KEYENCE

3D Interference Measurement Sensor

WI-5000 Series

Repeatability

0.1 μm

0.000004"

Measurement time (min.)

0.13 sec

Measurement of

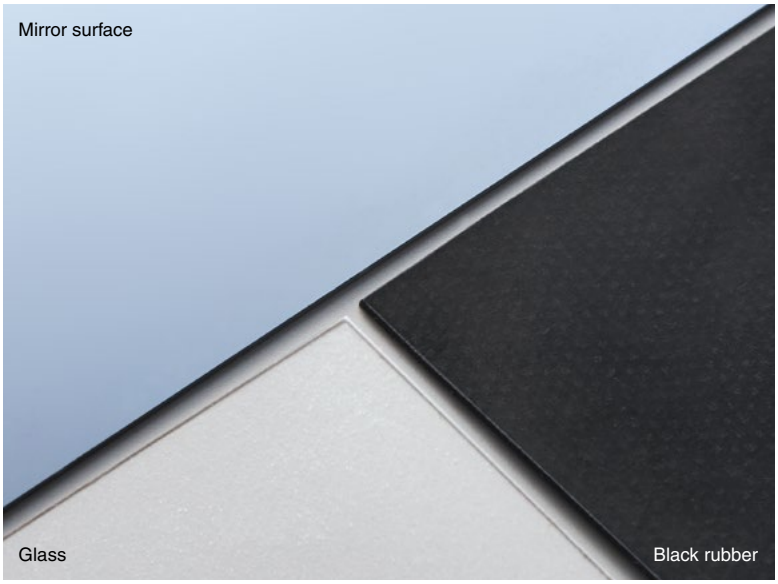
Transparent/ mirrored targets

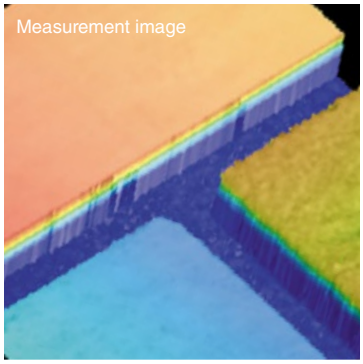
Accurate Surface Measurements at High Speed

Solving measurement challenges using white light interferometry

Measure highly varied surfaces with dynamic one-shot image capture

White light interferometry makes it possible to measure the height of any target that reflects light. With a single shot, all surface types can be captured in the 3D image, including reflective surfaces such as glass or mirrors, and diffuse surfaces like black rubber.



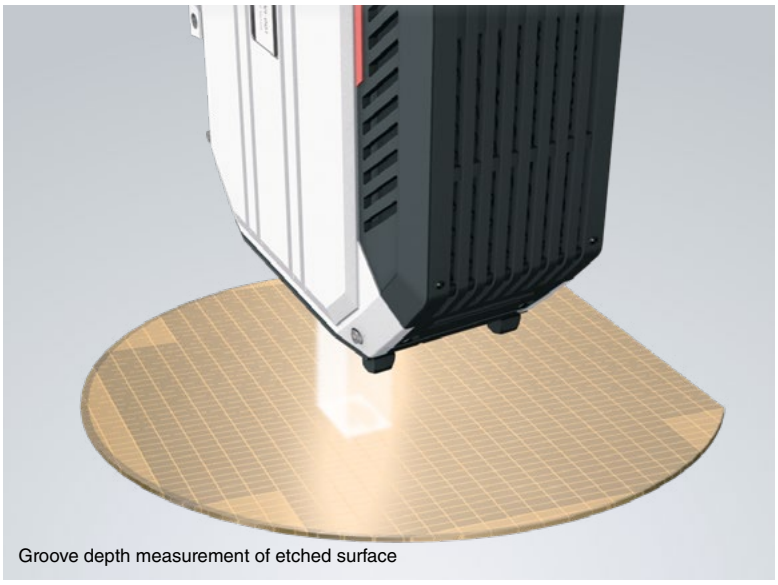


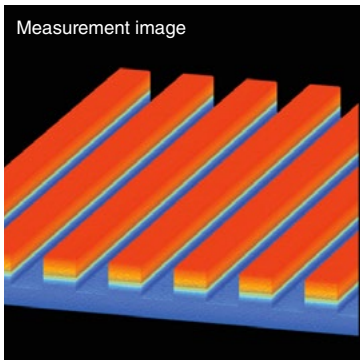
Measured values

Mirror surface height:
619.2 µm 0.024378"
Black rubber surface height:
529.8 µm 0.020858"
Glass surface height:
325.6 µm 0.012819"

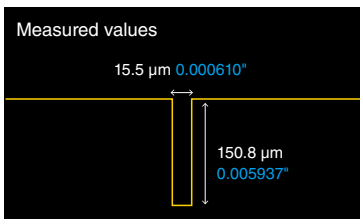
Superior measurement of groove and hole depths

The system's coaxial design enables depth measurement of grooves, holes, and other targets with narrow openings that are difficult to measure by conventional means. Such measurements are not possible with general-purpose laser displacement sensors because the transmitter and receiver are on different axes.


Groove depth measurement of etched surface

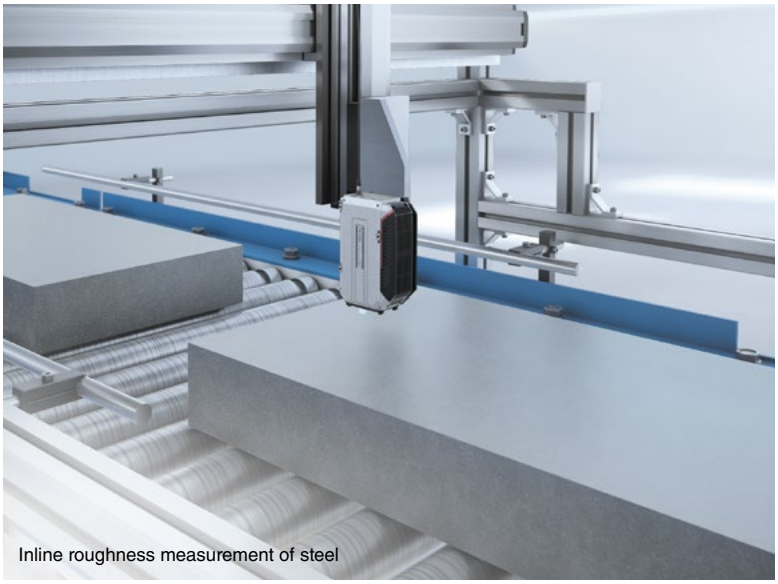


Measured values

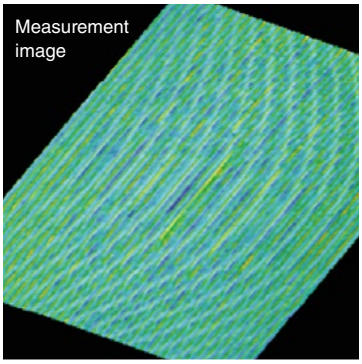


Surface roughness (Sa/Sz) and line roughness (Ra/Rz) measurement

Surface roughness (Sa/Sz) and line roughness (Ra/Rz) measurement can be performed automatically. Inspection can be performed immediately at the point of production.



Inline roughness measurement of steel

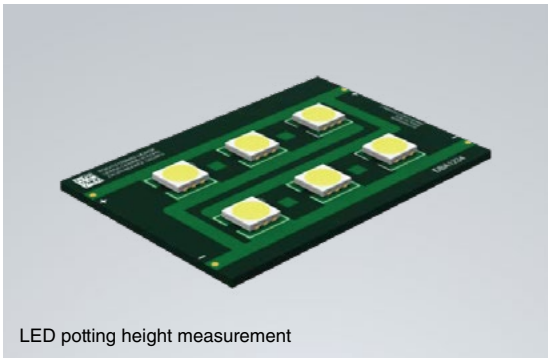


Measured values

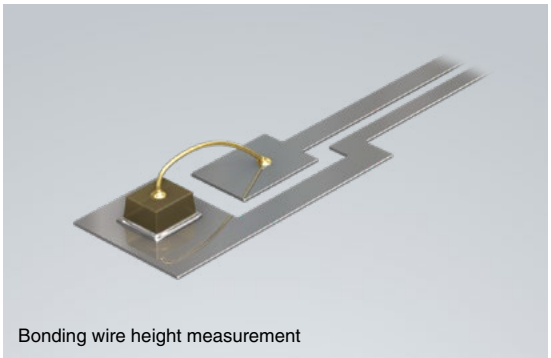
Surface roughness Sz:
4.7 µm 0.000185"
Surface roughness Sa:
2.1 µm 0.000083"

Accurate measurement of gels, resins, and bonding wires

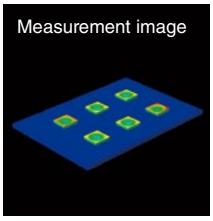
Transparent materials and fine targets can be difficult to measure because they don't reflect much light. The WI-5000 makes height measurement of these targets, such as transparent gels, semi-transparent resins, and bonding wire possible. White light interferometry enables measurement even when the reflections are weak or wrap around the target, such as with loop top heights.



LED potting height measurement

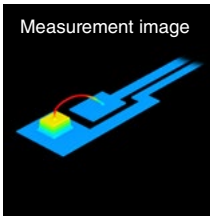


Bonding wire height measurement



Measured values

Potting height
118.5 µm 0.004665"



Measured values

Wire height: 192.4 µm
0.007575"

Instant high-accuracy 3D measurement

3D Interference Measurement Sensor

WI-5000 Series

One-shot 3D measurement of any material

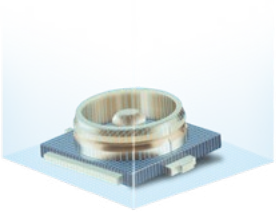
White light interferometry enables one-shot 3D image capture of areas with multiple surface types. The coaxial sensor makes it possible to measure nearly any material, including transparent or mirrored targets.

Inline and near-line inspection

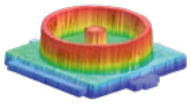
High-resolution 3D images are captured in as little as 0.13s, making automated inspection of precise features and surfaces a reality. The optional dedicated stand can also be used for near-line measurements.

Various 3D measurement tools

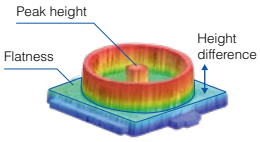
Complete set up in just a few clicks by selecting from a menu of 3D measurement tools. Everything from height and width to volume and multi-point inspections can be programmed with ease.



Captures the entire surface



Corrects for misalignment/tilt



Measures various dimensions

Just **0.13** seconds

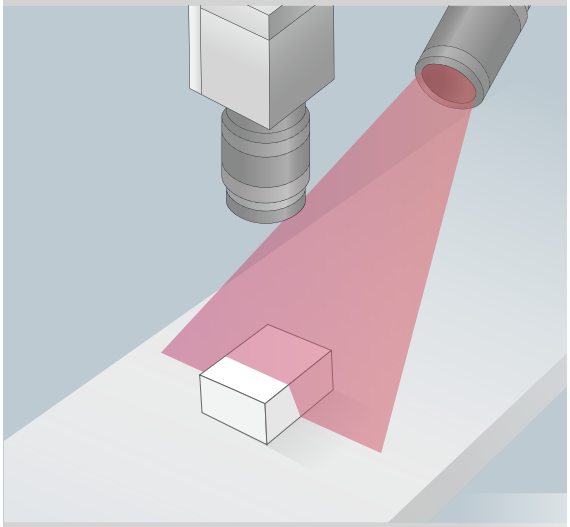
One-shot 3D measurement of any material

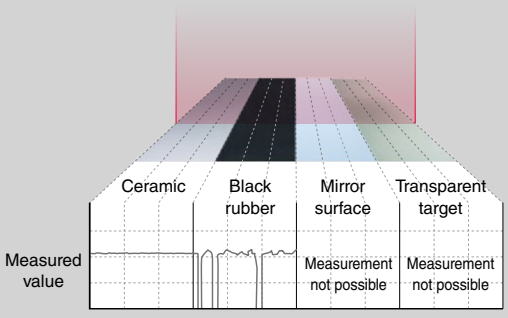
Surface measurement with impressive speed and stability

Capturing an image of targets with multiple surface types is difficult because light reflects differently from transparent and opaque targets. Because the WI Series offers coaxial measurement, high-accuracy 3D measurement is possible without adjusting camera angles for each material.

Before

General-purpose 3D camera (for diffuse reflection)

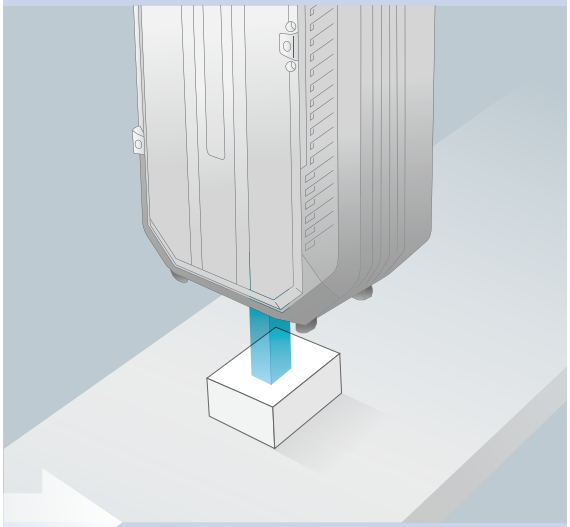


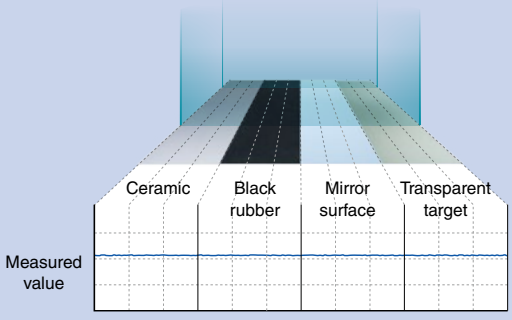


Measurement affected by material/color

After

WI-5000 Series





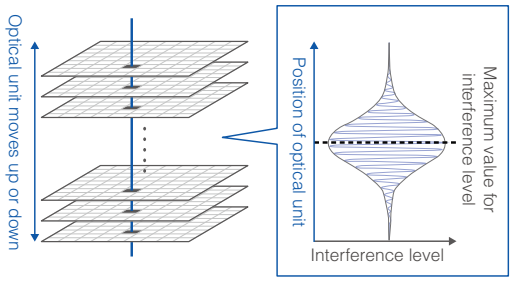
Measurement unaffected by material/color

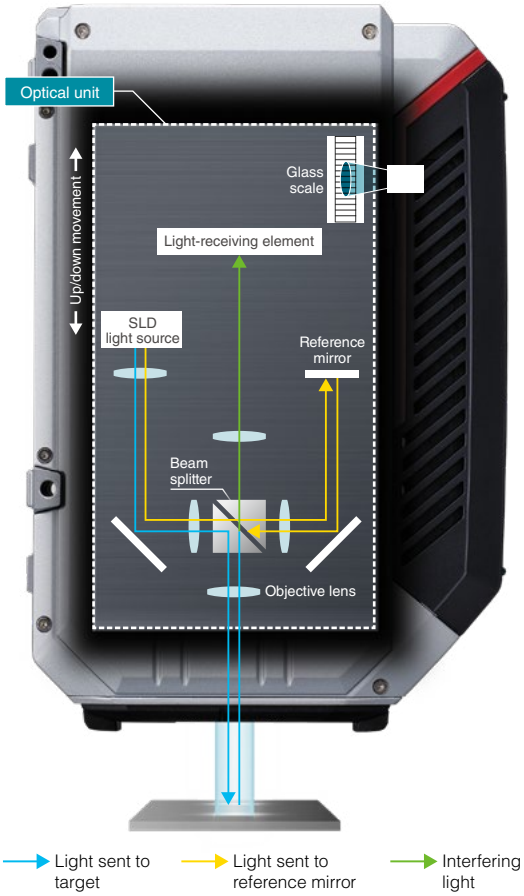
White light interferometry enables instant 3D image capture of any material

The light emitted is split into two by the beam splitter, with one beam reflected off the target and the other reflected off the reference mirror. Both beams then enter the light-receiving element as interfering light waves.

The optical unit—an assembly of all the optical components—is then moved up and down to change the length of the optical path of the beam reflected from the target to obtain contrasting images.

Because the interfering light waves entering the light-receiving element have the highest level of interference when the lengths of their optical paths coincide, the device reads the position of the optical unit at the highest level of interference for each measurement point in the images. This data is then used to determine the distance to the target.





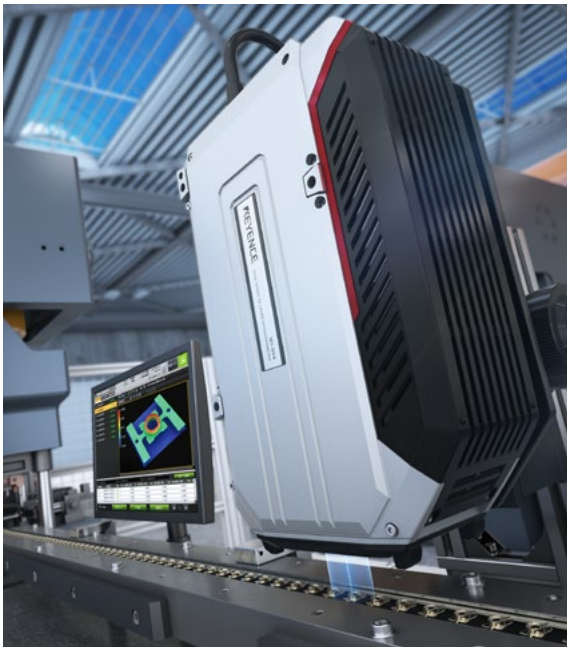
Select from 3 measurement range options

KEYENCE offers three types of sensor heads, designed to meet a variety of application requirements—from high-resolution height measurement at a pitch of 4 µm 0.000157" to high-accuracy batch measurement over a 10 × 10 mm 0.39" × 0.39" area.

	High-resolution model WI-001	Standard model WI-004	Wide-field model WI-010
Measurement range	1 × 1 mm 0.04" × 0.04"	4 × 4 mm 0.16" × 0.16"	10 × 10 mm 0.39" × 0.39"
Minimum detection area	4 × 4 µm 0.000157" × 0.000157"	15 × 15 µm 0.000591" × 0.000591"	40 × 40 µm 0.001575" × 0.001575"
Height measurement range	1.4 mm 0.06" (Standard Mode), 0.7 mm 0.03" (High-Speed Mode)		
Reference distance	18 mm 0.71"		
Repeatability (height difference)	0.1 µm 0.000004"		

Inline and near-line inspection

Automate inspection with high-speed measurement

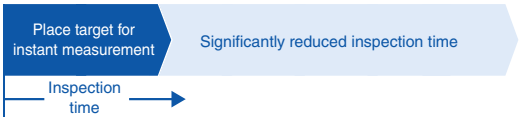


Capturing a 3D image of an area in one shot makes it possible to complete multi-point inspections without a precision stage to adjust part position. This significantly reduces measurement time, enabling 100% inspection.

With the WI-5000 Series

- Does not require a high-precision moving stage
  ➡ **Performs one-shot 3D measurement**
- No precise positioning required
  ➡ **Position-correction function included**
- Multiple measurements can be made simultaneously
  ➡ **Measurement time is significantly reduced**

Processing flow of multi-point measurement

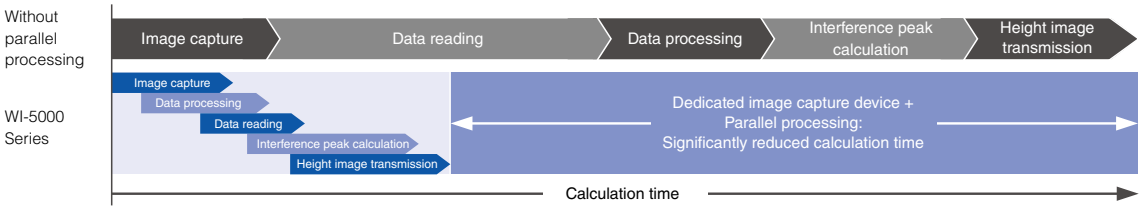


Unique surface-based high-speed measurement

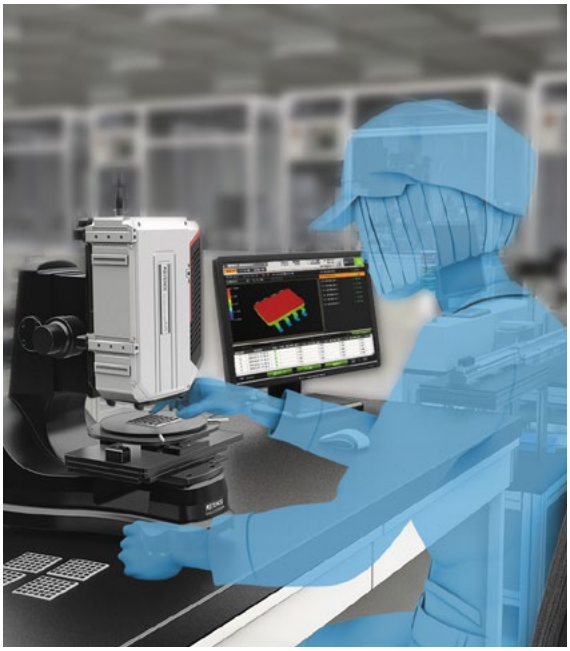
Dedicated image sensor + IPO*-Engine

* Interference Parallel Operation

A dedicated high-speed image sensor capable of processing data at ultra-high speeds is mounted inside the system. The sensor uses a new parallel processing engine that reads captured data, calculates the interference peak, and transmits the height image at ultra-high speed. This makes it possible to perform high-precision 3D measurements at line speed.



Easy and accurate near-line inspection

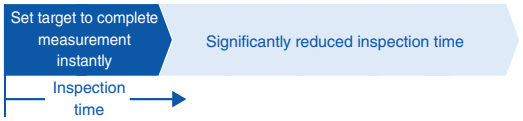


A dedicated stand to secure the sensor head is available for near-line inspections.
The position correction function allows inspection to be performed simply by placing the target onto the stage. This significantly reduces the labor required for inspection while eliminating errors introduced by the different techniques of individual operators.

With the WI-5000 Series

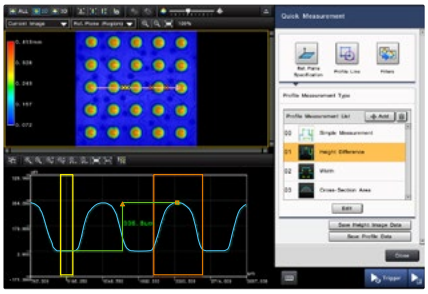
- No precise positioning required
  - ➡ **Reduces labor required for inspection**
  - ➡ **Eliminates the potential for operator error**

Processing flow of height difference measurement



Quick measurement

Easily evaluate prototypes by capturing height data for 3D measurement. The cross-section of the captured 3D data can also be visualized and measured. Various profile measurement functions are available, including height difference, width, angle, and cross-sectional area.



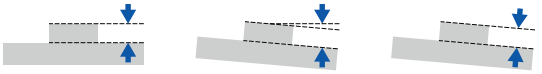
Logging function

Measurement results can be saved in the controller with a single click. The measurement results of a complete lot can even be saved to a CSV file, so generating documentation on a PC is simple.

Various 3D measurement tools

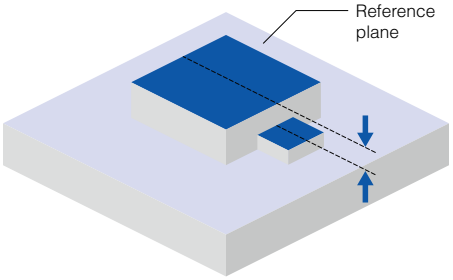
Height/height difference

The WI-5000 Series is able to measure height differences and height over a specified measurement area. Even tilted targets can be measured accurately by specifying a reference plane. Average, peak, and valley can be selected for a measurement region.



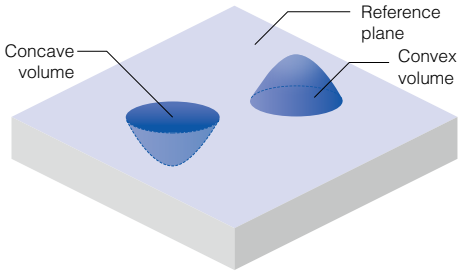
Without reference plane correction

With reference plane correction



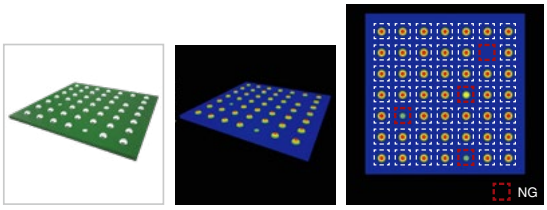
Volume

The volume of space surrounding a specified measurement region and reference plane can be measured. The space above or below a reference plane can be specified.

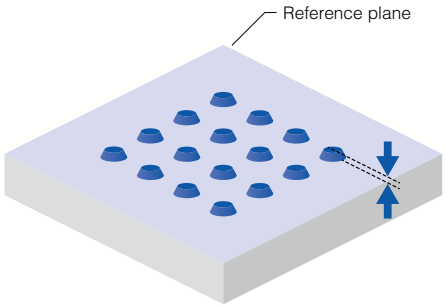


Multi-point height/area

The ability to arrange multiple measurement regions enables efficient measurement of the height, area, and volume of multiple targets within the image.

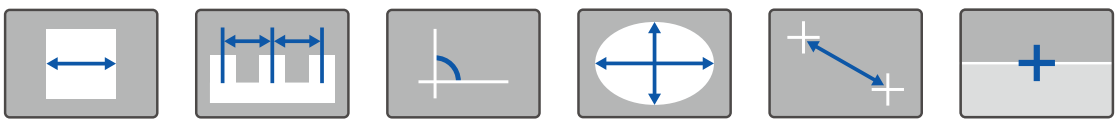


BGA ball height measurement



Diameter/width/distance

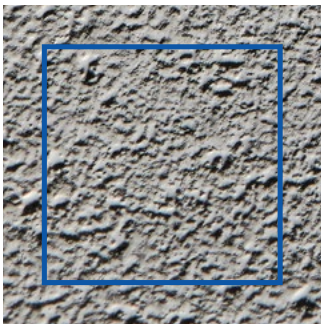
Edges can be detected by setting threshold values for height data, and then diameter, width, distance, and other dimensions can also be measured.

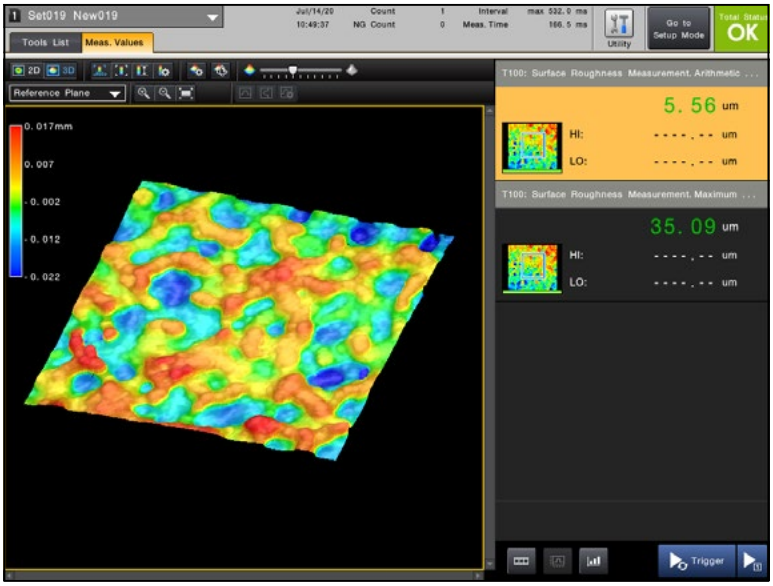


Edge Width | Center Pitch | Angle | Diameter | Distance | Position

New function

Surface roughness (Sa/Sz)

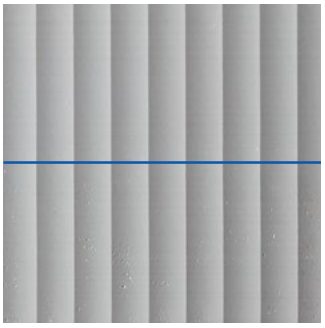


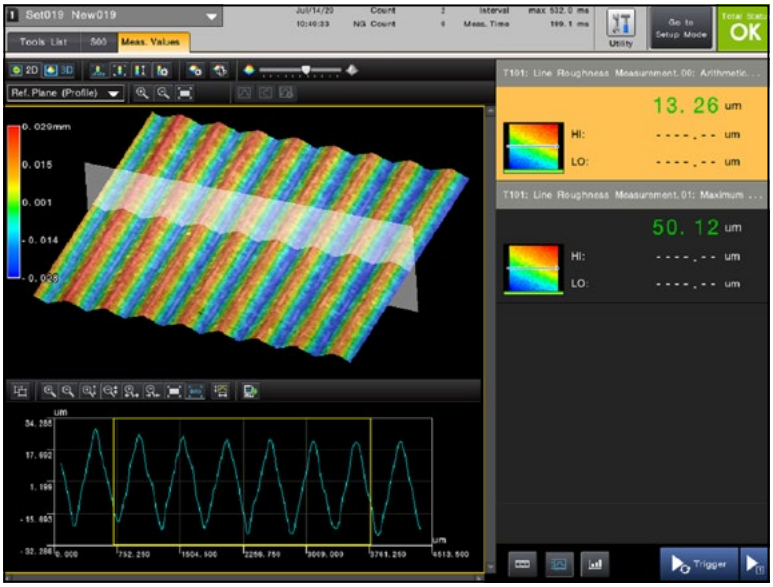


Surface roughness (Sa/Sz) can be measured over a specified region. Targets with irregular surfaces, such as cast metal, can be quantitatively evaluated for roughness.

New function

Line roughness (Ra/Rz)



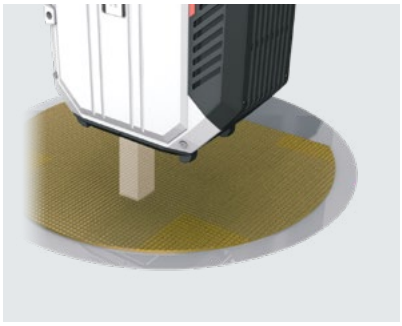


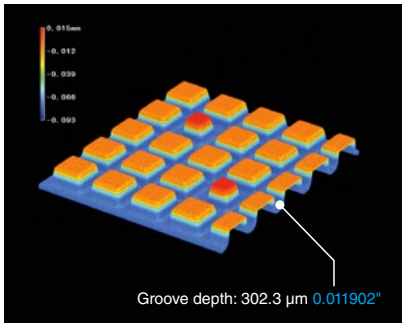
Line roughness (Ra/Rz) of a specified region can be measured. Molded products and ground metal surfaces can be evaluated inline with a stationary time of 0.13 seconds.

Semiconductor/Electronics Industries

Post-dicing groove depths

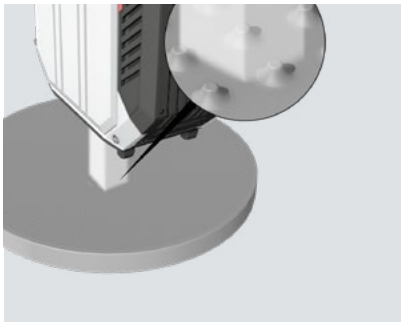
The depth of grooves cut during dicing is an important factor in subsequent processes.
White light interferometry-based coaxial measurement enables 3D measurement with no blind spots, even for narrow groove depths.

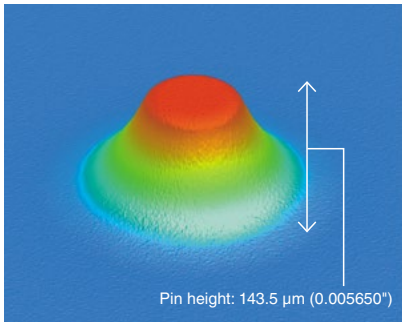




Pin height of electrostatic chucks

Using a rotary or XY stage allows quick measurements of pin height at multiple locations across the chuck. The results can also be linked to the measurement location, and measurement results can be output to a PC as needed.

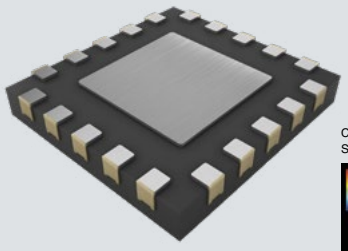




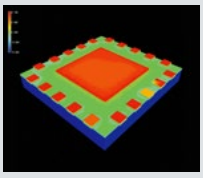
New function

Coplanarity tools: Center of gravity-based reference plane calculation

Setting the target's center of gravity on the coplanarity screen allows measurement of height differences to detect improperly seated terminals automatically. With conventional systems, the center of gravity position of the tangent plane may vary due to differences in the position between the upward-facing and downward-facing orientations. This new function corrects the center of gravity when calculating the tangent plane, providing more stable coplanarity measurement of SMT devices.



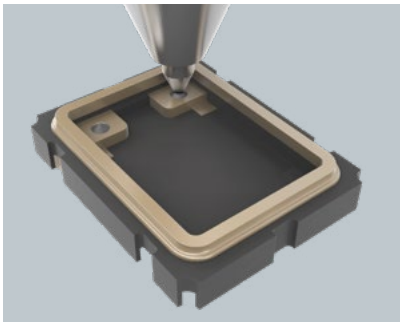
Coplanarity measurement of SMT devices

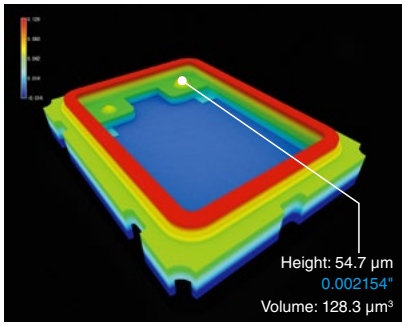


Electronic/Electrical Industries

Height/volume of precision adhesive

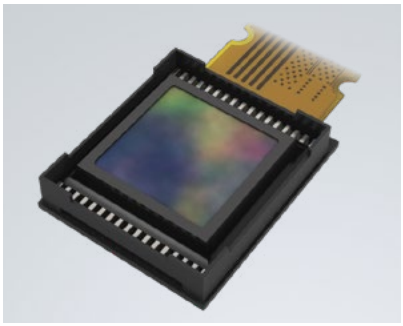
The height and volume of adhesive can be measured immediately after application.
The principles of white light interferometry provide micron-level measurements with high accuracy.

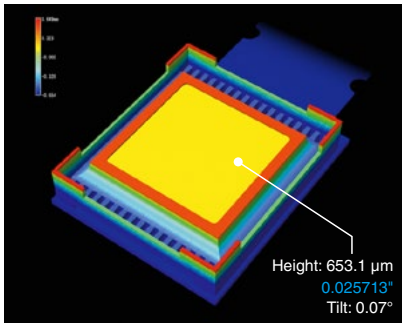




Height and tilt of CMOS cover glass

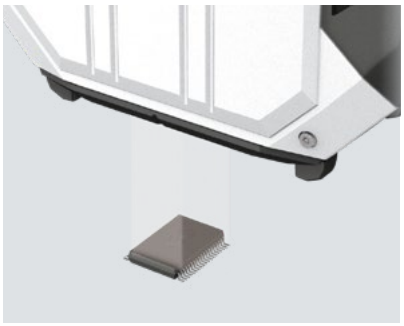
The WI-5000 Series can be used to inspect the package height and tilt of CMOS sensors.
Measurements can be performed based on a reference plane, eliminating errors caused by the part not laying flat.

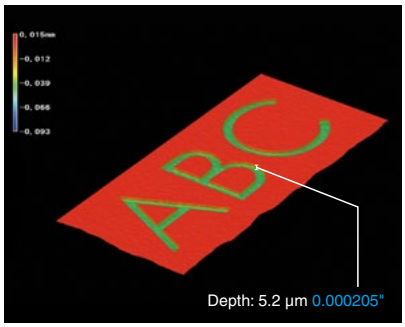




Laser marking depth on mold surfaces

Coaxial measurement allows mirrored mold surfaces to be measured accurately, without adverse effects from reflections.
The WI Series can perform accurate depth measurements of shallow laser engravings only a few micrometers deep.

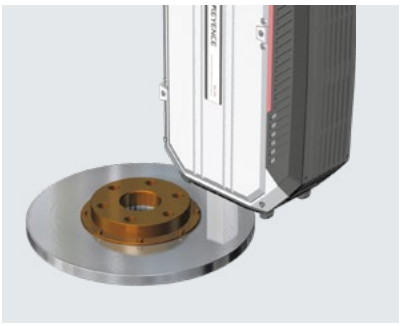


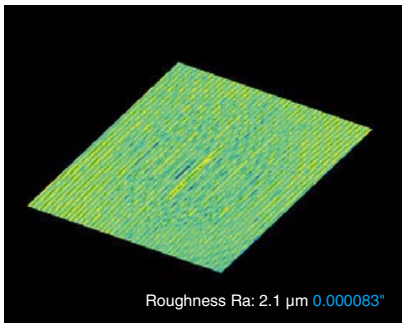


Automotive Industry

Brake disc surface roughness

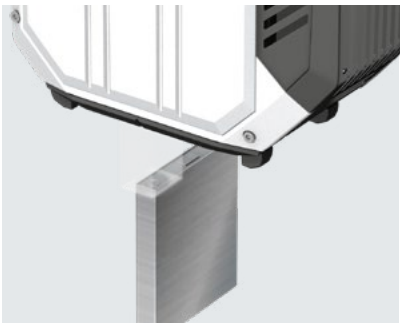
The WI-5000 Series can quickly measure various locations on the surface of the disk. This helps reduce inspection time, thus making it possible to increase inspection frequency.

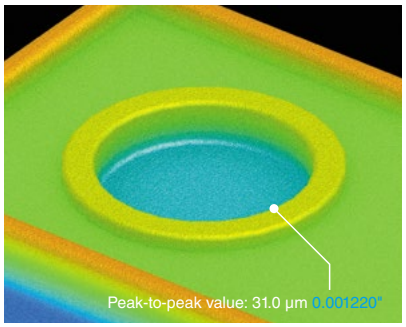




Post-weld inspection of secondary battery cells

Coaxial measurement makes it possible to measure welding and caulking shapes with no blind spots.

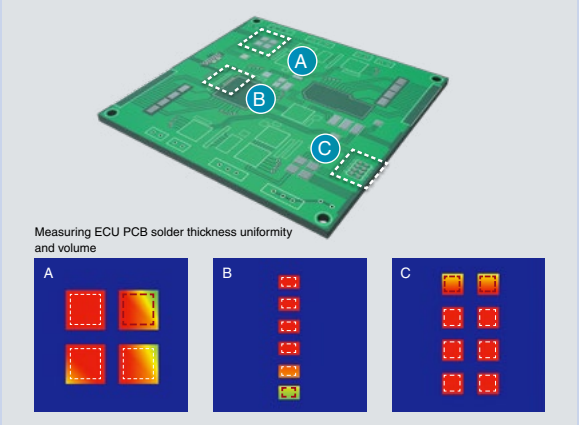




XY stage interlocking with dedicated functions

Segmented measurement function for large targets

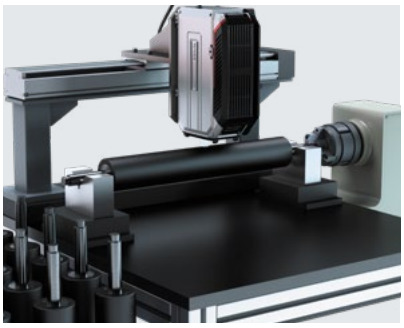
Through linked XY stage operation, segmented measurement is effective for targets that are too large to fit in the 10 × 10 mm 0.39" × 0.39" measurement area. The execution condition branching function also eliminates the need to switch programs even when measuring multiple locations under different master image conditions for even faster operation. A reference plane creation function that uses multiple reference height data points is also available. This function enables accurate surface slant adjustment even when the measurement and reference surfaces are separated.

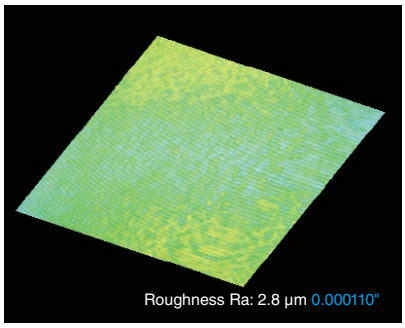


Other Industries

Roughness of rubber rollers

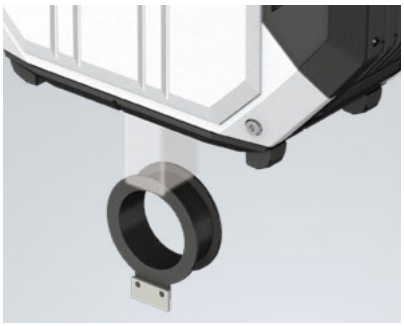
With contact-type roughness meters, measuring soft targets such as rubber rollers is difficult. Because white light interferometry is a non-contact method, measurement can be carried out without scratching the target surface.

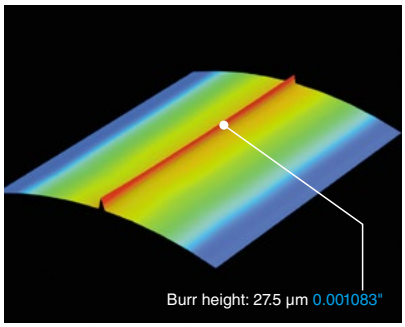




Parting line burr height

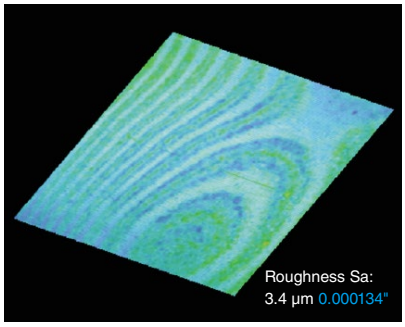
The WI-5000 Series can be used to measure height differences (burrs) on parting lines of molded products. Burr height can affect the seal of products. Non-contact quantitative measurement allows better control of the molding conditions.





Surface roughness of large targets

The surface roughness of large targets, such as rolled steel sheets, can be measured. High-speed non-contact measurement is possible even in locations where conventional systems had difficulty, such as the center of steel sheets.



System Configuration

Sensor head
WI-001/004/010

Sensor head connecting cable

Sensor head connecting cable

Cable type	Connector type	Cable length		
		3 m 9.8'	5 m 16.4'	10 m 32.8'
Standard cable	Straight	**WI-C3**	**WI-C5**	**WI-C10**
	L-shaped	**WI-C3L**	**WI-C5L**	**WI-C10L**
Hi-flex robotic cable	Straight	**WI-C3R**	**WI-C5R**	**WI-C10R**

Controller
WI-5000

RGB monitor cable

RGB monitor cable
OP-66842 (3 m 9.8') /
OP-87055 (10 m 16.4')

Color LCD monitor
8-inch: **CA-MP81** / 12-inch: **CA-MP120**

Dedicated monitor stand
OP-87262

Options

Dedicated stand
WI-S1

SD card (industrial grade)
CA-SD16G (16 GB)
CA-SD4G (4 GB)
CA-SD1G (1 GB)

Adapters for communication cables
9-pin: **OP-26486**
25-pin: **OP-26485**
9-pin SYSMAC: **OP-84384**
9-pin MELSEC: **OP-86930**

USB cable
OP-66844

RS-232C communication cable
OP-26487 (2.5 m 8.2')

Ethernet cable
OP-66843 (3 m 9.8')

Extension I/O cable
OP-51657 (3 m 9.8')

Step calibration block
OP-88165

Specifications

Sensor head

Model		WI-001	WI-004	WI-010
Reference distance		18 mm 0.71"		
Measurement range	Z	1.4 mm 0.06" (Standard Mode), 0.7 mm 0.03" (High-Speed Mode)		
	XY	1 × 1 mm 0.04" × 0.04"	4 × 4 mm 0.16" × 0.16"	10 × 10 mm 0.39" × 0.39"
Minimum detection area		4 × 4 µm 0.000157" × 0.000157"	15 × 15 µm 0.000591" × 0.000591"	40 × 40 µm 0.001575" × 0.001575"
Repeatability (height difference)*1		0.1 µm 0.000004"		
Linearity (height difference)*2		±2.8 µm 0.000110" (±0.2% of F.S., F.S. = 1.4 mm 0.06", +20 to +30°C 68 to 86°F)		
Light source for measurement		Infrared SLD		
	Center wavelength	830 nm		
	Laser class (IEC60825-1)	Class 3R		
	Output	3.6 mW		
Guide light source		Red semiconductor laser		
	Wavelength	660 nm		
	Laser class (IEC60825-1)	Class 1		
	Output	0.15 mW		
Sampling frequency	Internal trigger	133 ms (High-Speed Mode), 266 ms (Standard Mode)		
	External trigger*3	266 ms max. (High-Speed Mode), 532 ms max. (Standard Mode)		
Environmental resistance	Ambient light	Incandescent lamp/fluorescent lamp: 5000 lux max.		
	Ambient temperature	0 to +35°C 32 to 95°F		
	Relative humidity	20 to 85% (No condensation)		
Weight		Approx. 3000 g		

The resolution of the height (distance from head reference plane to measurement workpiece) is 1 µm 0.000039" *4.

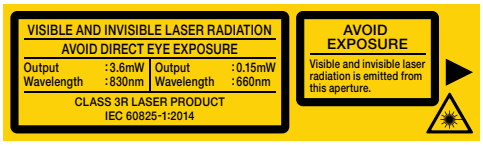
*1 This is the σ value (Auto Maintenance Mode: OFF, Capture Timing: "Prioritize Accuracy") when measuring the average height difference of two rectangular areas*5 for 30 seconds using a KEYENCE standard target.

*2 This is the value (Auto Maintenance Mode: OFF, Capture Timing: "Prioritize Accuracy") when measuring the average height difference of two rectangular areas*5 using a KEYENCE standard target.

*3 The target stop time for capturing is 120 ms (High-Speed Mode) or 240 ms (Standard Mode).

*4 This is the ±3σ value (Auto Maintenance Mode: OFF) when measuring the average height of a single rectangular area*5 for 30 seconds using a KEYENCE standard target.

*5 The rectangular size is WI-001: 0.3 × 0.9 mm 0.01" × 0.04", WI-004: 1.1 × 3.7 mm 0.04" × 0.15", WI-010: 3.0 × 9.0 mm 0.12" × 0.35".



Controller

Model		WI-5000
No. of connectable sensor heads		1
No. of registration settings		Up to 1000 settings on SD Card 1 and SD Card 2 individually (depending on the capacity and configuration of the SD Card), external switching possible
No. of measurement tools		100 tools/setting (20 are intended for position adjustment)
Measurement mode	Height	Height Measurement, Height Difference Measurement, Arranged Multi-Point Height Measurement, Free Multi-Point Height Measurement, Profile Measurement, and Continuous Height Measurement
	Dimension measurement	Measure Distance, Measure Width, Line/Angle, Detect Circle, and Detect Point
	Auxiliary function	Calculation, Image Region Generator, Line Display, Circle Display, Point Display, and Scale Display
Interface	Control input	20 (Input terminal block: 5, Parallel I/O: 15)
	Control output	• 28 (Output terminal block: 6, Parallel I/O: 22) • Photo MOSFET*1
	RS-232C	Value output and control I/O (Cannot be used with a PLC link using the RS-232C port)
	PLC-Link	Value output and control I/O using Ethernet port or RS-232C port (Cannot be used when EtherNet/IP® is in use; RS-232C non-procedural communication cannot be used when RS-232C port is in use)
	Ethernet	• Value output and control I/O • In addition to the functions above, uploading/downloading inspection settings, various simulations, and transmission/reception/remote connection of image and other data are possible when KEYENCE's PC application software is connected. • FTP client/server function supported, VNC server function (supporting monitor screen display only on clients other than a PC), and BOOTP function supported • 1000BASE-T/100BASE-TX/10BASE-T
	USB	• In addition to value output and control I/O, uploading/downloading inspection settings, various simulations, and transmission/reception/remote connection of image and other data are possible when KEYENCE's PC application software is connected. • Dedicated USB 2.0
	EtherNet/IP®	• Value I/O and control I/O using Ethernet port (Cannot be used when PLC-Link is in use) • Cyclic communication supported (up to 1436 bytes), Message communication supported • Max. number of connections: 32 • Conforms to conformance test ver. CT12
	Mouse	Menus can be operated with the optional dedicated mouse (Included with controller)
	USB HDD	Image and other data can be output when connecting an HDD (2 TB max.) to the dedicated USB port (Conforms to USB 3.0, bus power supported; Rated output: 900 mA)
	Monitor output	Analog RGB output XGA, 1024 × 768 (24-bit color, 60 Hz)
Minimum display unit		0.1 µm, 0.001°, 0.0001 mm², 0.00001 mm³
Display language		English / Japanese / Simplified Chinese / Traditional Chinese / Korean (initial language set at first startup)
Rating	Power voltage	24 VDC ±10%
	Maximum current consumption	2.7 A
Environmental resistance	Ambient temperature	0 to +45°C 32 to 113°F (DIN rail mounting), 0 to +40°C 32 to 104°F (bottom mounting)
	Relative humidity	35 to 85% (No condensation)
Weight		Approx. 2000 g

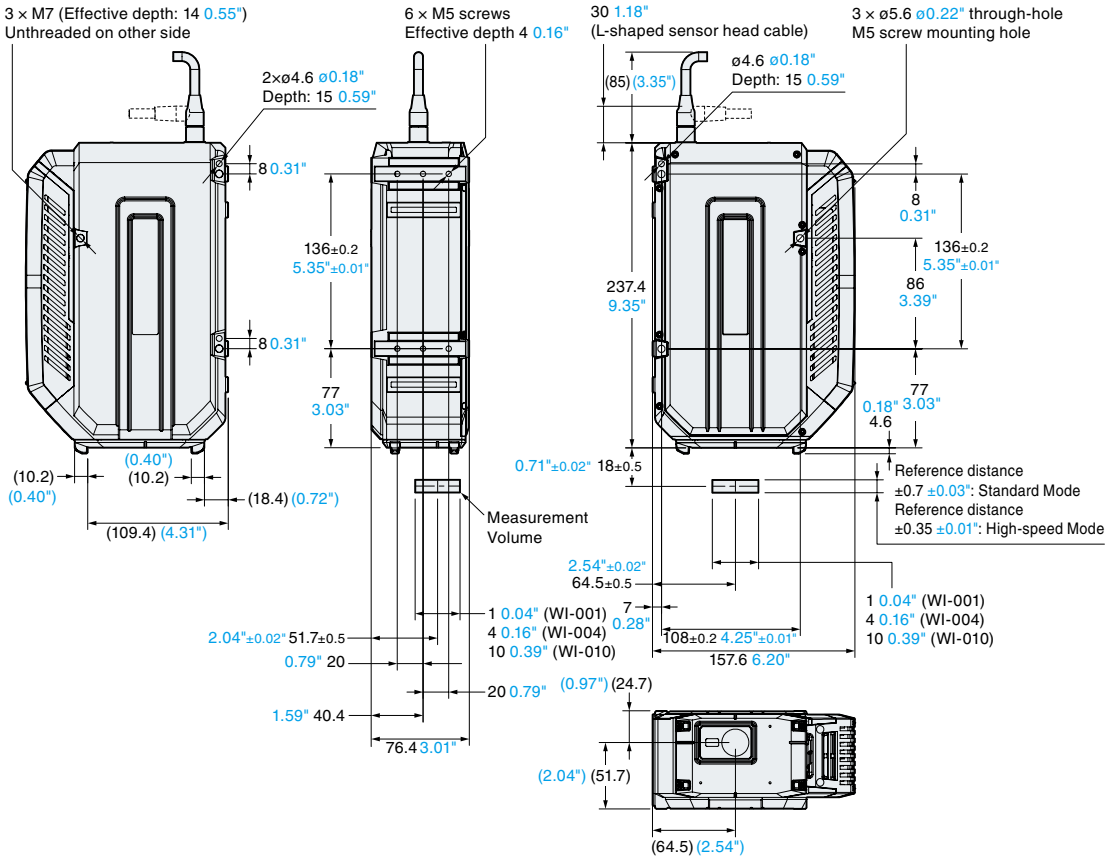
*1 Either positive common connecting—compatible with NPN input devices—or negative common connecting—compatible with PNP input devices—is feasible.

Dedicated stand

Model	WI-S1
XY stage moving range	X axis: 75 mm 2.95", Y axis: 50 mm 1.97"
XY stage tilt angle	±2°
Z stage moving range	Coarse movement: 64 mm 2.52", fine movement: 2.0 mm 0.08"
Dimensions (excluding moving parts)	231 (W) × 408 (H) × 360 (D) mm 9.09" (W) × 16.06" (H) × 14.17" (D)
Weight	Approx. 10 kg

Dimensions

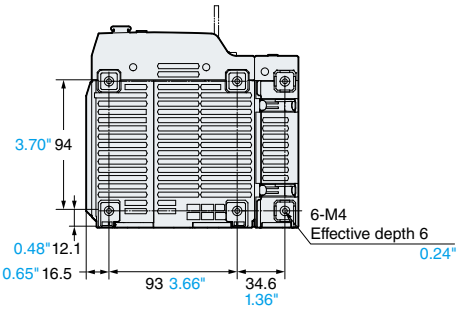
Sensor head
WI-001/004/010

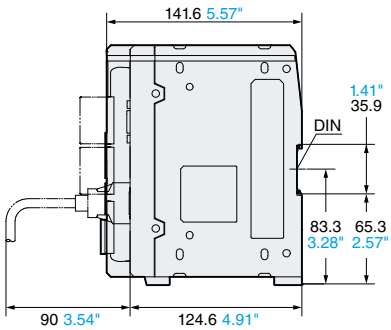


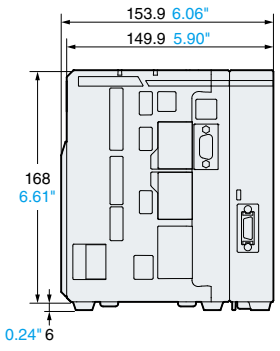
Sensor head connecting cable

Cable length (A = 3 m 9.8' / 5 m 16.4' / 10 m 32.8')

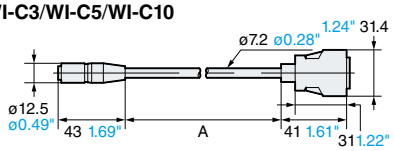
Controller
WI-5000



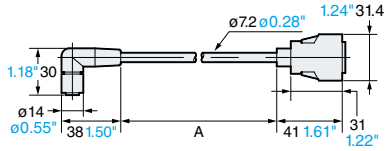




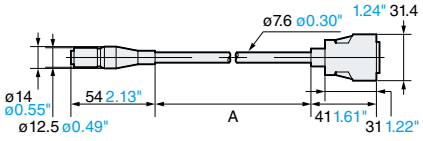
Standard cable (Straight)
WI-C3/WI-C5/WI-C10



Standard cable (L-shaped)
WI-C3L/WI-C5L/WI-C10L

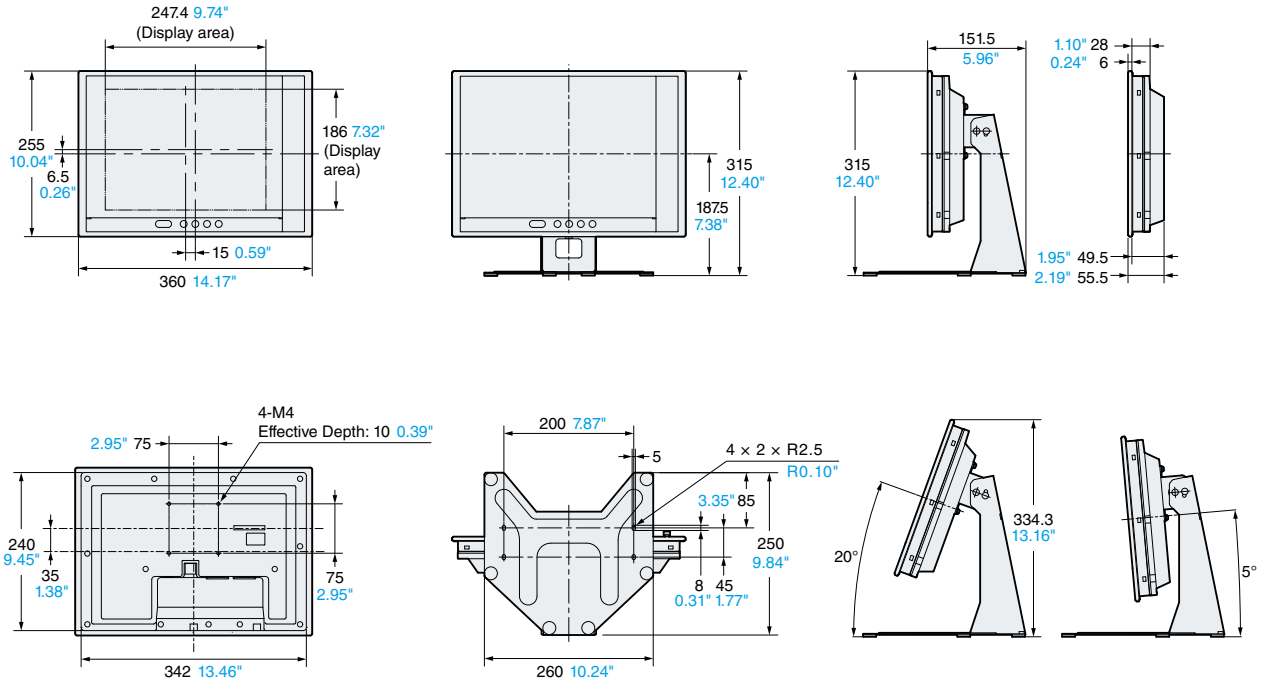


Hi-flex robotic cable (straight)
WI-C3R/WI-C5R/WI-C10R

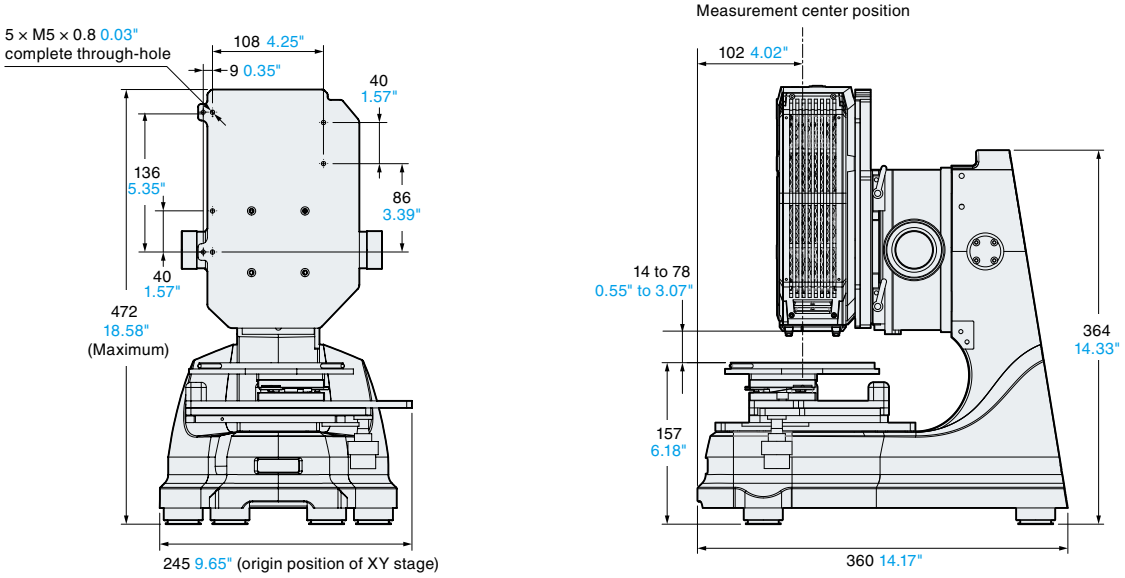


Unit: mm inch

Color LCD monitor
CA-MP120



Dedicated stand
WI-S1



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Complete product lineup to suit any application, from point measurements to surface measurements

1D Displacement Sensor

CL-3000 Series

Take advantage of high-precision measurement of all targets with simple sensor head installation and program settings. The CL-3000 Series is an ultra-compact confocal displacement sensor that improves inspection reliability while supporting a variety of target materials, installation locations, and applications.

2D Displacement Sensor

LJ-X8000 Series

The LJ-X8000 Series boasts the highest resolution measurement in the industry with 3200 points/profile—four times that of conventional models. Choose from a wide variety of sensor heads, including ultra-long-range models, to suit a wide variety of applications and industries.

3D Displacement Sensor

WI-5000 Series

The WI-5000 Series measures surfaces rather than points or lines with its unique one-shot 3D image capture.
Using the principles of white light interferometry, the WI-5000 Series provides accurate measurement of the target even if the colors or materials vary in reflectivity.

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