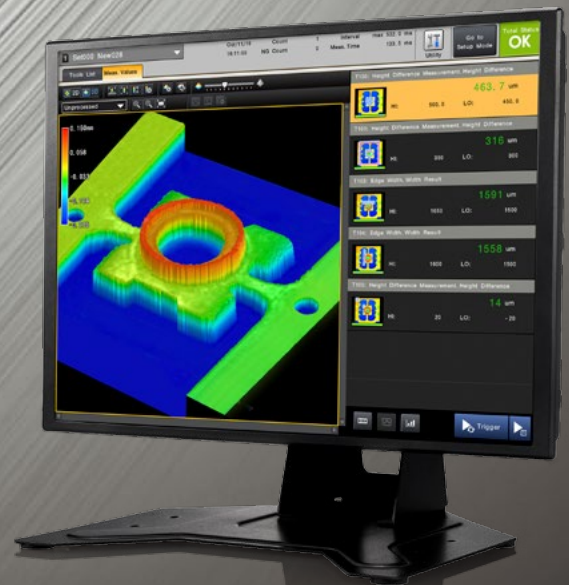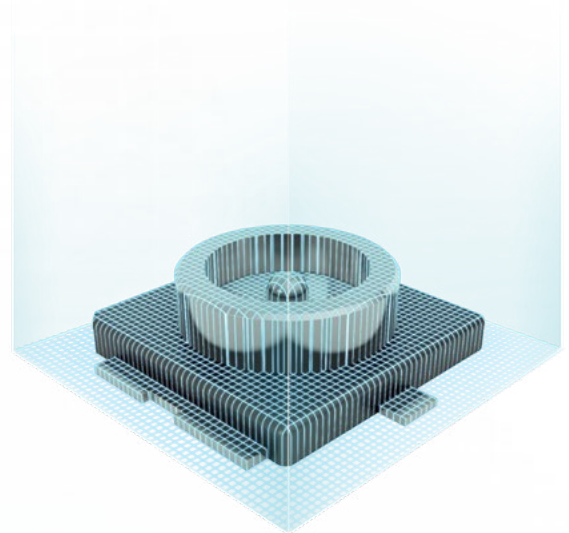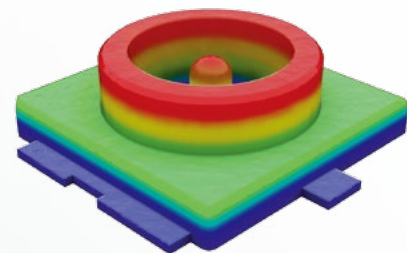# KEYENCE

INSTANT HIGH-ACCURACY
3D MEASUREMENT

WI-5000 Series

Measure height with exceptional accuracy — 80,000 points in just 0.13 seconds

Capture 80,000 points of height data

Compile accurate 3D shapes

1 *CAPTURE SHAPES EXACTLY AS THEY ARE*

The WI-5000 Series captures 80,000 points of height data instantaneously across a maximum measurement area of 10 × 10 mm 0.39" × 0.39". The principles of white light interferometry result in accurate measurement of the target shape even if its colors or materials vary in reflectivity.

2 *100% INSPECTION IN PROCESS*

KEYENCE has developed a proprietary system capable of high-speed measurement of 80,000 points in as little as 0.13 seconds. The high-speed performance makes high-accuracy, in-line inspection a reality.
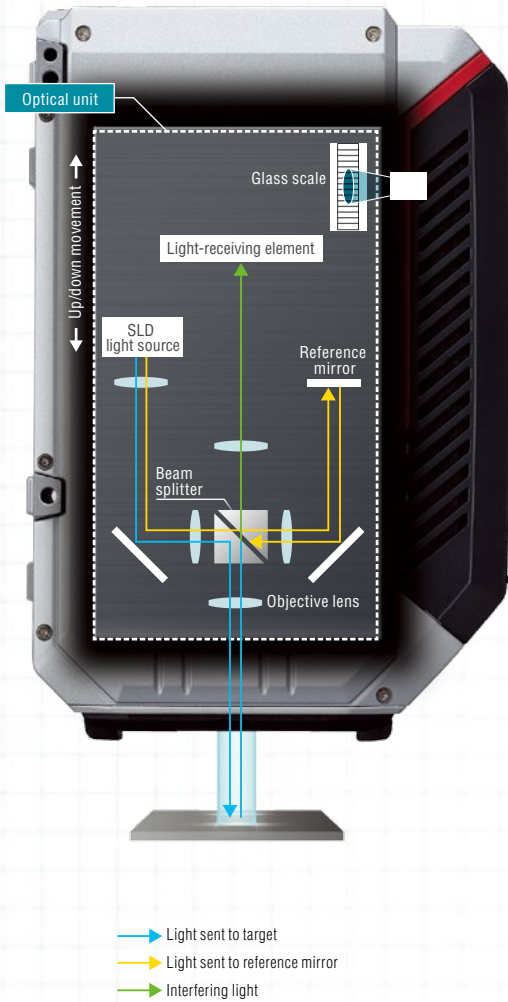
3 *EFFICIENT OFFLINE INSPECTION*

Using the dedicated mounting stand, the sensor is easily configured for offline inspection. Additionally, many functions, such as simplified measurement and data capture were specifically designed for efficient and effective offline use.

**3D Interference Measurement Sensor**
WI-5000 Series

CAPTURE SHAPES PRECISELY AS THEY ARE

Optical unit

Glass scale

Light-receiving element

Up/down movement

SLD light source

Reference mirror

Beam splitter

Objective lens

→ Light sent to target
→ Light sent to reference mirror
→ Interfering light

Highly-Accurate Measurements are acquired with white light interferometry

The light emitted from the light source is split in two by the beam splitter. One beam reflects off the target and the other reflects off the reference mirror. Both beams then strike the light-receiving element as interfering light waves. These interfering light waves provide the highest level of interference when the lengths of their optical paths coincide. The optical unit, which incorporates all the optical components, moves up and down to obtain contrasting images. For each measurement point in these images, the device reads the position of the optical unit at the highest level of interference. This information is then used to determine the distance to the target.

Optical unit moves up and down.

Position of the optical unit

Maximum value

Interference level

Contrast image

Interference level waveform
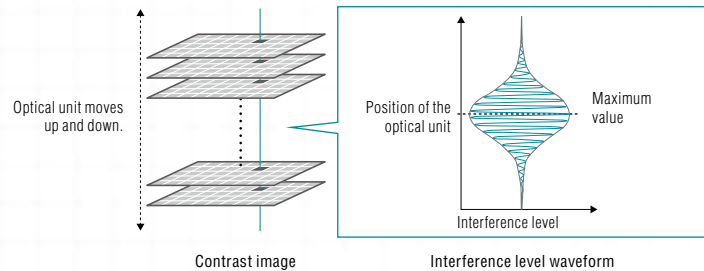
Select the sensor head that best suits your application

KEYENCE offers three types of sensor heads, each of which is designed for a specific application — from the high-resolution model to the wide-field model the WI-5000 has the flexibility to solve your application.

	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)		
Repeatability (height difference)	0.1 µm 0.000004"		

Exceptional stability combined with excellent response

The principles of white light interferometry overcome the issues that impede the accuracy of profile measurement, such as differences in target materials and colors as well as areas with dead zones that cannot be measured.
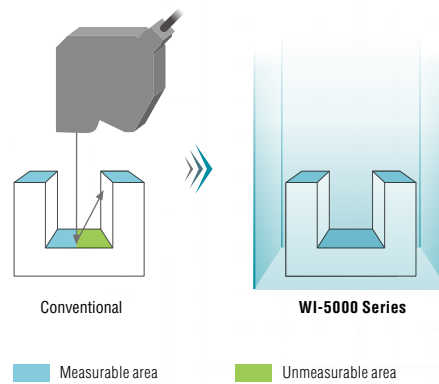
UNAFFECTED BY MATERIALS AND COLORS

The WI-5000 Series emits light with a wide dynamic range. This allows the sensor to simultaneously measure targets with different reflectivity (such as shiny metal and dull rubbers) from a single captured image. Accurate shapes can be captured even for measurement targets made of resin or other translucent material, because the process is not affected by internal reflections.
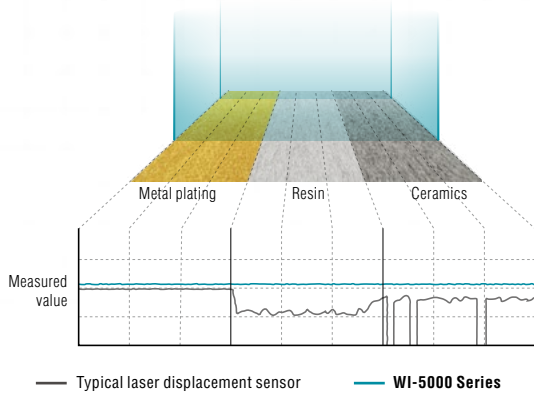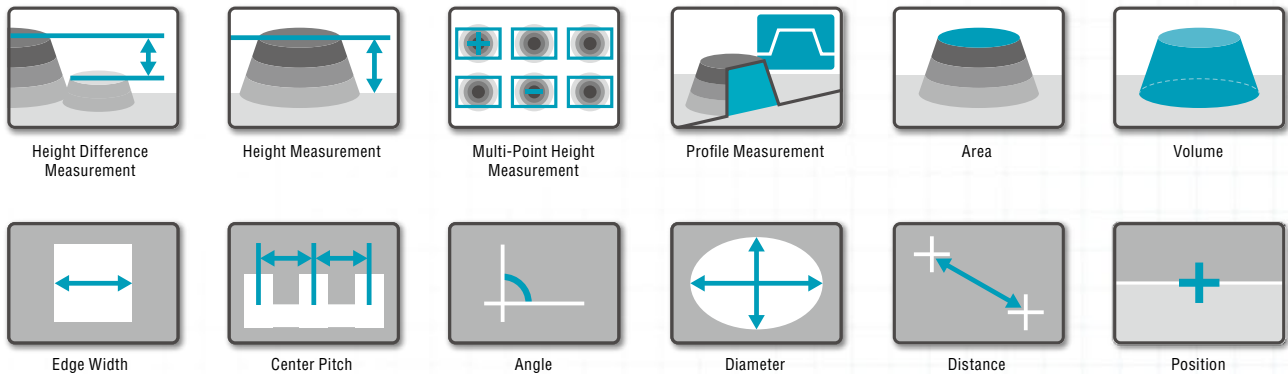
UNAFFECTED BY DEAD ZONES

When a conventional triangulation method is used to measure an object, the light returning to the sensor can be blocked causing "dead zones" which cannot be measured. This effect is avoided with the WI-5000 Series.

Metal plating   Resin   Ceramics

Measured value

—— Typical laser displacement sensor   —— **WI-5000 Series**

Conventional   **WI-5000 Series**

■ Measurable area   ■ Unmeasurable area

Featuring a wide range of measurement modes for a diverse variety of inspections

The WI-5000 Series features a wide range of measurement modes that can overcome a variety measurement challenges. From those requiring height data (such as height difference/volume measurement) to those requiring plane data (such as width/area measurement) the WI-5000 has the tools to solve the application.

Height Difference Measurement

Height Measurement

Multi-Point Height Measurement

Profile Measurement

Area

Volume

Edge Width

Center Pitch

Angle

Diameter

Distance

Position

2 100% INLINE MEASUREMENT AT HIGH SPEEDS

Instead of measuring points, the WI-5000 Series measures over a surface, ensuring 100% inspection instead of mere sample inspection

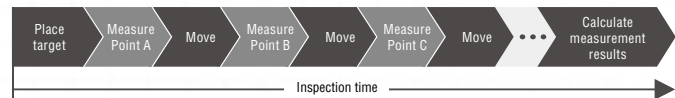**CONVENTIONAL METHOD** ▶ **1D DISPLACEMENT SENSOR + MOVING STAGE**
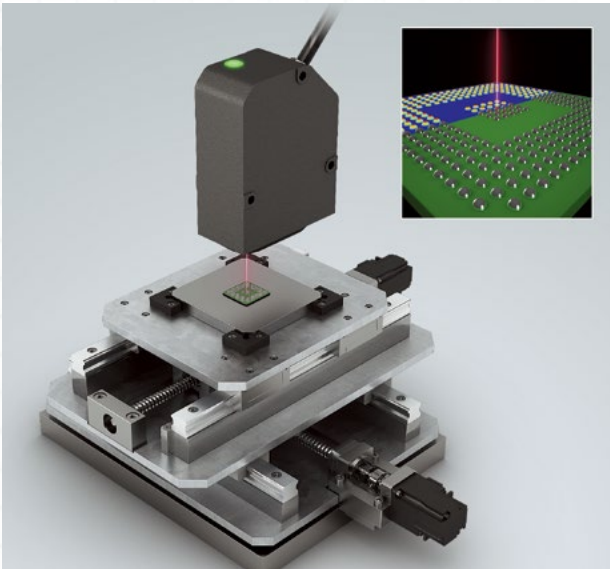
In order to measure multiple points, the sensor must scan the target quickly and accurately. Doing so requires the stage to be moved, which makes inspection extremely time-consuming. Additional instrumentation that can be costly or complex is also required.

CONVENTIONAL METHOD

• Requires a high-precision moving stage
• Requires a highly accurate positioning control mechanism
• Requires programming of processing software

➡ **Complex instrumentation**

Processing flow of multi-point measurement

| Place target | Measure Point A | Move | Measure Point B | Move | Measure Point C | Move | ••• | Calculate measurement results |

⟵ Inspection time ⟶

WI-5000 Series ▶ **ELIMINATES THE NEED FOR A MOVING STAGE**

With the surface measurement method, multiple points are captured simultaneously without the need for a high-precision moving stage. This simplifies instrumentation, significantly reduces measurement time, and enables 100% inspection.

With the WI-5000 Series

• Does not require a high-precision moving stage

➡ **Accommodates batch area measurement**

• Does not require precise positioning

➡ **Incorporates a position-correction function measurement**

• Integrates a variety of measurement functions.

➡ **Does not require programming prior to measurement**

Processing flow of multi-point measurement

| Place target. Measurement is completed instantaneously. | Measurement time significantly reduced |

⟵ Inspection time ➡

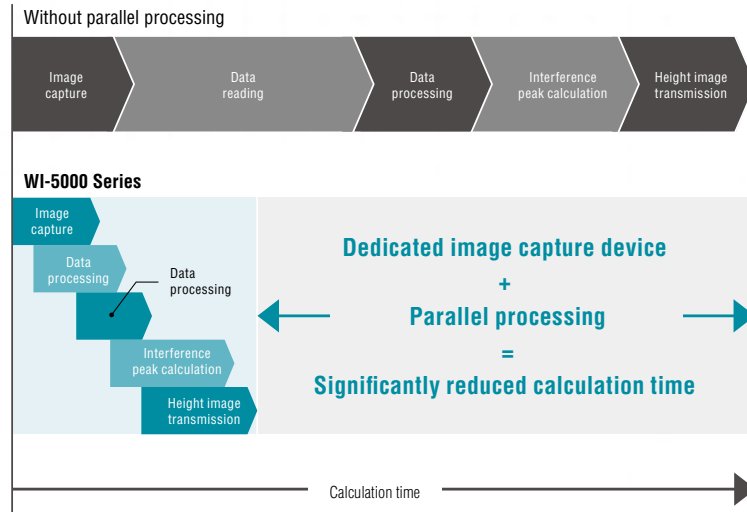# Our proprietary system performs area measurement at high speed

Achieves high-speed measurement across the surface

Dedicated image pickup device + IPO*-Engine

*Interference Parallel Operation

KEYENCE has mounted a dedicated image capture device inside the system. Following high-speed image capture, it processes the data at ultra-high speed. This is made possible with a new parallel processing engine that reads the captured data, calculates the interference peak, and transmits the height images at ultra-high speed.

This configuration significantly accelerates the high-accuracy inference calculation, a time-consuming process with conventional configurations. This innovation enables batch measurement of 80,000 points of height data.
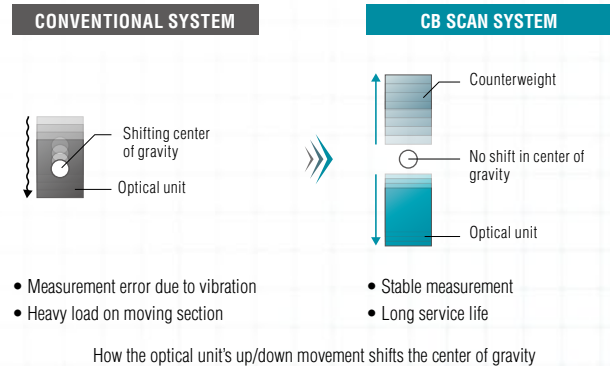
Without parallel processing

| Image capture | Data reading | Data processing | Interference peak calculation | Height image transmission |

WI-5000 Series

Image capture

Data processing — Data processing

Interference peak calculation

Height image transmission

**Dedicated image capture device
+
Parallel processing
=
Significantly reduced calculation time**

Calculation time

Innovative design
that suppresses vibration

CB* Scan System

*Counter-balanced

KEYENCE has developed a mechanical structure that minimizes vibration generated during Z-axis scanning. As the optical unit moves during the scan sequence, the center of gravity inside the sensor head shifts. This system offsets this shift by moving a counterweight in the opposite direction. This innovation contributes to stable measurement during high-speed scanning and allows the compact sensor head to be embedded into various manufacturing devices.

CONVENTIONAL SYSTEM

Shifting center of gravity

Optical unit

• Measurement error due to vibration
• Heavy load on moving section

CB SCAN SYSTEM

Counterweight

No shift in center of gravity

Optical unit

• Stable measurement
• Long service life

How the optical unit's up/down movement shifts the center of gravity

3 STREAMLINED OFFLINE INSPECTION FOR SIGNIFICANTLY REDUCED LABOR TIMES

Simply place the target on the stage for complete, error-free, and instantaneous 3D measurement, even with an inexperienced operator

CONVENTIONAL METHOD ▷ INSPECTION WITH A MEASURING MICROSCOPE

A conventional measuring microscope requires manual movement of the stage along the X/Y axes and sliding up or down for focus adjustment, resulting in inspections with excessive labor requirements. Additionally, different operators can often measure the same part differently, introducing another source of error into your measurements.

CONVENTIONAL METHOD

- Manually move stage along X/Y axes
- Slide stage up or down to adjust focus

➡ **Requires hours of labor while introducing measurement errors**

Processing flow of height difference measurement

Set target	Adjust focus	Set zero-point	Slide stage	Adjust focus	Read measured value

Inspection time →

## WI-5000 Series ▷ WITH DEDICATED STAND

A dedicated stand to secure the sensor head is available for offline 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

- Does not require precise positioning

➡ **Significantly reduces labor required for inspections**
➡ **No errors introduced by individual operators**

Processing flow of multi-point measurement

Set target. Measurement is completed instantaneously.	Inspection time is reduced significantly

Inspection time →
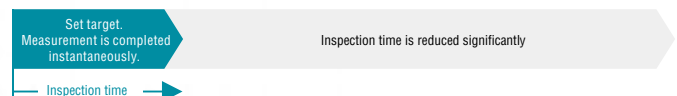
Featuring a variety of useful functions for a wide range of applications

FOR EASY EVALUATION OF PROTOTYPES:

QUICK MEASUREMENT

A 3D measurement can be captured and then measured, without any pre-programming. A cross-section of a captured 3D image can also be measured. Various measurement functions are available, including height difference, width, angle, and cross-sectional area.
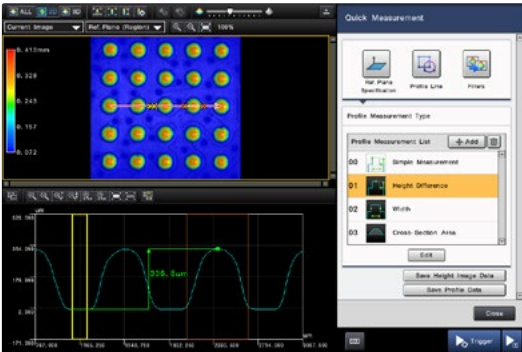
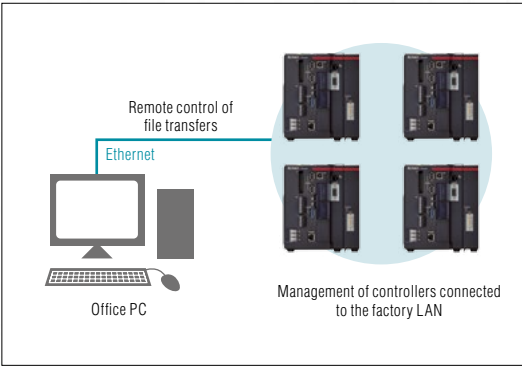WHEN DATA RECORDING IS TIME-CONSUMING:

LOGGING FUNCTION

The measurement result can be saved in the controller with a single click. What's more, the measurement results of a complete lot can be saved to a CSV file so that documentation can easily be generated on a PC.


WHEN WORKING WITH MULTIPLE SYSTEMS:

REMOTE OPERATION FUNCTION

With the included software, you can collect the measurement results from the controllers at a remote site or change their settings from your desktop PC.

Remote control of file transfers

Ethernet

Office PC

Management of controllers connected to the factory LAN

Measuring the height of terminals on surface-mounted components

The wide dynamic range ensures stable measurements even when terminals (highly reflected light) and ceramic packages (low reflected light) are present in an image.
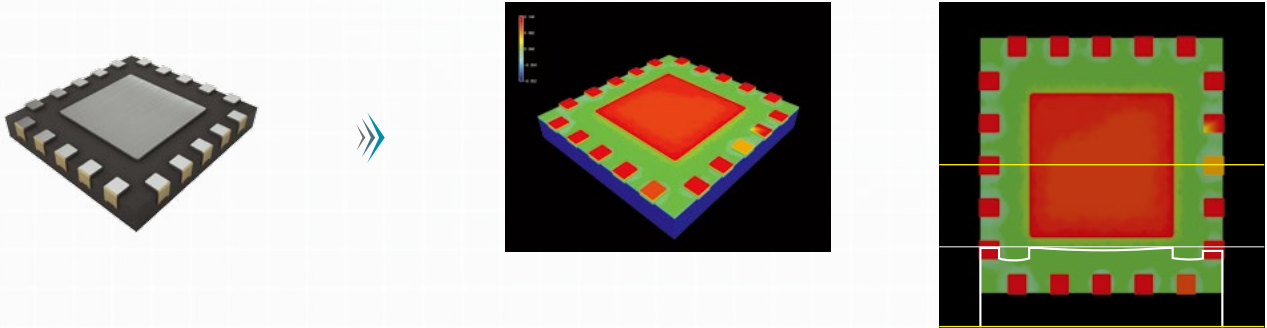

Measuring the height/volume of precision adhesive

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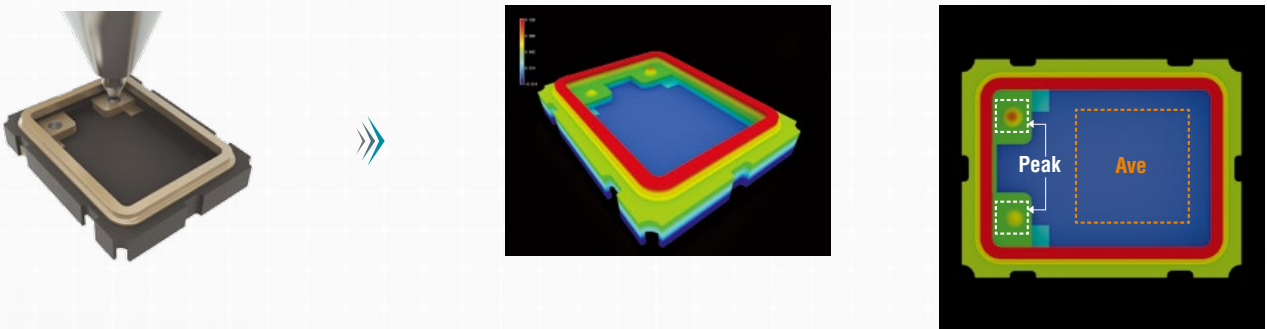

Measuring the dimensions/flatness of precision parts

Various dimensions of precision pressed parts — such as height, flatness, and pitch — can be measured simultaneously. High-speed sampling has made it possible to incorporate 100% inspection in a production facility.
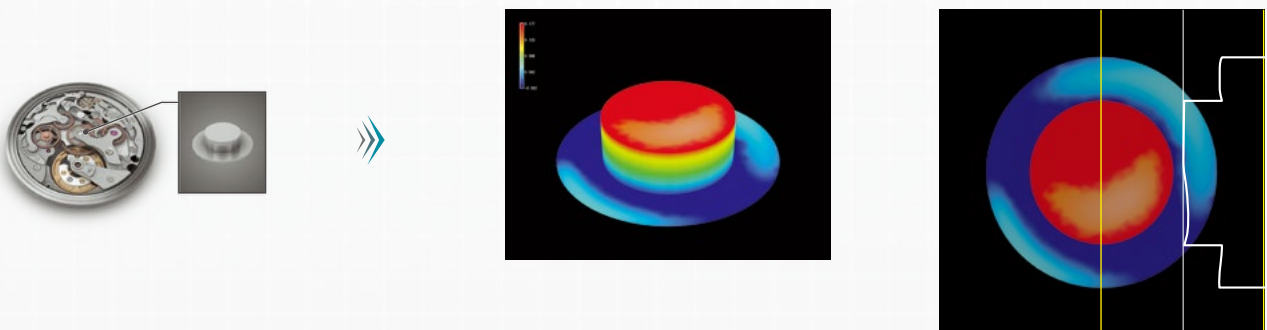
Measuring the height of balls on BGA

The Multi-Point Height Measurement tool allows for easy measurement of multiple balls on a BGA.
The peak value of each ball as well as the area and volume can be measured instantaneously.

☐ : NG
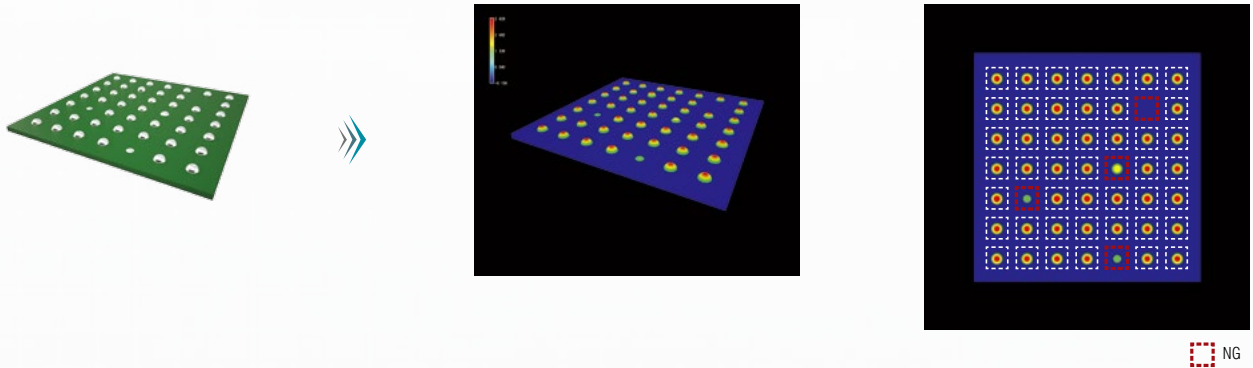
Measuring the thickness of printing on PCBs

Multi-Capture is effective for targets exceeding the measurement area of 10 × 10 mm 0.39" × 0.39". Multiple sections can be measured under different conditions without the need to switch programs.

A

A

B

C

☐ : NG

Sensor head
WI-001/004/010

Dedicated stand
WI-S1
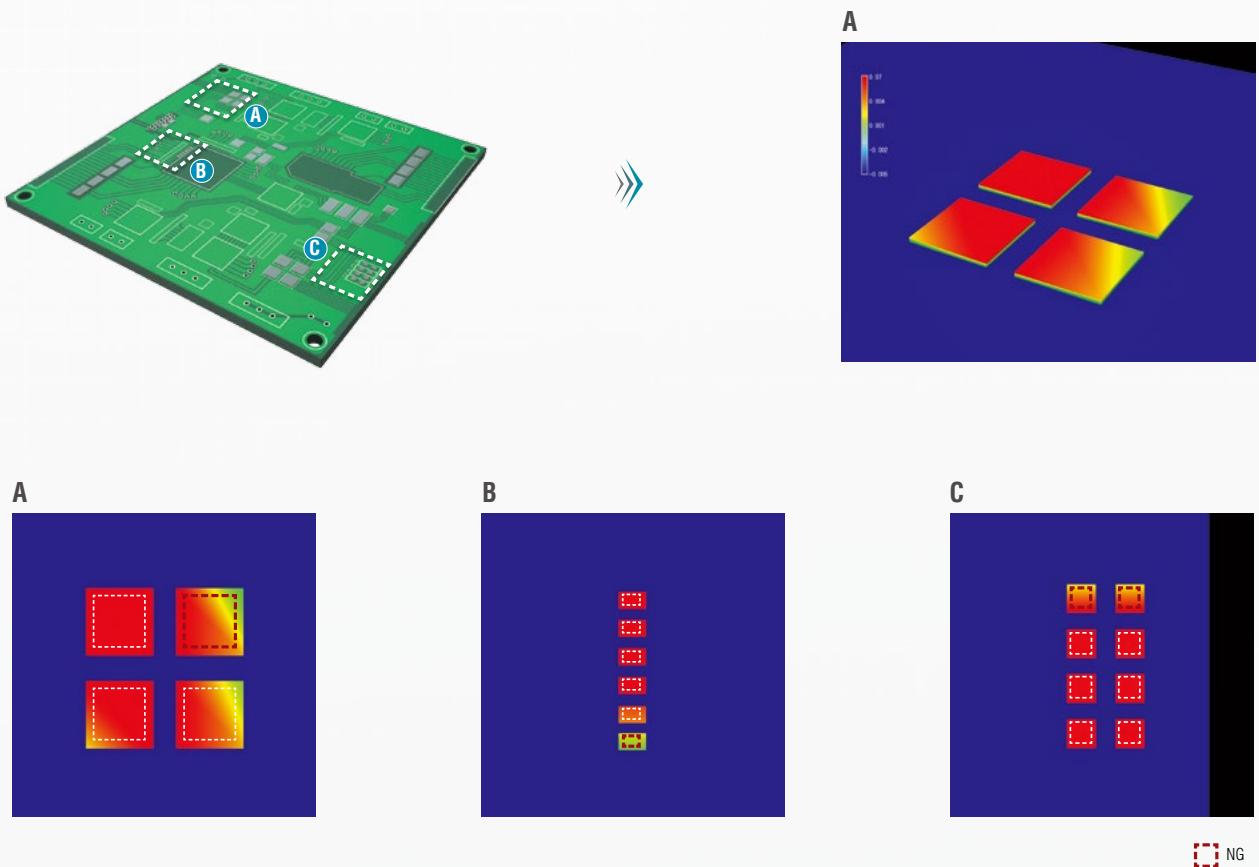
Sensor head connecting cable

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**

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

Controller
WI-5000

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

RGB
monitor cable

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

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')

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

Dedicated monitor stand
OP-87262

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 +95F°		
	Relative humidity	20 to 85% (No condensation)		
Weight		Approx. 3000 g		

The laser classification for FDA(CDRH) is implemented based on IEC60825-1 in accordance with the requirements of Laser Notice No. 50.
The resolution of the height (distance from head reference plane to measurement workpiece) is 1 µm(*4).
*1 This is a σ value (Auto Maintenance Mode is OFF, Capture Timing is "Prioritize Accuracy") when the average height difference of two rectangular areas(*5) has been measured for 30 seconds using a KEYENCE standard target.
*2 This is the value (Auto Maintenance Mode is OFF, Capture Timing is "Prioritize Accuracy") when the average height difference of two rectangular areas(*5) has been measured using a KEYENCE standard target.
*3 The workpiece stopping time at capturing is 120 ms (High Speed Mode) or 240 ms (Standard Mode).
*4 This is ±3 σ value (Auto Maintenance Mode is OFF) when the average height of a single rectangular area(*5) has been measured for 30 seconds using a KEYENCE standard target.
*5 The rectangular size is WI-001 : 0.3 mm × 0.9 mm 0.01" × 0.04", WI-004 : 1.1 mm × 3.7 mm 0.04" × 0.15", WI-010 : 3 mm × 9 mm 0.12" x 0.35".

Controller

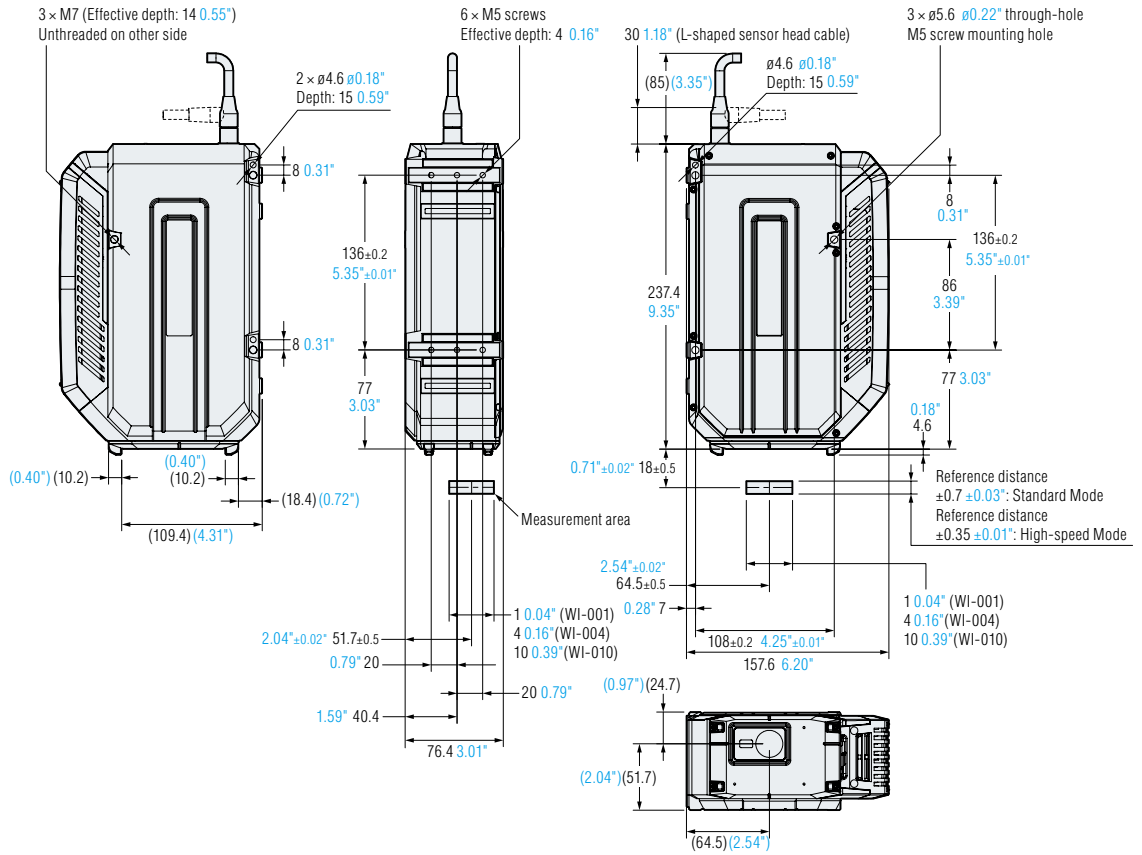| Model		WI-5000
No. of connectable sensor heads		1
No. of registration settings		Up to 1000 settings on SD Card 1 and SD Card 2 individually (depending on the capacity and configuration of the SD Card), external switching possible
No. of measurement tools		100 tools/setting (20 are intended for position 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: 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 when PLC link using the RS-232C port is in use)
	PLC-Link	Value output and control I/O using the Ethernet port or RS-232C port (cannot be used when EtherNet/IP™ is in use. RS-232C No-protocol communication cannot be used when the 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 the 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 Version CT12.
	Mouse	Menus can be operated with the optional dedicated mouse (included with the controller).
	USB HDD	Image and other data can be output when a HDD (2 TB max.) is connected to the dedicated USB port (conforms to USB3.0, 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/Chinese (simplified)/Chinese (traditional)/Korean selectable (Initial language should be determined during the initial startup.)
Rating	Power voltage	24 VDC ±10%
	Maximum current consumption	2.7 A
Environmental resistance	Ambient temperature	0 to +45°C 32 to +113F° (DIN rail mounting), 0 to +40°C 32 to +104F°(bottom mounting)
	Relative humidity	35 to 85% (No condensation)
Weight		Approx. 2000 g

*1 Either positive common connecting which is compatible with NPN input devices, or negative common connecting which is compatible with PNP input devices is feasible.
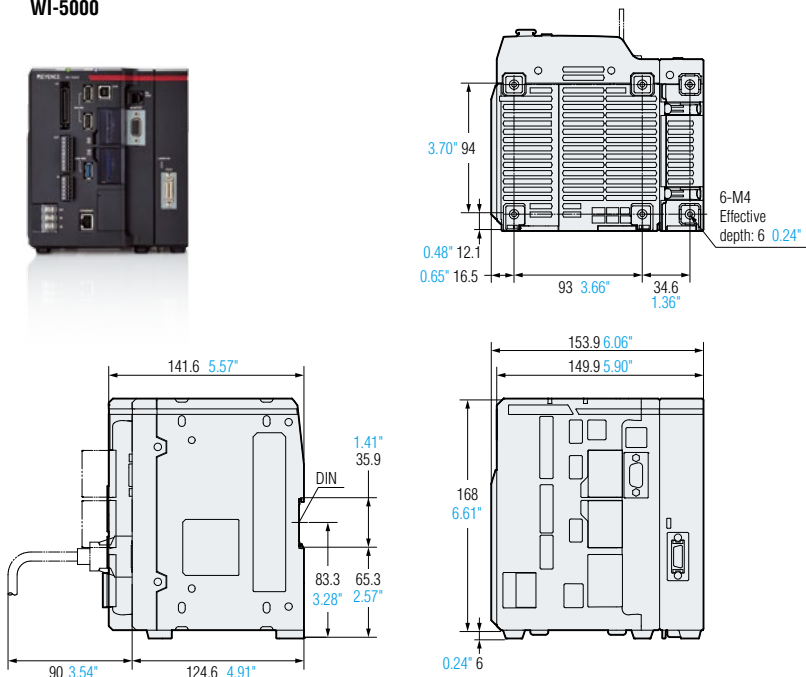
Dedicated stand

| 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) x 408 (H) x 360 (D) mm 9.09" (W) x 16.06" (H) x 14.17" (D)
Weight	Approx. 10 kg

DIMENSIONS

Sensor head
WI-001/004/010

3 × M7 (Effective depth: 14 0.55")
Unthreaded on other side

2 × ø4.6 ø0.18"
Depth: 15 0.59"

6 × M5 screws
Effective depth: 4 0.16"

30 1.18" (L-shaped sensor head cable)

(85) (3.35")

ø4.6 ø0.18"
Depth: 15 0.59"

3 × ø5.6 ø0.22" through-hole
M5 screw mounting hole

8 0.31"

8 0.31"

136±0.2
5.35"±0.01"

237.4
9.35"

8
0.31"

136±0.2
5.35"±0.01"

86
3.39"

77
3.03"

77 3.03"

0.18"
4.6

(0.40") (10.2)

(0.40")
(10.2)

(18.4) (0.72")

(109.4) (4.31")

Measurement area

0.71"±0.02" 18±0.5

Reference distance
±0.7 ±0.03": Standard Mode
Reference distance
±0.35 ±0.01": High-speed Mode

2.54"±0.02"
64.5±0.5

0.28" 7

2.04"±0.02" 51.7±0.5

0.79" 20

20 0.79"

1.59" 40.4

76.4 3.01"

1 0.04" (WI-001)
4 0.16"(WI-004)
10 0.39"(WI-010)

108±0.2 4.25"±0.01"

157.6 6.20"

(0.97") (24.7)

(2.04")(51.7)

(64.5)(2.54")

1 0.04" (WI-001)
4 0.16"(WI-004)
10 0.39"(WI-010)

Controller
WI-5000

3.70" 94

0.48" 12.1

0.65" 16.5

93 3.66"

34.6
1.36"

6-M4
Effective
depth: 6 0.24"

141.6 5.57"

1.41"
35.9

DIN

83.3
3.28"

65.3
2.57"

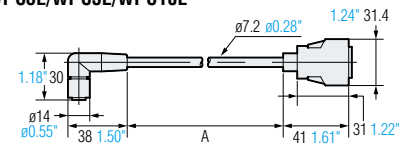90 3.54"

124.6 4.91"

153.9 6.06"

149.9 5.90"

168
6.61"

0.24" 6

Sensor head connecting cable
Cable length (A = 3 m 9.8'/5 m 16.4'/10 m 32.8')

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

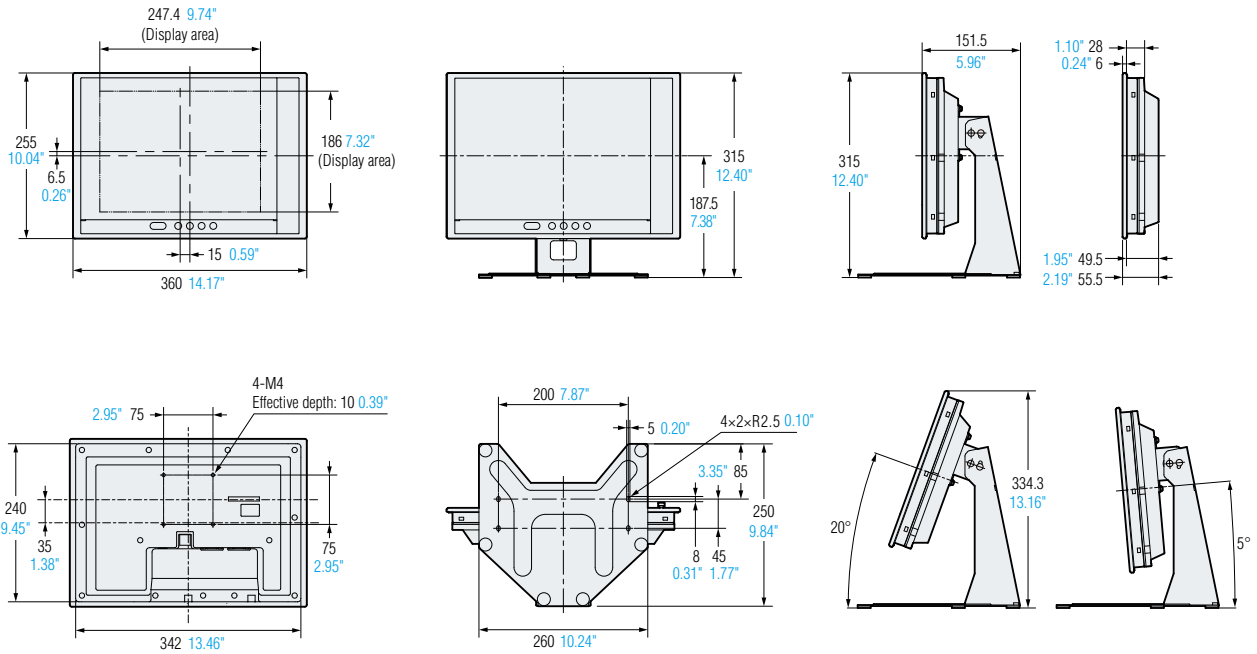ø7.2 ø0.28"

1.24" 31.4

ø12.5
ø0.49"

43 1.69"

A

41 1.61"

31 1.22"
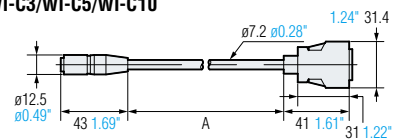
Standard cable (L-shaped)
WI-C3L/WI-C5L/WI-C10L

ø7.2 ø0.28"

1.24" 31.4

1.18" 30

ø14
ø0.55"

38 1.50"

A

41 1.61"

31 1.22"

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

ø7.6 ø0.30"

1.24" 31.4

ø14
ø0.55"

ø12.5 ø0.49"

54 2.13"

A

41 1.61"

31 1.22"
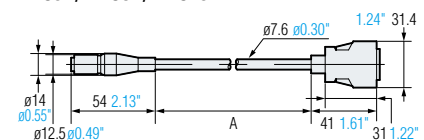
Color LCD monitor
CA-MP120

247.4 9.74"
(Display area)

255
10.04"

6.5
0.26"

186 7.32"
(Display area)

15 0.59"

360 14.17"

315
12.40"

187.5
7.38"

151.5
5.96"

315
12.40"

1.10" 28
0.24" 6

1.95" 49.5
2.19" 55.5

4-M4
Effective depth: 10 0.39"

2.95" 75

240
9.45"

35
1.38"

75
2.95"

342 13.46"

200 7.87"

5 0.20"

4×2×R2.5 0.10"

3.35" 85

250
9.84"

8 45
0.31" 1.77"

260 10.24"

20°

334.3
13.16"

5°

Dedicated stand
WI-S1

5 × M5 × 0.8 0.03"
complete through-hole

108 4.25"

9 0.35"

1.57"
40

136
5.35"

86
3.39"

40
1.57"

18.58"
472
(Maximum)

9.65" 245 (origin position of XY stage)

Measurement center position

102 4.02"

0.55" to 3.07"
14 to 78

14.33"
364

6.18"
157

360 14.17"

15

COMPLETE PRODUCT LINEUP TO SUIT ANY APPLICATION, FROM POINT MEASUREMENTS TO SURFACE MEASUREMENTS

1D DISPLACEMENT SENSOR

LK-G5000 Series

Today's laser displacement sensors must be able to measure a variety of targets with exceptional speed, accuracy, and versatility. KEYENCE is meeting these needs by adopting advanced technologies that demonstrate industry-leading performance in all areas.

2D DISPLACEMENT SENSOR

LJ-V7000 Series

This product was designed with inline profile measurement in mind and is capable of capturing 64,000 images per second.
Using the industry first double-blue polarized laser, this system is able to provide extremely stable and highly accurate profile measurements on even the most challenging of targets.
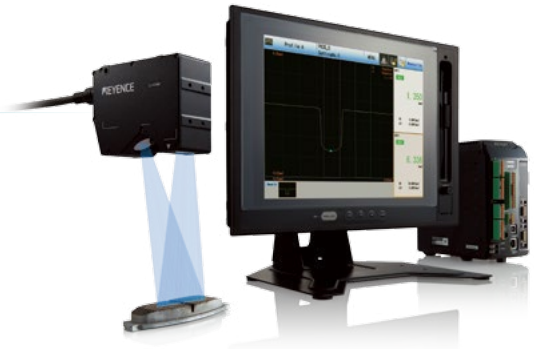
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