SMS Smart Measuring System
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Data Management Software by Mitutoyo

Shop-floor Type CNC Coordinate Measuring Machine MiSTAR 555

- Accuracy across a wide temperature range of 10 to 40 °C has been achieved thanks to a combination of technologies such as the symmetric guide structure, uniform material, and temperature compensation.
- Equipped with the newly developed environment-resistant ABS scale, the machine benefits from significantly enhanced contamination tolerance. This eliminates the need for initialization and improves work efficiency.
- The footprint is reduced to about 80% compared with that of the conventional moving bridge model by adopting the horizontal-arm structure and installing the CMM controller and PC under the measuring table.

Equipped with the **PH10MQ** probe head

MiSTAR 555

SPECIFICATIONS

Items \ Model		MiSTAR 555
Measuring range	X axis	570 mm
	Y axis	500 mm
	Z axis	500 mm
Maximum permissible length measurement error*1*2 ISO 10360-2: 2009 (18 to 22 °C) (Probe used SP25M)		2.2 + 3L/1000 µm
Drive speed		CNC MODE: 5 to 350 mm/s (max. combined speed 606 mm/s)
Drive acceleration		1556 mm/s^2 (max. combined acceleration 2695 mm/s^2)
Workpiece	Max. height	660 mm
	Max. loading	120 kg
Accuracy guaranteed temperature range		10 to 40 °C
Mass (including the controller and installation platform)		655 kg

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

Refer to the **MiSTAR 555** Brochure (**E16028**) for more details.

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

- The **CRYSTA-Apex V500/700/900** Series, CNC CMMs deliver high accuracy (1.7 µm), high speed, and high acceleration. This series includes models suitable for small- to medium-sized workpieces.
- The temperature compensation system supplied as standard can deliver accuracy across a wide temperature range of 16 to 26 °C.

CRYSTA-Apex V574

CRYSTA-Apex V776

CRYSTA-Apex V9106

The PH20 5-axis control touch-trigger probe is available. Excludes CRYSTA-Apex V9108, CRYSTA-Apex V9168 and CRYSTA-Apex V9208.

SPECIFICATIONS

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 V 9106	CRYSTA-Apex V 9108	CRYSTA-Apex V 9166	CRYSTA-Apex V 9168	CRYSTA-Apex V 9206	CRYSTA-Apex V 9208
Measuring range	X axis	900 mm					
	Y axis	1000 mm		1600 mm		2000 mm	
	Z axis	600 mm	800 mm	600 mm	800 mm	600 mm	800 mm

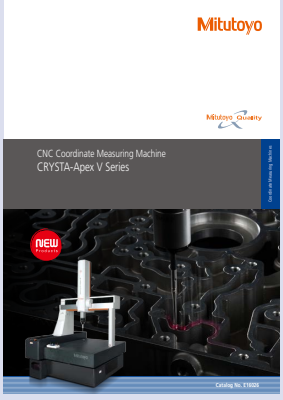
Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

CRYSTA-Apex V Series Accuracy

Unit: µm

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)



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

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

- The **CRYSTA-Apex V1200/1600/2000** Series are large-sized CNC CMMs developed for supporting quality evaluation of large parts.
- The temperature compensation system supplied as standard can deliver accuracy across a wide temperature range of 16 to 26 °C.

CRYSTA-Apex V122010

CRYSTA-Apex V162012

SPECIFICATIONS

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 V 162012	CRYSTA-Apex V 162016	CRYSTA-Apex V 163012	CRYSTA-Apex V 163016	CRYSTA-Apex V 164012	CRYSTA-Apex V 164016
Measuring range	X axis	1600 mm					
	Y axis	2000 mm		3000 mm		4000 mm	
	Z axis	1200 mm	1600 mm	1200 mm	1600 mm	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

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Helical scan

Gasket scan

Sweep scan

Airfoil section scan

Standard CNC CMM
CRYSTA-Apex EX 1200R Series

- **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

SPECIFICATIONS

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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High Accuracy CNC CMM
STRATO-Apex Series

- 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.
- For position detection, the same ultra-high-precision length measuring unit (internally developed) as that used in the **LEGEX** series has been adopted. It enables excellent position detection for highly-accurate measurement. 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

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		$E_{0,MPE} = 0.7 + 2.5L/1000$*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

Refer to the **STRATO-Apex** Series Brochure (**E16001**) for more details.

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High-accuracy Separate Guide Type STRATO-Apex Series

- The **STRATO-Apex** Series are CNC CMMs that use Mitutoyo's standard structure for large machines which are designed to be used for measuring large and heavy workpieces with high accuracy. The measuring accuracy and drive speed are the world's highest in the X-axis measuring range of 2000 mm and 3000 mm.
- 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.
- These series are equipped with a system to automatically restore accuracy deterioration (MOVAC) 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.

STRATO-Apex 3000G Series

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SPECIFICATIONS

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 local Mitutoyo sales office.

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Ultra-high Accuracy CNC CMM
LEGEX Series

- The **LEGEX** 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.
  It has been designed to minimize deformation affected by variable load, etc. by conducting in-depth stress analyses based on FEM structural analysis simulations. In addition, other technologies have been utilized in the structure of the drive unit, minimizing vibration, etc., to provide ultra-high accuracy.
- For position detection, it has adopted an ultra-high-precision length measuring unit (internally developed) created by combining an ultra-high-precision crystallized glass scale having a thermal expansion coefficient of 0 with a high-resolution, high-performance reflective linear encoder, thereby enabling excellent position detection for ultra-high-precision measurement.

LEGEX 9106

SPECIFICATIONS

Items \ Model		LEGEX 574	LEGEX 774	LEGEX 776	LEGEX 9106	LEGEX 12128*
Measuring range	X axis	500 mm	700 mm	700 mm	900 mm	1200 mm
	Y axis	700 mm	700 mm	700 mm	1000 mm	1200 mm
	Z axis	450 mm	450 mm	600 mm	600 mm	800 mm

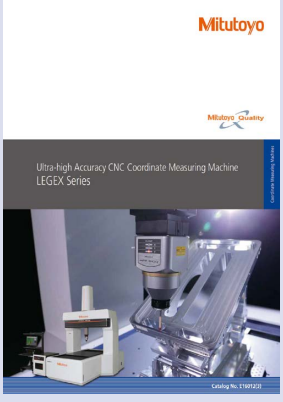
* Custom-made model. For information about **LEGEX 12128**, contact your local Mitutoyo sales office.
Note: For measuring table, the standard specification is ceramic coating. A hand scraper version is available as a made-to-order item.

LEGEX Series Accuracy

Unit: µm

Probe used	Length measurement error*1 ISO 10360-2: 2009
MPP-310Q	$E_{0,MPE}$=0.28 + L/1000*2

*1 Specifications vary by configuration, size, and thermal environment.
*2 L = Measuring length (unit: mm)
Note: For **LEGEX 12128**, contact your local Mitutoyo sales office.



Refer to the **LEGEX** Series Brochure (**E16012**) for more details.

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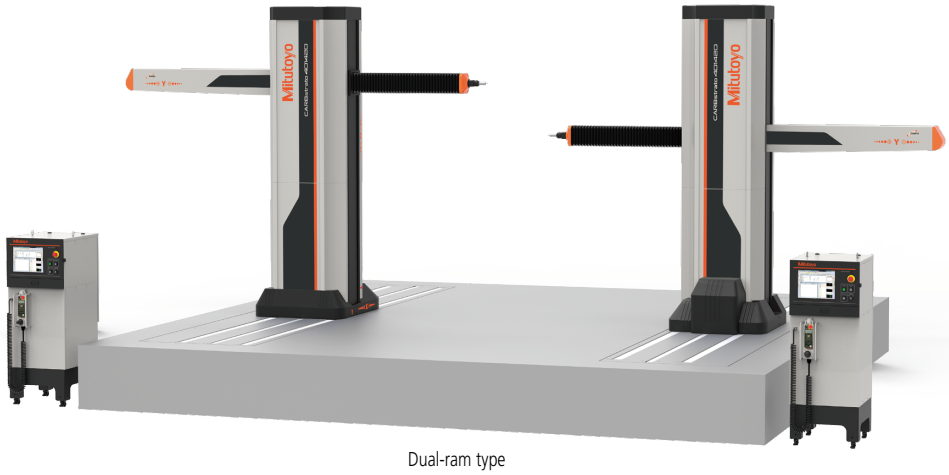
Car Body Measuring System CARBstrato Series

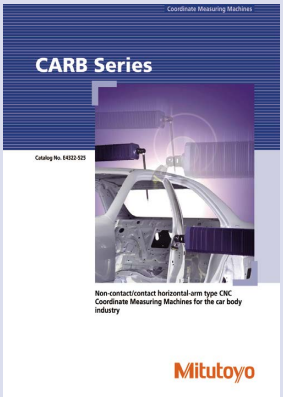
Measurement example for dual-ram type
(Simultaneous use of touch-trigger probe and line laser probe)

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

- Single- & Dual-ram systems
  Single- and dual-ram types are available to suit the intended use.
  Single-ram type: Measures a workpiece using a single ram
  Dual-ram type: Measures a workpiece placed between two simultaneously controlled rams



Dual-ram type



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

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In-line Type CNC CMM MACH-3A Series

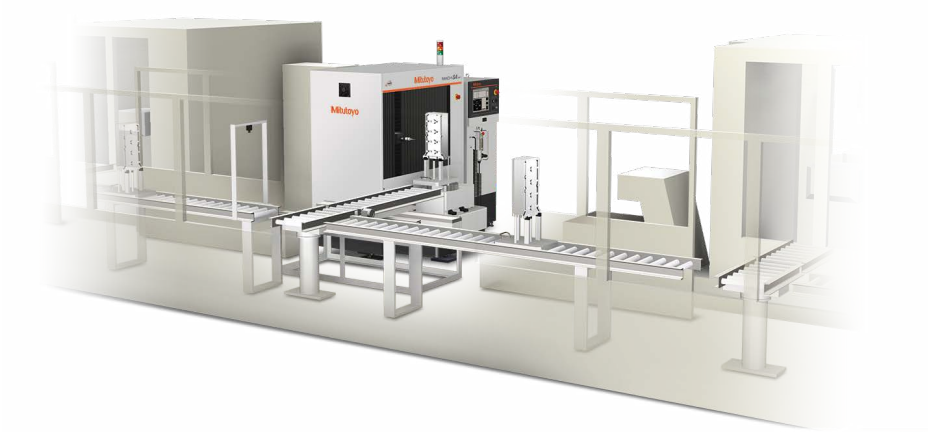
• In-line type CNC CMM (Horizontal-ram type) Incorporating the CMM controller and the host computer in the main unit results in a compact space-saving footprint for the shop floor. This series is designed for 24-hour operation with high stability and remarkable durability. Accuracy can be guaranteed within a temperature range of 5 to 40 °C.

MACH-3A 653
The indexing table shown is optional

SPECIFICATIONS

Items \ Model		MACH-3A 653
Measuring range	X axis	600 mm
	Y axis	500 mm
	Z axis	280 mm
Accuracy*1*2	19 to 21 °C	$E_{0,MPE} = 2.2 + 3.5L/1000$ µm*3

*1 Specifications vary by configuration and thermal environment.
*2 For guaranteed accuracy within a temperature range other than 19 to 21 °C, please contact your local Mitutoyo sales office.
*3 L = Measuring length (unit: mm)



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

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In-line Type CNC CMM
MACH-V9106

- This makes it possible to build a flexible measuring system to replace gage measurements on power train production lines. 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.

MACH-V9106

SPECIFICATIONS

Items \ Model		MACH-V9106
Measuring range	X axis	900 mm
	Y axis	1000 mm
	Z axis	600 mm
Accuracy*1*2	19 to 21 °C	$E_{0,MPE} = 2.5 + 3.5L/1000\,\mu m$*3

*1 Specifications vary by configuration and thermal environment.
*2 For guaranteed accuracy within a temperature range other than 19 to 21 °C, please contact your local Mitutoyo sales office.
*3 L = Measuring length (unit: mm)

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

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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

Note: Stand, measuring table, etc. are options.

SPECIFICATIONS

Items \ Model		KGM12128-C
Measuring range	X axis	120 mm
	Y axis	120 mm
	Z axis	80 mm
Accuracy*1*2	19 to 21 °C	$E_{0,MPE}$ = 2.4 + 5.7L/1000 µm*3

*1 Specifications vary by configuration and thermal environment.
*2 For guaranteed accuracy within a temperature range other than 19 to 21 °C, please contact your local Mitutoyo sales office.
*3 L = Measuring length (unit: mm)

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

Software for Manual/CNC Coordinate Measuring Machines MCOSMOS

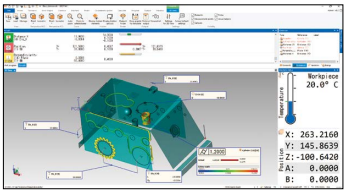
MCOSMOS software modules

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

- **MCOSMOS** is the data processing program family for the CMM that runs on Windows.

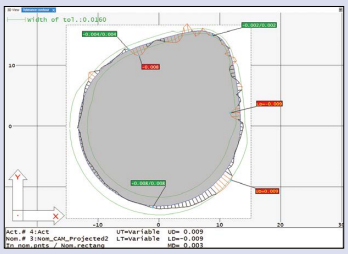
GEOPAK [General purpose measurement program]

For (online/offline) part program creation, using the measurement of geometric elements. Extensive tolerance comparisons and output functions are included.



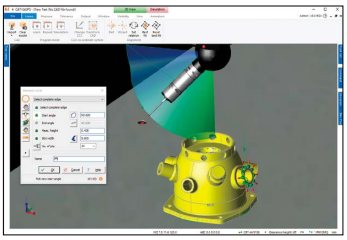
SCANPAK [Contour measurement program]

SCANPAK is a program for measuring/evaluating contours for profile requirements. Graphical display for reporting & output back to m/c tool and many other operations are possible.



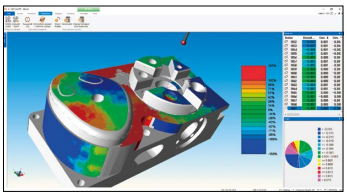
CAT1000P [Online/Offline teaching program]

For (online/offline) part program creation, using the measurement of geometric elements directly from the CAD model, with automatic collision avoidance.



CAT1000S [Curved surface evaluation program]

CAD model-based generation of surface measurement points, and comparison of actual/nominal data, with graphical output.

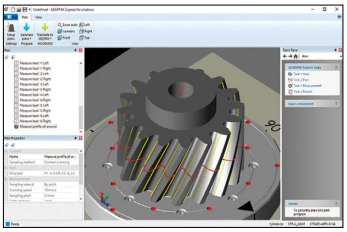


GEARPAK-Worm [Gear evaluation program]

This is a software for evaluation of tooth form based on worm measurement data obtained from CNC CMMs.

GEARPAK Express [Gear evaluation program]

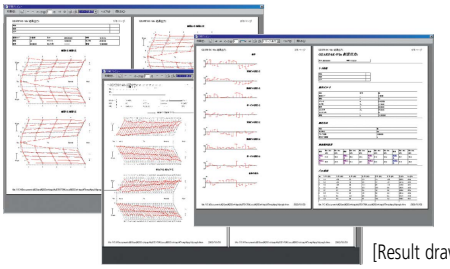
This is a program for evaluation of involute gear teeth obtained from CNC CMMs, and tooth profile based on cylindrical gear measurement data.



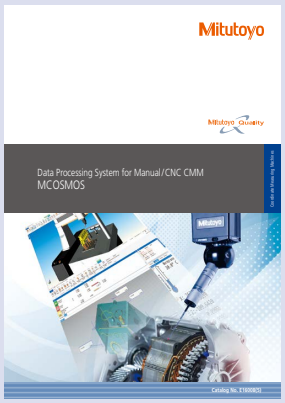
[Result drawing]

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

This is a software for evaluation of tooth form, pitch error, etc., based on measurement data from bevel or hypoid gears obtained by CNC CMM.



[Result drawing]



Refer to the **MCOSMOS** Software Brochure (**E16008**) for more details.

FORMTRACEPAK-AP [Analysis program]

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

SURFPAK-SP [Analysis program]

This is a software program as 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.

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.

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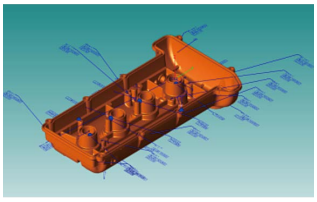
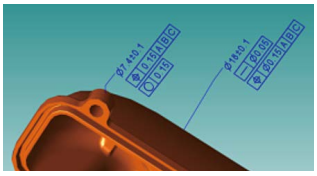
Automatic measurement program generation software MiCAT Planner

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

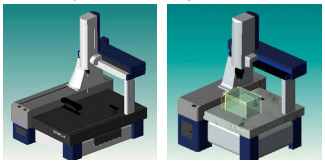
- Identifies tolerance information included in 3D models with Product and Manufacturing Information (PMI), defines measurement locations and creates a measurement program fully automatically.
  Also, even with the 3D CAD model without PMI, the measurement program can be created automatically just by adding tolerance information on **MiCAT Planner**.
  This is more efficient than the conventional teaching model.
- Through its optimization function, the software estimates the shortest route for measurement with the minimum of probe repositioning and tool changing, and creates a program that enables measurement in the minimum possible time.
- Utilizing the rule editor function to set the measurement rules prevents variation in measurement quality between program writers.

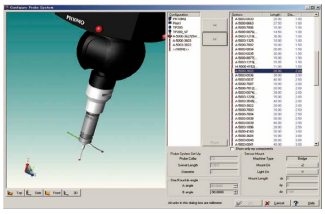
CAD data with tolerances



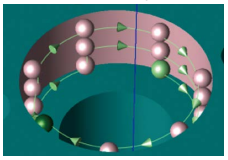


CMM System configuration

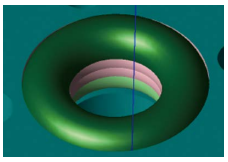




User-defined measurement rules
(number of locations to measure with tolerance information and sampling method, etc.,)

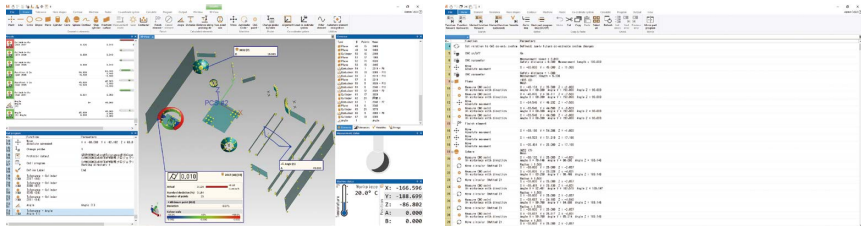


Example of sampling method: contact measurement



Example of sampling method: scanning measurement

Instantly and automatically creates a measurement program



Output a measurement program for MCOSMOS

Tolerance information add function

Lets you add tolerances in the software even for 3D CAD models containing no tolerance information. Automatically create optimal measuring programs based on the added tolerance specifications.

Supported languages

Available in 16 languages

Case study

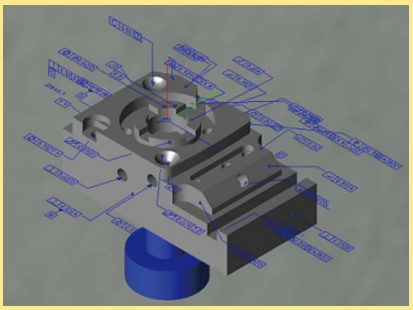
Compare the measurement part-programming time for a test piece.

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 at the same time improve product quality.

Refer to the **MiCAT Planner** Brochure (**E16019**) for more details.

• 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 **SurfaceMeasure201FS**).

Refer to the **SurfaceMeasure** Brochure (**E16000**) for more details.

Non-contact type laser probe SurfaceMeasure

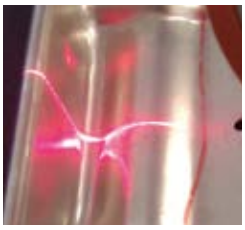
• Ultra-high speed data collection
The **SurfaceMeasure** probe works by emitting laser beams onto the workpiece to collect coordinate values from its surface, and can collect data at the ultra-high speed of 300,000 points/second.*
* When using **SurfaceMeasure1110**

• Advantages of non-contact type
Non-contact measurement enables measurement of materials that can 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 a simple and comfortable laser-scanning environment since measurement is now powder and spray free.

• Evaluation cases
The collected 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

403

1110

201FS

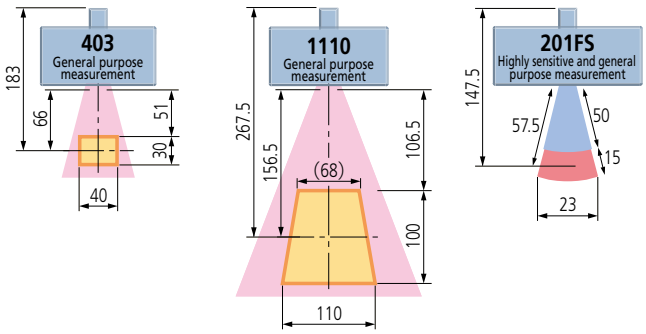
SPECIFICATIONS

		SurfaceMeasure 403	SurfaceMeasure 1110	SurfaceMeasure 201FS
Laser irradiation method		Line Laser		Flying spot
Max. scan width		40 mm	110 mm	23 mm
Max. scan depth		30 mm	100 mm	15 mm
Working distance		66 mm	156.5 mm	57.5 mm
Scanning error*		8 µm	9 µm	1.8 µm
Max. acquisition rate		60,000 points/sec	300,000 points/sec	25,000 points/sec
Mass		430 g	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	4 mW	2.5 mW	1 mW

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

Measuring range

Unit: mm



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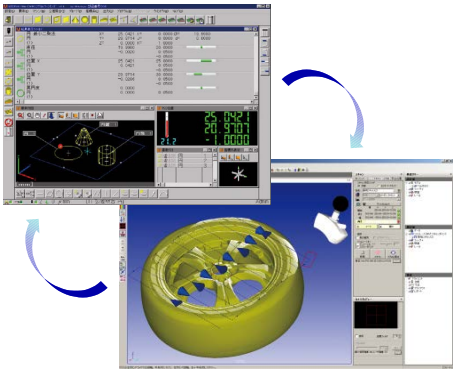
Point Cloud Processing Software for Coordinate Measuring Machines MSURF

• **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.

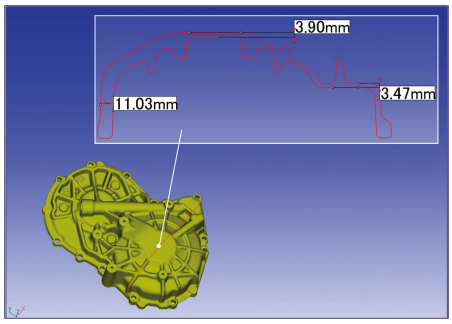
MSURF-S

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

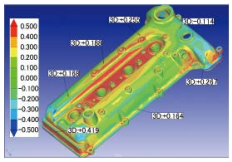


MSURF-I

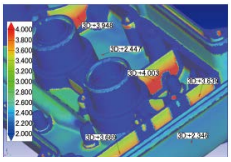
Conducts analysis or comparison verification of measured point cloud data in reference to nominal data (supporting CAD data import).



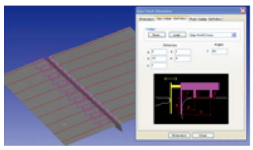
Section evaluation (dimensional calculation)



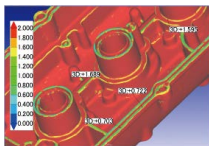
Error color-coded map



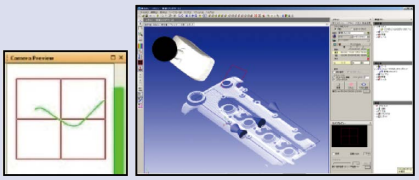
Thickness color-coded map



Evaluation of step/clearance



Surface curvature evaluation



Note: If not using the **ACR3** probe changer, probe replacement is performed manually.

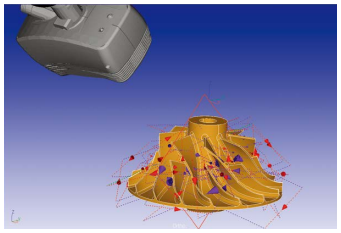
MSURF-MESH PRO

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**

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**.

Scanning probes

SP25M

Compact high accuracy type scanning probe

This compact, multifunctional and highly accurate scanning probe is only 25 mm in diameter, which enables it to access shrouded workpiece features. Data collection is 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.

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.

SP80

High accuracy scanning probe (supports 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.

MPP-10

Probe for effective thread-depth measurement

This is the only probe in the world that is dedicated to measure effective screw-thread depth on a CNC CMM. The probe can also attach to a probe head (**PH10M**/**10MQ**) to change the orientation to measure bores in various directions.

REVO-2

High speed 5-axis scanning head

This high-speed scanning head delivers high accuracy measurement while delivering high-throughput. Contact measurement with a stylus that can be up to 500 mm in length increases flexibility and makes simultaneous 5-axis measuring with non-step indexing possible.

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.

SurfaceMeasure403

SurfaceMeasure1110

SurfaceMeasure201FS

QVP

QUICK VISION probe

This CNC CMM Quick Vision Probe utilizes Mitutoyo's technology in a vision measuring machine for totally-automated video measurement.

CF20

Centering microscope for CMMs

This centering microscope enables measurement of small holes or elastic bodies that are very difficult to measure using a contact measurement method such as with a touch-trigger probe. It also allows a CMM to be used as a very large microscope.

CCTV Monitor System for CMM (optional)

A probe for roughness measurement

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

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.

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.

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.

N

MH20i

Touch-trigger probe with manual probe head

This touch-trigger probe equipped with a manual probe head is designed for use with manual CMMs. The probe head may be manually indexed to 168 positions.

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 significantly be 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

PH1

Manual probe head

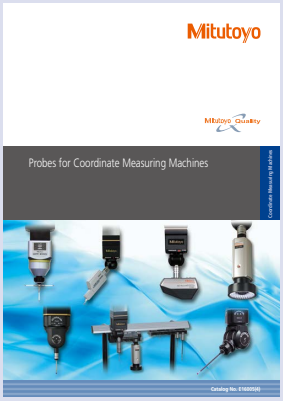
This manual probe head is designed for use with the **TP200**/**TP20** touch-trigger probes.
The attached probe is manually positioned in the desired orientation to suit the measuring task.

▲Mounting example of touch-trigger probe

PH6M

Fixed probe head

A fixed probe head with autojoint connector for use with **TP7M** or **SP25M**.



Refer to the Probes for Coordinate Measuring Machines Brochure (**E16005**) for more details.

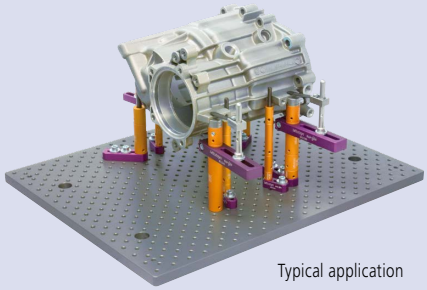
Clamping System

- A workpiece can be mounted on a CMM's measuring table using a variety of combinations of **Eco-Fix** clamping components. A dedicated fixturing jig is not necessary.
- Economical starter kits "**Eco-fix Kit S**" and "**Eco-fix Kit L**" are available as shown below.
- Using the optional receiver plate set relieves you of the trouble of positioning the workpiece.

Eco-fix Kit

Eco-fix Kit L

Receiver plate set (optional)



Typical application

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).

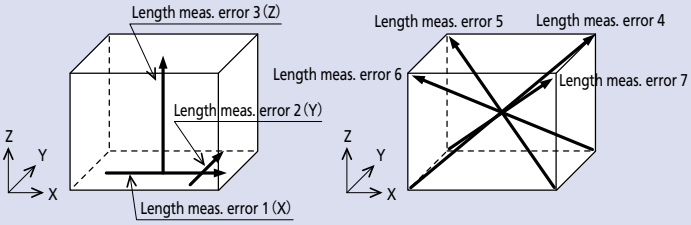


Figure 1 Measauring directions to obtain length measurement error

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

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

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.

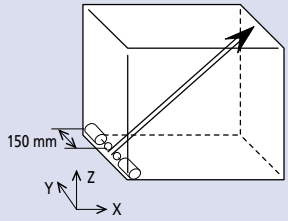


Figure 2 Length measurement error when Z-axis stylus offset is 150 mm

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.

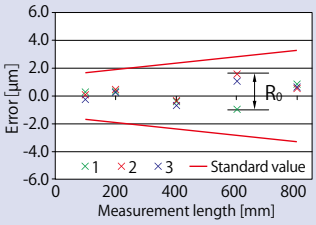


Figure 3 Repeating range of length measurement

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.

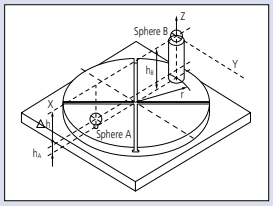


Figure 4 Evaluation of a CMM with a rotary table

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.

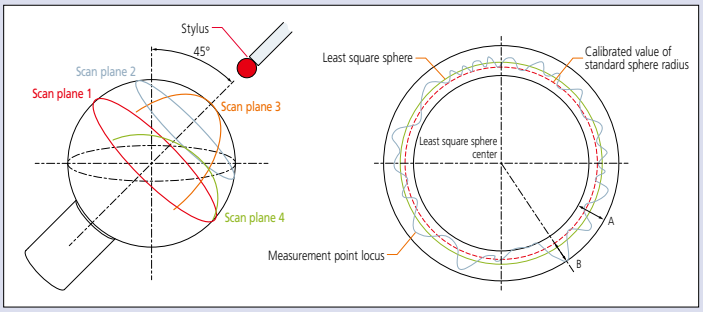


Figure 5 Target measurement planes for the maximum permissible scanning probing error and its evaluation concept

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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.

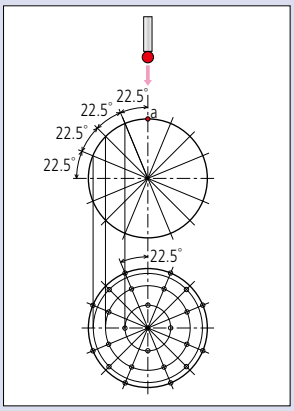
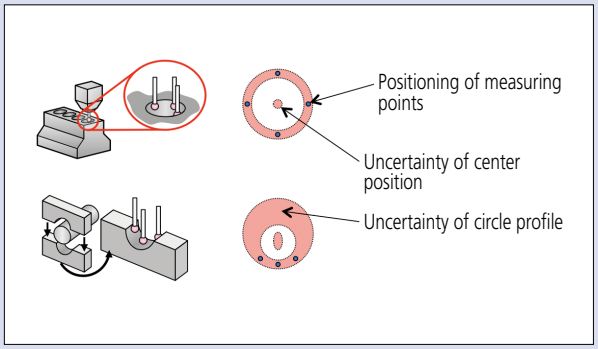


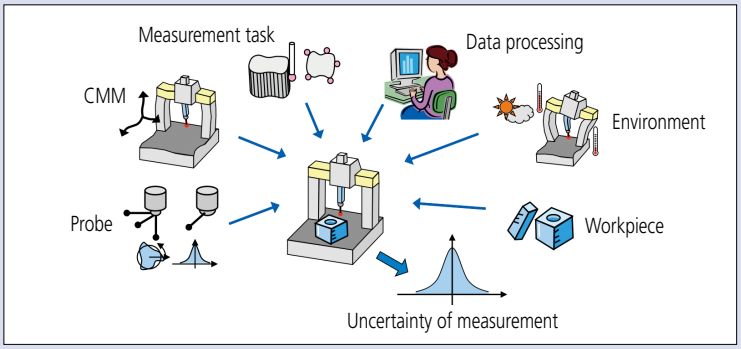
Figure 6 Target points of measurement for Single Stylus Form Error

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.



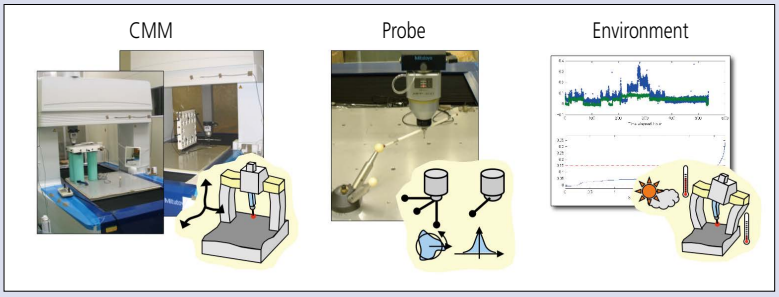
Example of circle measurement by CMM



Major contributions that cause uncertainty in CMM measurement results

Measurement uncertainty of the CMM and the Virtual CMM software

The Virtual CMM software* enables straightforward, automated estimation of the measurement uncertainty of a CMM. The software simulates a CMM on a PC based on its machine characteristics and performs virtual (simulated) measurements. The simulated measurements are performed according to the part program created by the machine operator. The machine's performance is evaluated from experimental values based on geometrical characteristics of the actual machine, probing characteristics, and temperature environment, etc., and the measurement uncertainty of the CMM is estimated by the software package.
ISO15530 Part 4 (ISO/TS 15530-4 (2008)) defines how to verify the validity of task-specific measurement uncertainty using computer simulations.
Virtual CMM conforms to this specification.



Quantification of CMM uncertainty elements by experiment

* Virtual CMM is a software package originally developed by PTB (Physikalisch-Technische Bundesanstalt).

Relevant parts of ISO 15530: Geometrical Product Specifications (GPS) – Coordinate measuring machines (CMM): Technique for determining the uncertainty of measurement –
Part 3: Use of calibrated workpieces or measurement standards
Part 4: Evaluating task-specific measurement uncertainty using simulation [Technical Specification]

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