

## Telecentric Measurement System

**NEW** TM-X5000 Series

Silhouette-based analysis for guaranteed accuracy



**NEW**

Large  $\phi 120$  mm  
field of view model  
now available

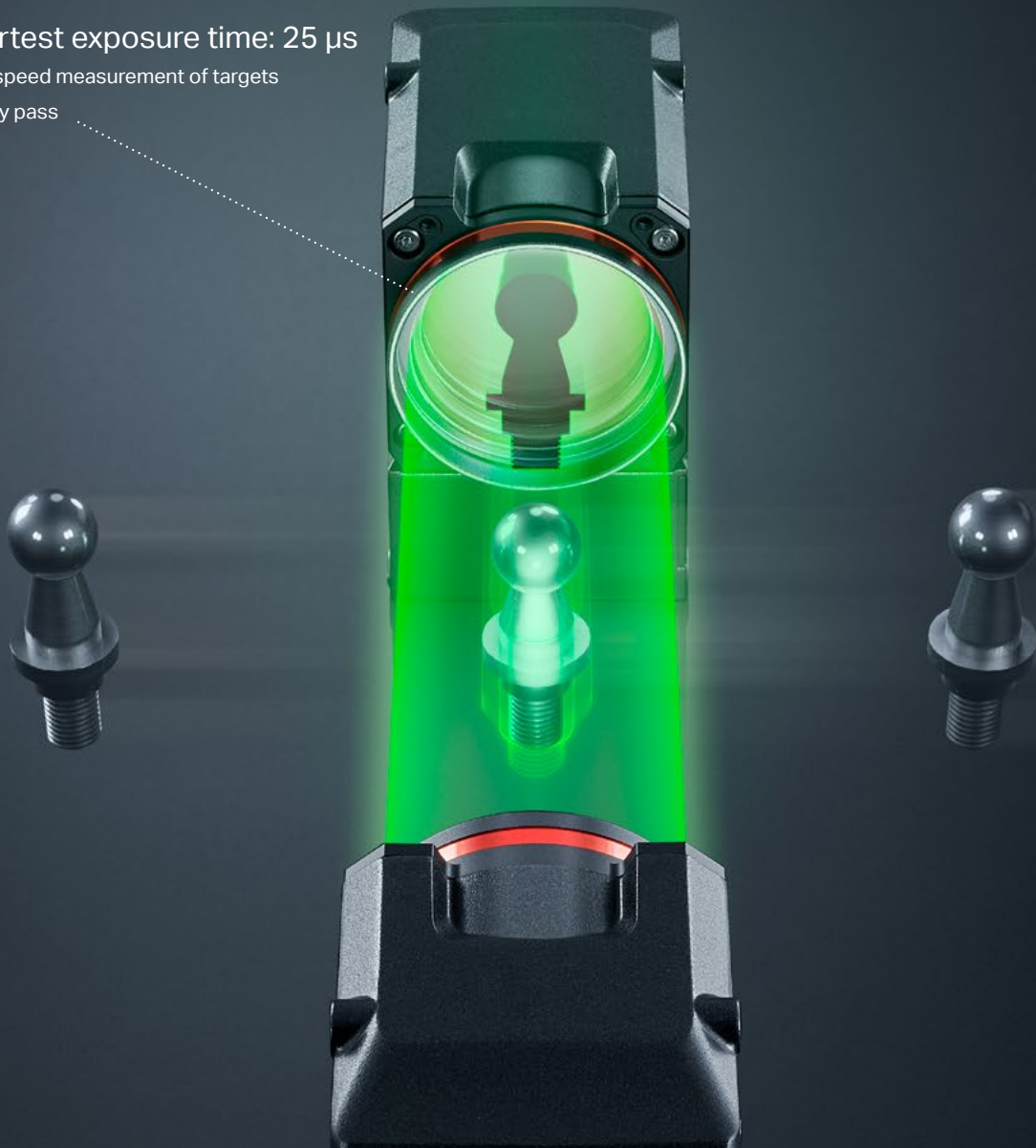
Max. field of view  
of conventional  
models:  
 $\phi 65$  mm

Max. field of view  
of new model:  
 $\phi 120$  mm

Fast and accurate inline measurement

# Measure parts in motion

Shortest exposure time: 25  $\mu$ s  
High-speed measurement of targets  
as they pass



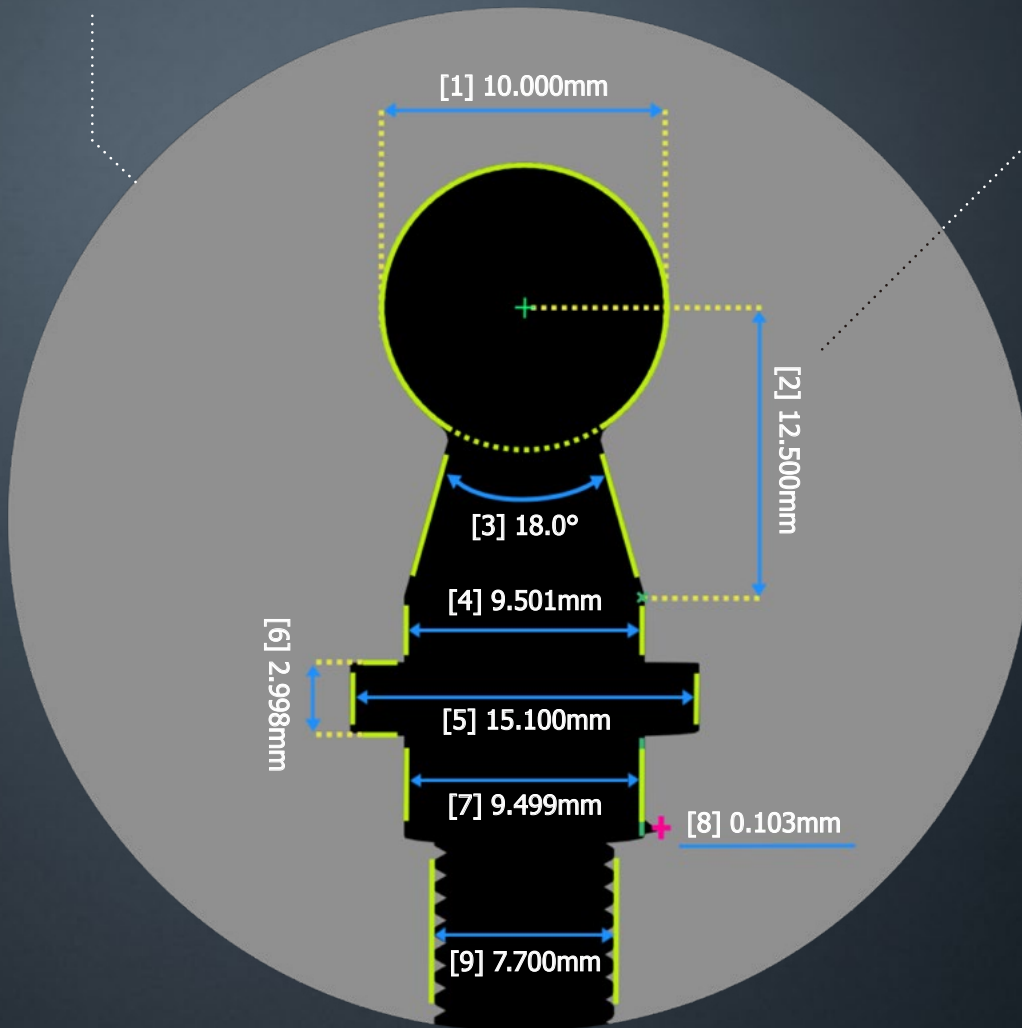
■ System configuration



# Calibrated high-speed measurement

Dual telecentric optical system  
No need to worry about focusing or misalignment

Silhouette-based analysis  
Stable measurement of any material



■ Selection of sensors available to suit a variety of applications

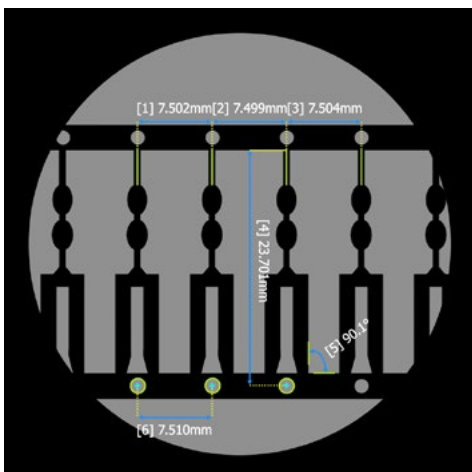
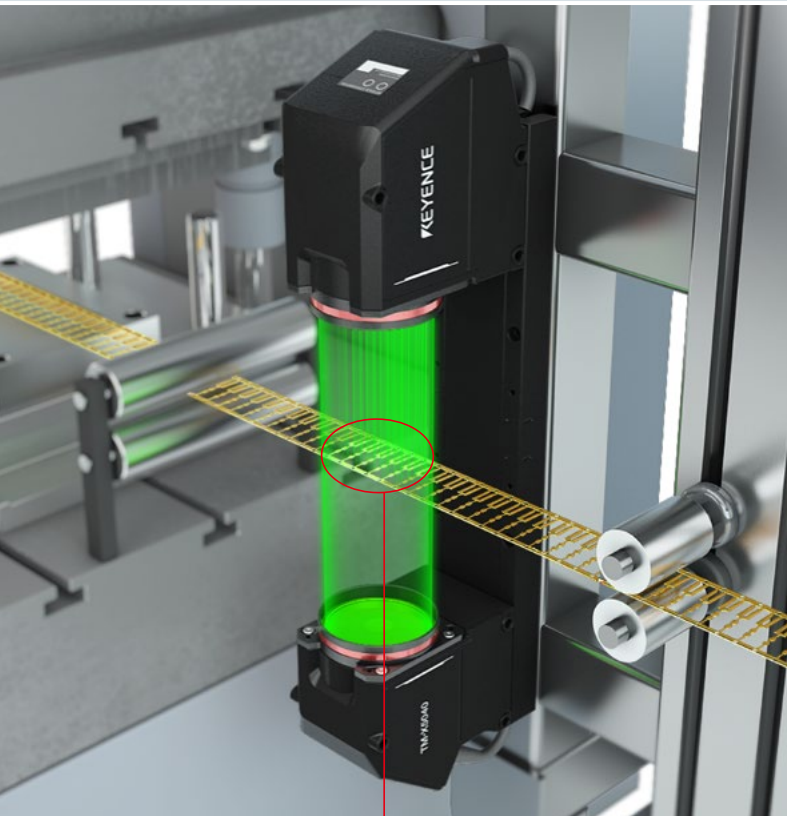
Field of view		ø6 mm	ø40 mm	ø65 mm	ø120 mm
Repeatability		±0.03 µm	±0.08 µm	±0.1 µm	±0.2 µm
Measurement position accuracy		±0.2 µm	±1 µm	±1.2 µm	±2.5 µm
Sampling cycle		As fast as 3 ms (approx.)			

# Versatile solution for any industry

## GD&T

Instant measurement of all drawing instructions

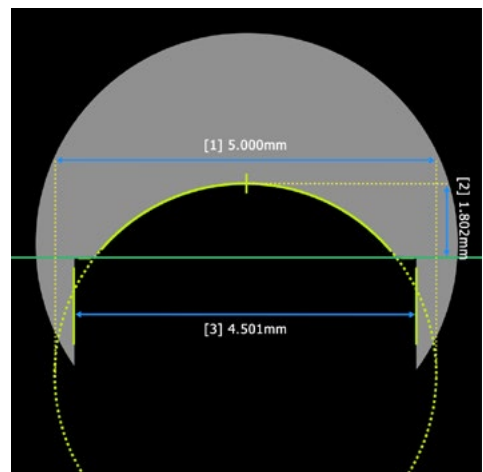
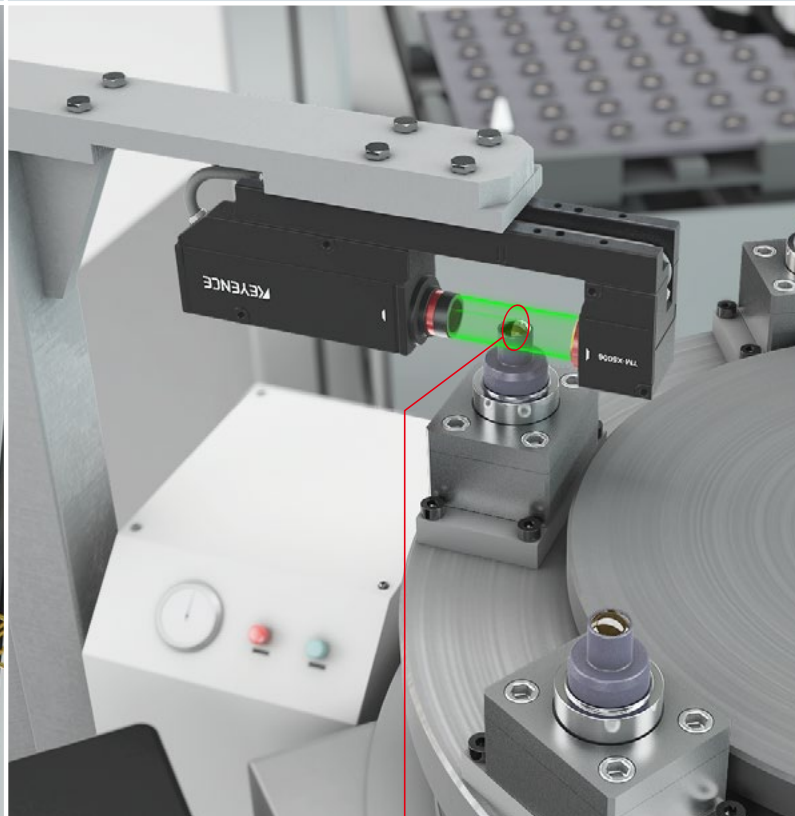
Lead frame dimensions



## Outer diameter/profile

Batch measurement of up to 100 dimensions (diameter, width, height, radius, etc.)

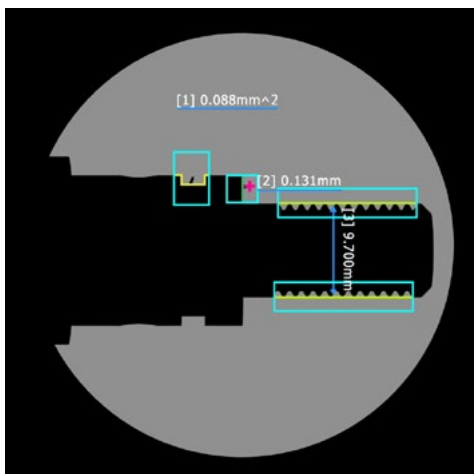
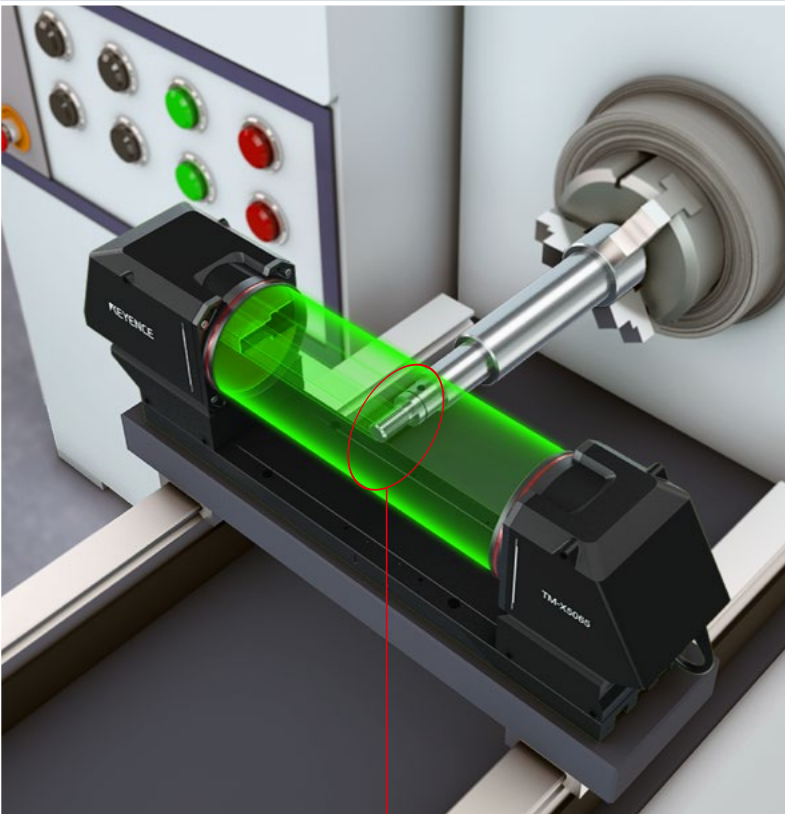
Lens diameter/height



## Abnormality detection

Detect foreign particles, flaws, burrs, or chips, while performing dimensional measurement.

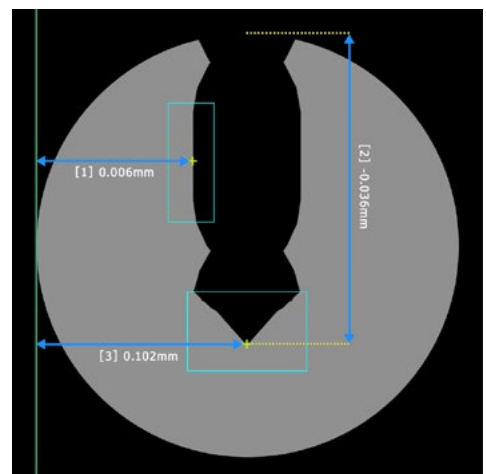
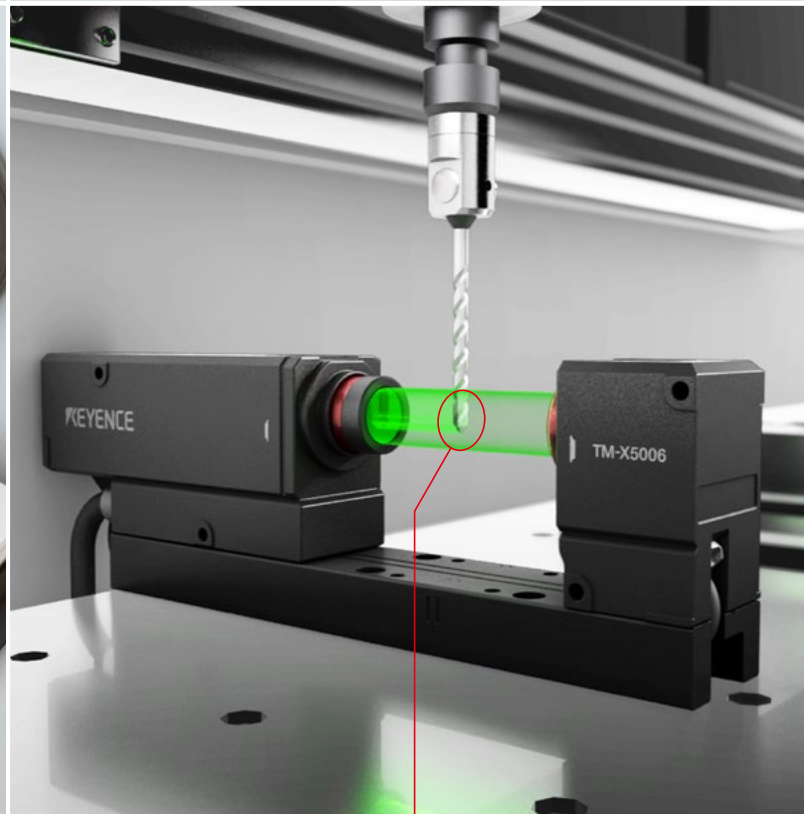
Shaft diameter and foreign particle detection



## Runout and positioning

Measure runout for rotating targets and get position feedback.

Tool run-out/positioning

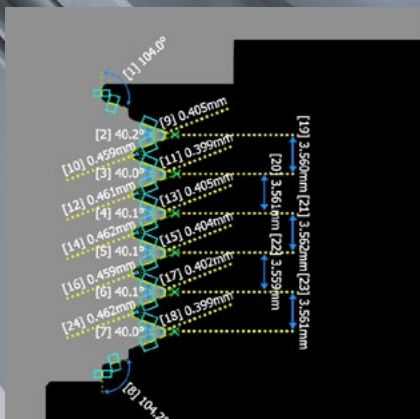


# Simplified measurement with easy installation

Optical-axis alignment  
function for easy installation



Wide range of tools for up to  
100 simultaneous measurements



## All-in-one setup for robust inline measurement

The system provides a pre-calibrated solution for backlit inspection. The dual telecentric optical system has a large depth of field, eliminating errors caused by poor focus.

## Guaranteed accuracy throughout the field of view

Distortion-free lenses and sub-pixel processing ensure a measurement position accuracy of  $\pm 0.2 \mu\text{m}$  with no calibration necessary.

## Simple configuration, advanced capability

The modern interface features a wide variety of measurement tools that let you intuitively configure the settings.

Telecentric Measurement System

**NEW** TM-X5000 Series



# All-in-one setup for robust inline measurement

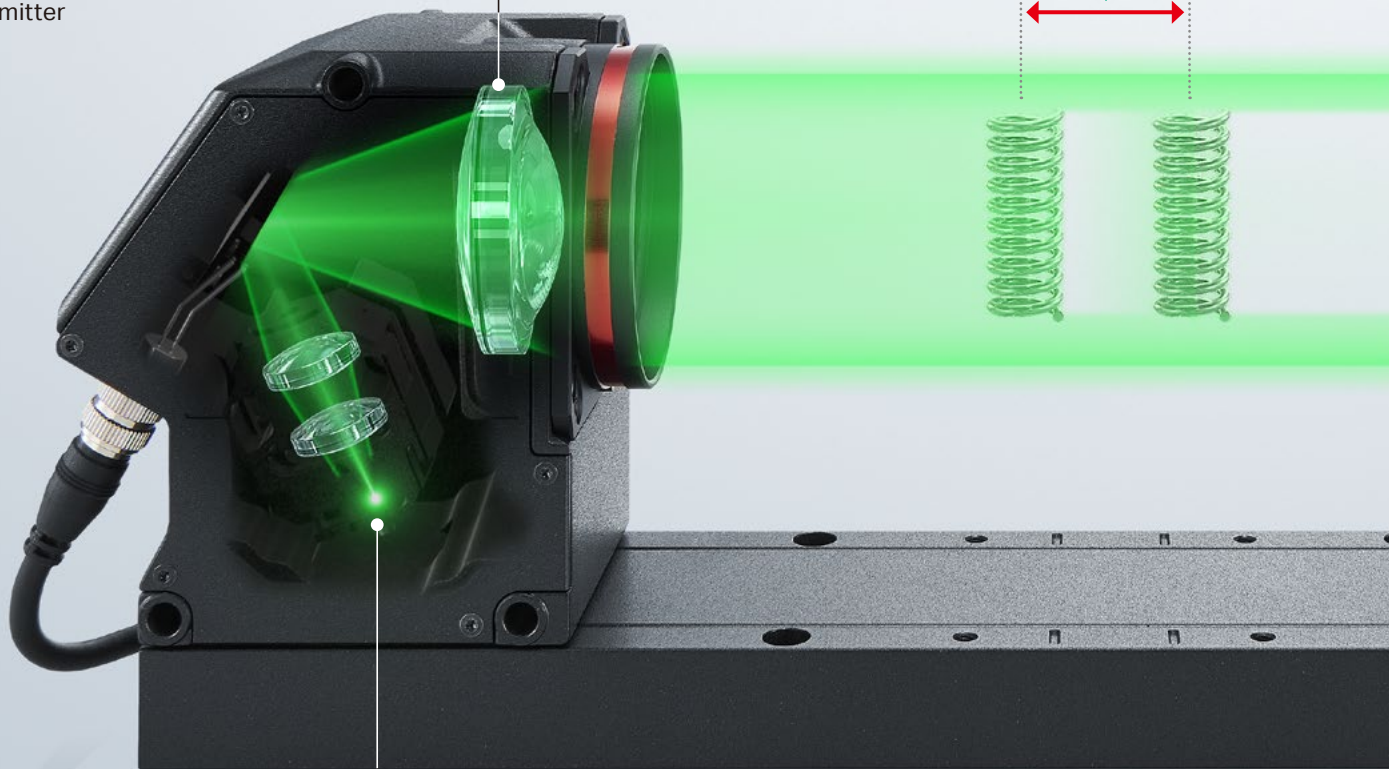
## Measurement principle

### Dual telecentric silhouette-based system provides exceptional stability

The transmitter emits collimated lighting with a green LED to project a shadow on the CMOS sensor in the receiver. Measurement is then performed using this captured image. The TM-X5000 Series includes telecentric lenses in both the transmitter and the receiver, ensuring stable, high-accuracy measurement.

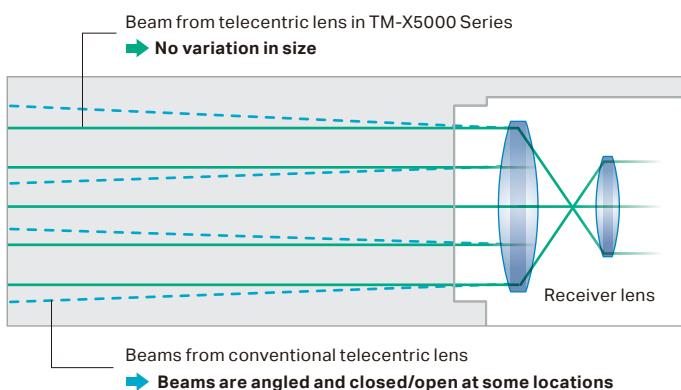
Telecentric lens  
in transmitter

High-brightness  
InGaN green LED



## Reliable measurement through advanced telecentricity

The specially designed telecentric optics greatly improve measurement repeatability by increasing uniformity throughout the field of view. Compared with conventional telecentric optical systems, the TM-X5000 Series offers about 100 times greater telecentricity.



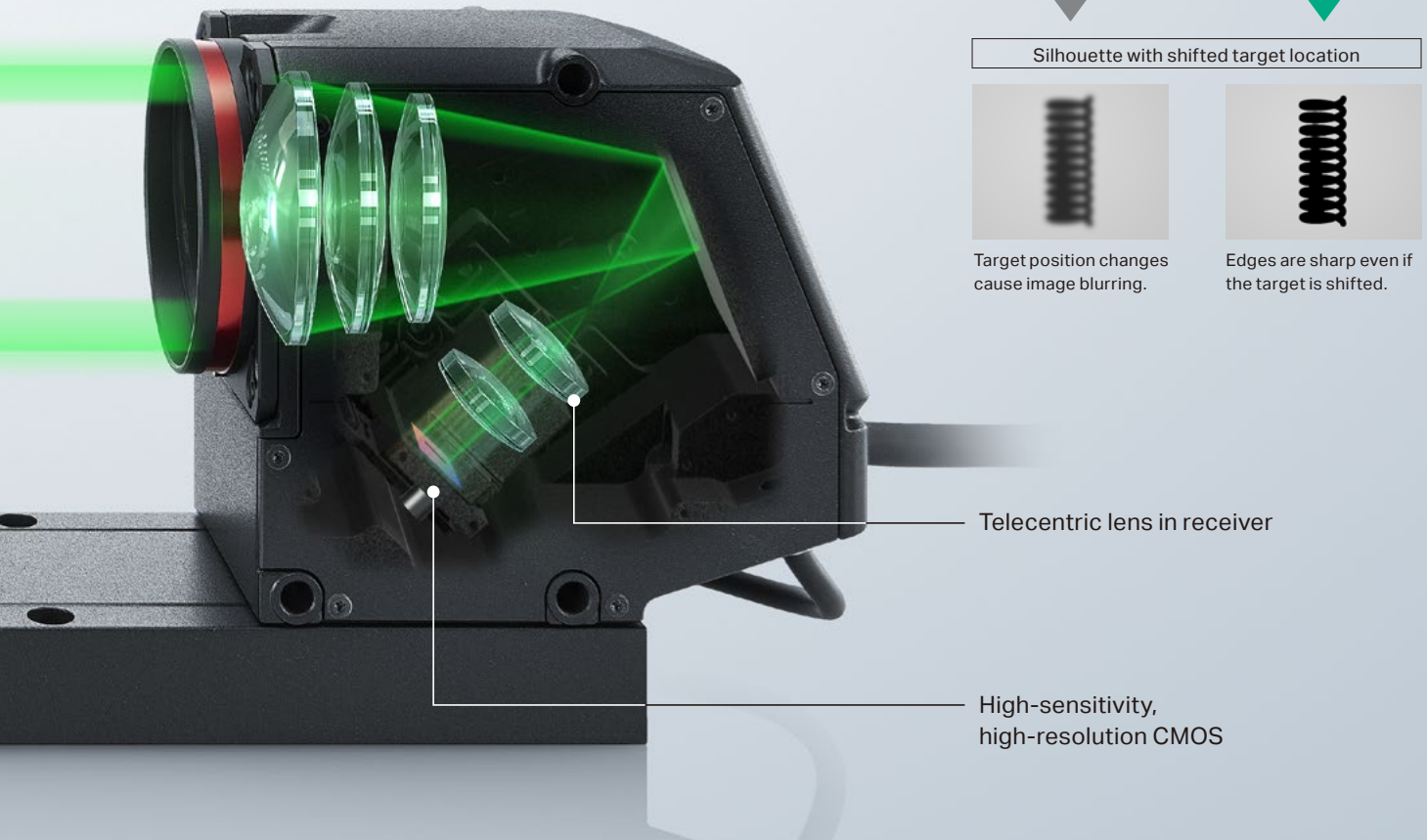
### Telecentricity: Measure of deviation from perfectly collimated light

The TM-X5000 Series has a telecentricity of just  $0.0001^\circ$  (typical value for TM-X5065). With KEYENCE's exceptional optical system, you can have confidence in the results even for misaligned targets.



## Large depth of field: $\pm 20$ mm

By utilising telecentric lenses in both the transmitter and receiver, the system can capture focused images of the target over a large depth of field. This provides clear, sharp edges and stable measurement results, even in cases where the target's position can vary.



Conventional optical systems

TM-X5000

Silhouette with optimal target location



Silhouette with shifted target location



Target position changes cause image blurring.



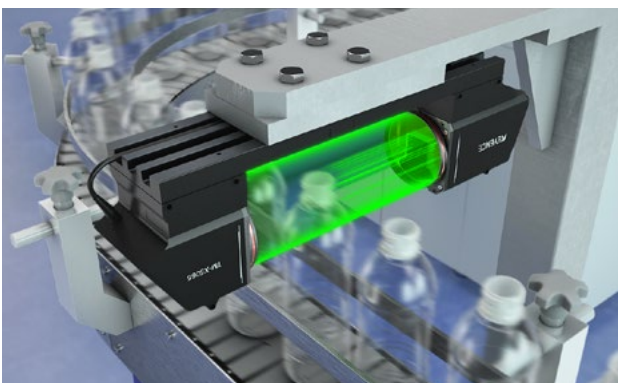
Edges are sharp even if the target is shifted.

Telecentric lens in receiver

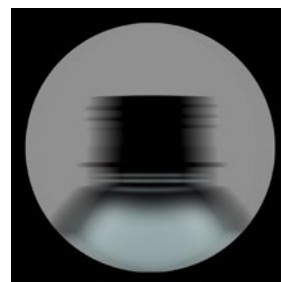
High-sensitivity, high-resolution CMOS

## Blur-free measurement of moving targets High-speed exposures in as little as 25 $\mu$ s

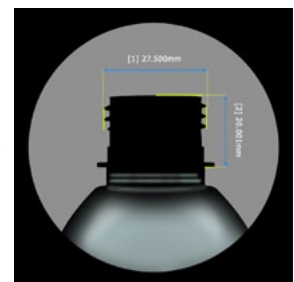
The optical system uses a high-intensity LED that significantly increases the received light intensity, allowing for exposure times of just 25  $\mu$ s—40 times faster than conventional models. This enables accurate measurement of high-speed targets by eliminating any blur from the image.



Example: Plastic bottle opening inspection  
Measurement is possible even if targets are rotating or passing at high speeds.

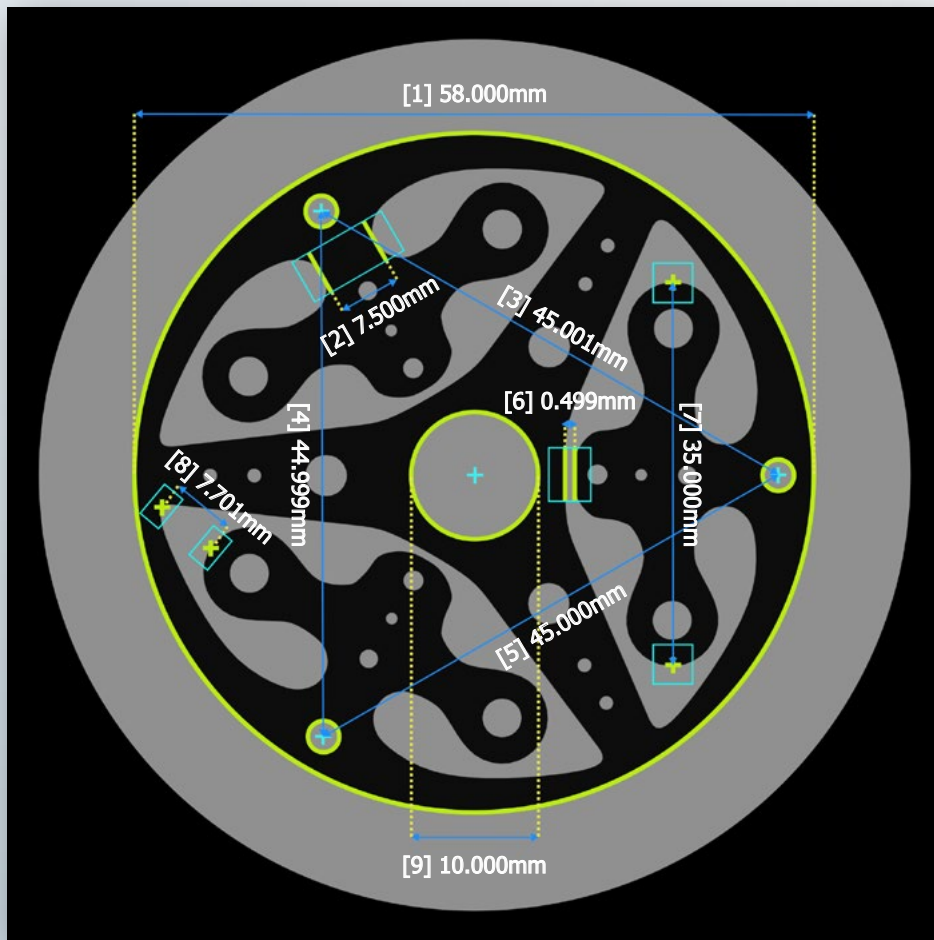


Conventional systems



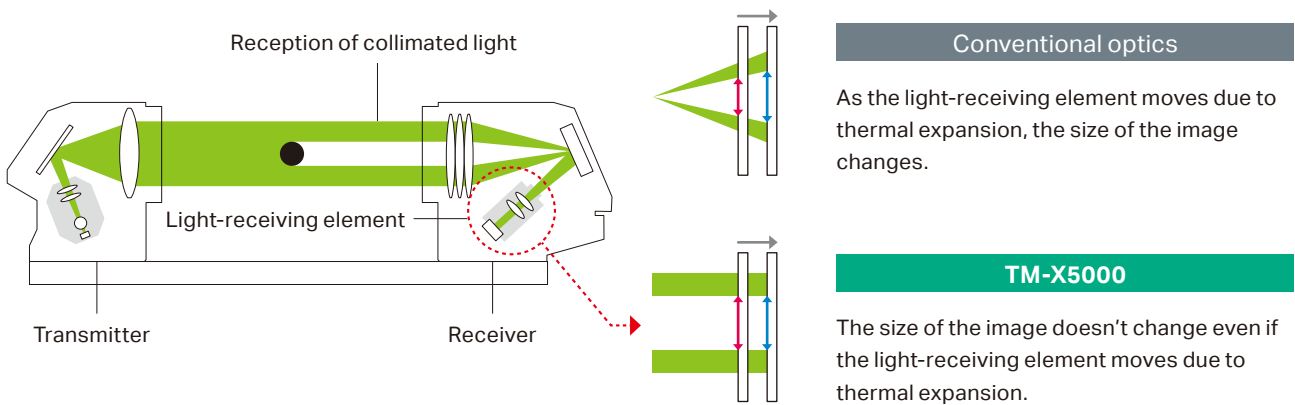
TM-X5000

# Guaranteed accuracy throughout the field of view



## Minimal effects from ambient light and temperature changes

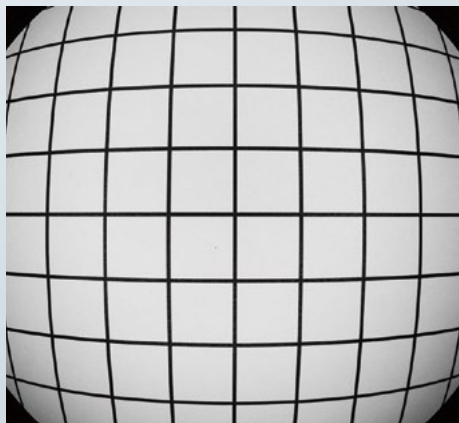
Designed to receive only collimated light, the dual telecentric optical system is resistant to ambient light. This design also minimises error due to temperature changes because thermal expansion is unlikely to impact the size of the formed image.



## Accurate results with no calibration or adjustment required

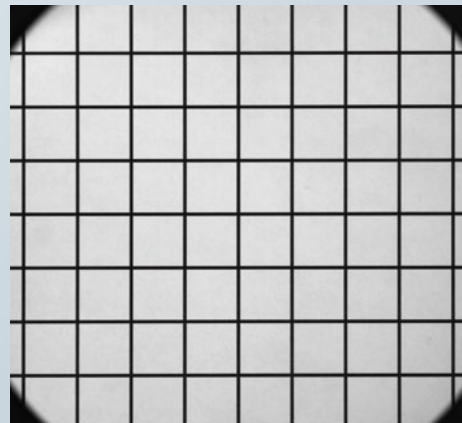
Low-distortion lenses help minimise distortion of the captured image even near the edges. KEYENCE also uses a proprietary algorithm that can perform measurement with no need to worry about the position of targets. This eliminates the need for conventional lighting, fixed target positioning, and calibration.

### Conventional lens



Distortion occurs near the edges

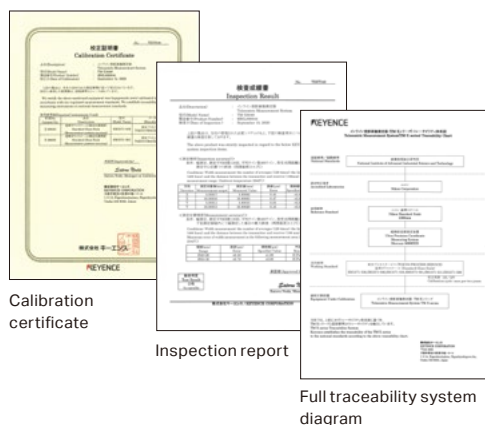
### TM-X5000 lens



Minimal distortion throughout the entire field of view

## Backlit inspection that's backed by a calibration certificate

To ensure reliable measurements, KEYENCE maintains traceability according to international standards for optical measuring instruments. Measurement position and repeatability accuracy (correctness) are guaranteed before the product is shipped.



Calibration certificate

Inspection report

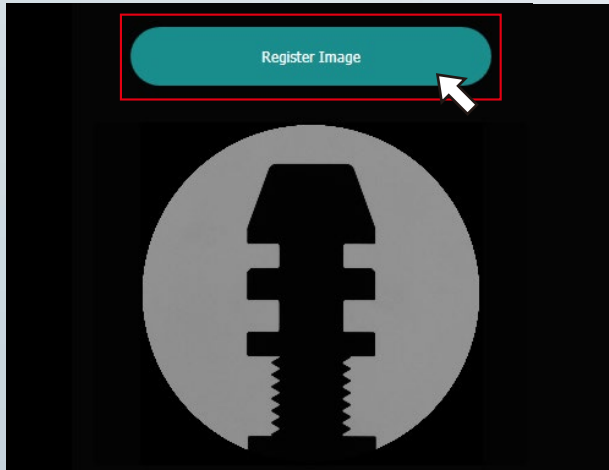
Full traceability system diagram

International Standard	National Institute of Advanced Industrial Science and Technology (AIST)
JCSS accredited calibration laboratory	Reference scale
Reference standard	Precision coordinate measuring instrument
Common standard	Reference scale
Measuring instrument to be calibrated	TM-X5000 Series Telecentric Measurement System

# Simple configuration, advanced capability

Step 1

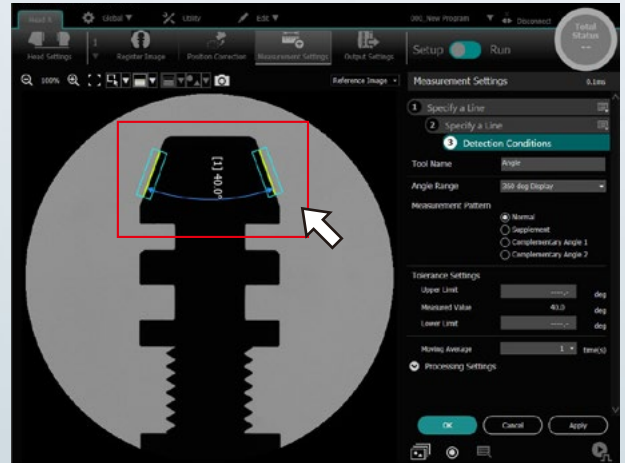
Register Target



Register the target being measured.

Step 2

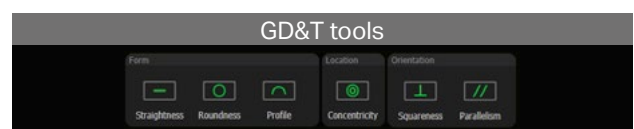
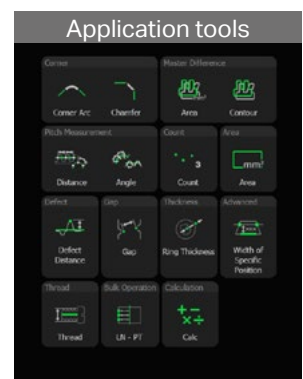
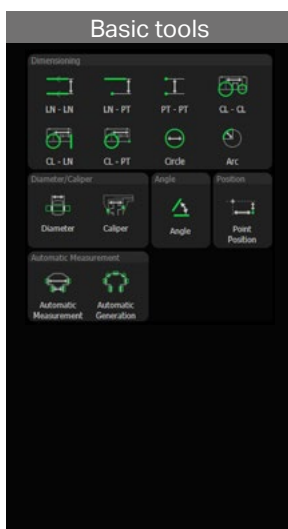
Select Measurement



Select the tool to use for measurement and click the area to be measured.

## Easy-to-use measurement tools make setup simple

Take advantage of more than 100 measurement tools that can be mixed and matched. Utilise a wide range of inline inspections beyond simple dimensional measurements, including GD&T, master comparisons for identifying products, and defect distance measurements for visual inspections.

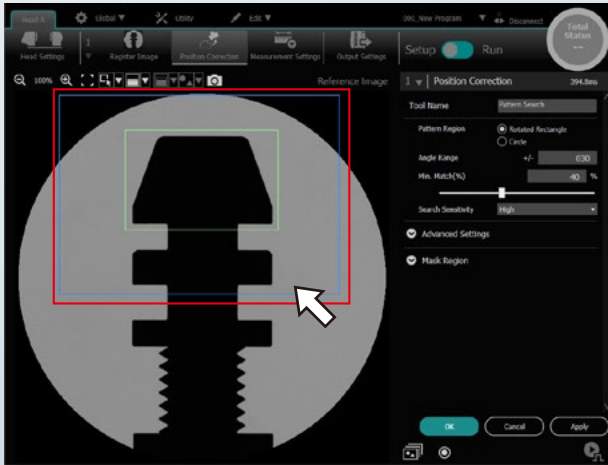


### Step 3

Apply Position Correction



Ready to measure moving targets!

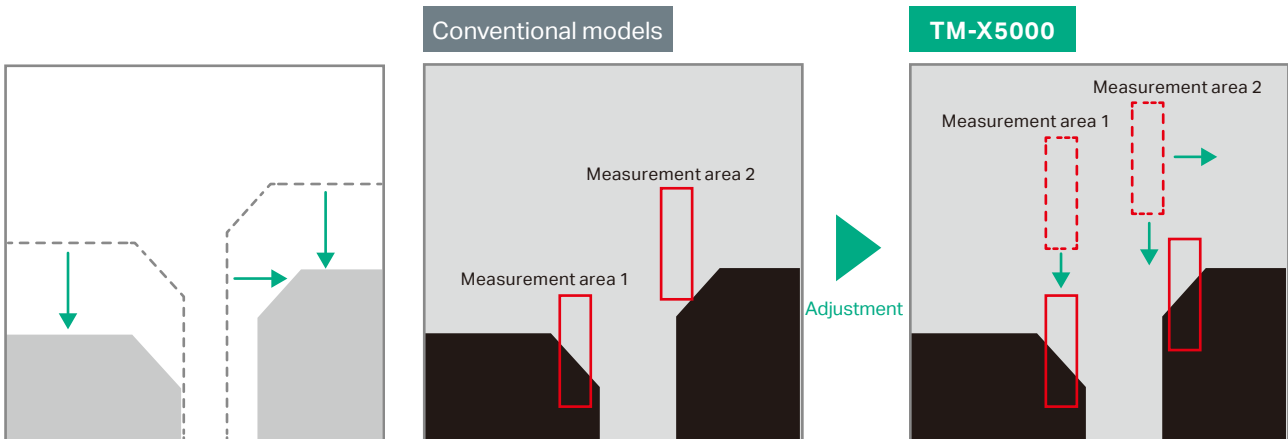


Draw a square around the shape of the target, and set the area for position correction.



## Set up to four position adjustment areas

The position adjustment function allows users to set various position adjustments in multiple locations. This is effective when measuring items such as height differences, gaps, and angles between two targets that can move independently.



In this example, two measurement targets have shifted from their original positions.

Measurement cannot be performed properly because position adjustment references only one target's location.

Measurement can be performed properly because adjustment is applied to measurement areas 1 and 2.

# Easy and flexible installation

## Two installation methods to choose from

### With included base

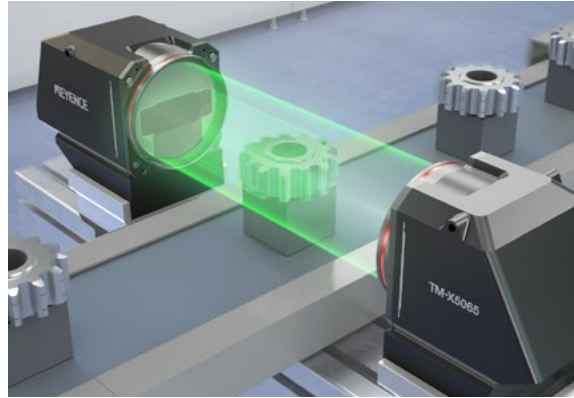
The included base can be used to hold the transmitter and receiver in place. This method is convenient for benchtop use.



Multi-point shaft diameter/pitch measurement

### Without base

The sensor can be installed without the base to avoid interfering with existing fixtures or conveyors.



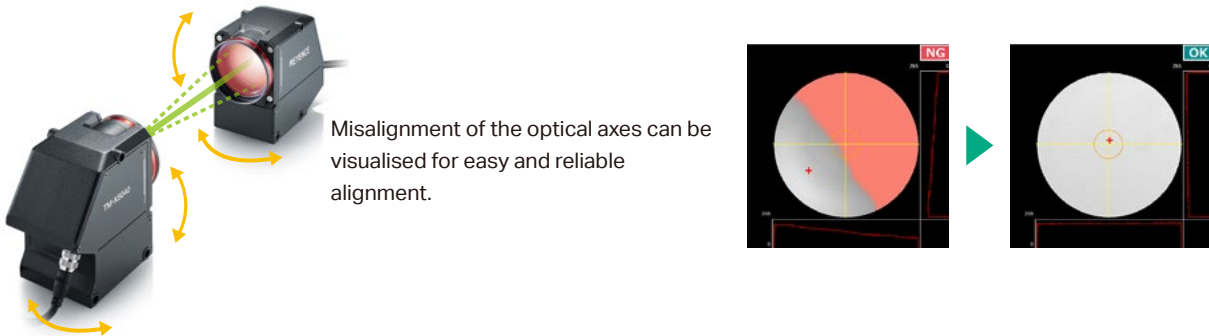
Diameter and slot detection for gears on a conveyor



Designed to make installation without the base simple

### Optical-axis alignment function

The optical-axis alignment function makes it possible to quickly confirm proper transmitter-receiver alignment without using the base. This eliminates the need for post-setup calibration, making it easy to perform high-accuracy measurement.

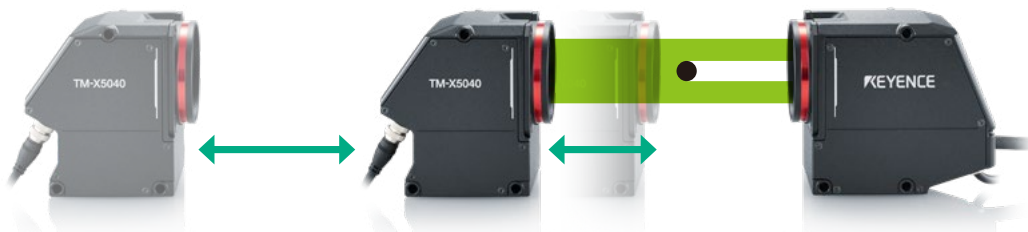


Misalignment of the optical axes can be visualised for easy and reliable alignment.

### Adjustable installation distance

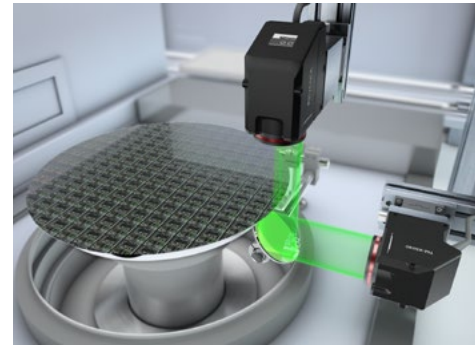
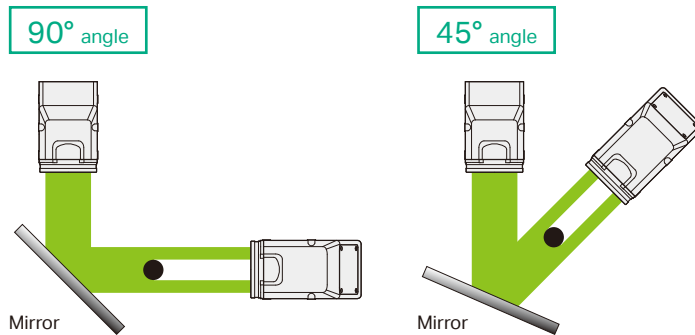
The installation distance of the transmitter head can be adjusted as necessary. The telecentric design allows the sensor to maintain a focused image as the installation distance changes, minimising the effects on accuracy.

(Contact KEYENCE for accuracy information when changing the installation distance of the receiver head.)



## Measure in space-constrained areas using mirrors

In situations where installation space is limited, angled mirrors can be used to bend the optical axis. For best results, mirrors should have a flatness of  $\lambda/4$  and be placed between the transmitter and measurement target.



Wafer notch profile measurement

## Ultra-compact head

Compared to imaging systems that use conventional telecentric lenses in both the transmitter and receiver, the ultra-compact structure of the TM-X5000 Series requires less installation space.

### Conventional imaging system with telecentric lenses



### TM-X5000 Series



Significantly reduced size

## Highly durable

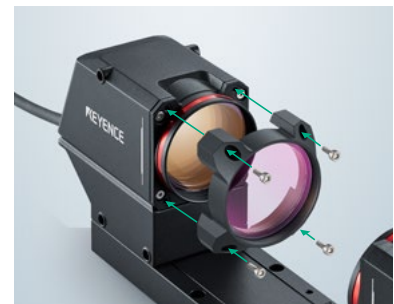
The TM-X5000 Series is a highly durable system with high-flex cables for easier head movement during measurement. An easy-to-install special protective cover is also available for added security.



High-flex cable



Dust- and water-resistant IP64 enclosure



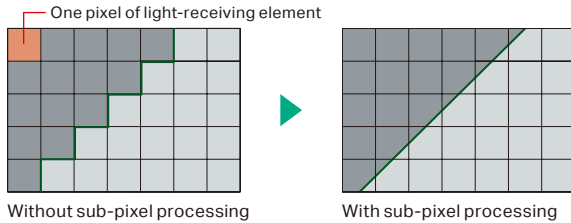
Special protective cover

# Advanced functions for stable inspection and operation

## Eliminating variations in edge detection

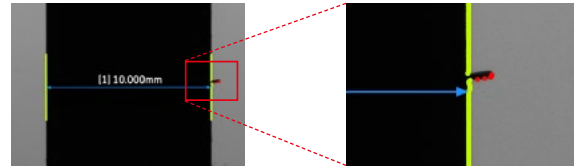
### Sub-pixel processing

By splitting each pixel into 100 or more sub-pixels, this function enables a wide field of view while ensuring high-accuracy measurement.



### Abnormality exclusion function

To ensure stable measurement, this function excludes abnormalities such as foreign particles and chips in the measurement area.



## Significant reduction in startup adjustment time

### Setting changes and batch testing using archived images

Archived images can be used for immediate identification of problem areas, which is especially useful during startup. Changes can be set and tested against the batch of images, significantly reducing the time spent on adjustments and checking targets.

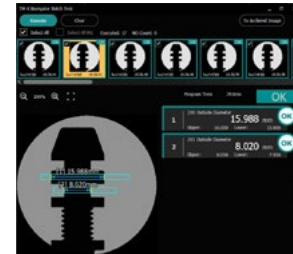
Identify problems using archived images



Display archived images for correction



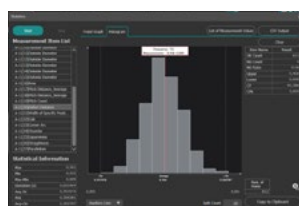
Perform batch testing to complete correction



## On-site traceability and trend management

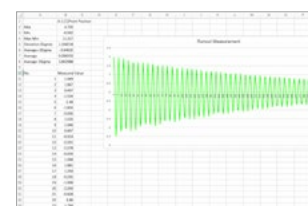
### Statistical analysis (Histogram)

The histogram allows users to check for product variations. The graph includes OK and NG counts, NG rates, and maximum, minimum, average, and deviation values.



### Excel-based analysis

Measurements can be exported directly to Excel for further analysis or to support user preferences for managing trends.



\* Excel is a trademark or registered trademark of Microsoft Corporation in the United States and other countries.

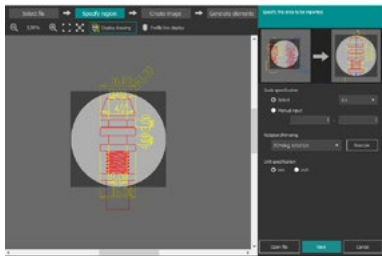


## CAD import function for creating measurement settings files

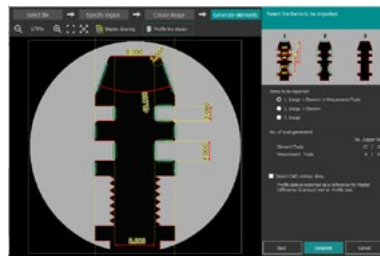
Inspection programs can be quickly created by importing DXF format CAD data. Programs can be easily created even when no measurement target is available.

\* The CAD import module (TM-H1C) sold separately, is required to use the CAD import function.

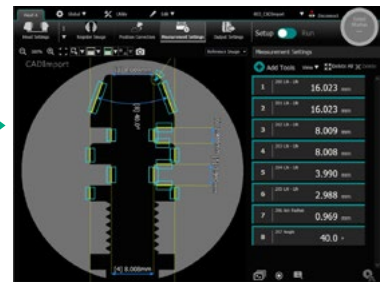
Open the CAD file and specify the import area.



Fill in the area to be imported with black and select the tool to import.



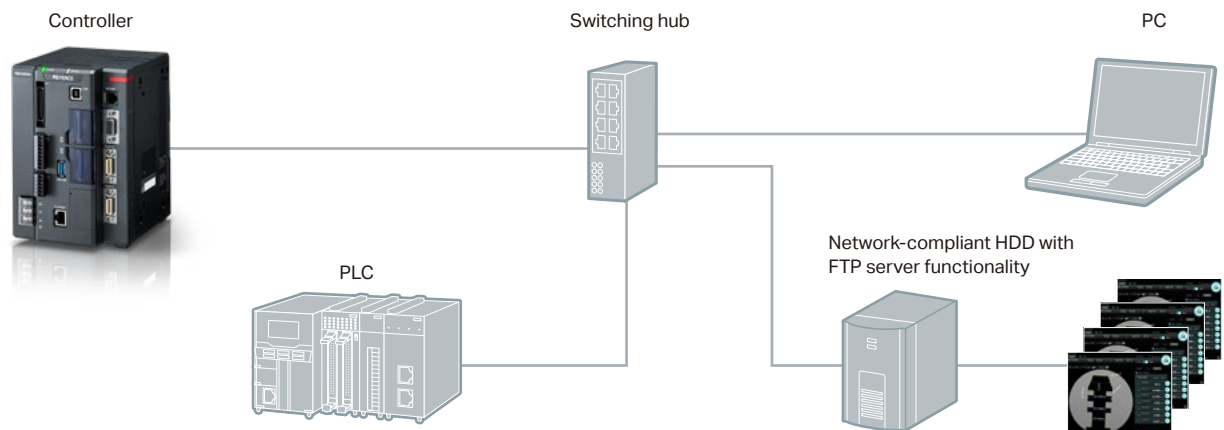
The creation of the measurement settings file is complete.



## Operation support with TM-X Navigator

TM-X Navigator makes it possible to reconfigure and operate controllers remotely.

This enables simulations based on previously acquired measurement images and settings, even if the equipment is not connected.



Images and measurements can be output to FTP servers, enabling long-term image storage when using a large-capacity HDD with an FTP server function.

EtherNet/IP<sup>®</sup> RS-232C/Ethernet PLC link



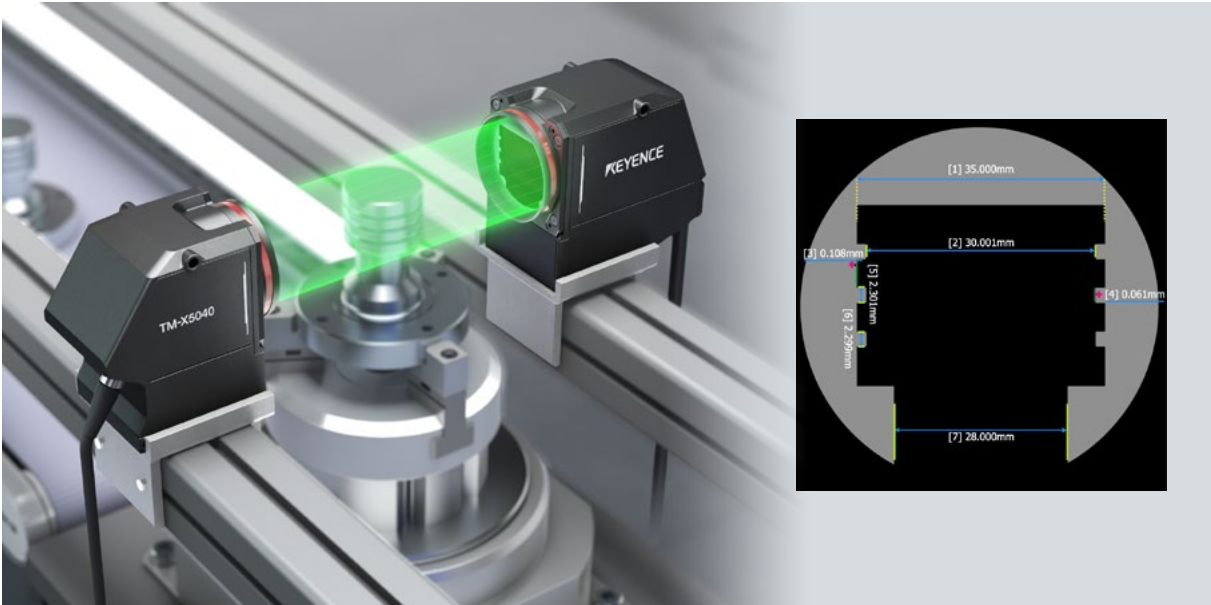
EtherCAT<sup>®</sup> is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

## Communication libraries for original program creation

KEYENCE offers sample programs showing how to use communication libraries. This makes creating programs to control and monitor TM-X5000 Series devices easy. The programs can also be used for outputting captured images and point-sequence data from specified locations to create unique and complex detection and measurement processes.

## Measurement and foreign particle inspection of stepped shafts

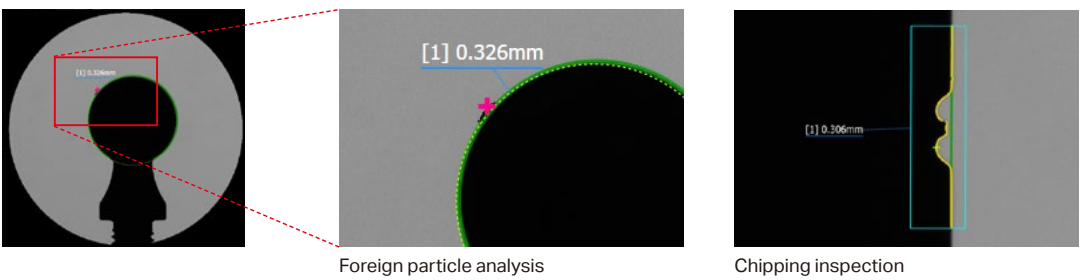
In addition to measurement of various dimensions of the entire circumference, rotating targets can also be inspected for burrs and foreign particles.



### Detect abnormalities and complete dimensional inspection simultaneously

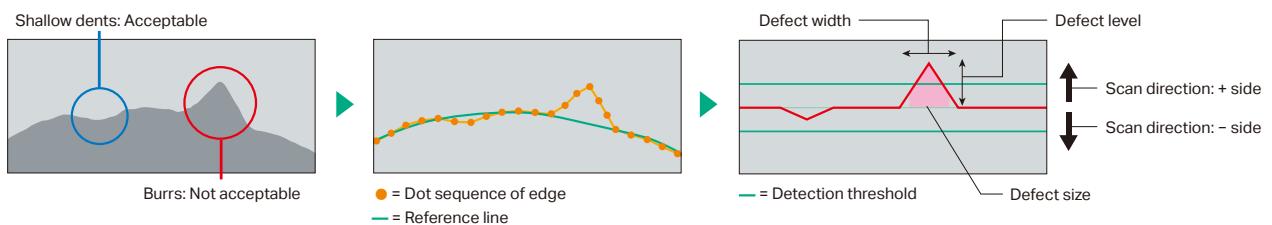
#### Defect distance measurement

Extracting the contours of a target's edge enables detection of abnormalities such as burrs, chips, and foreign particles by identifying areas that deviate from the contour line. This function measures the distance between the extracted contour and the tip of the abnormality. Extracted contours can include straight lines, circles, wavy surfaces, and other complex shapes consisting of curved lines.



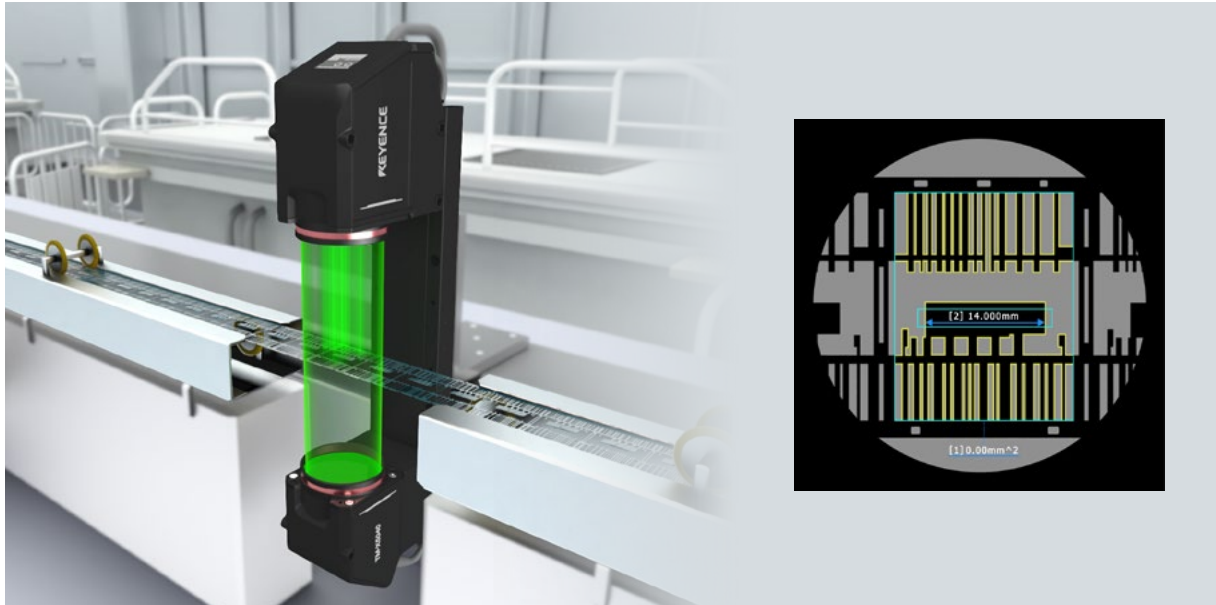
#### Algorithm for identifying defects while ignoring normal variation

A variety of parameters are available for identifying certain defects. Settings can be optimised according to the inspection category, such as +/- from the reference line (for burrs and flaws) and amount exceeding the specified threshold.



## Measurement and inspection of lead frames

Multiple dimensions and inspections can be completed simultaneously, enabling reliable defect detection of lead frames with complex shapes.



## Master comparison tool for intuitive inspection of complex shapes

### Master comparison tool (Area)

In addition to traditional dimensional measurements such as pitch and hole area, the master comparison tool compares the area of the target at different locations with a master image to identify defects.

This tool allows consistent inspection of complex shapes that are otherwise difficult to analyse, such as lead frames.

\* To compare the dimensions of a different part of the master image, use the master comparison tool (contour).

Registered master image

+

Captured image (with position adjustment)

Normal product

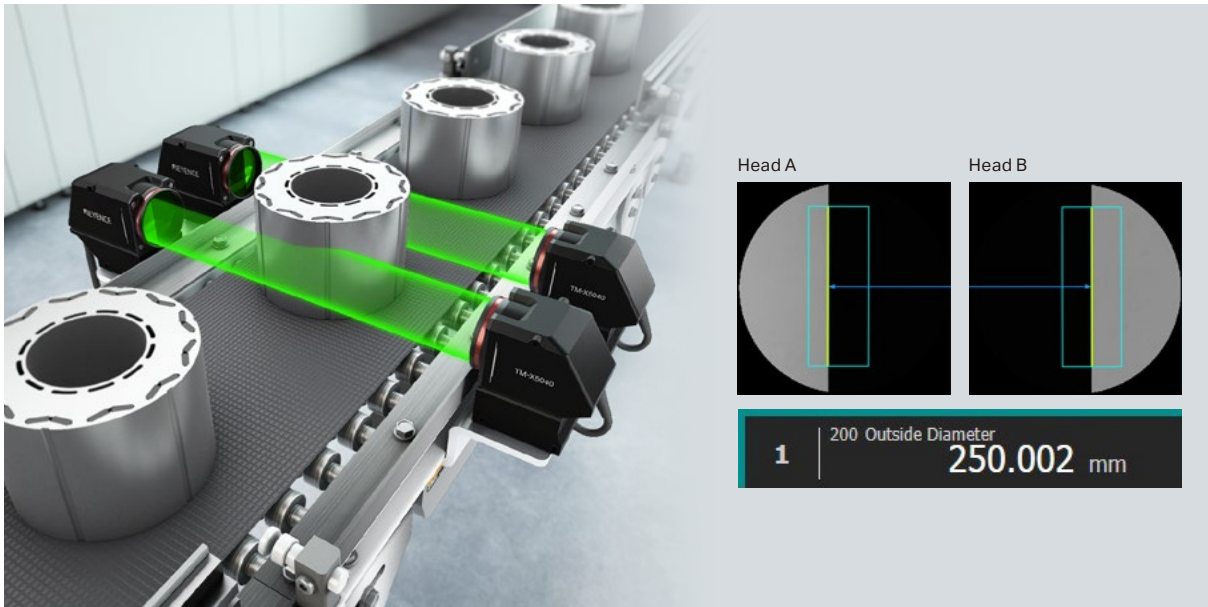
Unacceptable bending

Unacceptable cut marks

Comparison Result	200 Master Difference	Area Difference (mm <sup>2</sup> )	Status
Normal product	1	0.00	OK
Unacceptable bending	1	2.90	NG
Unacceptable cut marks	1	0.51	NG

## Motor core outer diameter measurement

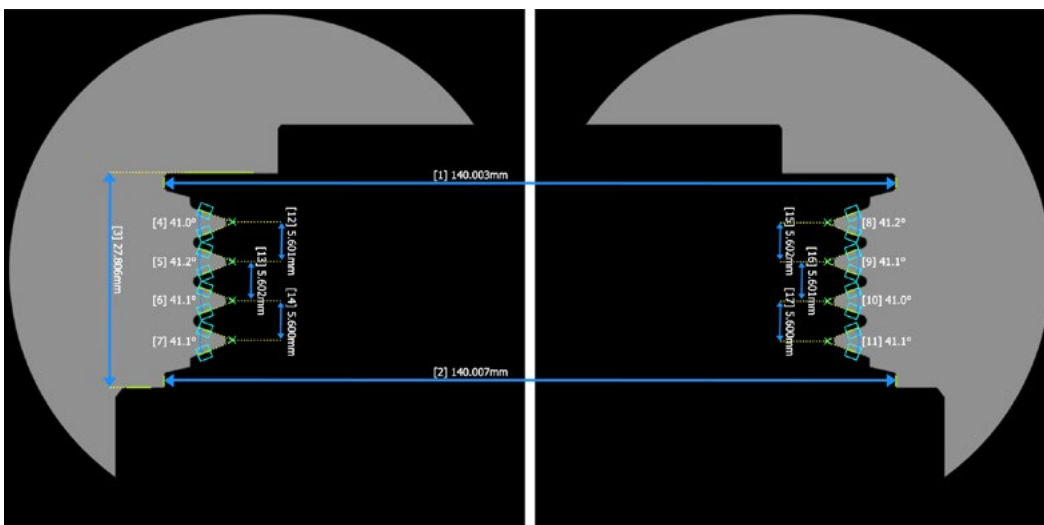
Targets larger than the field of view can be measured by using two heads. Cross-head tool sharing makes this type of measurement accurate and simple to perform.



Wide range of tools can be applied across two heads

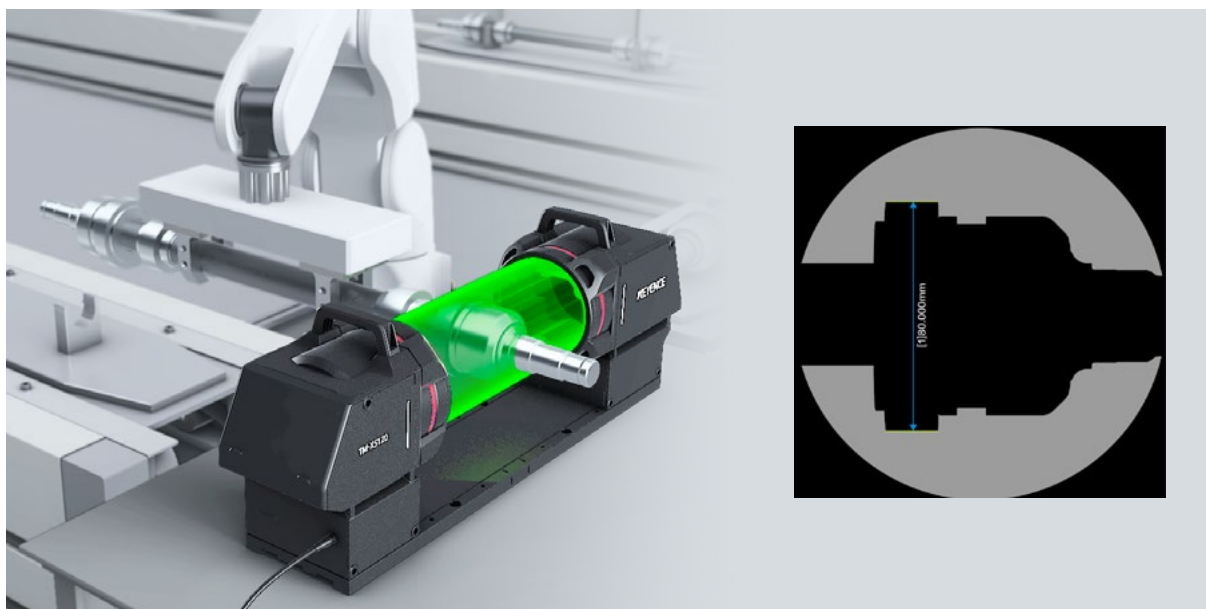
### Cross-head sharing of tool settings

Tools configured in one head can be shared between both heads. This allows for a variety of measurements, including line-to-line distance measurement and diameter measurement of circles created by combining the two head images. The large pulley below shows an example of performing dimensional measurement across two heads using this functionality.



## Drive shaft dimensional measurement

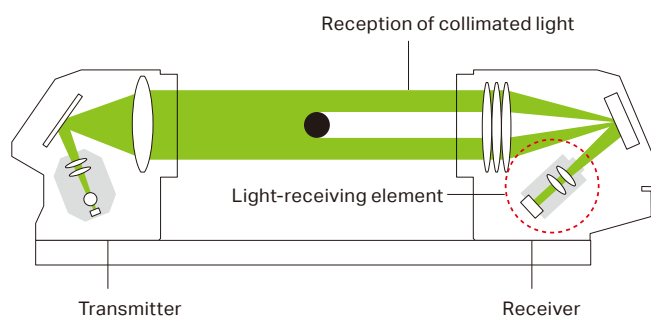
Measure targets with a maximum diameter of 120 mm with a single sensor head.



Dual telecentric optical system for high-accuracy measurement with no adjustment necessary

### High-speed imaging with a large depth of field and minimal noise

The dual telecentric optical system creates a large depth of field for capturing images with low noise, even at high shutter speeds. This makes the system ideal for virtually any application, with no need for adjustments or calibration after installation.



### Stable measurement of thin wires

With four times the number of pixels of conventional models and an upgraded optical system, the TM-X5000 Series can stably measure fine wires.

#### Minimum measurable outer diameter

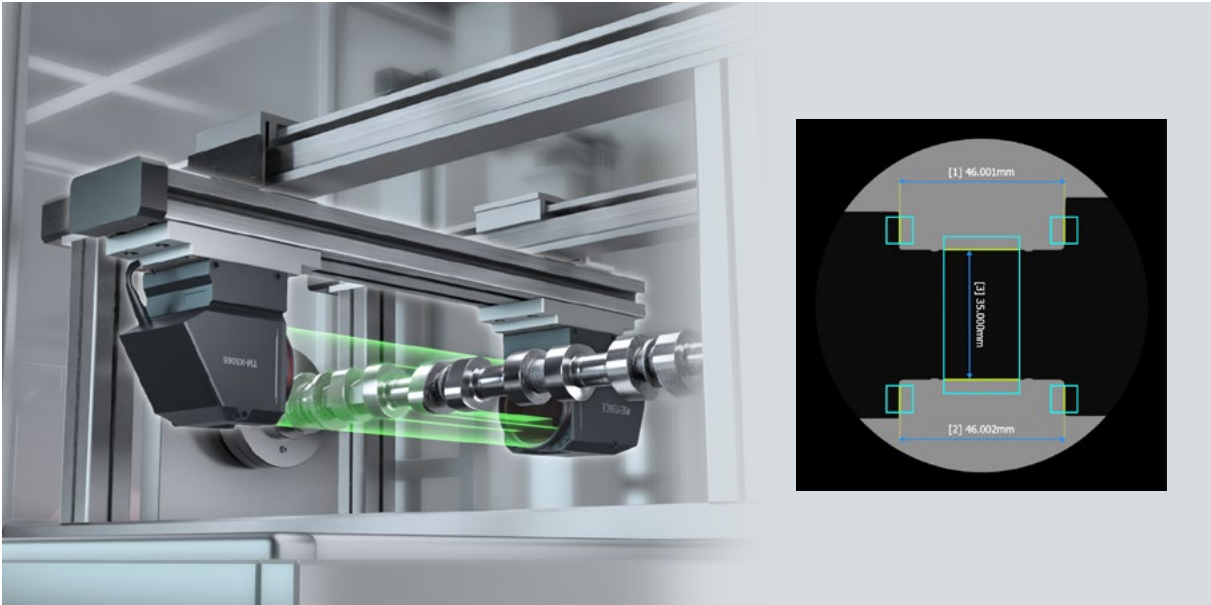
TM-X5006	TM-X5040	TM-X5065	TM-X5120
20 μm	150 μm	250 μm	500 μm

\* Contact KEYENCE for measurement of wires with even smaller diameters.



## Camshaft diameter between journals

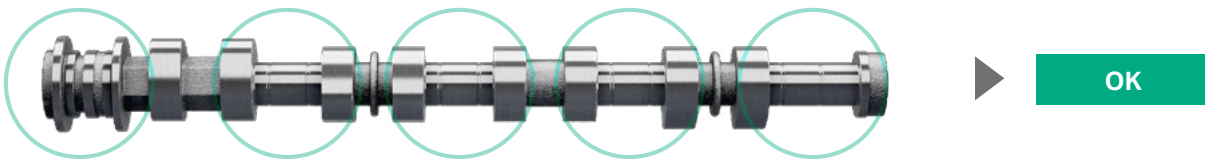
Measuring a long target is possible by moving the device along the entire target.



### Automatic pattern recognition and recipe switching for fast, simple operation

#### For long targets

Total evaluation for longer targets is possible by dividing them into several sections. Each program can include up to eight recipes with unique master images, so analysis can be performed even if captured images and measurement items differ from one location to the next. The recipe is switched automatically between measurements to ensure fast operation.



#### For various targets

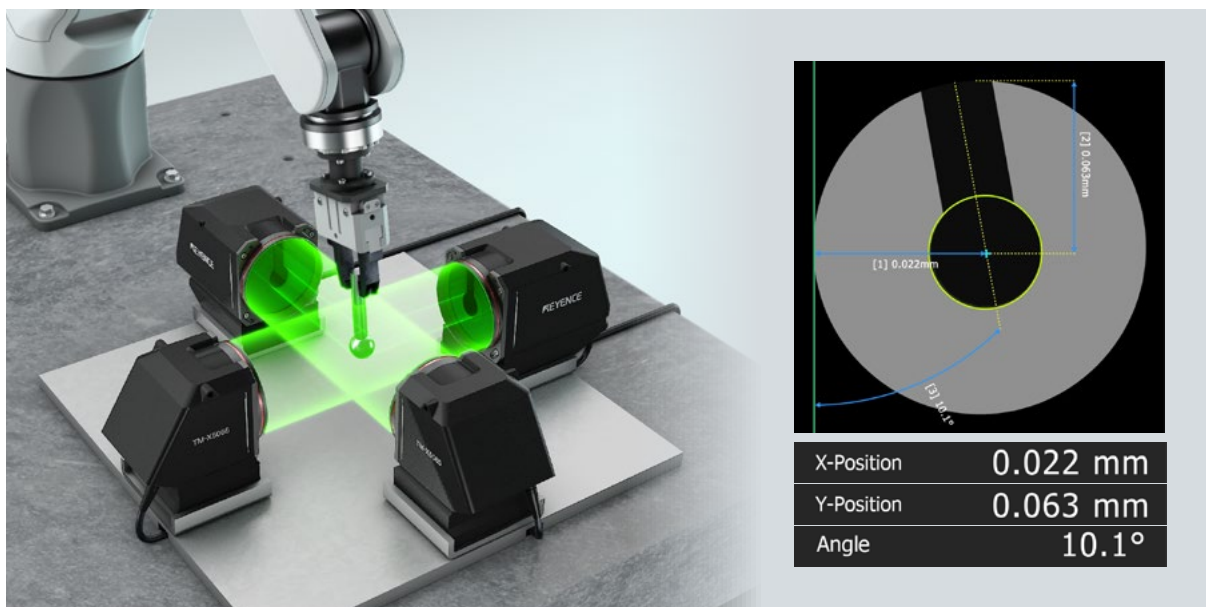
Automatic switching between recipes can also be used for measurement with mixed production lines or when analysing various targets at random.

After identifying the shape of the target, the controller automatically switches to the appropriate recipe according to the target shape. This eliminates the need for a signal or command input between different product types.



## Robot stop accuracy and dynamic evaluation

The TM-X5000 can be used to quantify the stopping and movement accuracy of a robot that moves to the same position repeatedly.



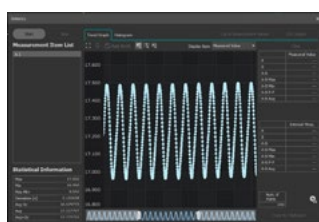
## R&D and prototyping phase functions

### Statistical analysis and historical image function for easy data analysis

For each sampling cycle, both the measured values and the captured images are logged. This information can then be used for measuring dynamic changes in shapes and sizes as well as runout and stroke.

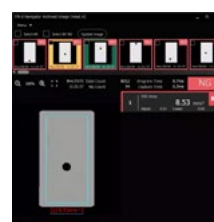
#### Statistical analysis (trend graph)

The trend graph displays the changes in values over time to visualise dynamic changes such as target runout and misalignment.



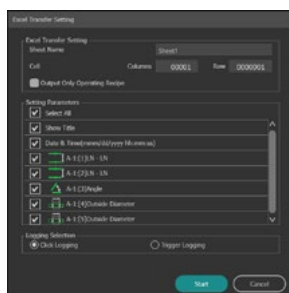
#### Historical image function

When measuring the area of a water droplet, previously captured images can be re-measured using a PC program, as shown in the image to the right. Additional measurements such as width and length can also be performed when re-measuring an image.



### Log data directly to Excel

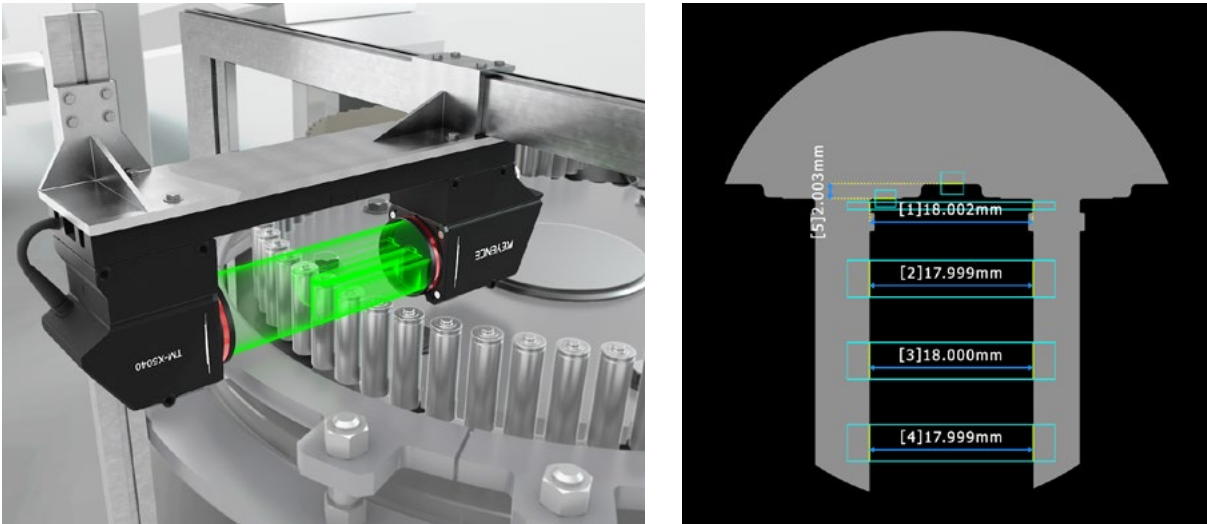
The Excel output function writes measurement data to specified cells in Excel on command (using a mouse click or external signal). This function is useful for quickly recording prototype measurements or avoiding errors during manual logging.



Date & Time	A-1 [1] (Angle)	A-1 [2] (Outside Diameter)	A-1 [3] (Outside Diameter)	A-1 [4] (Corner Dia)	A-1 [5] (Chamber)	A-1 [6] (Chamber)	A-1 [7] (Outside Diameter)	A-1 [8] (LN)	A-1 [9] (Chamber)
Nov-29-2018 12:26:54	40	15.997	15.999	1.32	0.342	0.26	0.019	9.732	0.342
Nov-29-2018 12:26:58	40	15.999	15.995	1.32	0.342	0.26	0.019	9.730	0.35
Nov-29-2018 12:27:07	40	15.989	15.985	1.32	0.342	0.26	0.019	9.730	0.35
Nov-29-2018 12:27:15	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:21	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:29	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344
Nov-29-2018 12:27:35	40	15.988	15.996	1.348	0.329	0.344	0.018	9.742	0.344

## Multi-point diameter and terminal height of batteries

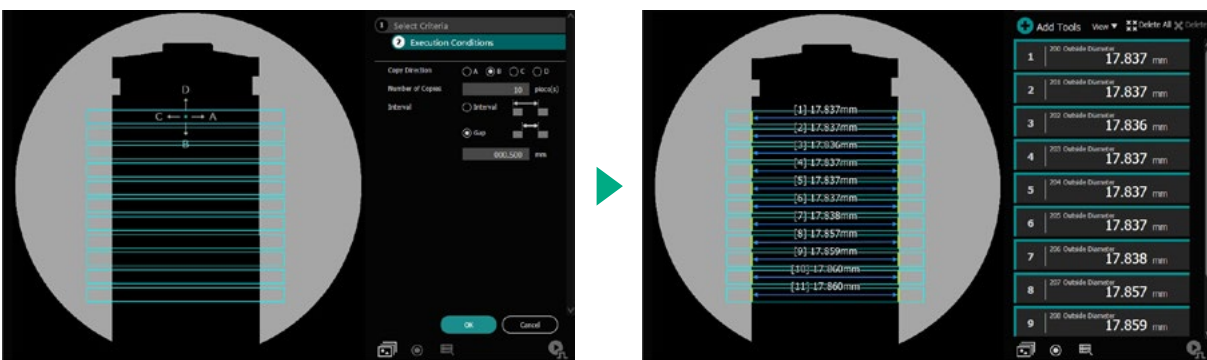
With an exposure time of just 25  $\mu$ s, the TM-X5000 Series is capable of inline multi-point diameter and terminal height measurement of cylindrical batteries, improving quality while maintaining line speed.



### Reduced setup time for targets with multiple measurements

#### Multi-setting copy function

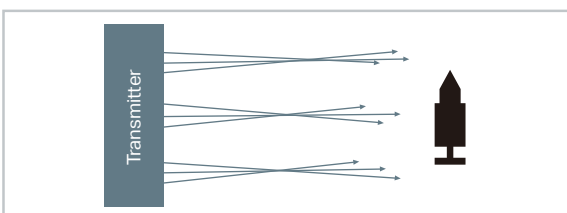
The multi-setting copy function can be used for batch copying and arranging various tools in any number, direction, and interval to simplify configuration of multiple measurement tools.



#### High-accuracy telecentric lens in the transmitter improves reliability

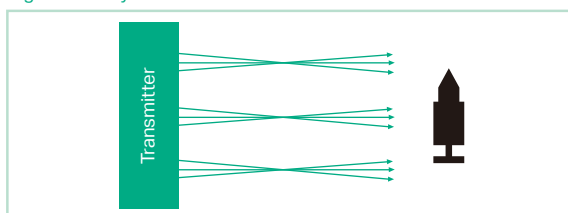
Utilising a telecentric lens in the transmitter improves the consistency of the light source throughout the field of view. This enables repeatable, high-accuracy measurement, even if the target can move throughout the field of view.

Conventional telecentric illumination



The angle and intensity distribution of the light source is not uniform, leading to poor reproducibility in some situations.

High-accuracy telecentric illumination

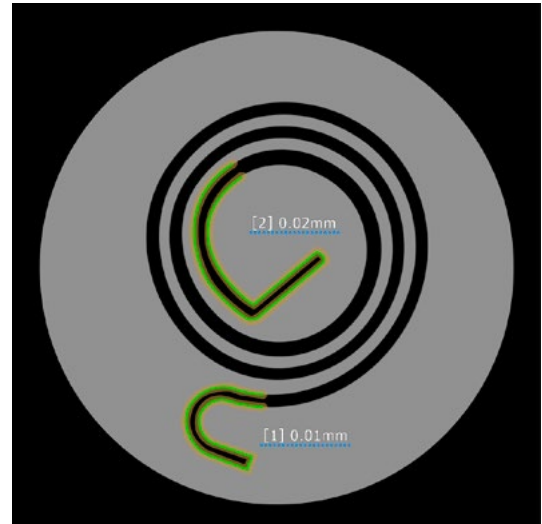


Variation in the angle and intensity distribution of the light is minimal, ensuring high reproducibility, even if the target is misaligned.



## Spiral spring profile measurement

The Master Comparison Tool (Contour) makes it possible to check whether the profile shape of curved parts have been machined correctly.



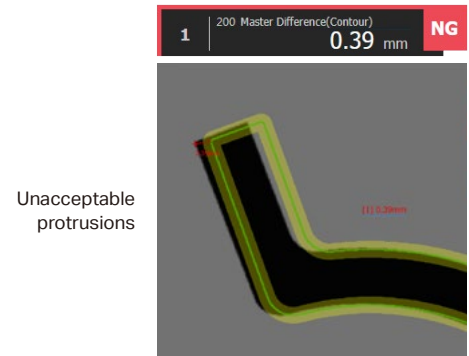
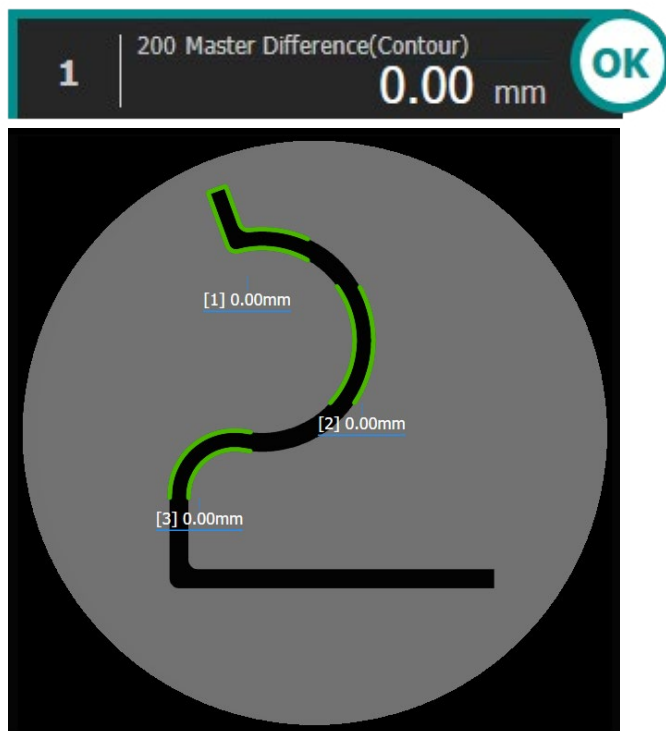
## Differential dimension measurement from the master image's profile

### Master comparison tool (Contour)

Differential dimension measurement is possible by comparing the profile line of a reference master image and the actual measurement target. The shape of the reference profile can also be imported from CAD data. The contour tool can also be used if a profile is specified in the drawing.

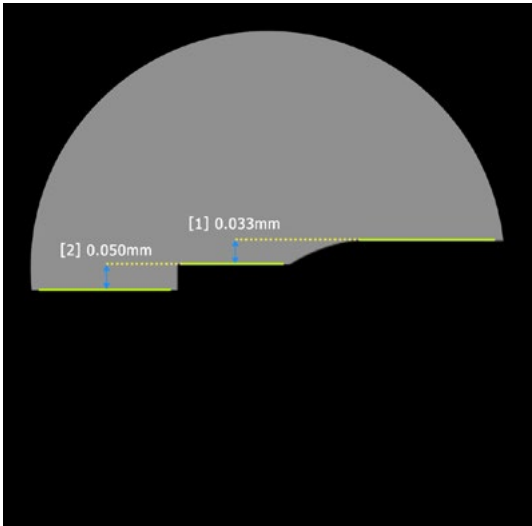
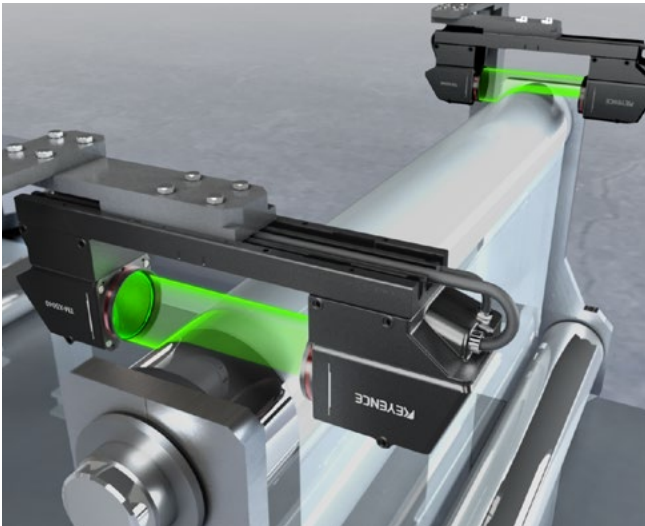
\* The CAD import module (TM-H1C) sold separately, is required to use the CAD import function.

Plate spring profile measurement - Good part



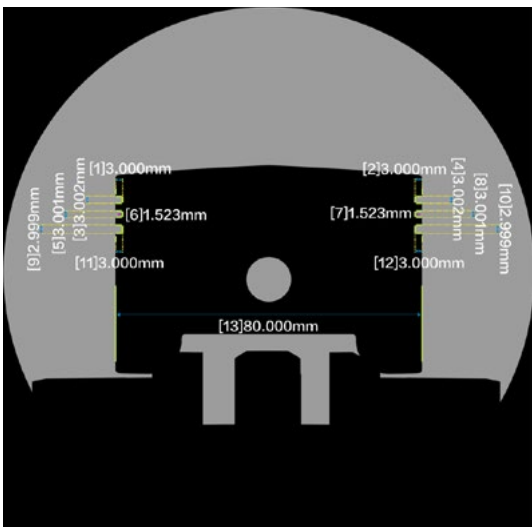
## Film substrate and coating material thickness

By capturing the silhouette at the edge of the web, the roll, the base material, and the coating can all be referenced in a single image. This enables simultaneous thickness measurement of both the base material and coating layer. These measurements can be performed both for transparent and non-transparent materials.



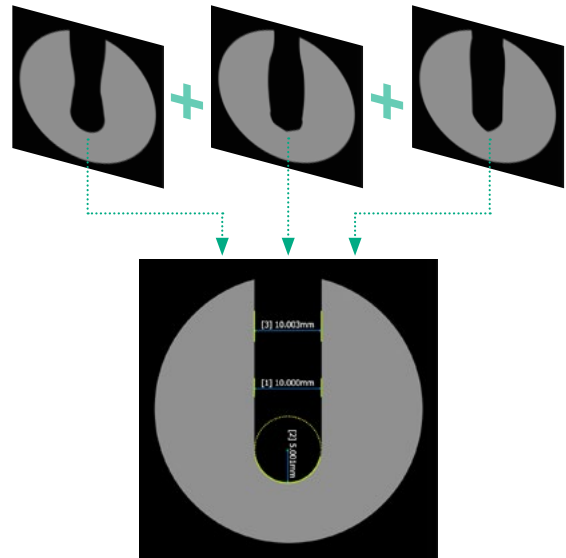
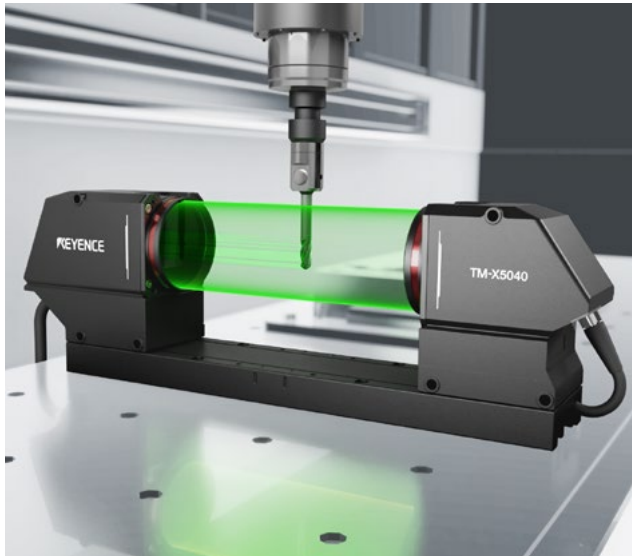
## Piston head dimensional measurement

Measurement of piston head outer diameters and clearance can be performed inline. Measure targets with diameters up to 120 mm with a single sensor head.



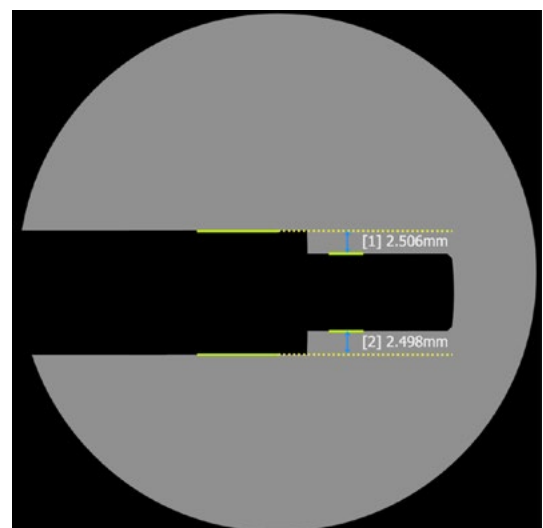
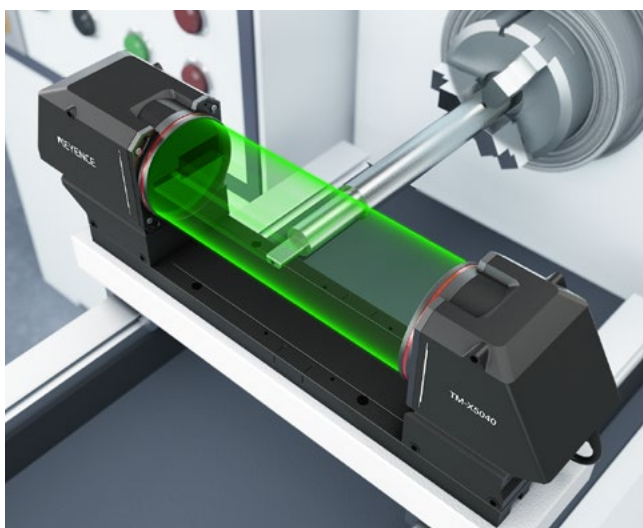
## Outer and tip diameter measurement of ball end mills

The image composition function combines multiple projections into a single image for inspections such as the outer diameter and arc diameter of rotationally asymmetric targets. The ability to select between the light and dark areas of the composite image also makes it possible to inspect for chips.



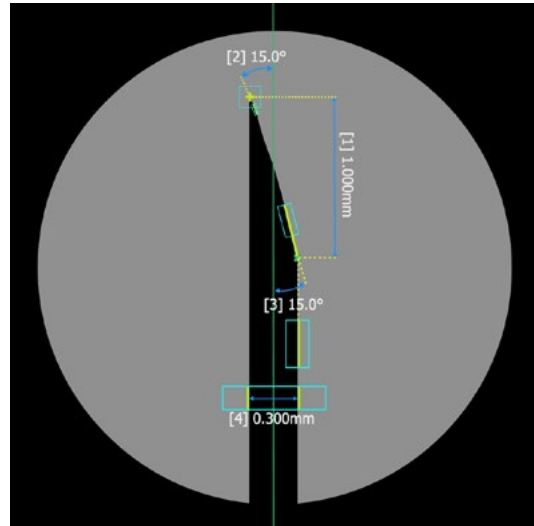
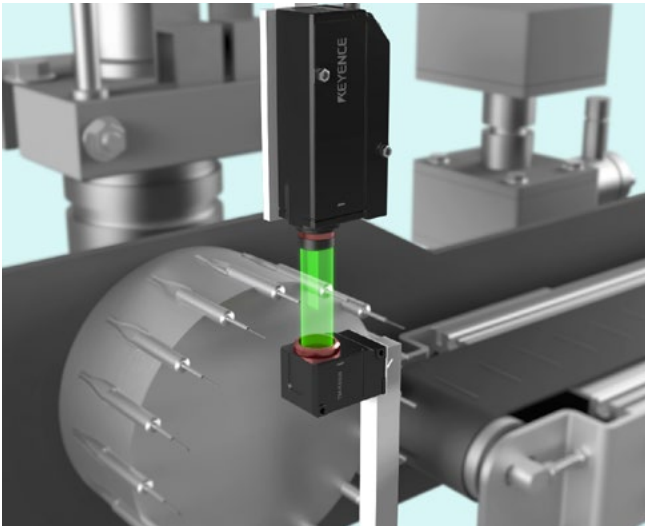
## Measurement of H-cut shaft dimensions

Measurement can be performed to determine whether the H-cut is in alignment with the shaft axis. The distance to the surface of the shaft is measured when the H-cut is at its smallest on the top and bottom, and the difference between these two measurements is used to calculate alignment with the shaft.



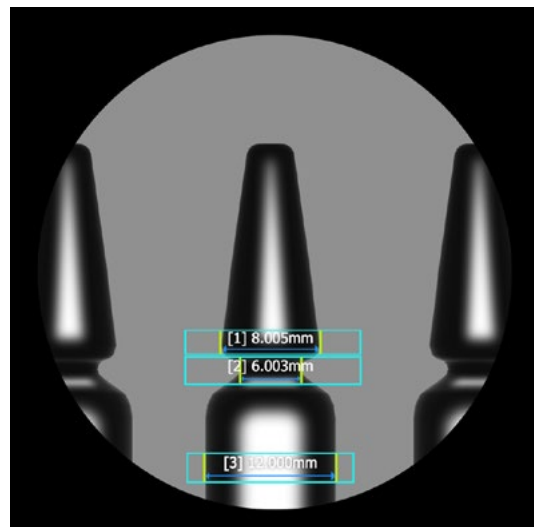
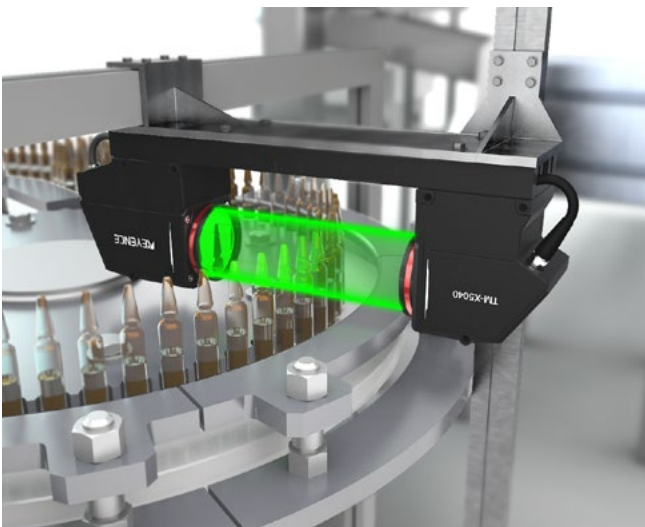
## Outer diameter, angle, and tip length of needles

High-accuracy dimensional measurements—including diameter, angle, and tip length—with a repeatability of  $\pm 0.03 \mu\text{m}$  can help to improve the quality of injection needles.



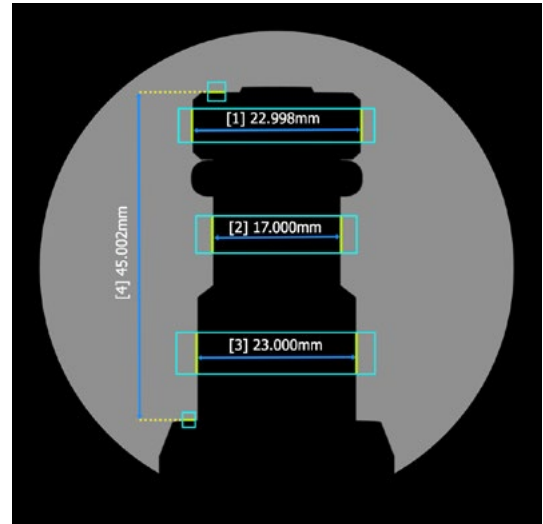
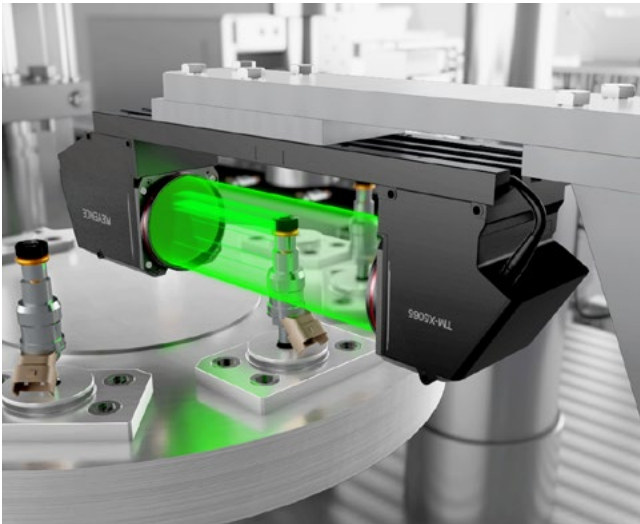
## Maximum, minimum, and average outer diameter of ampoules

When measuring the outer diameter of an ampoule, measurement must be performed at multiple points. Silhouette-based analysis ensures high-accuracy measurement of diameter and other dimensions, even for transparent targets, such as ampoules and vials.



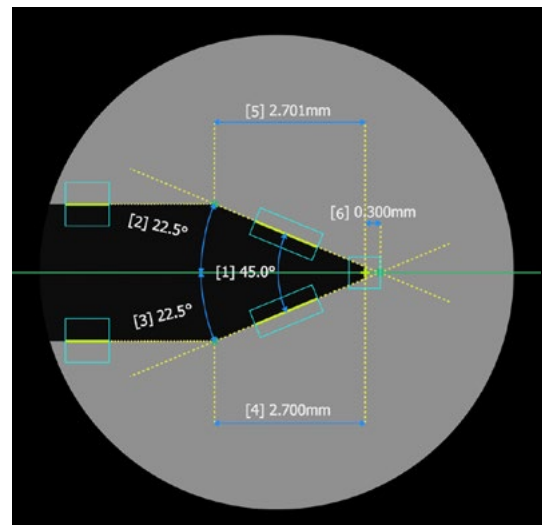
## Multi-point diameter and height measurement of injectors

Simultaneous multi-point measurement is possible for a wide variety of injectors. Because there is minimal distortion throughout the entire field of view, targets of any size can be measured accurately, even if they take up the full window.



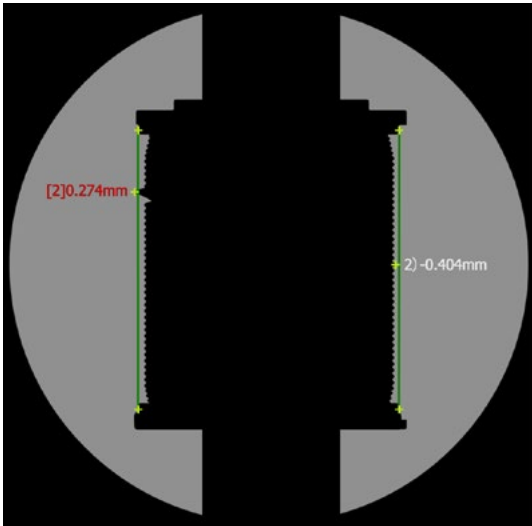
## TIG welding electrode wear measurement

This function measures the tip size of electrodes used for TIG welding. Periodic measurement of the electrode tip helps track wear and improves the quality of welds.



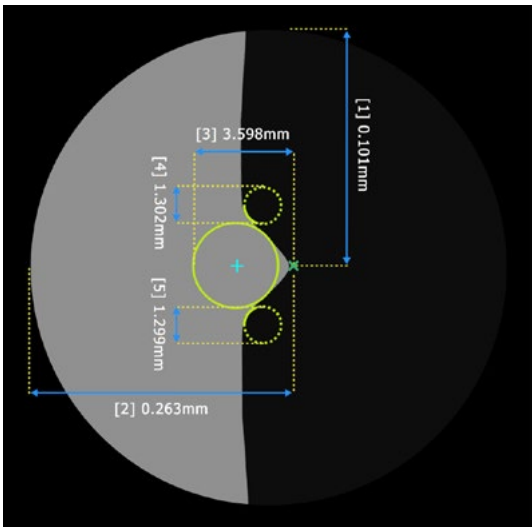
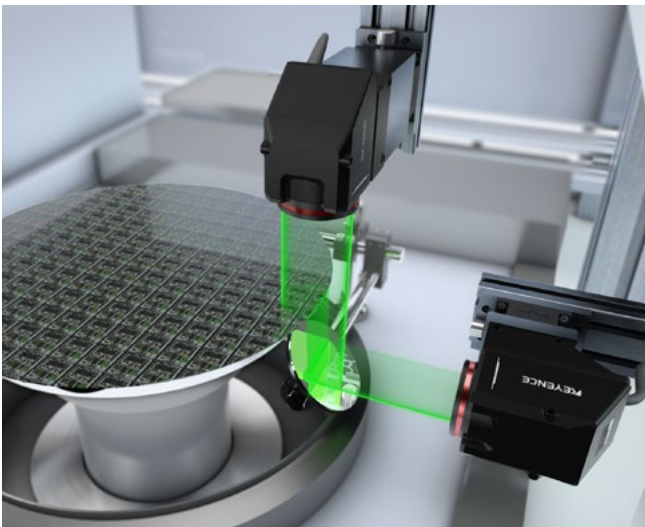
## Coil winding unevenness detection

A combination of tools, including point and straight line tools, can be used to measure protrusions on the coil. Setting the tolerance for these measurements makes it possible to determine whether the target is defective.



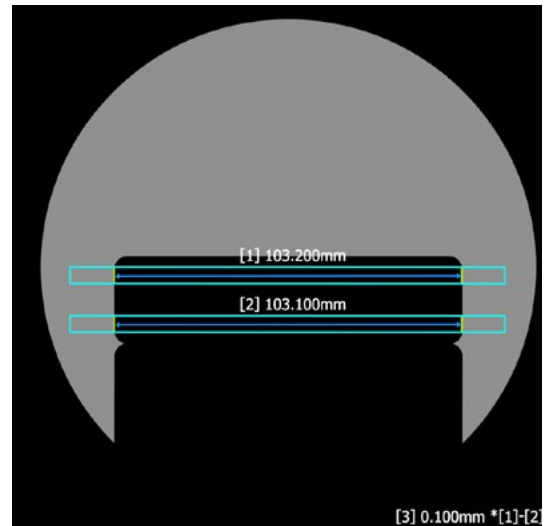
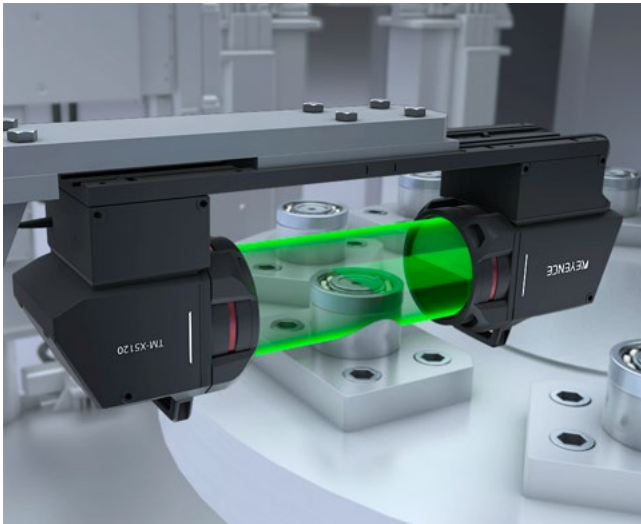
## Wafer notch position detection and dimensional measurement

Angled mirrors can be used to perform measurement where installation space is limited. In addition to detecting the coordinates of tangent circles at specified diameters and intersection point coordinates, angled mirrors can also be used to measure notch dimensions and identify shape problems.



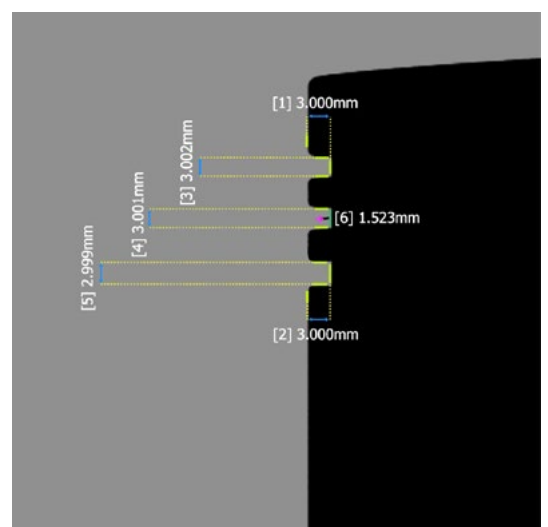
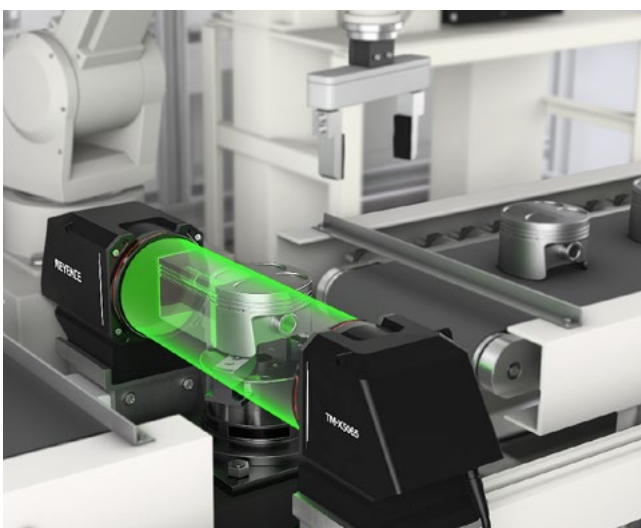
## Outer diameter measurement for large bearings

Measurement is possible even for bearings over  $\varnothing 100$  mm with just one sensor head. Differences between top and bottom outer diameter can also be measured.



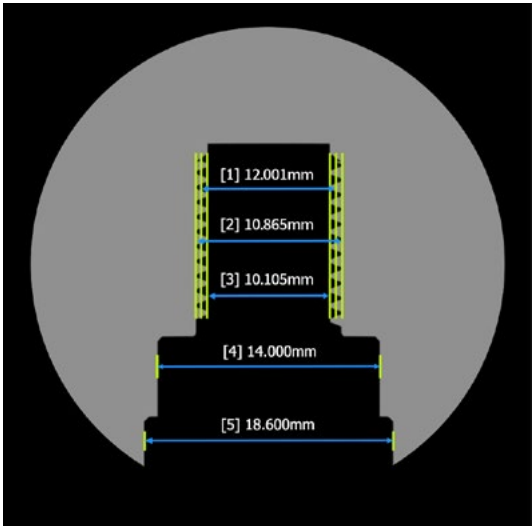
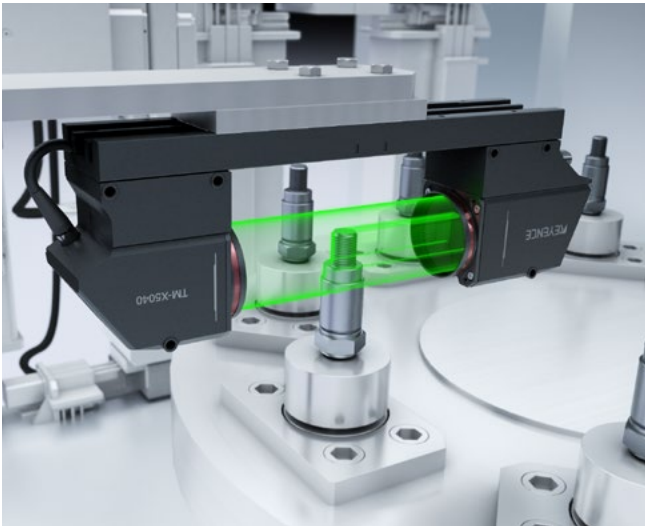
## Piston groove width and foreign particle inspection

Because piston rings are installed in the grooves of a piston, analysing the width of the piston grooves or looking for foreign particles is incredibly important. With the TM-X5000 Series, this process can be completed accurately.



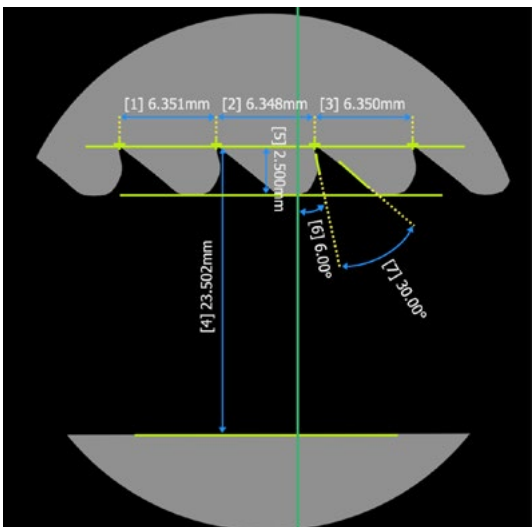
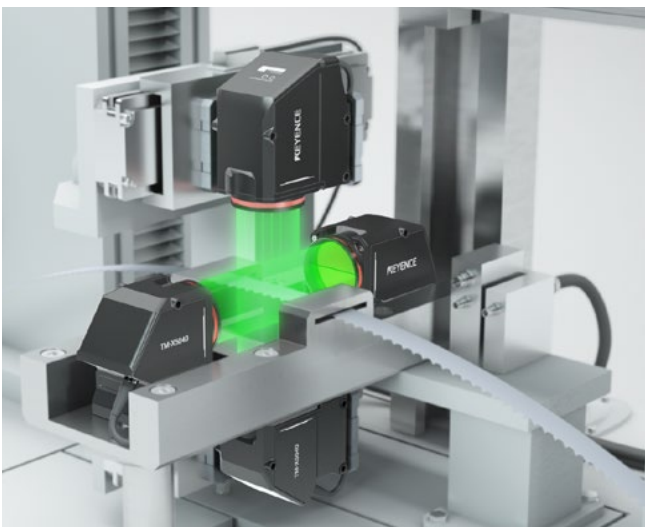
## Thread dimension measurement of solenoid valves

Perform inline thread inspections without the need for a conventional thread gauge. The included thread tool makes it easy to measure the effective diameter, major diameter, minor diameter, pitch, and thread angle.



## Band saw pitch, angle, and blade height

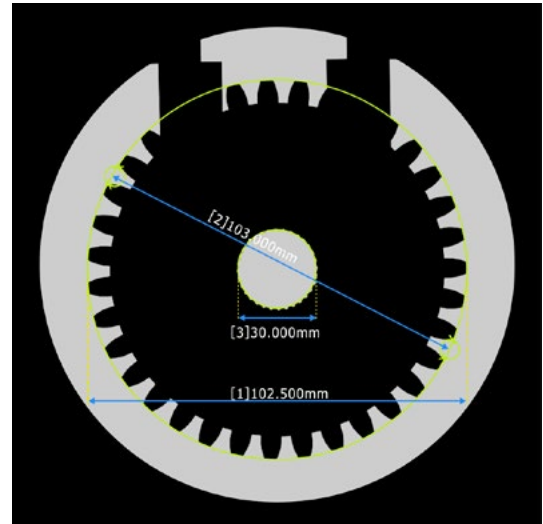
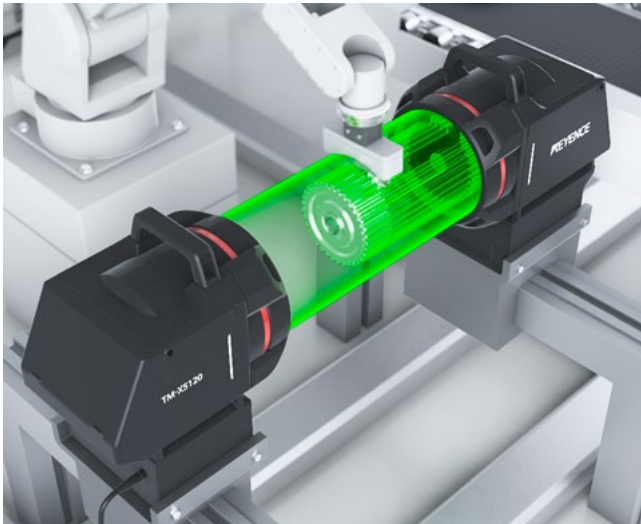
While conventional systems use a projector to perform offline inspection, the TM-X5000 Series can perform inline inspection of the pitch, angle, and blade height of band saws.





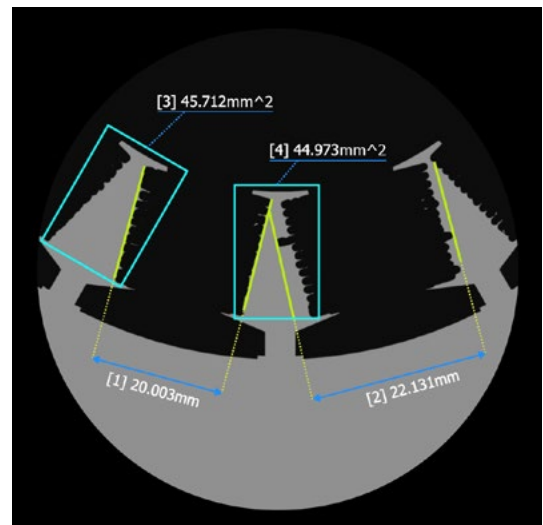
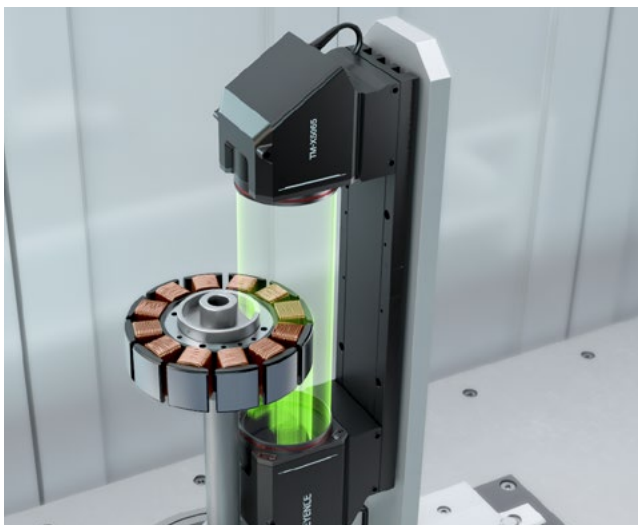
## Large gear measurement

Perform OBD (Over Ball Diameter) inspections, conventionally done with contact-type systems, as well as outer and inner diameter measurements simultaneously.



## Motor winding defect inspection

The dual telecentric optical system's large depth of field means inspection can be performed for an entire winding, including the winding width, even for targets that take up the entire field of view.



## Four models to suit a variety of applications

Compact, ultra-high-accuracy model

### TM-X5006

Measuring range	ø6 mm
Repeatability	±0.03 μm
Measurement position accuracy	±0.2 μm



Standard model

### TM-X5040

Measuring range	ø40 mm
Repeatability	±0.08 μm
Measurement position accuracy	±1.0 μm



Wide-field model

### TM-X5065

Measuring range	ø65 mm
Repeatability	±0.1 μm
Measurement position accuracy	±1.2 μm



Ultra-wide-field model

### TM-X5120

Measuring range	ø120 mm
Repeatability	±0.2 μm
Measurement position accuracy	±2.5 μm



# List of Components

## Sensor head



Two heads can be connected to a single controller.  
(Connecting different heads is possible.)

## Required

Head connection cable  
High-flex 3 m cable: **CB-C3R**  
High-flex 5 m cable: **CB-C5R**  
High-flex 10 m cable: **CB-C10R**



<Extension>  
High-flex 10 m extension cable:  
**CB-C10RX**  
Extension cable repeater:  
**TM-CX10U**



## Required

Controller  
**TM-X5000**



### Dedicated display

USB cable  
**OP-35331** (3 m)



12-inch dedicated monitor  
**TM-MP120**



Ethernet cable  
**OP-66843** (3 m)



Monitor stand  
**OP-87262**



### PC or Windows device with touch panel

USB cable  
**OP-35331** (3 m)



PC / Windows device with touch panel



Ethernet cable  
**OP-66843** (3 m)



### RGB monitor

Controller-monitor cable  
**OP-66842** (3 m)



RGB monitor



## Expansion units

EtherCAT® unit  
**CB-NEC20E**



PROFINET unit  
**CB-NPN20E**

EtherNet/IP® unit  
**CB-NEP20E**

## Optional accessories

CAD import module  
**TM-H1C**



Protective cover  
**OP-88575**  
(2-piece set for TM-X5040)  
**OP-88576**  
(2-piece set for TM-X5065)  
**OP-88775**  
(2-piece set for TM-X5120)



## Transmitter-receiver cable

Transmitter-receiver extension cable  
**OP-87033** (1 m)

Transmitter-receiver extension cable  
**OP-87034** (3 m)



## Communication cables and connectors

I/O expansion connector cable  
**OP-51657** (3 m)

RS-232C cable conversion connector  
**OP-26486**

RS-232C cable  
**OP-26487** (2.5 m)

Ethernet cable  
**OP-66843** (3 m)

USB cable  
**OP-35331** (3 m)

## Other

SD card (industrial-grade)  
16 GB **CA-SD16G**  
4 GB **CA-SD4G**  
1 GB **CA-SD1G**  
512 MB **OP-87133**

Dedicated mouse  
**OP-87506**  
Mouse stand  
**OP-87601**  
24 VDC power supply  
**CA-U4**

# Specifications

## Sensor head

Model			TM-X5006	TM-X5040	TM-X5065	TM-X5120
Transmitter/receiver distance			60 mm	180 mm	270 mm	436.7 mm
Measuring range	Field of view	High-accuracy measurement area	ø4 mm	ø26 mm	ø40 mm	ø60 mm
		Measurement area	ø6 mm	ø40 mm	ø65 mm	ø124 mm
	Depth of field	High-accuracy measurement area	2 mm	10 mm	20 mm	20 mm
		Measurement area	4 mm	20 mm	30 mm	40 mm
Exposure time			25/50/100 µs (Adjustable 3-stage)			
Imaging time (Trigger interval)			Approx. 24 ms (at "Full" vertical/horizontal measurement range sizes) Approx. 3 ms (at "4/16" vertical/horizontal measurement range sizes)			
Light source			InGaN green LED			
Measurement position accuracy*1	High-accuracy measurement area		±0.2 µm	±1 µm	±1.2 µm	±2.5 µm
	Measurement area		±0.3 µm	±2 µm	±2.2 µm	±3.5 µm
Repeatability*2			±0.03 µm	±0.08 µm	±0.1 µm	±0.2 µm
Environmental resistance	Enclosure rating*3		IP64			
	Operating ambient temperature		0 to +45°C			
	Operating ambient humidity		85% RH or less (No condensation)			
Material			Aluminium			Aluminium/PBT
Weight	Transmitter		Approx. 160 g	Approx. 620 g	Approx. 1300 g	Approx. 5900 g
	Receiver		Approx. 480 g	Approx. 890 g	Approx. 1900 g	Approx. 7900 g
	Base		Approx. 210 g	Approx. 670 g	Approx. 1500 g	Approx. 4300 g

\*1 Error when measuring width of KEYENCE standard object (glass calibration scale).

\*2 Average value of ±2σ measuring the width of a KEYENCE standard object (glass calibration scale) 16 times in the centre of the measurement area.

\*3 Excluding connectors and cable boxes.

## Dedicated monitor for TM-X

Model			TM-MP120
LCD panel	Display element		TFT LCD
	Display colours		16 million colours
	Number of dots		1024 × 768 (W × H)
	Effective display area		245.7 × 184.3 (W × H mm)
	Backlight		White LED (non-replaceable); Life expectancy (normal temperature/humidity): Approx. 50000 hours
Interface	Ethernet		1 port on rear (1000BASE-T/100BASE-TX)
	USB*1		1 port on front, 2 ports on rear
Ratings	Power voltage		24 VDC ±10%
	Max. current consumption		2.5 A
Environmental resistance	Operating ambient temperature		0 to +50°C
	Operating ambient humidity		85% RH or less (No condensation)
	Structure		Panel-embedded, IP65f (dust-/drip-proof) on front operating section only
Weight			Approx. 2400 g

\*1 Use USB cable OP-35331 (3 m) to connect to the controller.

## Cable

Type	Model	Cable length	Weight
Head connection cable	CB-C3R	3 m	Approx. 250 g
	CB-C5R	5 m	Approx. 410 g
	CB-C10R	10 m	Approx. 740 g
Head connection extension cable	CB-C10RX	10 m	Approx. 740 g
Transmitter-receiver cable	OP-87033	1 m	Approx. 60 g
	OP-87034	3 m	Approx. 130 g

## Extension cable repeater

Model			TM-CX10U
Max. connections	Number of steps		2
	Cable length		30 m total (10 m between devices)
Environmental resistance	Operating ambient temperature		0 to +45°C
	Operating ambient humidity		85% RH or less (No condensation)
Weight			Approx. 60 g

## Controller

Model		TM-X5000
Number of connectable sensor heads		2
Number of setting registrations		Up to 1000 settings (depending on SD card capacity and setting contents) for SD card 1 and SD card 2 individually. External switching is possible.
Memory cards		<ul style="list-style-type: none"> <li>• SD card slot × 2</li> <li>• Supports OP-87133 (512 MB), CA-SD1G (1 GB: Equipped as standard for SD1 slot), CA-SD4G (4 GB), CA-SD16G (16 GB)</li> </ul>
Number of configurable tools		Up to 100 measurement tools and 100 element tools per head*1
Interface	Control inputs	20 (Terminal block: 5, Parallel I/O: 15)
	Control outputs	<ul style="list-style-type: none"> <li>• 28 (Terminal block: 6, Parallel I/O: 22)</li> <li>• Photo MOSFET*2</li> </ul>
	RS-232C	Numerical value output and control input/output
	PLC link	Numerical value output and control input/output using Ethernet port (Cannot be used in conjunction with EtherNet/IP®, PROFINET, and EtherCAT®) Compatible models: Mitsubishi Electric PLCs (MELSEC Q Series, L Series, iQ-R Series, iQ-F Series)
	Ethernet	<ul style="list-style-type: none"> <li>• Numerical value output and control input/output</li> <li>• Connection to KEYENCE dedicated monitor (TM-MP120)</li> <li>• Connection to KEYENCE PC application software</li> <li>• Support for FTP client/server functions, BOOTP functions</li> <li>• 1000BASE-T/100BASE-TX/10BASE-T</li> <li>• Support for jumbo frames (Ethernet port on main unit only)</li> </ul>
	USB	<ul style="list-style-type: none"> <li>• Connection to KEYENCE dedicated monitor (TM-MP120)</li> <li>• Connection to KEYENCE PC application software</li> <li>• USB 2.0 only</li> </ul>
	EtherNet/IP®	<ul style="list-style-type: none"> <li>• Numerical value output and control input/output using Ethernet port or optional EtherNet/IP® unit CB-NEP20E (Cannot be used in conjunction with PLC link, PROFINET, and EtherCAT®)</li> <li>• Supports cyclic communication (max. 1436 bytes) and message communication</li> <li>• Maximum connections: 32 (Ethernet port) / 1: Exclusive Owner, 4: Input only (CB-NEP20E)</li> <li>• Conforms to conformance test Version CT17 (Ethernet port) / CT17 (CB-NEP20E)</li> </ul>
	PROFINET	<ul style="list-style-type: none"> <li>• Numerical value output and control input/output using Ethernet port or optional PROFINET unit CB-NPN20E (Cannot be used in conjunction with PLC link, EtherNet/IP®, and EtherCAT®)</li> <li>• Supports cyclic communication (max. 1408 bytes (Ethernet port) / 1212 bytes (CB-NPN20E))</li> <li>• Supports non-cyclic communication (recorded data)</li> <li>• Conforms to Conformance Class A (Ethernet port) / C (CB-NPN20E)</li> </ul>
	EtherCAT®	<ul style="list-style-type: none"> <li>• Numerical value output and control input/output using optional EtherCAT® unit CB-NEC20E (Cannot be used in conjunction with PLC link, EtherNet/IP®, and PROFINET)</li> <li>• Supports cyclic communication (process data object communication) (Input: max. 530 bytes / Output: max. 534 bytes)</li> <li>• Supports non-cyclic communication (mailbox communication) • Supports CoE</li> <li>• Conforms to conformance test V2.2.1.0</li> </ul>
	SNTP	Automatic date and time correction when connected to SNTP server
	USB HDD	Various data output, including image data, when connecting an HDD (2 TB max.) to dedicated USB port (USB 3.0 support, bus-powered, rated output: 900 mA)
Simple monitor output	Analogue RGB output, XGA (1024 × 768 (24-bit colour, 60 Hz))	
Minimum display unit		0.01 μm, 0.0001°, 0.0001 mm <sup>2</sup>
Display language (Simple monitor output)		Switchable between English, Japanese, Simplified Chinese, Traditional Chinese, Korean, Thai, German, French, Italian, Spanish (Mexico), Czech, Hungarian, and Polish
Ratings	Power voltage	24 VDC ±10%
	Current consumption	3.5 A
Environmental resistance	Operating ambient temperature	0 to +45°C (when installed on a DIN rail) / 0 to +40°C (when installed on a surface)
	Operating ambient humidity	85% RH or less (No condensation)
Weight		Approx. 1600 g

\*1 Up to 7 master comparison tools (area/contour), 19 pitch measurement tools (distance/angle), 13 foreign particle distance tools (rotating rectangle), 8 foreign particle distance tools (circle/arc), and 7 profile extraction tools (depending on SD card capacity and settings).

\*2 Positive common connection for NPN input devices and negative common connection for PNP input devices supported.

• EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

## TM-X Navigator operating environment

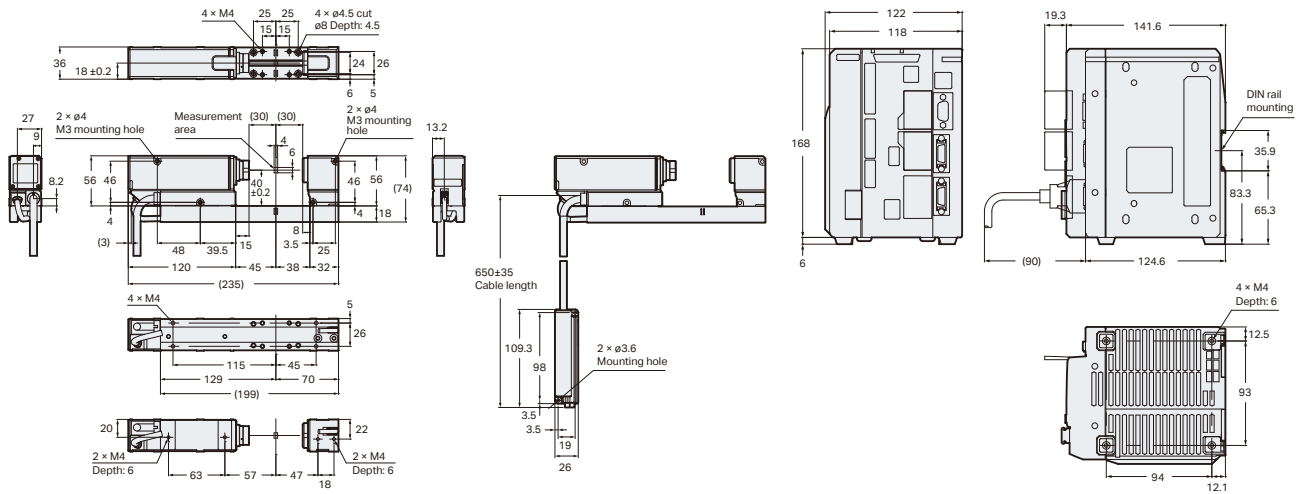
Model		TM-H1X
Supported OS		Microsoft Windows11 (pro)/Microsoft Windows10 Home/Pro/Enterprise <ul style="list-style-type: none"> <li>• Supported OS languages: English, Japanese, Simplified Chinese, Traditional Chinese, Korean, Thai, German, French, Italian, Spanish (Mexico), Czech, Hungarian, and Polish</li> </ul>
Required free space on hard disk		2 GB or more (with additional space for storing images required)
Display resolution		1366 × 768 pixels or higher (1920 × 1080 pixels or higher recommended)

• Windows® is a trademark or registered trademark of Microsoft Corporation in the United States and other countries.

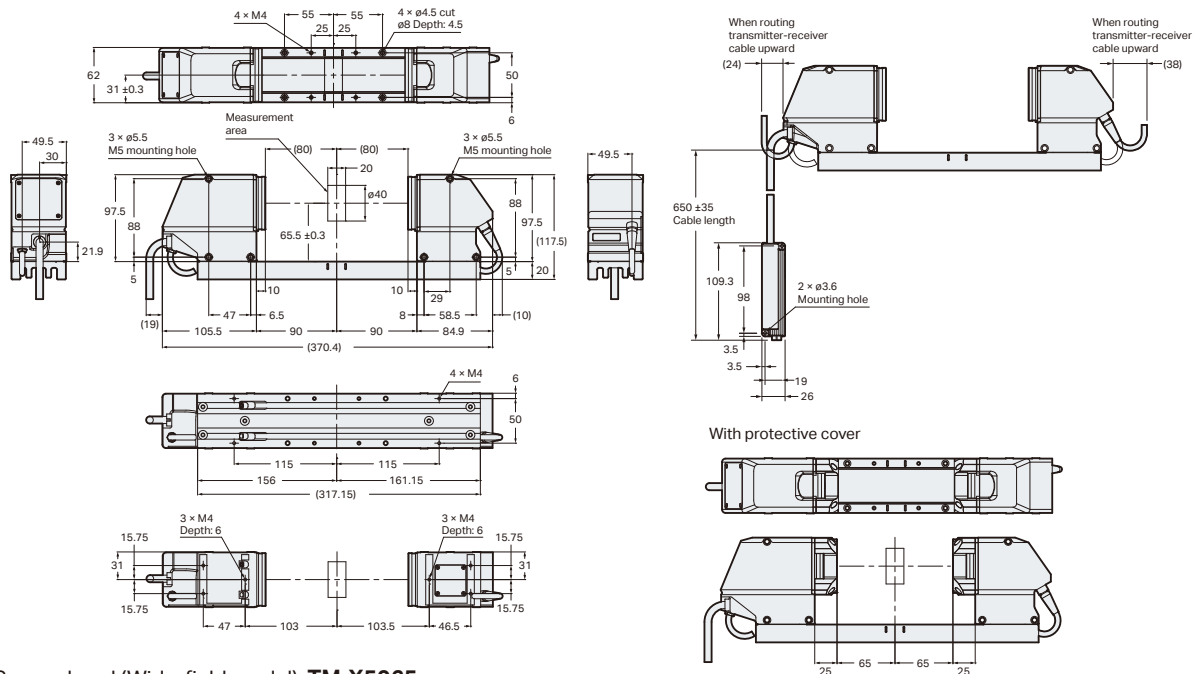
# Dimensions (Unit: mm)

Sensor head (Compact, ultra-high-accuracy model): **TM-X5006**

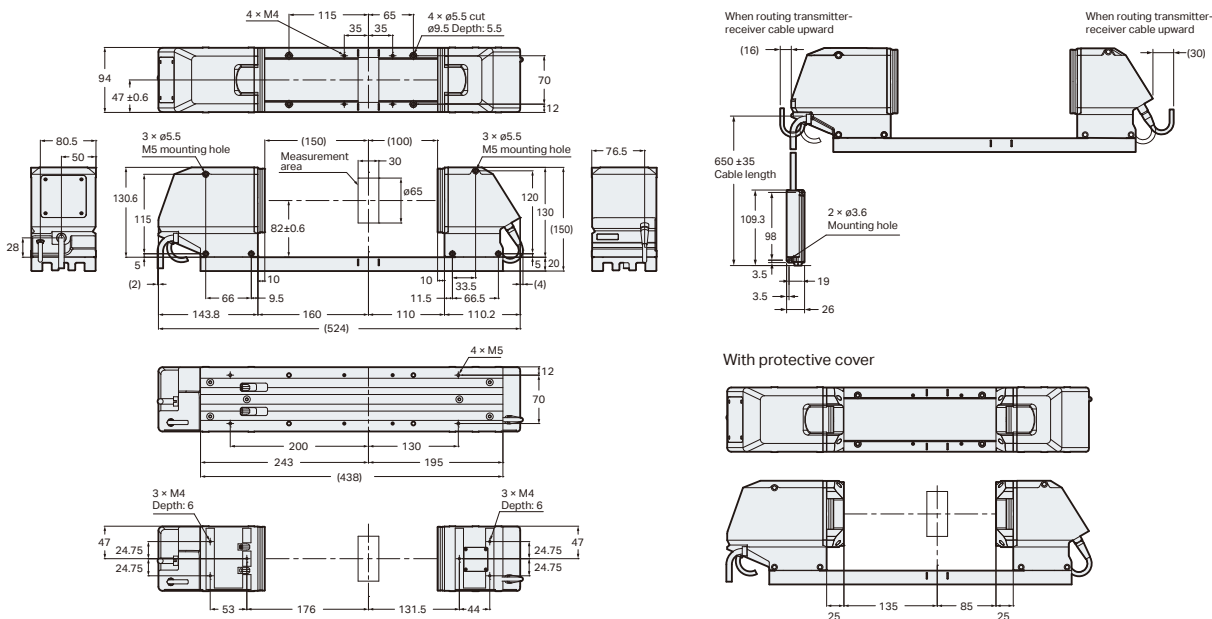
Controller: **TM-X5000**



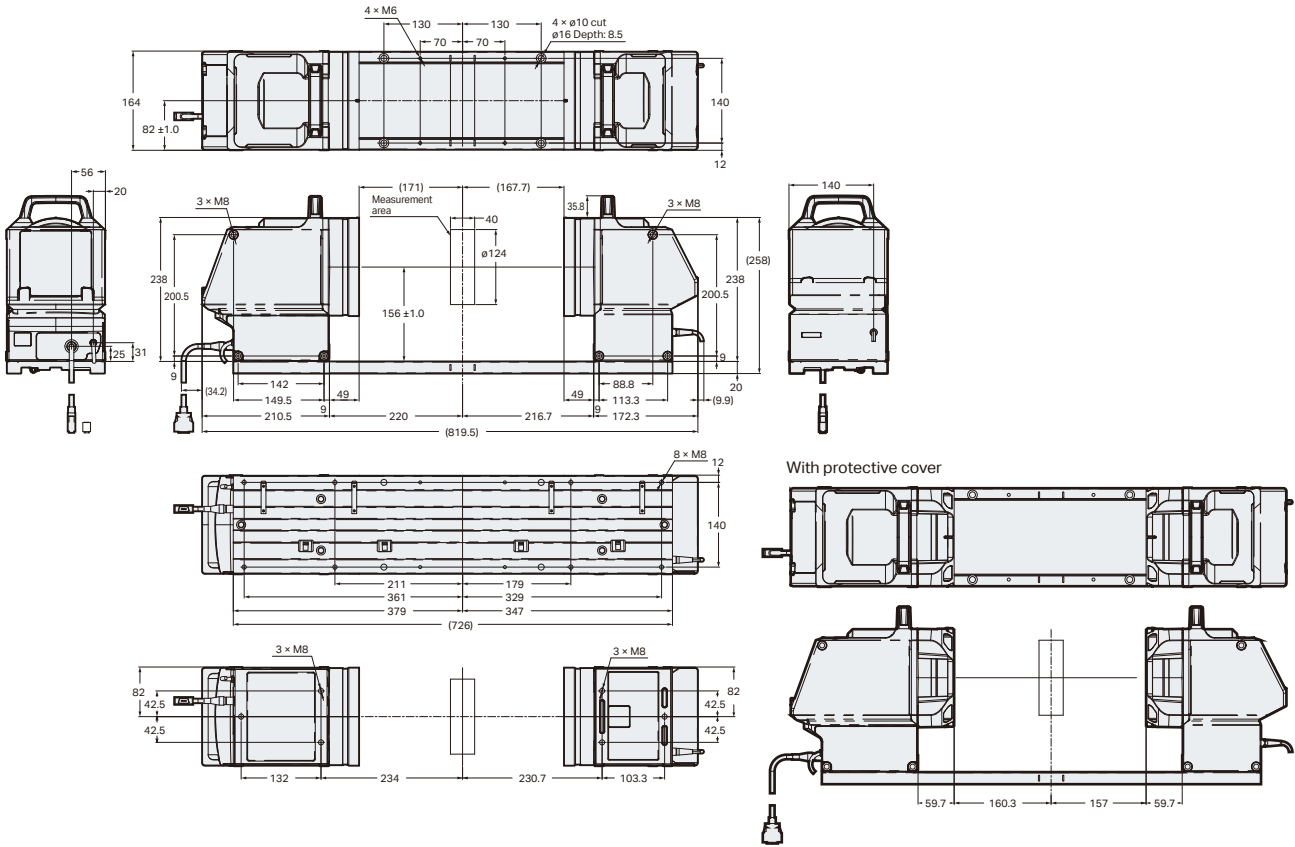
Sensor head (Standard model): **TM-X5040**



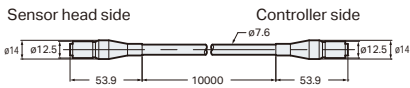
Sensor head (Wide-field model): **TM-X5065**



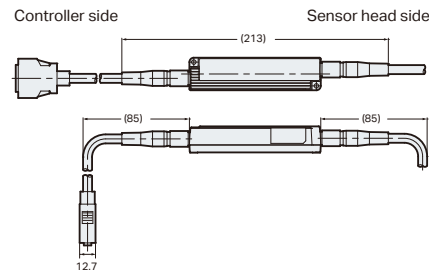
Sensor head (Ultra-wide-field model): **TM-X5120**



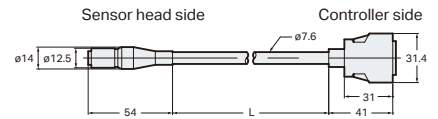
Head connection extension cable:  
**CB-C10RX**



With cables connected

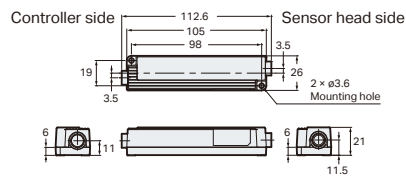


Head connection cable:  
**CB-C3R/CB-C5R/CB-C10R**

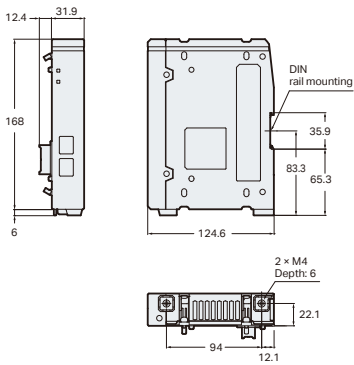


Model	CB-C3R	CB-C5R	CB-C10R
Cable length (L)	3 m	5 m	10 m

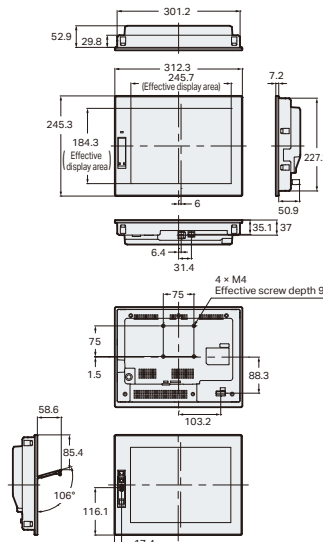
Head connection extension repeater:  
**TM-CX10U**



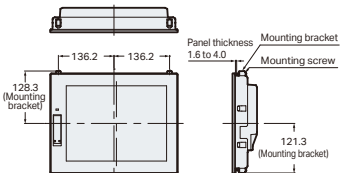
Expansion unit:  
**CB-NEC20E/CB-NPN20E/CB-NEP20E**



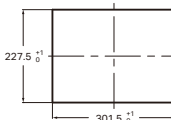
Dedicated monitor for TM-X:  
**TM-MP120**



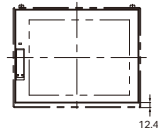
With mounting bracket (accessory) attached



Panel cutting dimensions



Panel installation (front)



Related Products

## High-speed inline measurement of outer diameters, gaps, and widths

### LS-9000 Series High-Speed Optical Micrometer



## KEYENCE CORPORATION

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