Featured Products

Shop-floor Type CNC Coordinate Measuring Machine

MiSTAR Series

Refer to page L-3 for details.

CNC Coordinate Measuring Machine

MICROCORD CRYSTA-Apex V Series

Refer to page L-4 for details.

Non-contact Line-Laser Probe

SurfaceMeasure

Refer to page L-16 for details.

SMS Smart Measuring System

An online system to monitor the operational and mechanical statuses of measuring machines. This allows you to grasp the state of a process flow from the operational status of measuring machines within a production process.

MeasurLink ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink® (refer to page A-3 for details).

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Coordinate Measuring Machines

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CMM

Mitutoyo

Coordinate Measuring Systems

Precision measuring technology in three dimensions

Shop-floor Type CNC Coordinate Measuring Machine MiSTAR 555 & 575

SMS Smart Measuring System

MeasurLink® ENABLED
Data Management Software by Mitutoyo

- An accuracy-guaranteed temperature range of 10 to 40° C is possible thanks to a combination of technologies, such as the symmetric guide structure, uniform material and temperature compensation.
- A contamination resistance more than 2 times better than conventional Mitutoyo CMMs is achieved by adopting a newly developed environment-resistant ABSOLUTE scale*.

  * ABSOLUTE scale that provides an absolute XYZ-values relative to an internal reference point for each coordinate captured. This eliminates the need for an initialization operation.
- The footprint is reduced to about 80% compared to conventional moving bridge models by adopting the horizontal-arm structure and installing the CMM controller and PC under the measuring table.
- Design allows open access from 3 sides.

MiSTAR 555

SPECIFICATIONS

25.4 mm = 1.0 inch

Items \ Model		MiSTAR 555	MiSTAR 575
Measuring range	X-axis	570 mm	570 mm
	Y-axis	500 mm	700 mm
	Z-axis	500 mm	500 mm
Maximum permissible length measurement error*1*2 ISO 10360-2: 2009 (18 to 22° C)		2.2 + 3L/1000 µm	
Drive speed		5 to 350 mm/s (max. combined speed 606 mm/s) in CNC MODE	
Drive acceleration		1556 mm/s² (max. combined acceleration 2695 mm/s²)	
Workpiece	Max. height	660 mm	
	Max. loading	120 kg	180 kg
Accuracy guaranteed temperature range		10 to 40° C	
Mass (including the controller and installation platform)		655 kg	805 kg

*1 Specifications vary by configuration, size, and thermal environment.
*2 L = Measuring length (unit: mm)
Note1: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.
Note2: For information about guaranteed accuracy outside of the 18 to 22° C temperature range, contact your nearest M³ Solution Center.

SMS Smart Measuring System

Status monitoring boosts uptime with timely adjustments and alerts for events like busy, idle, or maintenance. Operators can optimize machine use and repurpose idle instruments for measuring other parts.

MeasurLink® ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink® (refer to page A-3 for details).

Equipped with the **PH10MQ** probe head

MRT240
Rotary table diameter 240 mm

Refer to the **MiSTAR Series** Brochure (**B2321(3)**) for more details.

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Status monitoring boosts uptime with timely adjustments and alerts for events like busy, idle, or maintenance. Operators can optimize machine use and repurpose idle instruments for measuring other parts.

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink® (refer to page A-3 for details).

Coordinate Measuring Systems

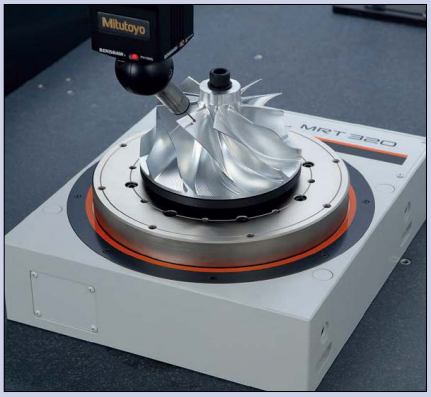
Precision measuring technology in three dimensions

Standard CNC CMM
CRYSTA-Apex V500/700/900 Series

MeasurLink® ENABLED
Data Management Software by Mitutoyo

- The CRYSTA-Apex V500/700/900 series, CNC CMMs deliver high accuracy (1.7 µm), high speed, and high acceleration. This series offers flexibility with a wide range of models to suit practically any size workpiece.
- Has achieved a contamination resistance more than 2 times better than conventional Mitutoyo CMMs by adopting a newly developed ABSOLUTE scale* that is highly resistant to the challenging production-line environment.

  * ABSOLUTE scale that provides an ABSOLUTE value for each measurement point. This eliminates the need for an initialization operation.
- Equipped with a temperature compensation system that guarantees the specified accuracy within the wide range of 16 to 26 °C under certain environmental conditions, although high-accuracy CMMs should ideally be installed in a temperature-controlled room.



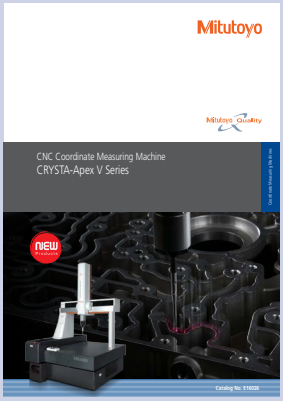
MRT320
Rotary table diameter 320 mm

CRYSTA-Apex V574

CRYSTA-Apex V776

CRYSTA-Apex V9106

Find a Distributor



Refer to the **CRYSTA-Apex V Series** Brochure (**E16026**) for more details.

SPECIFICATIONS

25.4 mm = 1.0 inch

Items \ Model		CRYSTA-Apex V544	CRYSTA-Apex V574	CRYSTA-Apex V776	CRYSTA-Apex V7106
Measuring range	X-axis	500 mm		700 mm	
	Y-axis	400 mm	700 mm	700 mm	1000 mm
	Z-axis	400 mm		600 mm	

Items \ Model		CRYSTA-Apex V9106 (Z600) / 9108 (Z800)	CRYSTA-Apex V9166 (Z600) / 9168 (Z800)	CRYSTA-Apex V9206 (Z600) / 9208 (Z800)
Measuring range	X-axis	900 mm		
	Y-axis	1000 mm	1600 mm	2000 mm
	Z-axis	600 mm/800 mm		

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known, can always be relied upon.

CRYSTA-Apex V Series Accuracy

Series	Probe used	Length measurement error*1 ISO 10360-2: 2009
500/700/900 Series	**SP25M**	$E_{0, MPE}$=1.7 + 3L/1000*2

*1 Specifications vary by configuration, size, and thermal environment.
*2 L = Measuring length (unit: mm)

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Coordinate Measuring Systems

Precision measuring technology in three dimensions

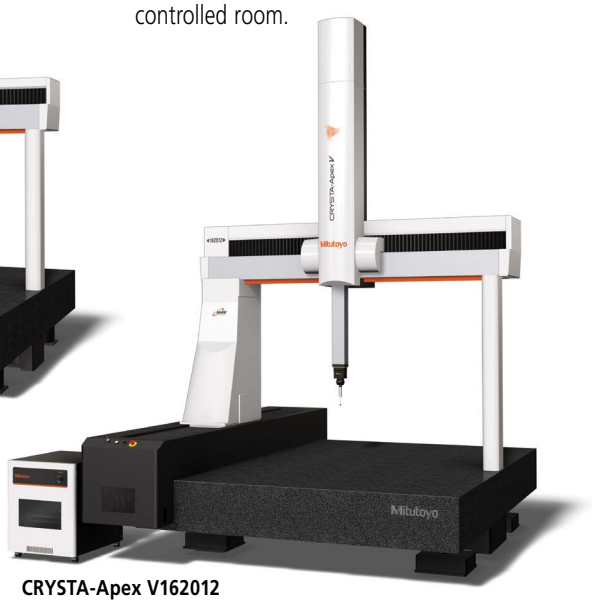
Standard CNC CMM
CRYSTA-Apex
V1200/1600/2000 Series

SMS Smart Measuring System

MeasurLink® ENABLED
Data Management Software by Mitutoyo

- The **CRYSTA-Apex V1200/1600/2000** Series are large-sized CNC CMMs developed for supporting quality evaluation of large parts.
- Equipped with a temperature compensation system that guarantees the specified accuracy within the wide range of 16 to 26° C for **CRYSTA-Apex V1200** and 16 to 24° C for **V1600/2000** under certain environmental conditions, although high-accuracy CMMs should ideally be installed in a temperature-controlled room.

CRYSTA-Apex V122010



CRYSTA-Apex V162012

SPECIFICATIONS

25.4 mm = 1.0 inch

Items \ Model		CRYSTA-Apex V121210	CRYSTA-Apex V122010	CRYSTA-Apex V123010
Measuring range	X-axis	1200 mm		
	Y-axis	1200 mm	2000 mm	3000 mm
	Z-axis	1000 mm		

Items \ Model		CRYSTA-Apex V162012 (Z1200)/V162016 (Z1600)	CRYSTA-Apex V163012 (Z1200)/V163016 (Z1600)	CRYSTA-Apex V164012 (Z1200)/V164016 (Z1600)
Measuring range	X-axis	1600 mm		
	Y-axis	2000 mm	3000 mm	4000 mm
	Z-axis	1200 mm/1600 mm		

Items \ Model		CRYSTA-Apex V203016	CRYSTA-Apex V204016
Measuring range	X-axis	2000 mm	
	Y-axis	3000 mm	4000 mm
	Z-axis	1600 mm	

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known, can always be relied upon.

CRYSTA-Apex V Series Accuracy

Unit: µm

Series	Probe used	Length measurement error *1 ISO 10360-2: 2009
1200 Series	**SP25M**	$E_{0, MPE}$=2.3 + 3L/1000*2
1600 Series		$E_{0, MPE}$=3.3 + 4.5L/1000 (4.5 + 5.5L/1000)*2 *3
2000 Series		$E_{0, MPE}$=4.5 + 8L/1000*2

*1 Specifications vary by configuration, size, and thermal environment.
*2 L = Measuring length (unit: mm)
*3 ( ) indicates Z: 1600 mm specification

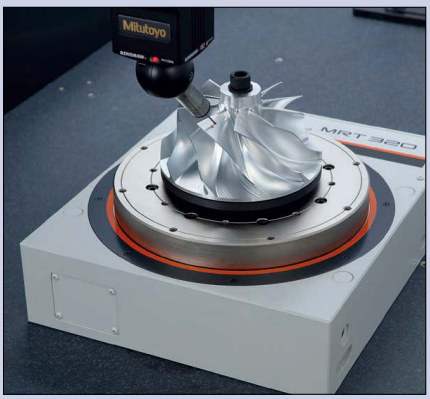
SMS Smart Measuring System

Status monitoring boosts uptime with timely adjustments and alerts for events like busy, idle, or maintenance. Operators can optimize machine use and repurpose idle instruments for measuring other parts.

MeasurLink® ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink® (refer to page A-3 for details).

MRT240
Rotary table diameter 240 mm



MRT320
Rotary table diameter 320 mm

Got Questions?

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Coordinate Measuring Systems

Precision measuring technology in three dimensions

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Standard CNC CMM
CRYSTA-Apex EX 1200R Series

MeasurLink® ENABLED
Data Management Software by Mitutoyo

- **CRYSTA-Apex EX 1200R** Series products are advanced CNC CMMs equipped with the REVO-2 probe head and a choice of probes to create a range of standard 5-axis measuring machines.
- 5-axis operation reduces the time required for probe repositioning movements and allows more flexible positioning. This also facilitates access to complex workpieces and saves time both during programming and measurement.
- Allows ultra high-speed 5-axis scanning (max. 500 mm/s), far surpassing conventional 3-axis control. Support for high-speed sampling of up to 4,000 points per second allows acquisition of densely spaced measurement points, even during fast scanning.
- Internal implementation of laser sensing technology ensures high-accuracy measurement, even with long styli (up to 500 mm*).

* Distance from probe rotation center to stylus tip

CRYSTA-Apex EX 123010R

Helical scan

Gasket scan

Sweep scan

Airfoil section scan

MRS2 Tiered Racks

SPECIFICATIONS

25.4 mm = 1.0 inch

Items \ Model		CRYSTA-Apex EX 121210R	CRYSTA-Apex EX 122010R	CRYSTA-Apex EX 123010R
Measuring range	X-axis	1200 mm		
	Y-axis	1200 mm	2000 mm	3000 mm
	Z-axis	960 mm		

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

CRYSTA-Apex EX 1200R Series Accuracy

Unit: µm

Probe used	Length measurement error*1 ISO 10360-2: 2009
REVO + RSP2 + RSH250	$E_{0, MPE}$=2.9 + 4L/1000*2
REVO + RSP3-3 + RSH3-3	$E_{0, MPE}$=2.5 + 3L/1000*2

*1 Specifications vary by configuration, size, and thermal environment.
*2 L = Measuring length (unit: mm)

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Mitutoyo

Coordinate Measuring Systems

Precision measuring technology in three dimensions

High Accuracy CNC CMM
STRATO-Apex Series

SMS Smart Measuring System

MeasurLink® ENABLED
Data Management Software by Mitutoyo

- The **STRATO-Apex** Series of CNC CMMs offer improved structural rigidity and guide systems to guarantee very high accuracy measurement. High drive speed and high acceleration provide lower cycle times in critical measurement applications.
- The **STRATO-Apex** Series uses the same ultra-high accuracy length measuring unit (manufactured in-house) as used in the **LEGEX** Series for position detection, allowing for extremely advanced position detection and enabling control of these ultra-high-accuracy machines. It also applies various other technologies, such as a high-speed control program, that enable high speed and accuracy.

STRATO-Apex 574

STRATO-Apex 7106

STRATO-Apex 9166

STRATO-Apex 162016

SPECIFICATIONS

25.4 mm = 1.0 inch

Items \ Model		STRATO-Apex 574	STRATO-Apex 776	STRATO-Apex 7106
Measuring range	X-axis	500 mm	700 mm	
	Y-axis	700 mm	700 mm	1000 mm
	Z-axis	400 mm	600 mm	

Items \ Model		STRATO-Apex 9106	STRATO-Apex 9166	STRATO-Apex 162012	STRATO-Apex 162016	STRATO-Apex 163012	STRATO-Apex 163016
Measuring range	X-axis	900 mm		1600 mm			
	Y-axis	1000 mm	1600 mm	2000 mm		3000 mm	
	Z-axis	600 mm		1200 mm	1600 mm	1200 mm	1600 mm

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known, can always be relied upon.

STRATO-Apex Series Accuracy Unit: µm

Series	Probe used	Length measurement error*1 ISO 10360-2: 2009
574 Series	**SP25M**	$E_{0,MPE} = 0.7 + 2.5L/1000$*2
700/**900** Series		$E_{0,MPE} = 0.9 + 2.5L/1000$*2
1600 Series		$E_{0,MPE} = 2.5 + 4.0L/1000$ (3.0 + 4.0L/1000)*2 *3

*1 Specifications vary by configuration, size, and thermal environment.
*2 L = Measuring length (unit: mm)
*3 ( ) indicates Z: 1600 mm specification

SMS Smart Measuring System

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MeasurLink® ENABLED Data Management Software by Mitutoyo

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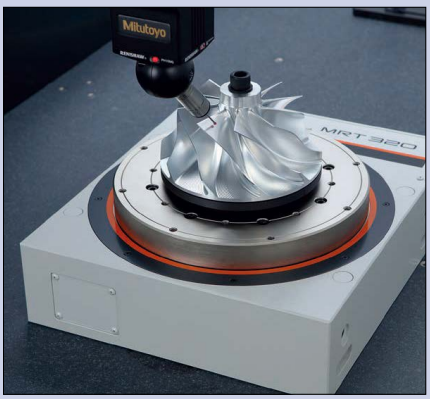
MRT240
Rotary table diameter 240 mm



MRT320
Rotary table diameter 320 mm

Talk to Sales

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Status monitoring boosts uptime with timely adjustments and alerts for events like busy, idle, or maintenance. Operators can optimize machine use and repurpose idle instruments for measuring other parts.

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink® (refer to page A-3 for details).

High Accuracy CNC CMM STRATO-Active Series

- The **STRATO-Active** Series is a lineup of intermediately priced coordinate measuring machines between the CRYSTA-Apex V and STRATO-Apex with 4 models being offered: 776; 7106; 9106; 9166.
- The **STRATO-Active** includes thermal compensation as standard and has a larger guaranteed temperature range of 18~22° C (64.4~71.6° F) compared to 19~21° C (66.2~69.8° F) for the STRATO-Apex.

STRATO-Active 7106

SPECIFICATIONS

25.4 mm = 1.0 inch

Items \ Model		STRATO-Active 776	STRATO-Active 7106	STRATO-Active 9106	STRATO-Active 9166
Measuring range	X-axis	700mm		900 mm	
	Y-axis	700mm	1000mm	1000mm	1600mm
	Z-axis	600mm			

STRATO-Active Series Accuracy

Unit: µm

Series	Probe used	Length measurement error*1 ISO 10360-2: 2009
700/**900** Series	**SP25M**	$E_{0,MPE} = 1.2 + 3L/1000$*2

*1 Specifications vary by configuration, size, and thermal environment.
*2 L = Measuring length (unit: mm)

High-accuracy Separate Guide Type STRATO-Apex G

- The **STRATO-Apex G** Series are CNC CMMs that use the standard Mitutoyo CMM structure for large machines which are designed to be used for measuring large and heavy workpieces with high accuracy. The picture below gives a good idea of how large the machine is. The measuring accuracy and drive speed are the world's highest in the X-axis measuring range of 2000 mm (78.7 in) and 3000 mm (118.1 in).

STRATO-Apex 3000G Series

- High-accuracy linear encoders (manufactured in-house) are built into the length measuring units used for position detection. Their excellent position detection capability is what makes the control of these high-accuracy devices possible. The series also applies a multitude of technologies regarding structure, control, component processing, assembly, and other aspects that enable large CMMs to deliver high-accuracy measurements.
- This series of CMMs is equipped with a system to automatically restore accuracy deterioration (MOVAC - Mitutoyo On-site Volumetric Accuracy Compensation system) caused by foundation deformation as a standard feature.
- Equipped with a temperature compensation system that guarantees the specified accuracy within the wide range of 18 to 22° C under certain environmental conditions, although high-accuracy CMMs should ideally be installed in a temperature-controlled room.
- Safety devices such as a Z-axis beam sensor, tape switch, and area sensor are available as options.

SPECIFICATIONS

25.4 mm = 1.0 inch

Items \ Model		STRATO-Apex 2000G Series	STRATO-Apex 3000G Series	STRATO-Apex 4000G Series
Measuring range	X-axis	2000 mm	3000 mm	4000 mm
	Y-axis	3000 mm/4000 mm/5000 mm/6000 mm		
	Z-axis	1200 mm/1600 mm/2000 mm		

Note: For information on accuracy specifications, contact your nearest M³ Solution Center.

Coordinate Measuring Systems

Precision measuring technology in three dimensions

Ultra-high Accuracy CNC CMM
LEGEX TAKUMI

SMS Smart Measuring System

MeasurLink® ENABLED
Data Management Software by Mitutoyo

- The **LEGEX TAKUMI** Series is an ultra-high precision CNC CMM with the world's highest level of accuracy, made possible by rigorous analysis of all possible error-producing factors and the elimination or minimization of their effects.
- The fixed bridge structure and precision air bearings running on highly rigid guideways ensure superior motion stability and ultra-high geometrical accuracy. Thorough testing, using FEM structure analysis simulation, guarantees geometric motion accuracy with minimal errors due to fluctuations in inertial loading and other variables. In addition, other technologies have been utilized in the structure of the drive unit, minimizing vibration, etc., to provide ultra-high accuracy.
- The combination of a Mitutoyo ultra-high accuracy crystallized glass scale with a coefficient of thermal expansion of almost zero and a high resolution, high-performance reflection type linear encoder provides excellent position detection for premium performance.
- Many optional systems are available, including probes (contact and non-contact types), data processing units, and many other items to support the ultra-high accuracy measurement of a wide variety of workpieces.

LEGEX TAKUMI 9106

SPECIFICATIONS

25.4 mm = 1.0 inch

Items \ Model		LEGEX TAKUMI 574	LEGEX TAKUMI 774	LEGEX TAKUMI 776	LEGEX TAKUMI 9106
Measuring range	X-axis	500 mm	700 mm	700 mm	900 mm
	Y-axis	700 mm	700 mm	700 mm	1000 mm
	Z-axis	450 mm	450 mm	600 mm	600 mm

Note: For measuring table, the standard specification is ceramic coating. A scraping specification is also available as an option.

LEGEX Series accuracy

Unit: µm

Probe used	Length measurement error*1 ISO 10360-2: 2009
MPP-310Q	$E_{0, MPE}$=0.23 + L/1000*2

*1 Specifications vary by configuration, size, and thermal environment.
*2 L = Measuring length (unit: mm)
Note: For **LEGEX 12128**, contact your nearest M³ Solution Center.

SMS Smart Measuring System

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MeasurLink® ENABLED
Data Management Software by Mitutoyo

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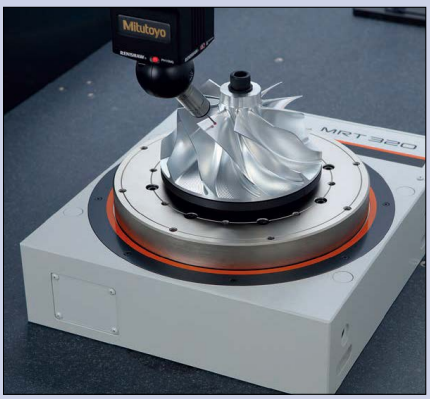
MRT240
Rotary table diameter 240 mm



MRT320
Rotary table diameter 320 mm

Refer to the **LEGEX TAKUMI** brochure **(16034)** for more details.

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Coordinate Measuring Systems

Precision measuring technology in three dimensions

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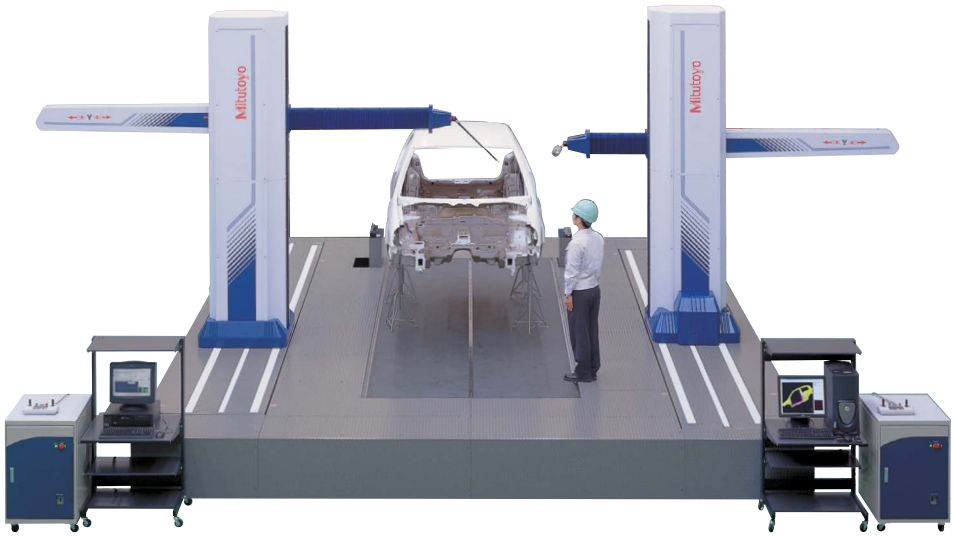
Car Body Measuring System CARBstrato Series

MeasurLink® ENABLED
Data Management Software by Mitutoyo

- The world's largest class of CMM.
  The **CARBstrato** series is a lineup of horizontal-arm type CNC CMMs, offering the world's largest measurement range that even makes it possible to measure car bodies.

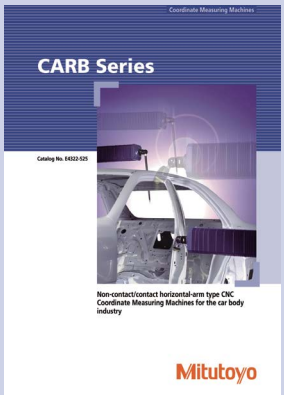
- Single-arm/Dual-arm systems.
  Single-arm/Dual-arm system types are available to suit the intended use.
  Single-arm type: Measures a workpiece using a single arm
  Dual-arm type: Measures a workpiece placed between two simultaneously controlled arms

Measurement example for dual-ram type
(Simultaneous use of touch-trigger probe and line laser probe)



CARBstrato 601624D (Dual-ram type)

Where to Buy



Refer to the **CARB** Series Brochure (**E16014**) for more details.

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Coordinate Measuring Systems

Precision measuring technology in three dimensions

In-line Type CNC CMM MACH-3A Series

SMS Smart Measuring System

MeasurLink® ENABLED
Data Management Software by Mitutoyo

- In-line type CNC CMM (Horizontal-arm type) incorporates the CMM controller and the host computer in the main unit resulting in a compact space-saving footprint for the shop floor. This series is designed for 24-hour operation with high stability and remarkable durability. In addition, its accuracy is guaranteed within the temperature range 5 to 40° C.

SPECIFICATIONS

25.4 mm = 1.0 inch

Items \ Model		MACH-3A 653
Measuring range	X-axis	600 mm
	Y-axis	500 mm
	Z-axis	280 mm
Accuracy*1	19 to 21 °C	$E_{0, MPE} = 2.5 + 3.5L/1000\,\mu m$*2

*1 Specifications vary by configuration, size, and thermal environment.

*2 L = Measuring length (unit: mm)

Note: For information about guaranteed accuracy within a temperature range other than 19 to 21 °C, contact your local Mitutoyo sales office.

MACH-3A 653
The indexing table shown is optional

SMS Smart Measuring System

Status monitoring boosts uptime with timely adjustments and alerts for events like busy, idle, or maintenance. Operators can optimize machine use and repurpose idle instruments for measuring other parts.

MeasurLink® ENABLED
Data Management Software by Mitutoyo

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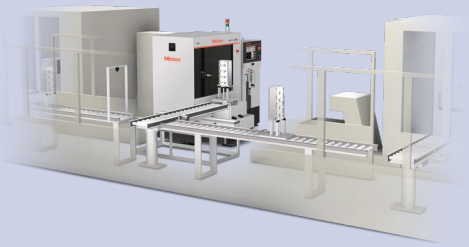
Refer to the **MACH** Series Brochure (**E16010**) for more details.



In-line Type CNC CMM MACH-V9106

SMS Smart Measuring System

MeasurLink® ENABLED
Data Management Software by Mitutoyo

- Makes building a flexible measuring system to replace gage measurements on power train production lines possible. It also allows for high throughput thanks to high acceleration and high drive speed. In addition, its accuracy is guaranteed within the temperature range 5 to 35° C.

SPECIFICATIONS

25.4 mm = 1.0 inch

Items \ Model		MACH-V9106
Measuring range	X-axis	900 mm
	Y-axis	1000 mm
	Z-axis	600 mm
Accuracy*1	19 to 21 °C	$E_{0, MPE} = 2.2 + 3.5L/1000\,\mu m$*2

*1 Specifications vary by configuration, size, and thermal environment.

*2 L = Measuring length (unit: mm)

Note: For information about guaranteed accuracy within a temperature range other than 19 to 21° C, contact your nearest M³ Solution Center.

MACH-V9106

SMS Smart Measuring System

An online system to monitor the operational and mechanical statuses of measuring machines. This allows you to grasp the state of a process flow from the operational status of measuring machines within a production process.

MeasurLink® ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink® (refer to page A-3 for details).

MRT240
Rotary table diameter 240 mm

Refer to the **MACH** Series Brochure (**E16010**) for more details.

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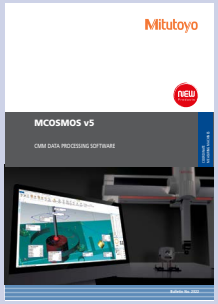
Status monitoring boosts uptime with timely adjustments and alerts for events like busy, idle, or maintenance. Operators can optimize machine use and repurpose idle instruments for measuring other parts.

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink® (refer to page A-3 for details).

Refer to the **MACH** Series Brochure (**E16010**) for more details.

Get a Quote



Refer to the **MCOSMOS** Software Brochure (**Bulletin No. 2322**) for more details.

Coordinate Measuring Systems

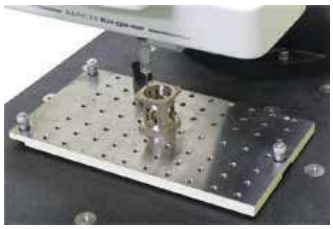
Precision measuring technology in three dimensions

CMM Equipped with High-accuracy/ High-speed/Flexible CNC Measuring Head Mach Ko-ga-me

- Can be used in standalone applications or integrated into work cells.
- If required, the system can measure workpiece features that exceed the **Ko-ga-me**'s X-stroke by mounting the workpiece, or the **Ko-ga-me**, on an auxiliary X-axis.
- Ideal for inspection of large or small workpieces and offers a wide choice of measuring probes including touch-trigger and scanning types. (Note: Probe choice may be restricted, depending on the application.)

KGM12128-C

Standalone system



Stand, measuring table, etc. are options.

SPECIFICATIONS

25.4 mm = 1.0 inch

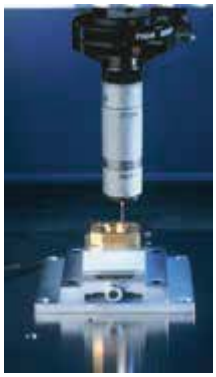
Items \ Model		KGM12128-C
Measuring range	X-axis	120 mm
	Y-axis	120 mm
	Z-axis	80 mm
Accuracy*1	19 to 21 °C	$E_{0,MPE}$=2.4 + 5.7L/1000 µm*2

*1 Specifications vary by configuration, size, and thermal environment.
*2 L = Measuring length (unit: mm)
Note: For information about guaranteed accuracy within a temperature range other than 19 to 21° C, contact your nearest M³ Solution Center.

Probes for MACH Ko-ga-me

Touch trigger PH6/TP200

Scanning PH6M/SP25M



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Coordinate Measuring Systems

Precision measuring technology in three dimensions

MiCAT
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the standard in world metrology software
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Software for Manual/CNC Coordinate Measuring Machines MCOSMOS

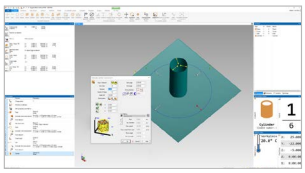
MCOSMOS software modules

	GEOPAK	CAT1000P	CAT1000S	SCANPAK
MCOSMOS-1	✓			
MCOSMOS-2	✓	✓	✓	
MCOSMOS-3	✓	✓	✓	✓

- MCOSMOS is the powerful and flexible metrology information system for the vast range of state-of-the-art Mitutoyo CMMs. Supported by an extensive lineup of optional software applications giving users complete control over a comprehensive range of sensors ready for every application.

GEOPAK [General purpose measurement program]

This universal geometrical measuring software delivers high-performance multidimensional measurements. With the ability to control your workpiece from design to completion, its various functions make GEOPAK one of the most powerful programs available.

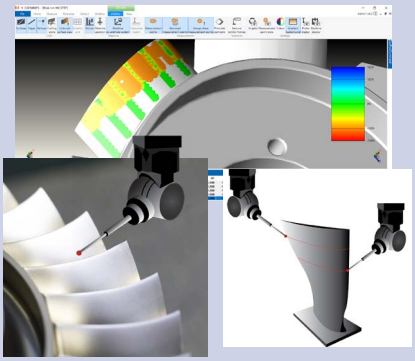


CAT1000P [Online/Offline progamming module]

CAT1000P (Prismatic), users create measurement programs from the CAD model using the seven basic geometric elements: point, line, plane, circle, sphere, cylinder, and cone. With automatic probe changes, probe path generation, and collision avoidance to generate a concise, efficient, and optimized measurement program. CAT1000P's 3D graphical display of the CMM, probe, and part provides a clear representation of the measured geometrical elements in 3D for part program simulation.

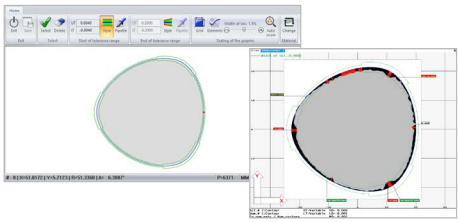
CAT1000S [Curved surface evaluation program]

This software is used for free-form surface evaluation and online/offline teaching.The measurement results are then displayed in easily interpreted graphics with sections color-coded based on non-conformances.



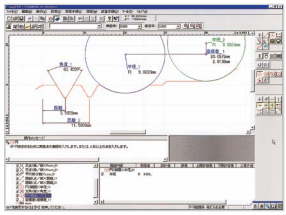
SCANPAK [Profile measurement program]

Quantitatively determine workpiece profiles and reflect this in the production process directly for optimizing workpieces immediately by using SCANPAK.



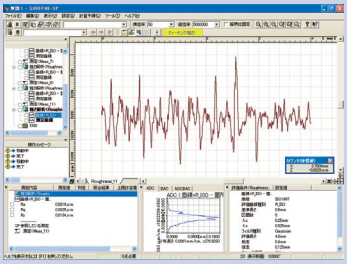
FORMTRACEPAK-AP [Analysis program]

This program is used for minutely analyzing two-dimensional curved lines captured by **SCANPAK**.



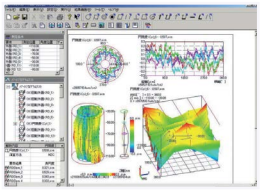
SURFPAK-SP [Analysis program]

This is a software program used for the **SURFTEST** roughness probe for a CMM. With this program, surface roughness analysis conforming to standards such as ISO, JIS, ANSI, and VDA are available. Cooperation with **MCOSMOS** enables fully automatic dimensional measurement and surface roughness measurement.



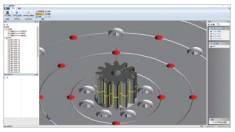
ROUNDPAK-CMM

The functionality of analysis software as used for roundness measuring machines is now available on **MCOSMOS**. As well as roundness and cylindricity evaluation, various filters are also available.



GEARPAK-Express Cylindrical [Gear evaluation program]

Gears with involute tooth shape can be measured with GEARPAK-Express. By inputting the gear parameters, the measurement program is generated automatically. GEARPAK-Express then evaluates the parameters and deviations for profile and flank line, pitch, tooth thickness, space width, dimension over one or two balls, base tangent length, radial runout, single and dual flank working test.



[Result drawing]

GEARPAK-Worm [Gear evaluation program]

GEARPAK-Worm for MCOSMOS measures cylindrical worms with flank types ZI, ZA, ZN, and ZK. After input of the Worm gear parameters, the measurement program is generated automatically.

GEARPAK-Bevel/Hypoid [Gear production support/evaluation program]

GEARPAK Bevel is currently supporting the measurement and evaluation of:
- Straight-Bevel Gear manufactured by Gleason Works Co.(Ring Gear/Pinion)
- Spiral-Bevel Gear manufactured by Gleason Works Co.(Ring Gear/Pinion)

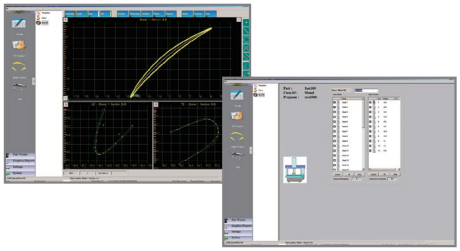
GEARPAK Hypoid is currently supporting the measurement and evaluation of:
- Hypoid Gear generated by Gleason Works Co.(Ring Gear [Formate, Helix-form]/Pinion)

By inputting the gear parameters, the measurement program is generated automatically.

[Result drawing]

MAFIS Express [Blade measurement/Evaluation program]

This software program enables creation of measurement programs and measurement and analysis of blades and blisks. A part program for measurement can be automatically created just by selecting required contents and evaluation conditions. The measurement results will be displayed in a report including 2D graphics.



Refer to the **MCOSMOS** Software Brochure (**Bulletin No. 2322**) for more details.

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

Coordinate Measuring Systems

Precision measuring technology in three dimensions

Automatic Measurement Program Generation Software MiCAT Planner

One-click programming that changes the relationship between people and precision measurement

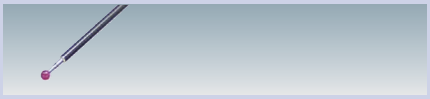
- Identifies tolerance information included in 3D models with Product and Manufacturing Information (PMI), defines the measurement plan and automatically creates a measurement program. For 3D CAD models without PMI, tolerance information may be added with MiCAT Planners fast tolerance assistant.
- With its optimization function, MiCAT Planner identifies the most efficient measurement path, minimizing probe repositioning and tool changes to deliver measurement programs in the shortest possible time.
- Utilizing the rule editor function to set the measurement rules prevents variation in measurement quality between program writers.

Tolerance information add function

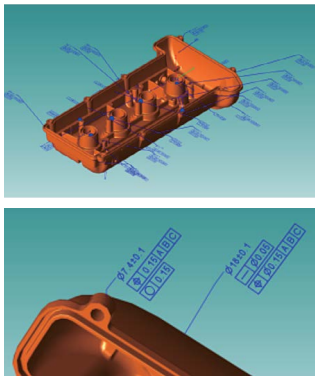
Lets you add tolerances in the software for 3D CAD models without tolerance information. Automatically create optimal measuring programs based on the user added tolerance specifications.

Supported languages

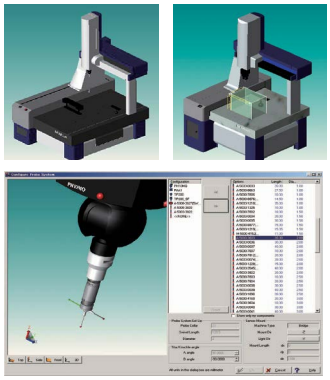
Available in 16 languages



CAD data with tolerances

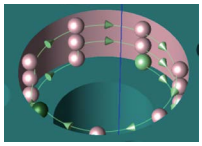


CMM System configuration

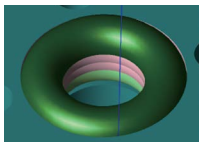


User-defined measurement rules

(number of locations to measure with tolerance information and sampling method, etc.,)

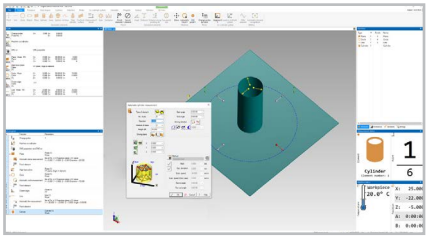


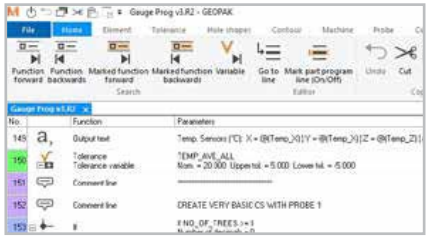
Example of sampling method: contact measurement



Example of sampling method: scanning measurement

Instantly and automatically creates a measurement program





An optimized measurement program for MCOSMOS

Case study

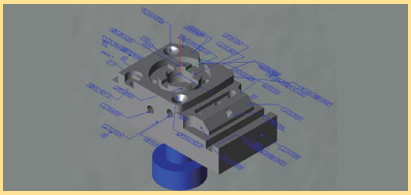
Compare the measurement part-programming time for a test piece.

1: Programming in 2D drawing: **approx. 45 to 60 minutes**

2: Programming using 2D drawing + 3D CAD: **approx. 15 to 20 minutes**

3: Create with **MiCAT Planner** (using 3D CAD model + PMI): **approx. 3 minutes!**

Note: The measurement rules are defined in advance.

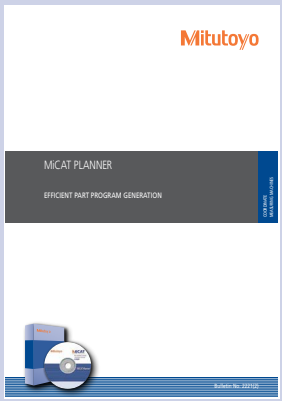


Part-programming time

Reduced by up to 95%!!

Guarantee a **dramatically reduced development phase** and improve product quality at the same time.

Need Support?



Refer to the **MiCAT Planner** Brochure (**Bulletin 2221(2)**) for more details.

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Mitutoyo

Coordinate Measuring Systems

Precision measuring technology in three dimensions

Scanning Probes

SP25M

Compact high accuracy type scanning probe

This compact, multi-functional and highly accurate scanning probe is only 25 mm in diameter, which enables it to access shrouded workpiece features. Data is collected by scanning measurement, ultra-high precision point measurement and center alignment point measurement. The probe can be attached to a probe head (**PH10M**/**10MQ**) to automatically change the orientation allowing for maximum flexibility in measurement. Reference SP25M scanning probe on L-18.

MPP-310Q

Ultra-high accuracy and low measuring force scanning probe

This ultra-high precision scanning probe incorporates built-in XYZ scales for highest-accuracy performance. The compact size of this probe is ideal for low measuring force and high speed scanning. Data collection can be performed by scanning measurement, ultra-high precision point measurement and center alignment measurement.

REVO-2

High speed 5-axis scanning head

This high-speed scanning head delivers high accuracy measurement while delivering high-throughput. Measurement with stylus up to 500 mm in length increases flexibility and makes simultaneous 5-axis measuring without probe head indexing.

SP80

High accuracy scanning probe (supporting long styli)

A highly accurate stylus up to 500 mm in length (both horizontally and vertically) can be installed on this probe. This ultra-high precision scanning probe allows data collection by scanning measurement, ultra-high precision point measurement and center alignment point measurement.

Non-contact probes

SurfaceMeasure

Non-contact type laser probe

This compact, high accuracy, non-contact type laser probe is designed for use with CNC CMMs. The scanning probe automatically adjusts to workpiece surface characteristics to deliver highly efficient measurements. Automatic laser intensity and camera sensitivity adjust according to the environment and the workpiece material for simpler and more comfortable laser scanning. (Refer to page L-17 for more information on SurfaceMeasure probes)

SurfaceMeasure 1110

SurfaceMeasure 201FS

QVP

QUICK VISION probe

This CNC CMM Quick Vision Probe utilizes Mitutoyo vision measuring machine technology for totally automated video measurement.

Roughness measurement probe

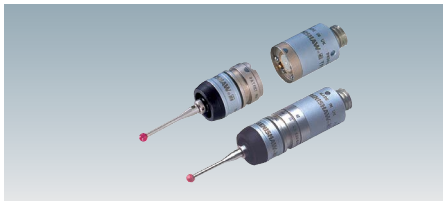
SURFTEST

Probe for surface roughness measurement

Mounting this probe on a CMM enables surface roughness measurement and analysis to be included in fully automatic CNC measurement cycles. This probe is compatible with an automatic probe changer and therefore can be automatically replaced with another type of probe for 3D coordinate measurement. A wide variety of roughness analyses can be performed using the dedicated evaluation program.

Touch-trigger probes

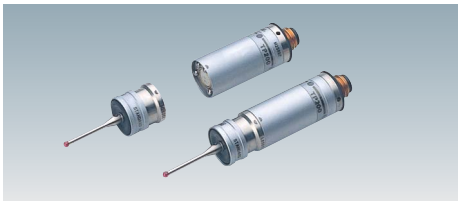
TP20



Compact touch-trigger probe

This compact touch-trigger probe is only 13.2 mm in diameter, making it an ideal choice for probing deep inside narrow or shrouded workpiece features. Styli auto-changing (optional) is supported when mounted on a CNC CMM.

TP200



Compact high-accuracy touch-trigger probe

This compact, high accuracy touch-trigger probe is only 13.5 mm in diameter, making it an ideal choice where high-accuracy measurement inside narrow or shrouded workpiece features is needed. Styli auto-changing (optional) is supported.

TP7M

High accuracy touch-trigger probe

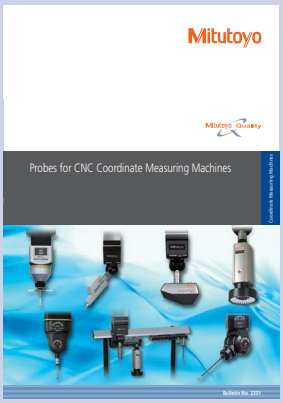
This high-accuracy touch-trigger probe has an excellent repeatability figure of of $2\sigma \leq 0.25$ µm. A long stylus, up to 150 mm in length, can be installed.

SMS Smart Measuring System

Status monitoring boosts uptime with timely adjustments and alerts for events like busy, idle, or maintenance. Operators can optimize machine use and repurpose idle instruments for measuring other parts.

MeasurLink® ENABLED
Data Management Software by Mitutoyo

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink® (refer to page A-3 for details).



Refer to the Probes for **CNC Coordinate Measuring Machines Brochure** (**Bulletin 2133**) for more details.

L

Status monitoring boosts uptime with timely adjustments and alerts for events like busy, idle, or maintenance. Operators can optimize machine use and repurpose idle instruments for measuring other parts.

Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink® (refer to page A-3 for details).

Coordinate Measuring Systems

Precision measuring technology in three dimensions

PH20

5-axis control touch-trigger system

Thanks to unique "head touches", it is possible to measure by movement of the probe head itself instead of moving the CMM elements. Also, measuring time can be significantly shortened by means of 5-axis concurrent movement and stepless positioning angle.

Probe heads

PH10M/10MQ

Motorized probe heads

These heads allow automatic control of positioning (up to 720 directions) of the mounted probe. It is possible to mount not only a touch-trigger probe but also any scanning probe, vision probe, laser probe, screw-thread depth probe, etc.
Auto-changing is available (optional).

▲Mounting example of touch-trigger probe

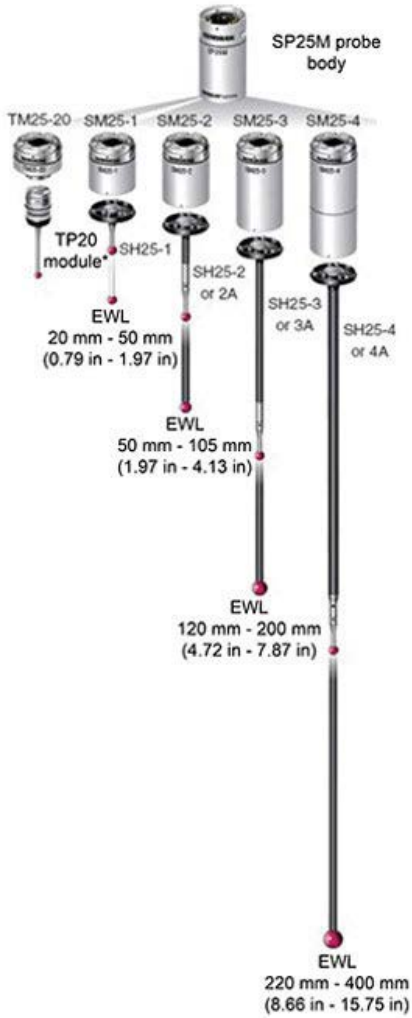
PH6M

Fixed probe head

A fixed probe head with autojoint connector for use with **TP7**, **SP25M**, and **QVP**.

SP25M Scanning Probe

The SP25M combines two sensors in a single housing. Users can switch between a choice of five scanning modules (which can carry M3 styli with lengths from 20 mm to 400 mm) and the TM25-20 adapter module that is compatible with Renishaw's TP20 range of probe modules. This capability enables scanning and touch-trigger probing in a single probe system.



SP25M modules and stylus holders

The SP25M's compact size and auto-joint mounting makes it compatible with the PH10M PLUS / PH10MQ PLUS and PH6M probe heads. It can also be mounted on a multi-wired probe extension bar. Together, these combinations permit excellent reach and access to part features.

A range of module kits allows SP25M users to build up their probing capability over time.

Each SM25-# scanning module is optimized in terms of gain and spring rate to suit the range of stylus lengths specified. For every module, there is a matching SH25-# stylus holder.

The SH25-3 and SH25-4 stylus holders are constructed with a fixed carbon fiber stem to which an M3 stylus is mounted, selected to provide the correct working length.

While the SP25M can carry cranked (non straight) styli configurations when using SM25-1 / 2 / 3 / 4 / 5 scanning modules and the original standard stylus holders (SH25-1 / 2 / 3 / 4 / 5), for optimum metrology where larger offsets are required Renishaw recommends the SH25-2A / 3A / 4A range of stylus holder, specifically designed to meet the challenges posed by such stylus arrangements.

Need Service?

Coordinate Measuring Systems

Precision measuring technology in three dimensions

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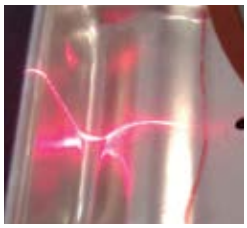
the standard in world metrology software
CMM

Non-contact Type Laser Probe SurfaceMeasure

- **Ultra-high speed data collection:**
  The **SurfaceMeasure** probe works by emitting a laser line onto the workpiece with ultra-high speed measuring to acquire 300,000 surface points/second.*
  * When using **SurfaceMeasure 1110**
- **Advantages of non-contact type:**
  Non-contact measurement enables measurement of materials that may be easily deformed by contact measurement, including plastics or thin, elastic parts.
- **Powder-less measurement:**
  Automatic configuration of the camera sensitivity and the laser intensity settings according to the environment and materials enable establishing an easy and trouble-free laser-scanning environment without the need for 3D scanning sprays.
- **Evaluation cases:**
  The measure point cloud data can be used by various optional software in a wide range of applications, such as editing, plane creation, comparison using CAD data and more.

Measurement of color sample plate



Measurement of glossy parts

1110

201FS

- The flying spot type is capable of scanning difficult parts, such as this impeller, precisely and achieves highest scanning accuracy in the class (in the case of **SurfaceMeasure 201FS**).

SPECIFICATIONS

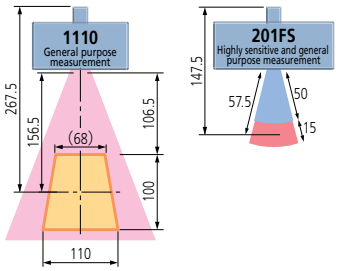
25.4 mm = 1.0 inch

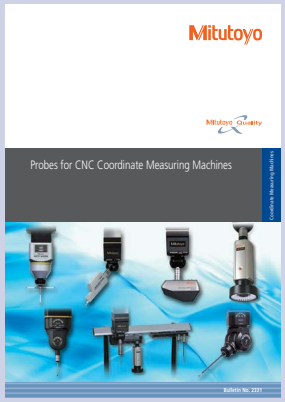
		SurfaceMeasure 1110	SurfaceMeasure 201FS
Laser irradiation method		Line Laser	Flying spot
Max. scan width		110 mm	23 mm
Max. scan depth		100 mm	15 mm
Working distance		156.5 mm	57.5 mm
Scanning error*		9 µm	1.8 µm
Max. acquisition rate		300,000 points/sec	25,000 points/sec
Mass		440 g	500 g
Laser Class	EN/IEC	Class2 [EN/IEC 60825-1 (2014)]	
	Laser Type	Red-light semiconductor	Semiconductor
Line Laser	Wave length	660 nm	670 nm
	Power output	2.5 mW	1 mW

* According to Mitutoyo's acceptance procedure. (1σ/sphere measurement, probe alone.)

Measuring range

Unit: mm





Refer to the Probes for **CNC Coordinate Measuring Machines Brochure** (**Bulletin 2133**) for more details.

Refer to the **SurfaceMeasure** Brochure (**Bulletin 2134(2)**) for more details.

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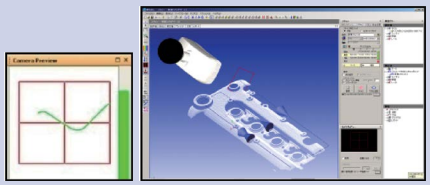
Coordinate Measuring Systems

Precision measuring technology in three dimensions

Point Cloud Processing Software for Coordinate Measuring Machines MSURF

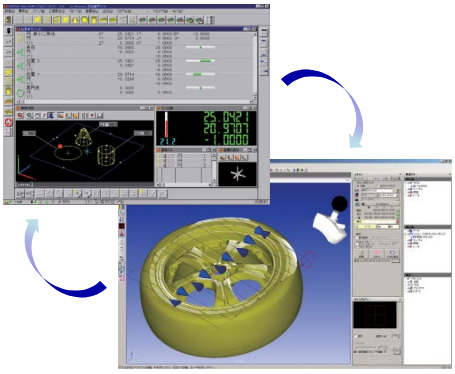
- **MSURF** is a software program that enables users to perform operations from measurement to evaluation on the same platform when the non-contact line laser probe, **SurfaceMeasure**, is used. Eight software modules are provided according to the task.



Note: I**ACR3** change rack enables automatic change of probes during CNC program execution thereby reducing measurement cycle time.

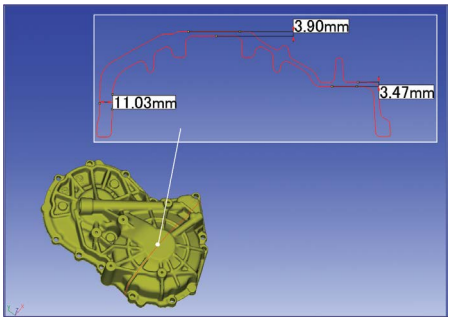
MSURF-S

Calculates point cloud data measured by CNC CMM with **SurfaceMeasure**. It generates scanning paths by defining the scanning start position, length, and width.

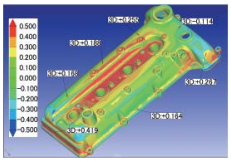


MSURF-I

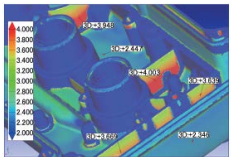
Conducts analysis or comparison verification of measured point cloud data in reference to nominal data (supporting CAD data import).



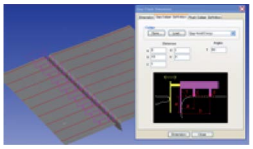
Section evaluation (dimensional calculation)



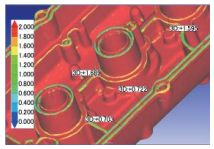
Error color-coded map



Thickness color-coded map



Evaluation of step/clearance



Surface curvature evaluation

Mitutoyo

Find Training

MSURF-G

MSURF-G is the off-line version of **MSURF-S**. It allows users to create measurement programs in advance of actual measurements on a CMM by using CAD data. Therefore, users can start measurement immediately at the time a real workpiece is ready. Since **MSURF-S** is a standalone PC application, only requiring installation by the user, it helps preserve valuable CMM time exclusively for productive measurement.

Note: **MSURF-G** cannot be combined with **MSURF-S**.

MSURF-MESH PRO

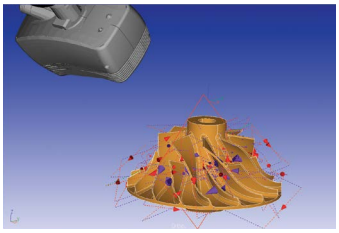
This software is provided with various functions such as filtering point cloud data and mesh data. The software is enhanced by adding functions to standard ones. It also enables functions such as mesh data thinning-out, highlighting, interpolation and outlier removal that are unavailable as standard.

Note: **MSURF-MESH PRO** has the optional functions of **MSURF-I**.

MSURF-PLANNER

MSURF-PLANNER is software to automatically create measurement macros (surface form, feature form) for the line laser probe from 3D CAD data.

Optimized data (travel path, number of probe head revolutions, etc.) of a measurement path will contribute to improvements in productivity.



Automatic generation of measurement macros by **MSURF-PLANNER**

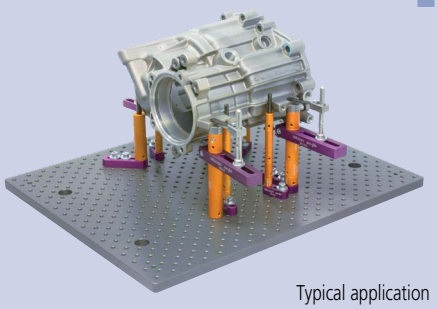
Coordinate Measuring Systems

Precision measuring technology in three dimensions

Mitutoyo ECO-FIX Fixture Systems

The Mitutoyo Eco-Fix modular fixture systems for CMM, Form, and Vision products, the work-holding setups work well for different part sizes/types and environments. The design combines operational modularity advances with lower-cost solutions. This can be found both in the reduction or elimination of hard fixturing costs and setup time. This system is comprised of well-marked, color-coded components designed to simplify part measurement requirements. Magnetic or threaded fastening points deliver fast, plug-and-play connectivity. First-time fixturing jobs can be established and reconfigured in a matter of minutes for quick turnaround for future part measurement. Or, as needed, fixtures can be built and stored to meet all common part measurement requirements. Base plates are hard-coated and other components are machined for durability.

- A workpiece can be mounted on a CMM's measuring table using combinations of Eco-Fix clamping components. Dedicated fixturing is no longer required.
- Individual starter kits are available, "Eco-fix Kit S" and "Eco-fix Kit L" as shown on the next page.
- The Eco-Fix Pallet Receiver System (PRS) is available with either "Eco-Fix Pallet Receiver Kit S" or "Eco-Fix Pallet Receiver Kit L" (shown below), eliminating the time consuming positioning of the workpiece.

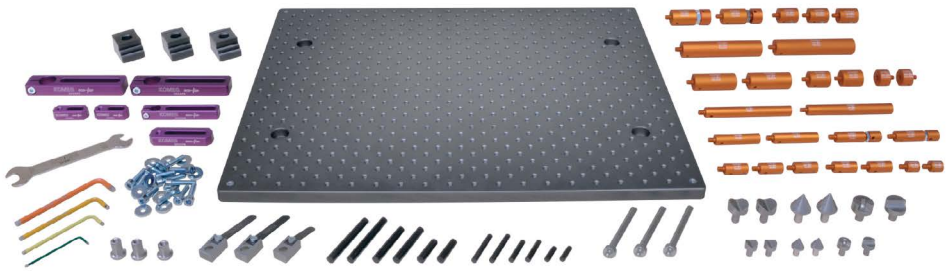


Typical application

ECO-FIX Pallet Receiver Kits

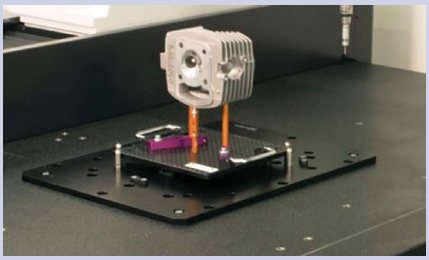
The sophisticated Mitutoyo manual Pallet Receiver System (PRS) significantly speeds up measuring on coordinate measuring machines as well as on form and vision measuring systems. Workpieces can be exchanged rapidly with the new system. The pallet system comprises the tried and tested Mitutoyo Eco-Fix system, a base plate with two handles and three semi-spheres on the bottom. The latter help users to quickly and precisely position the pallet on the receiver plate prisms fixed to the measuring machine in just one step. This way, fine adjusting of the position is a thing of the past.

Eco-Fix Pallet Receiver Kit L - K5512219
(Includes K551049, K551217, & K551216)



Eco-fix Kit L K551049

Part No.: K551344
Rack for six pallets, for the loading receiver pallet system



Receiver plate set (optional)

Receiver Plate K551217

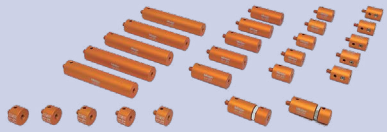
Handle Kit K551216

Schedule Service

L

Locating Pins 1 - K551123

Locating Pins 2 - K551124

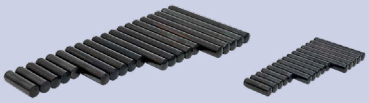


Clamping Elements 1 - K551125

Supporting Elements 1 - K551126

Supporting Elements 2 - K551127

Straight Pins - K551128



Receiver Brackets 1 - K551129

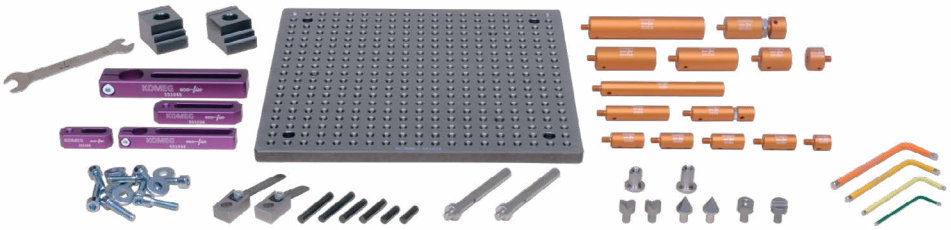
Receiver Brackets 2 - K551130

Magnet 1 - K551131

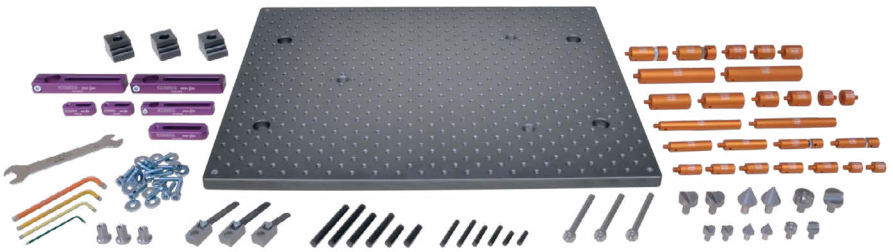
Joints 1 - K551132

ECO-FIX Fixture Kits

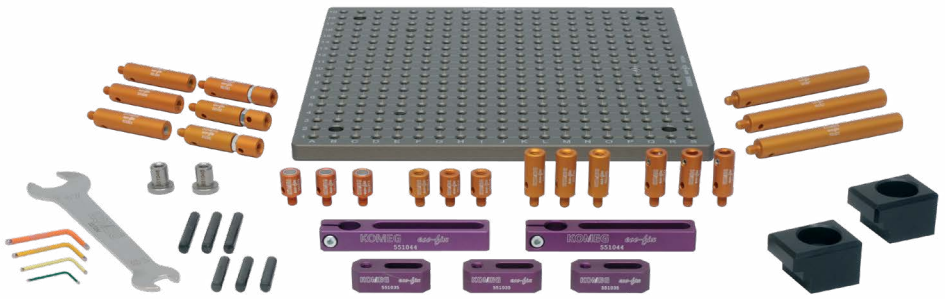
The entry-level Mitutoyo Eco-Fix Kit S version is comprised of a 250mm x 250mm base plate footprint and 59 total components in the system. The Eco-Fix Kit L is a larger version and built for more complex part fixturing applications (measuring 500mm x 400mm in base plate footprint and a total of 98 total components in the system).



Eco-Fix Kit - S K551048



Eco-Fix Kit L - K551049



Eco-Fix MAG S - K551089

Eco-Fix MAG L - K551090

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Coordinate Measuring Machines

Probing Accessories

Mitutoyo Styli Kits

M2

STARTER - K651376

BASIC 1 - K651377

BASIC 2 - K651354

PROFESSIONAL - K651379

Styli Kit M2/M3 - K651445

M3

STARTER - K651380

Carbon Fiber 1 - K651318

BASIC 1 - K651381

Carbon Fiber 2 - K651319

Carbon Fiber 3 - K651320

Materials used for spherical probes

Ruby

As the hardest of all probe element materials, ruby is the perfect all-round material. Spherical probes made of ruby have been used for most standard applications. The low specific density of ruby enables the mass of the stylus tip to be kept as small as possible. This effectively allows the elimination of false triggers caused by mass inertia when the CMM moves.

Zirconium oxide

Because of the specific surface properties of balls made of zirconium oxide - a ceramic compound – it is ideally suited for aggressive scanning of abrasive surfaces, such as workpieces made of cast iron. Zirconium oxide has virtually the same hardness and wear-resistant properties as ruby.

Silicon nitride

Silicon nitride is extremely hard and wear-resistant with the lowest surface roughness of all ball materials. Specific advantage: Silicon nitride is resistant to absorbing aluminum from workpiece surfaces.

Find a Distributor

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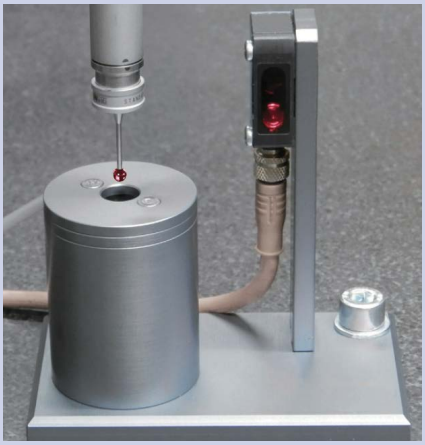
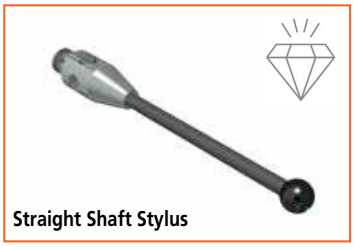


Diamond Styli

Solid diamond and diamond-coated balls offer significant advantage over other styli tip materials. Whether it is because the application demands extreme wear resistance or extreme long lasting is the requirement, diamond is a perfect choice.

General specification:

- The ball and stem connection is done by using hard soldering in a protective atmosphere.
- Stem material: carbide
- Styli lengths up to 50mm are currently supported.
- All styli specified with ruby balls and tungsten carbide stems can be replicated with diamond coated balls. (M2, M3, M4 and M5)



Straight Shaft Stylus

Stepped Shaft Stylus

Specification: Solid diamonds

- Available ball diameters are: ø0.3mm, ø0.6mm, ø0.8mm, ø1.0mm, ø2.0mm, ø3.0mm
- Sphericity deviation Grade 10 <250 nm

Specification: Diamond coated balls

- The diamond coating is applied on a silicon nitride ball.
- The black color is still visible through the translucent diamond coat.
- 0.05mm are added to the diameter of the nitride ball.
- Available ball diameters are: ø1.05mm, ø2.05mm, ø3.05mm, ø5.05mm, ø8.02mm
- Sphericity deviation Grade 10 <250 nm
- Sphericity deviation Grade 5 <130 nm for ø1.05mm, ø2.05mm, ø3.05mm, ø5.05mm on request

StyliCleaner

The integrated solution for automatic stylus tip cleaning improves reliability of measurement results and reduce machine downtime caused by manual cleaning and human error.

Risk at manual styli cleaning

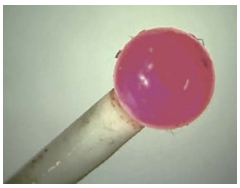
- Contaminations on the styli elements lead to significant deviations in the measurement results.
- Cleaning the stylus elements is time consuming and requires a high level of expertise.
- Human error can lead to damage and misplacement of the stylus.
- This leads to downtimes in which measurements cannot be made.

Solution

- Human error is avoided.
- Planning of automatic cleaning cycles to remove dust, oil or chips from spherical stylus elements.
- The cleaning cycle can be coupled to the calibration cycle, for example.
- The cleaning program can also be initiated by less qualified personnel using a bar or QR code.

Cleaning process

The stylus tip element is cleaned with cleaning agent for 10 seconds and then dried for 10 seconds residue-free with compressed air.



Contaminated stylus tip

Cleaned stylus tip

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Performance Assessment Method of Coordinate Measuring Machines

Regarding the performance assessment method of CMM, a revision of ISO 10360 Series was issued in 2003 and was partially revised in 2009.
The following describes the standard inspection method including the revised content.

Table 1 ISO 10360 Series

	Item	ISO Standard No.	Year of issue
1	Terms	ISO 10360-1	2000
2	Length measurement	ISO 10360-2	2009
3	Rotary table equipped CMM	ISO 10360-3	2000
4	Scanning measurement	ISO 10360-4	2000
5	Single/Multi-styli measurement	ISO 10360-5	2010
6	Software inspection	ISO 10360-6	2001

Maximum Permissible Length Measurement Error $E_{0, MPE}$ [ISO 10360-2: 2009]

Using the standard CMM with specified probe, measure 5 different calibrated lengths 3 times each in 7 directions within the measuring volume (as indicated in Figure 1), making a total of 105 measurements. If these measurement results, including the allowance for the uncertainty of measurement, are equal to or less than the values specified by the manufacturer, then it proves that the performance of the CMM meets its specification.
The result of OK/NG is required to be judged considering the uncertainties.
The maximum permissible error (standard value) of the test may be expressed in any of the following three forms (unit: μm).

$E_{0,MPE}\ (MPE_E) = A + L/K \leq B$
$E_{0,MPE}\ (MPE_E) = A + L/K$
$E_{0,MPE}\ (MPE_E) = B$

A: Constant (μm) specified by the manufacturer
K: Dimensionless constant specified by the manufacturer
L: Measured length (mm)
B: Upper limit value (μm) specified by the manufacturer

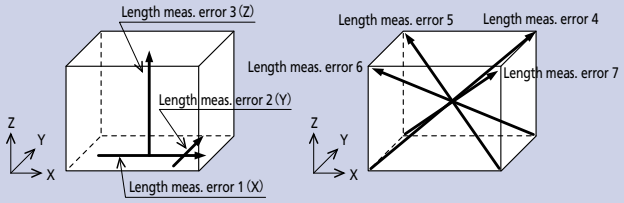


Figure 1 Measauring directions to obtain length measurement error

Note: ISO 10360-2: 2009 requires measurement in 4 different directions and recommends measurement parallel to each axis, while ISO 10360-2: 2001 specified the measurement "in 7 arbitrary directions."

The following error definitions were added in ISO 10360-2: 2009.

Maximum Permissible Length Measurement Error/ Length Measurement Error when stylus offset is 150 mm $E_{150, MPE}$ [ISO 10360-2: 2009]

In addition to length measurement in 7 directions, ISO 10360-2: 2009 specifies measuring in 2 lines over the diagonal YZ or XZ plane with probe offset as shown in Figure 2. Note: The stylus offset is set at 150 mm as default.

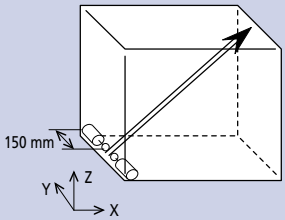


Figure 2 Length measurement error when Z-axis stylus offset is 150 mm

Maximum Permissible Limit of the Repeatability Range of Length Measurement $R_{0, MPL}$ [ISO 10360-2: 2009]

Calculate the maximum value from the results of three repeated measurements.

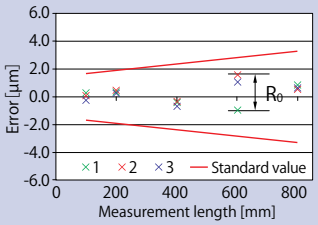


Figure 3 Repeating range of length measurement

Maximum Permissible Radial Four-Axis Error MPE_{FR}, Maximum Permissible Tangential Four-Axis Error MPE_{FT}, and Maximum Permissible Axial Four-Axis Error MPE_{FA} [ISO 10360-3: 2000]

The test procedure under this standard is to place two standard spheres on the rotary table as shown in Figure 4. Rotate the rotary table to a total of 15 positions including 0°, 7 positions in the plus (+) direction, and 7 positions in the minus (-) direction and measure the center coordinates of the two spheres in each position. Then, add the uncertainty of the standard sphere shape to each variation (range) of radial direction elements, connecting direction elements, and rotational axis direction elements of the two standard sphere center coordinates. If these calculated values are less than the specified values, the evaluation test is passed.

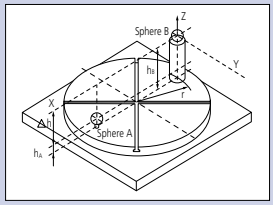


Figure 4 Evaluation of a CMM with a rotary table

Maximum Permissible Scanning Probing Error MPE_{THP} [ISO 10360-4: 2000]

This is the accuracy standard for a CMM if equipped with a scanning probe. The test procedure under this standard is to perform a scanning measurement in 4 planes on the standard sphere and then, for the least squares sphere center calculated using all the measurement points, calculate the radial range (dimension 'A' in Figure 5) within which all measurement points exist. Based on the least squares sphere center calculated above, calculate the radial distance between the calibrated standard sphere radius and the maximum measurement point and the minimum measurement point, and take the larger distance (dimension 'B' in Figure 5). Add an extended uncertainty that combines the uncertainty of the stylus tip shape and the uncertainty of the standard test sphere shape to each A and B dimension. If both calculated values are less than the specified values, this scanning probe test is passed.

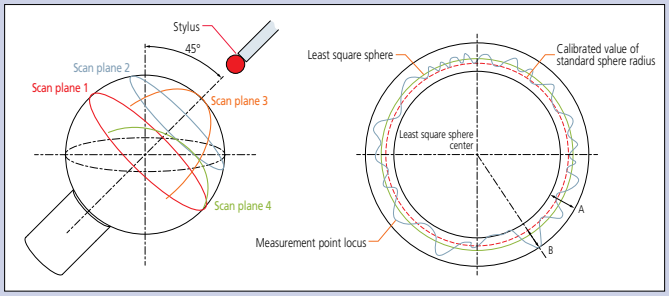


Figure 5 Target measurement planes for the maximum permissible scanning probing error and its evaluation concept

Maximum Permissible Single Stylus Form Error $P_{FTU, MPE}$ [ISO 10360-5: 2010]

This measurement was included in the dimensional measurement in ISO 10360-2: 2001. However, it is specified as "CMMs using single and multiple stylus contacting probing systems" in ISO 10360-5: 2010.
The measurement procedure has not been changed, and the following procedure should be performed.
Measure the defined target points on a standard sphere (25 points, as in Figure 6) and use all the results to calculate the center position of the sphere by the least squares method.
Then, calculate the radial distance from the center position of the sphere by the least squares method for each of the 25 measurement points and obtain the radial difference Rmax - Rmin. If this difference, to which a compound uncertainty of forms of the stylus tip and the standard test sphere are added, is equal to or less than the specified value, it can be judged that the probe has passed the test.

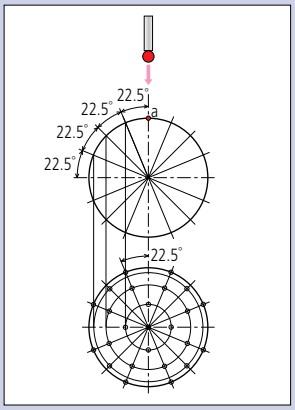
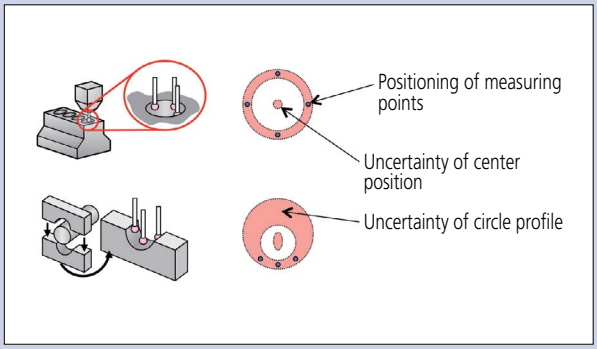


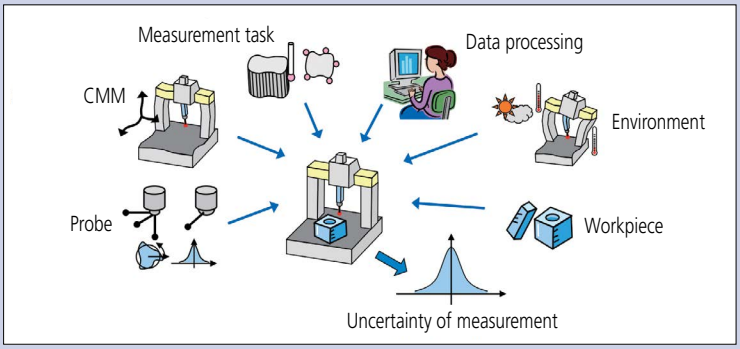
Figure 6 Target points of measurement for Single Stylus Form Error

Measurement Uncertainty of the CMM

Measurement uncertainty is an indication used for evaluating reliability of measurement results.
In ISO 14253-1: 1998, it is proposed to consider the uncertainty when evaluating the measurement result in reference to the specification.
However, it is not easy to estimate the uncertainty of the measurement performed by a CMM.
To estimate the uncertainty of the measurement, it is necessary to quantify each source of uncertainty and determine how it propagates to the measurement result. The CMM is subject to all types of settings that determine how the measurement should be performed, such as measurement point distribution, or datum definition, according to the drawing instruction or operator's intention. This fact makes it harder to detect the sources of uncertainty influencing the result. Taking circle measurement as an example, just a difference of one measurement point and its distribution causes the necessity of recalculation of the uncertainty.
Also, there are many sources of uncertainty to be considered with the CMM and their interactions are complex.
Because of the above, it is almost impossible to generalize on how to estimate measurement uncertainty of the CMM.



Example of circle measurement by CMM



Major contributions that cause uncertainty in CMM measurement results

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