Root-mean-square straightness deviation		✓		
STRsa	Straightness deviation of the extracted median line	✓	✓	✓	✓

\* The reference elements to which the parameter can be applied.