

High Speed, Multi-Point Laser Displacement Sensor

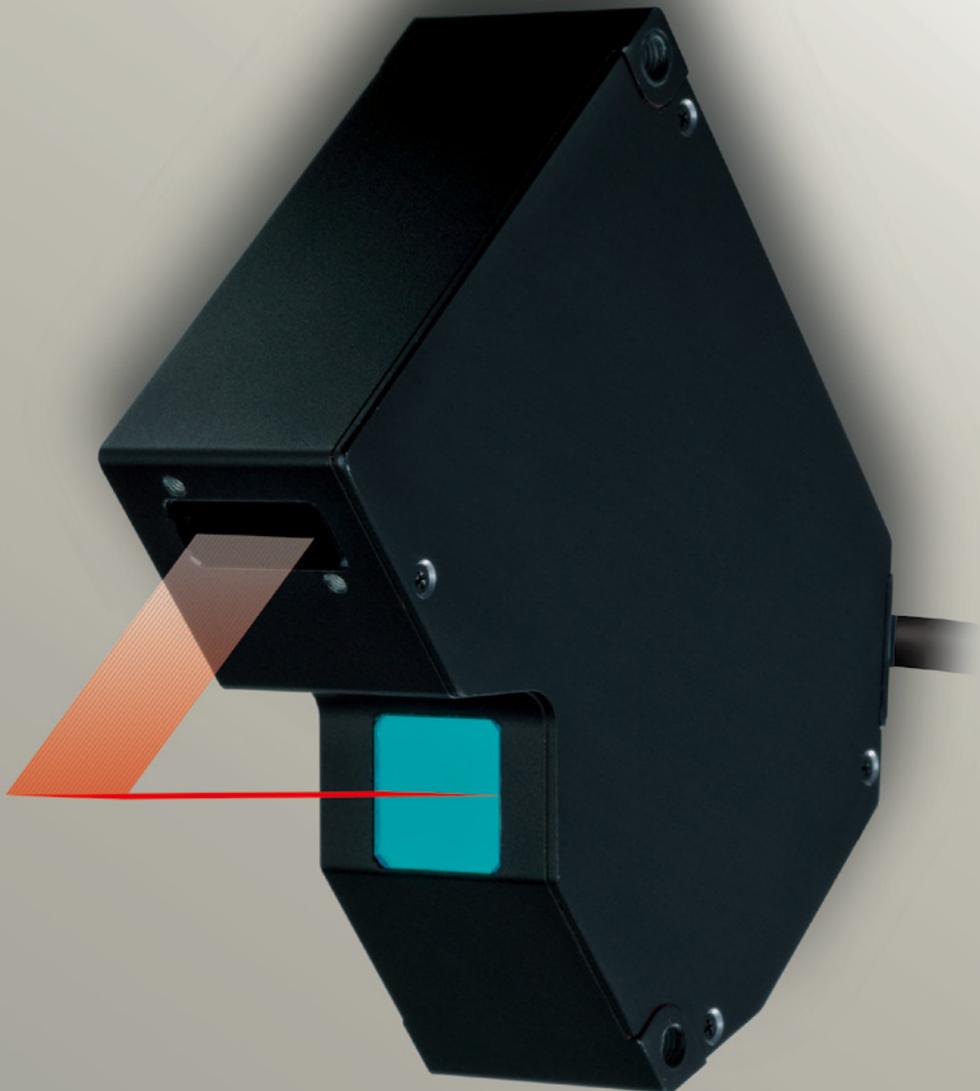
HL-D3 SERIES

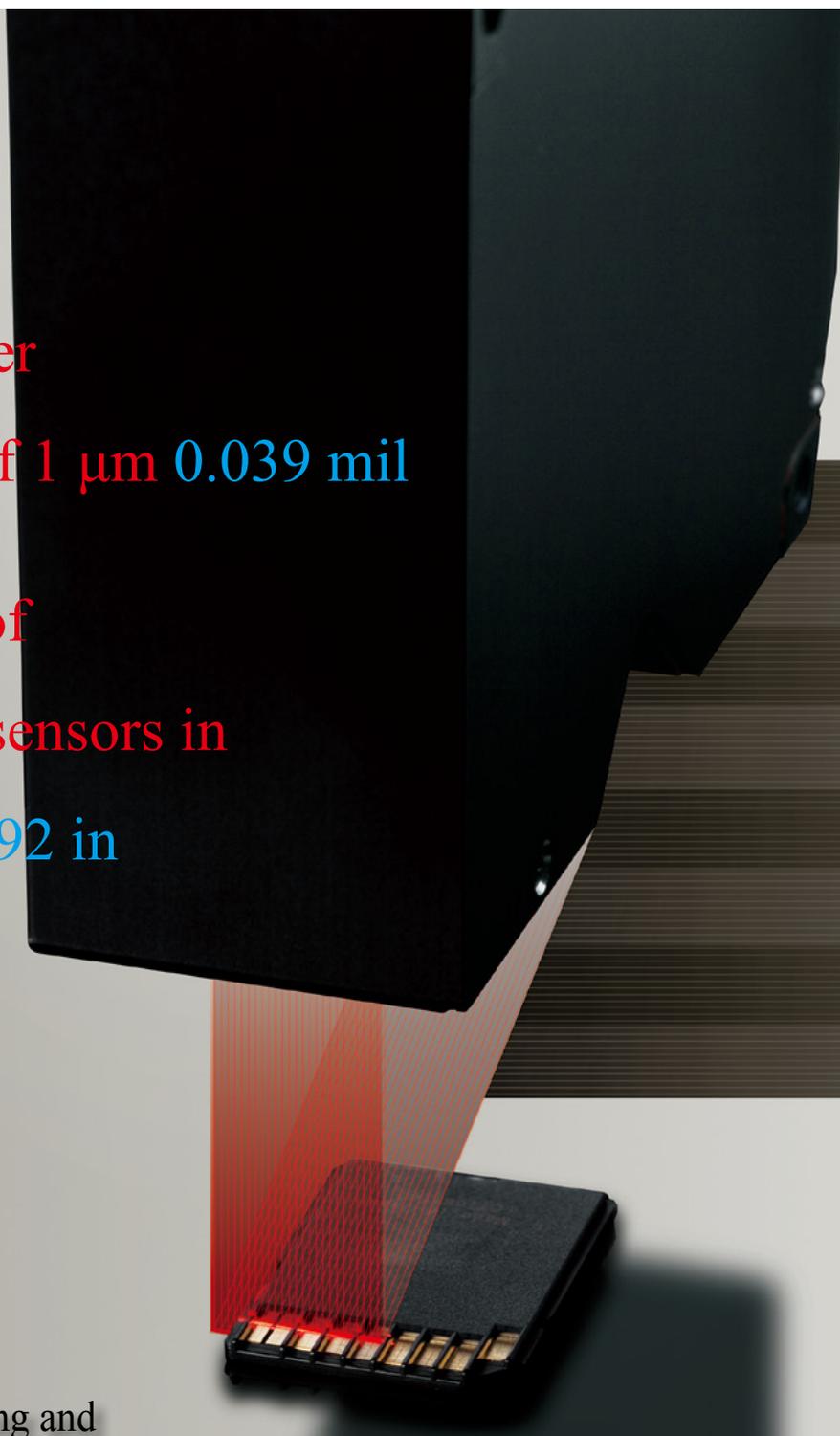
CE
Conforming to
EMC Directive

FDA
Conforming to
FDA regulations
(HL-D301B/D301C only)

High Speed Multi-point Sensing and Stable Appearance Measurement in One Device

The Ultimate Displacement Sensor for Production Sites





High-precision laser
with a resolution of $1\ \mu\text{m}$ $0.039\ \text{mil}$

The functionality of
500 displacement sensors in
just a $12.5\ \text{mm}$ $0.492\ \text{in}$
wide device!

High Speed Multi-point Sensing and
Stable Appearance Measurement in One Device

Measurement center distance and range (Z axis)

$50 \pm 10\ \text{mm}$
 $1.969 \pm 0.394\ \text{in}$

Measurement range of width (X axis)

$12.5\ \text{mm}$ $0.492\ \text{in}$

Sampling rate

Max. speed $80\ \mu\text{s}$ (2-point specified)

Resolution (Z axis)

$1\ \mu\text{m}$ $0.039\ \text{mil}$

(average number of samples: 64)

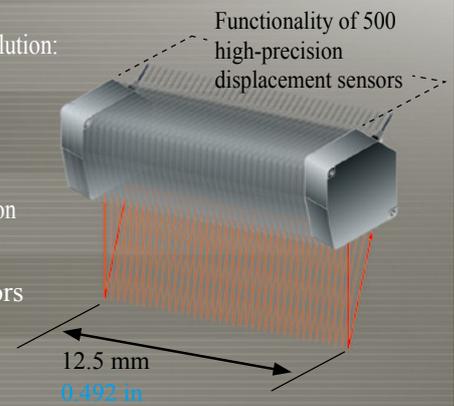
Dogged by measurement instability from material and color variations with conventional 2D laser displacement sensors?

Our new **HL-D3** series features high speed, multi-point laser displacement sensing that realize fast, stable detection without being affected by irrelevant variations.

The **HL-D3** series was developed based on a new concept of capturing the shape of objects with "points" instead of a "line." The new displacement sensors feature the following enhancements, neither compromising the Z-axis resolution:

- 1 Faster measurement, achieved by selecting only the desired sensing points
- 2 Adjustable light intensity for each sensing point, which contributes to stable, precision detection

This is equivalent to the performance of 500 high-precision displacement sensors with a resolution of $1\ \mu\text{m}$ **0.039 mil**.



Four Modes for Different Measurement Requirements

The **HL-D3** series is equipped with four sensing modes to cater to a variety of measurement needs, including in-line high-speed sensing and off-line high-precision detection.

Multi-select displacement sensing mode **MSDS**

The displacement sensor senses up to 10 measurement points specified on the X axis (measurement range of width) and completes the judgment at super-high speed.

See p.7 for more information.

Whole synchronized measurement mode

The displacement sensor performs sensing of all target objects with the same sensitivity adjustment throughout the entire measurement range of width (X axis). This mode is suitable for the sensing of fast-moving objects.

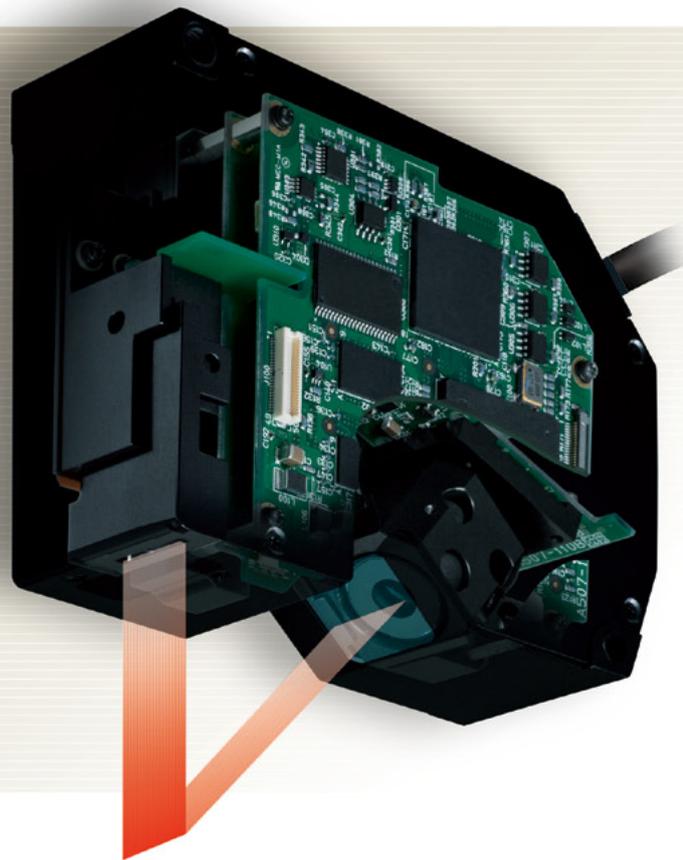
Multi-zone beam control measurement mode **MZBC**

High-precision sensing is achieved by segmenting the measurement range of width (X axis) to optimize light intensity. This mode is suitable for the sensing of objects with varied glossiness or color.

See p.9 for more information.

Constant pitch measurement mode

Sensing is performed at even intervals upon adjusting the sensitivity per the pitch specified along the measurement range of width (X axis). High-speed sensing is made possible by the reduced number of sensing points.



HL-D3 adopts parallel beam made possible by the latest optical system. The reduced area of shadow that appears when light is emitted on the target object made it possible to accurately sense the shape of the object.

Conventional model



HL-D3



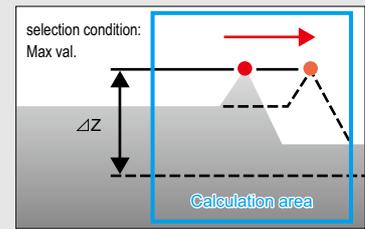
Multiple Shape Calculation Functions and Two Judgment Outputs

The **HL-D3** series calculates the shapes, including the height difference, width, and cross-sectional area, from the shape waveform based on the received light. At the same time, the displacement sensor uses these calculation results to instantaneously make Hi / Go / Lo judgments based on the present upper and lower limits.

(Only height calculation and step calculation in multi-select displacement sensing mode)

Thanks to the two sets of output, different shape calculations can be performed for each output or two sensor heads can be connected and used to output each judgment results.

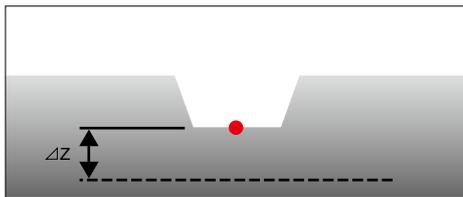
Shape calculation is performed using the representative values extracted from the set calculation area based on the specified conditions. This technique has the benefit of tolerating any shifts in the position of objects being sensed as long as they are within the calculation area.



(Set to extract max. value in the example above)

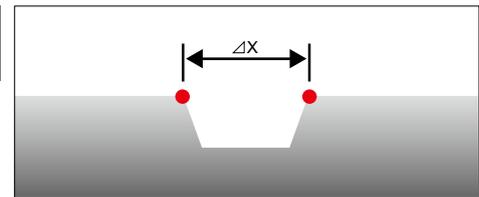
Height calculation

The height difference between the reference value and measured value is calculated.



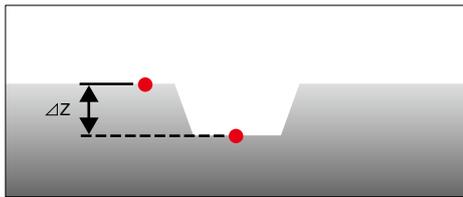
Width calculation

The width is calculated from 2 measured values.



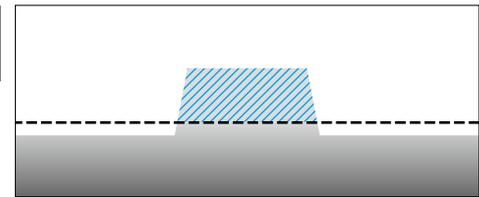
Step calculation

The height difference is calculated from 2 measured values.



Cross-sectional area calculation

HL-D3 calculates the cross-sectional area defined by the reference value.



Settings & Monitoring Software (HL-D3SMI) Provided as Standard

Conditions and the monitoring of measurements and judgment results can easily be set up by connecting to the **HL-D3C** controller and a PC pre-installed with **HL-D3SMI** using USB cables. The shape waveform based on the saved data can be reproduced on screen, which allows for it to be used as an analytical tool.

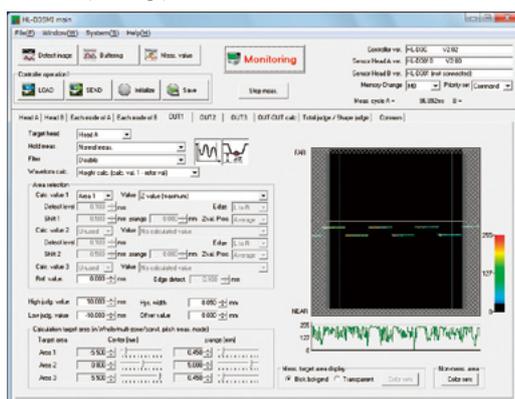
See also the columns on p.7 and 9.

Operating environment

OS	Microsoft Windows® Vista Business 32 bit SP or higher Microsoft Windows® 7 Professional 32 bit / 64 bit Microsoft Windows® 8 Pro 32 bit / 64 bit (Japanese, English, Chinese)
CPU	Pentium compatible CPU 1 GHz or higher
Memory	2 GB or higher
Screen display	1024 × 768 dots, 256 colors or higher
Hard disc	50 MB or more of available memory
USB interface	USB 2.0 Full Speed (USB 1.1 compatible) compliant

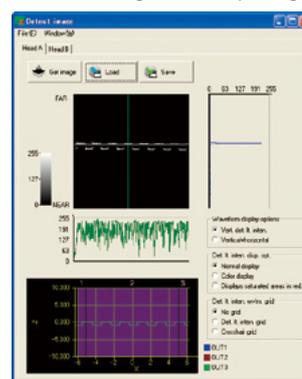
- * A CD-ROM drive is required for installation.
- * Windows Vista, 7 and 8 are trademarks or registered trademarks of Microsoft Corporation in the United States and other countries.
- * Pentium is a registered trademark of Intel Corporation.

Main (Settings) screen



The Main screen is where you set up the controller operations and the conditions for the sensor head and individual functions.

Received light intensity image screen



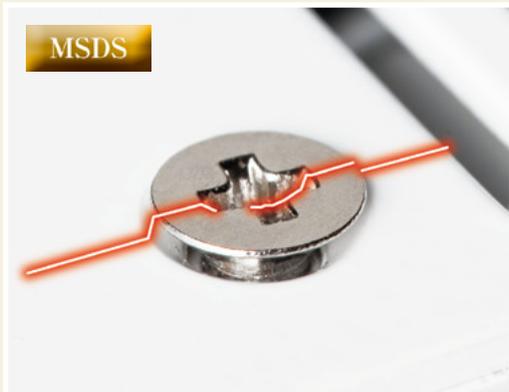
On this screen, you can review the light receiving status of the 2D image sensor built into the sensor head, as well as the shape waveform of the measured values.

Realizing High Speed Multi-point Sensing

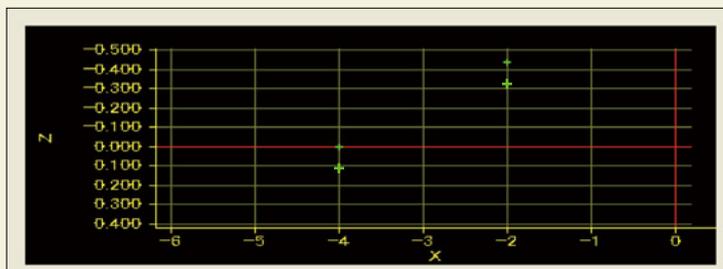
Multi-select displacement sensing

Application

Checking for loose screws



Screen display of sensing points in MSDS mode



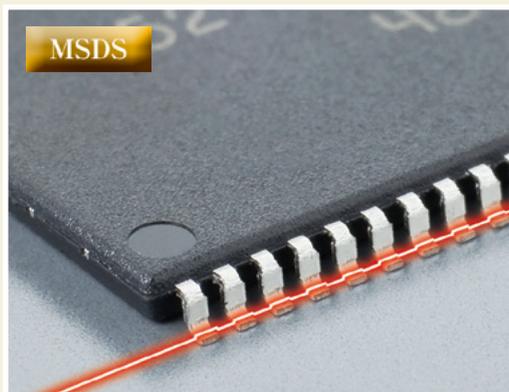
Missing and loose screws can be detected by sensing the displacement of the screw head from the reference plane. **HL-D3** provides Hi / Go / Lo judgment based on the sensing results. When two sensing points are used, in-line testing can be performed by virtue of the sensing performance that realizes a sampling rate of 80 μ s.

Screen display of calculated value and judgment

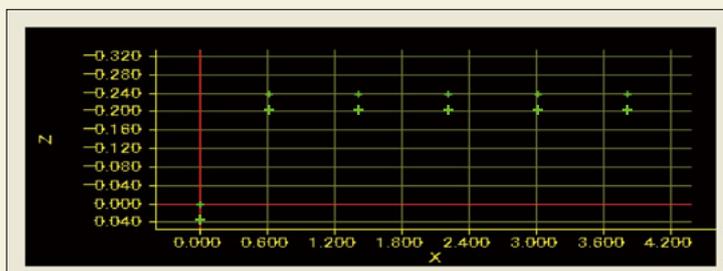


Application

Detecting misaligned pins on surface mounted components

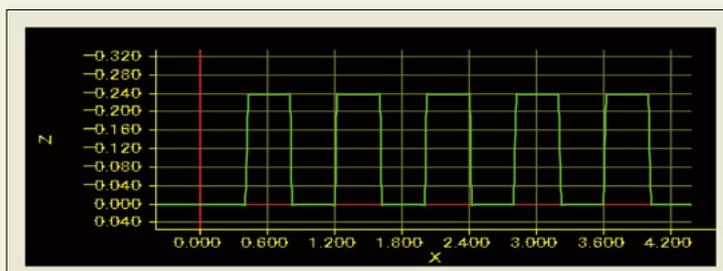


Screen display of sensing points in MSDS mode



HL-D3 can even sense the tiny pins of surface mounting components. The measured values can be managed by setting the reference plane and pins as sensing points.

Screen display of shape waveform in MZBC mode



What is multi-select displacement sensing?

MSDS

Conventional 2D displacement sensors produced the measurements of the specified points after sensing the entire measurement range of width (X axis), which made them unsuitable for high-speed sensing.

The **HL-D3** series performs efficient internal processing by sensing only the displacements at the specified points. This feature enables super-fast measurement, from sensing to calculation and judgment. Sensitivity is also adjusted at each point to ensure optimized sensing in order to also achieve high precision.

(MSDS: Multi-Select Displacement Sensing)

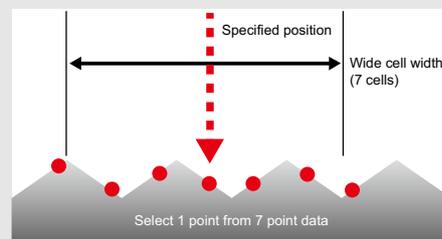
[Features]

- High-speed sampling
 - Max. speed 80 μ s (for 2-point specified)
- Sensing points can be specified as desired
 - Up to 10 points
- Measurements of specified points can be buffered
- Height, step calculation, and judgment results can be output
- Wide-cell function

[Wide-cell function]

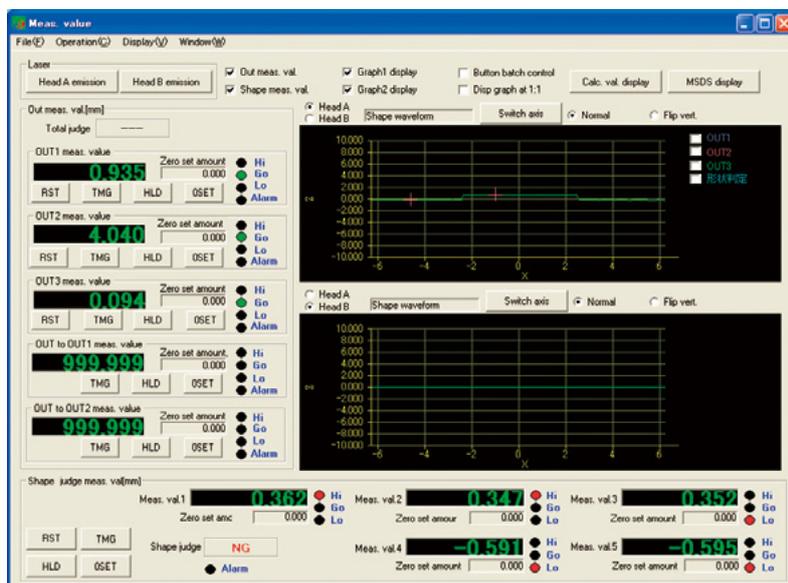
When the surface condition is rough, such as with cut metal, sensing of a single point will result in errors due to the uneven surface.

The wide-cell function expands the sensing points for the light receiving side and obtains the mean value (or maximum or minimum value, depending on the setting) to improve the stability of the measurements.



HL-D3SMI (monitoring software) can. PART 1

- Easily identify the sensed point based on the display of the displacement shape waveform obtained from the light intensity waveform
- Display the calculation area along with the displacement shape waveform in order to enable an instant understanding of the calculated point and area
- Display the calculated values of height difference, width, and cross-sectional area on the screen
- List the displacement value of each sensing point when operating in MSDS mode



Screen displaying measured values

Results display		
Head A display		
	X	Z
Pos. 1	-5.000	0.100
Pos. 2	-4.000	0.070
Pos. 3	-3.000	0.085
Pos. 4	-2.000	0.050
Pos. 5	-1.000	-0.449
Pos. 6	0.000	-0.456
Pos. 7	1.000	-0.159
Pos. 8	2.000	-0.001
Pos. 9	3.000	-0.016
Pos. 10	4.000	-0.031

Screen displaying multi-point displacement values

Acquiring Stable Shapes

Multi-zone Beam Control Function

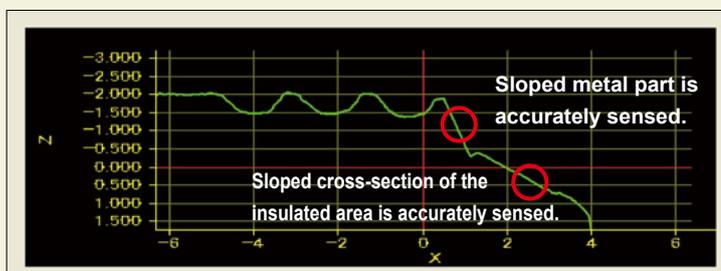
Application

Sensing Objects with Sloped Profile

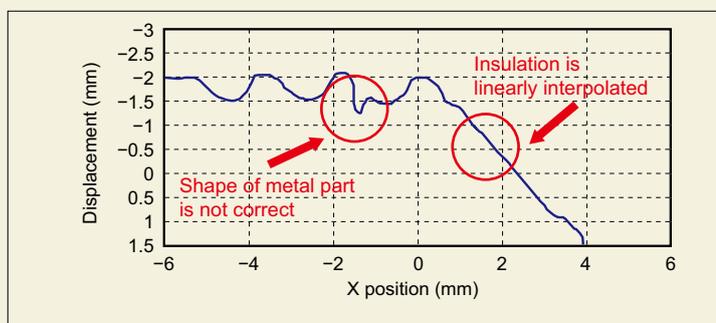


HL-D3 can accurately sense the shapes of the thread and black insulation of a miniature bulb.

Screen display of shape waveform

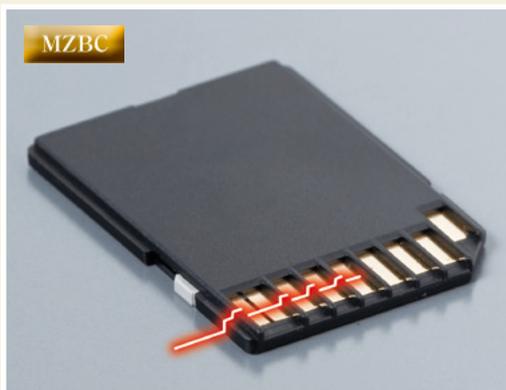


Sensing waveform by conventional model



Application

Sensing objects using both gold plates and black resin

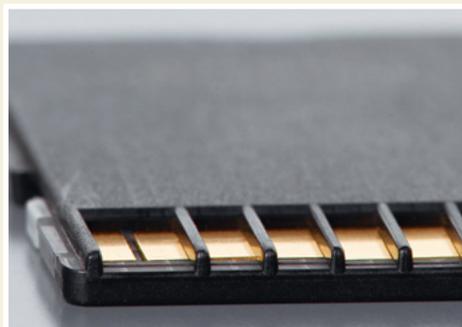


The terminal part of an SD card has gold-plated pads, as well as resin walls and dented parts that separate them. HL-D3 can accurately sense the two materials having different reflectance.

Screen display of shape waveform



Close-up of sensed part



What is multi-zone beam control?

MZBC

Conventional 2D displacement sensors uniformly use the same light intensity adjustment for the entirety of the measurement range of width (X axis). When parts with significantly differing reflectance exist, the received light intensity becomes saturated or insufficient, preventing the acquisition of effective measurement results.

The **HL-D3** series breaks down the measurement range of width (X axis) into small segments and adjusts the emission for each segmented unit (called "light intensity adjustment unit") for optimal sensitivity in order to achieve stable, high-precision sensing. (MZBC: Multi-Zone Beam Control)

[Features]

- Stable sensing is possible even with objects of which reflectance is not consistent throughout the whole object
 - Both metal and resin parts exist
 - Profile consists of flat and sloped parts
- High-precision sensing
 - Resolution of $1\ \mu\text{m}$ **0.039 mil** (average number of samples: 64 with average height measurement)
- Calculation and judgment results of width, step, and cross-sectional area can be output

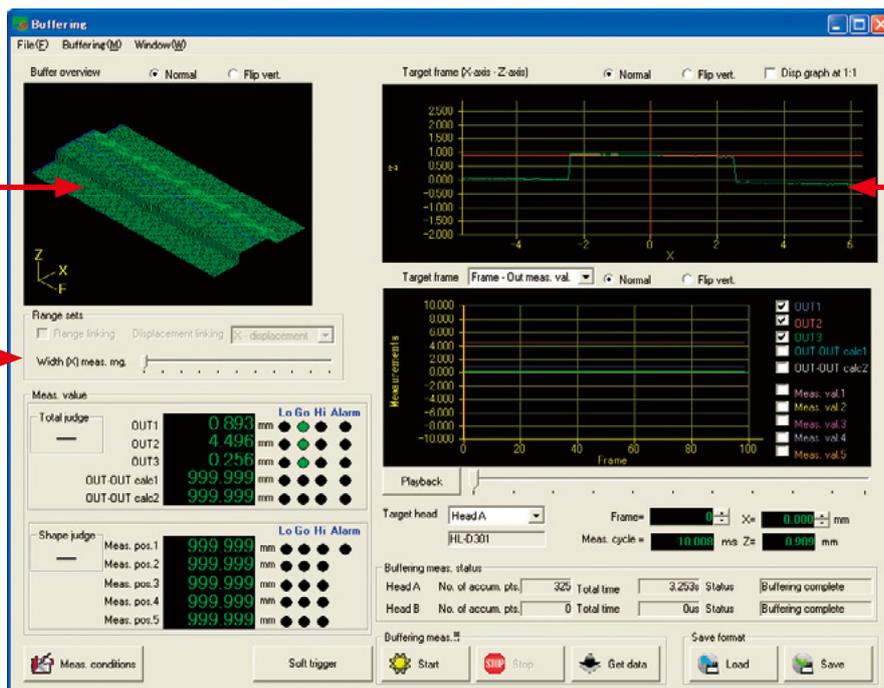
HL-D3SMI (monitoring software) can.

PART 2

- Store displacement shape waveform data, calculated measured values, and judgment results on the memory built into the controller during continuous sensing.
- Provides a stereoscopic representation of the shape by a 3D display of stored data.
- Replay the stored data on the buffering screen at a later time, provided that the stored data is saved in the dedicated file format.
- Allow waveform display and analysis by means of spreadsheet software based on the data saved in CSV file format.

3D display of buffering results

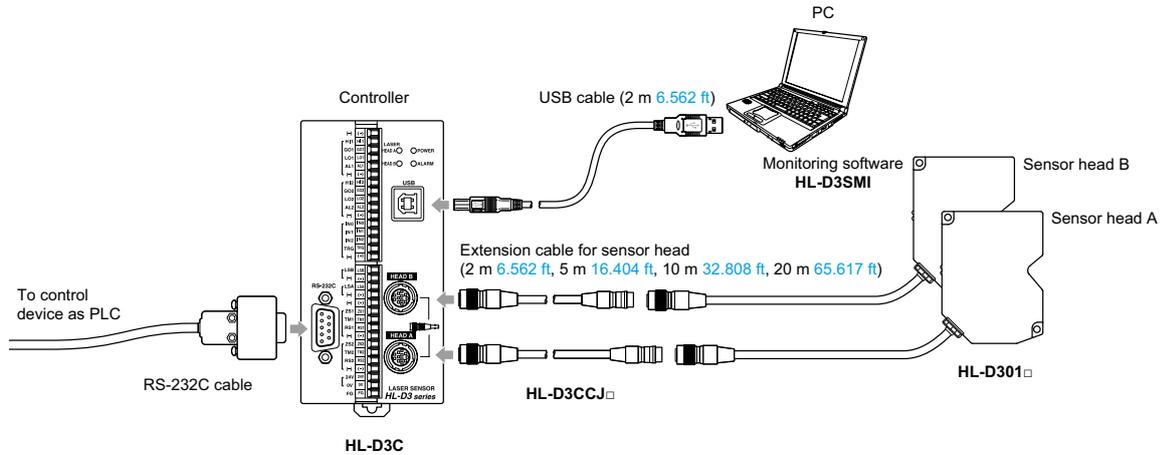
Calculated measurements and judgment results



Buffering display screen

HL-D3

SYSTEM CONFIGURATION



Set-up is performed based on the shape waveform obtained, which requires a computer pre-installed with the monitoring software (HL-D3SMI).

ORDER GUIDE

Sensor heads

Type	Appearance	Measurement center distance and height (Z axis) measurement range	Measurement range of width (X axis)	Resolution (height direction) (Note 1)	Laser class	Model No.
Diffuse reflection		50 ±10 mm 1.969 ±0.394 in	12.5 mm 0.492 in (with measurement center distance)	1 μm 0.039 mil	Class 2 (IEC / JIS / FDA, Laser Notice No.50)	HL-D301B
					Class 3R (IEC / JIS / FDA, Laser Notice No.50)	HL-D301C

Notes: 1) Value is the height mean value over the entire measurement range with the average number of samples being 64 and using measurement center distance.
2) Compliant with the FDA regulations based on the provisions of Laser Notice No.50.

Controller

Appearance	Model No.	Output
	HL-D3C	N-channel FET, open drain (Judgment output, Alarm output)

Options

Designation	Appearance	Model No.	Description
Sensor head extension cable		HL-D3CCJ2	Length: 2 m 6.562 ft
		HL-D3CCJ5	Length: 5 m 16.404 ft
		HL-D3CCJ10	Length: 10 m 32.808 ft
		HL-D3CCJ20	Length: 20 m 65.617 ft
			Cabletyre cable with connector on both ends Cable outer diameter: ø6.6 mm ø0.260 in Connector outer diameter: ø14.7 mm ø0.579 in max.

SPECIFICATIONS

Sensor heads

Type		Diffuse reflection type	
Item	Model No.	HL-D301B	HL-D301C
Measurement center distance		50 mm 1.969 in	
Height (Z axis) measurement range		±10 mm ±0.394 in	
Measurement range of width (X axis)	Near side	11.5 mm 0.453 in	
	Measurement center	12.5 mm 0.492 in	
	Far side	12.5 mm 0.492 in	
Unit of measurement output	Height (Z axis)	0.1 μm 0.004 mil	
	Width (X axis)	1 μm 0.039 mil (Note 2)	
Resolution	Height (Z axis)	1 μm 0.039 mil (Note 3)	
	Width (X axis)	5 μm 0.197 mil (Note 2, 4)	
Linearity (Note 5)	Height (Z axis)	±0.1 % F.S.	
Temperature characteristic		0.02 % F.S./°C	
Light source		Red semiconductor laser (Peak wavelength 658 nm 0.026 mil)	
	Output	Max. output: 1 mW	Max. output: 5 mW
	Laser class	Class 2 (IEC / JIS / FDA, Laser Notice No.50)	Class 3R (IEC / JIS / FDA, Laser Notice No.50)
Beam size (Note 6)		50 μm × 15 mm 1.969 mil × 0.591 in	
Receiving element		CMOS 2D image sensor	
Indicator	Laser emission	Green LED (lights up during laser emission)	
	Measurement range	Yellow LED [lights up when near the measurement center distance, blinks when within the measuring range, and lights out when outside of the measuring range. (at the measurement center position in the width direction)]	
Environmental resistance	Protection	IP67 (IEC) (excluding the connector)	
	Ambient temperature	0 to +45 °C +32 to +113 °F (No dew condensation), Storage: -20 to +70 °C -4 to +158 °F	
	Ambient humidity	35 % to 85 % RH, Storage: 35 % to 85 % RH	
	Ambient illuminance	Incandescent light: 3,000 lx or less at the light-receiving face (No direct sunlight or its reflection allowed)	
	Vibration resistance	10 to 55 Hz (period: 1 min.) frequency, 1.5 mm 0.059 in double amplitude in X,Y and Z directions for two hours each	
	Shock resistance	196 m/s ² acceleration (20 G approx.) in X,Y and Z directions three times each	
Cable		Cabletyre cable, 0.5 m 1.640 ft long with connector	
Cable extension		Extension up to total 20 m 65.617 ft is possible, with optional cable.	
Materials		Enclosure: Die-cast aluminum, Case cover: Die-cast aluminum, Front cover: Glass	
Weight		500 g approx. (including cable)	
Accessory		Laser warning label: 1 set	

Notes: 1) Where measurement conditions have not been specified precisely, the conditions used were as follows: (connected to the controller) supply voltage 24 V DC, ambient temperature +20 °C **+68 °F**, MZBC mode (adjustment unit: width of 100 μm **3.937 mil**), unit light receiving time 100 μs, average number of samples 64, measurement center distance, and target object is a white, light-diffusing object.

2) It is a value in which the sensor heads connected to a controller Ver. 2.00 or higher.

3) The value is the average of height measurement in full width at the measurement center distance.

4) This is the measurement value of a pin gauge rounded surface in the edge position measurement (start of falling edge) calculation setting. The measurement object: white ceramic pin gauge (ø10 mm **ø0.394 in**), unit light receiving time: 200 μs, measurement value extraction: base light intensity control, average number of samples: 64, width smoothing: ±4, all others are the initial settings.

5) Value represents the error in comparison with the ideal line of height measuring range (full scale) for the height measurement of the measurement center position in the width direction. The value in the specifications is the value within ±7.5 mm **±0.295 in** of the height measuring range.

6) This size applies when using measurement center distance and is defined as $1/e^2$ (13.5 % approx.) of the center light intensity. Leaked light occurs outside of the defined range; sensing performance may be affected when the reflectance around the detection point is higher than that detection point.

SPECIFICATIONS

Controller

Model No.		HL-D3C
Item		
Applicable sensor heads		HL-D301B, HL-D301C
Connectable sensor heads		Number of connectable units: Max. 2 units
Supply voltage		24 V DC \pm 10 % including ripple 0.5 V (P-P)
Current consumption		1 A or less (when 2 sensor heads are connected)
Sampling rate		Depends on the sensing mode and settings Multi-zone beam control mode : Standard 12.2 ms (Note 2) Whole synchronized measurement mode : Max. 2.5 ms (Note 3) Multi-select displacement sensing mode : Max. 80 μ s (Note 4)
Judgment output		N-channel FET, open drain • Maximum sink current: 100 mA • Applied voltage: 30 V DC or less (between output terminal and 0 V) • ON-resistance: 5 Ω or less
	Output operation	Open during output operation (switchable)
	Short-circuit protection	Incorporated
Alarm output		N-channel FET, open drain • Maximum sink current: 100 mA • Applied voltage: 30 V DC or less (between output terminal and 0 V) • ON-resistance: 5 Ω or less
	Output operation	Open when alarm is triggered (switchable)
	Short-circuit protection	Incorporated
External trigger input		Photocoupler insulation input
	Input operation	ON: short-circuiting to external insulation COM (-) , OFF: when open
	Applied voltage	30 V DC or less (leakage current: 0.1 mA or less)
Laser control input		Photocoupler insulation input
	Input operation	Laser emission: short-circuiting to external insulation COM (-) , Laser emission OFF: when open
	Applied voltage	30 V DC or less (leakage current: 0.1 mA or less)
Zero set input		Photocoupler insulation input
	Input operation	ON: short-circuiting to external insulation COM (-) , OFF: when open
	Applied voltage	30 V DC or less (leakage current: 0.1 mA or less)
Timing input		Photocoupler insulation input
	Input operation	ON: short-circuiting to external insulation COM (-) , OFF: when open
	Applied voltage	30 V DC or less (leakage current: 0.1 mA or less)
Reset input		Photocoupler insulation input
	Input operation	ON: short-circuiting to external insulation COM (-) , OFF: when open
	Applied voltage	30 V DC or less (leakage current: 0.1 mA or less)
RS-232C interface		Baud rate: 9,600, 19,200, 38,400, 57,600, 115,200 bit/s
USB interface		USB 2.0 full-speed (USB 1.1 compatible)
Settings / Data display		HL-D3SMI (accessory) or dedicated API
Indicator	Power	Green LED (lights up at power on)
	Sensor head A Laser radiation	Green LED [During continuous sensing: lights up during laser emission, blinks twice when turning off During sensing stop process: alternately lights up during laser emission (ON: 1 second / OFF: 1 second), blinks once when turning off]
	Sensor head B Laser radiation	Green LED [During continuous sensing: lights up during laser emission, blinks twice when turning off During sensing stop process: alternately lights up during laser emission (ON: 1 second / OFF: 1 second), blinks once when turning off]
	Alarm	Red LED (lights up when there is a sensing alarm or sensor head wire breakage)
Environmental resistance	Ambient temperature	0 to +50 °C +32 to +122 °F (No dew condensation or icing allowed), Storage: -20 to +70 °C -4 to +158 °F
	Ambient humidity	35 to 85 % RH , Storage: 35 to 85 % RH
	Vibration resistance	10 to 55 Hz frequency (period: 1 min) , 0.75 mm 0.030 in double amplitude in X, Y, and Z directions for 30 min. each
	Shock resistance	196 m/s ² acceleration (20G approx.) in X, Y, and Z directions three times each

SPECIFICATIONS

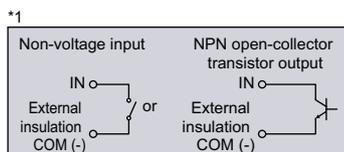
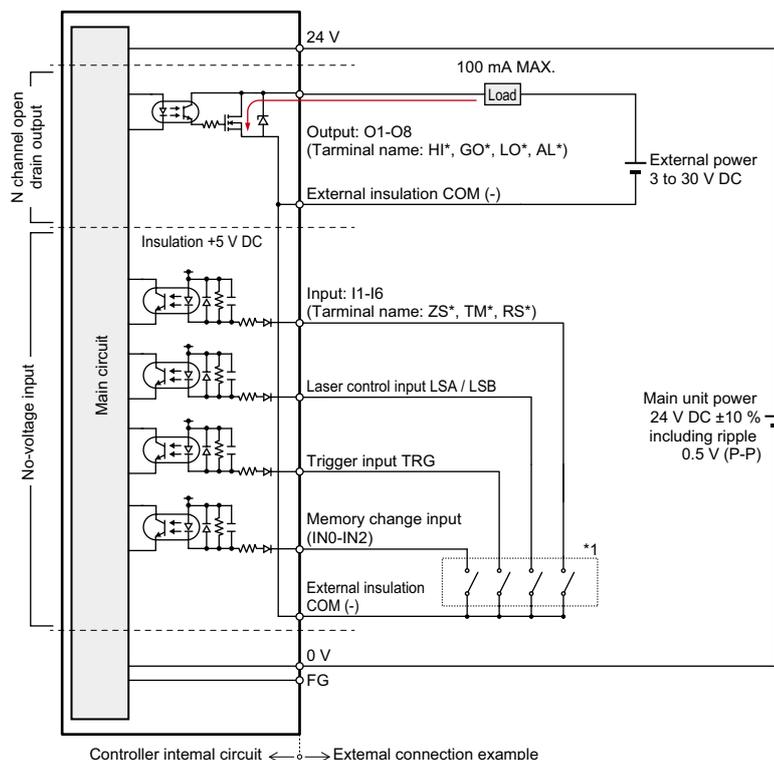
Controller

Model No.	HL-D3C
Item	
Material	Enclosure: Aluminum
Weight	300 g approx.
Accessories	HL-D3 set-up CD-ROM, (including HL-D3SMI and User's Manual), Instruction manual, USB cable (2 m 6.562 ft)

Notes: 1) Where measurement conditions have not been specified precisely, the conditions used were as follows: (connected to the sensor head) supply voltage 24 V DC, ambient temperature +20 °C +68 °F, MZBC mode (adjustment unit: width of 100 μm [3.937 mil](#)), unit light receiving time 100 μs, average number of samples 64, measurement center distance, and target object is a white, light-diffusing object.

- Value for using two judgment outputs with 1 sensor head in MZBC mode, with each measuring range set to Max. and light intensity not adjusted (continuous sensing).
- Value for obtaining displacement shape waveform data using buffering and 2 sensor heads in whole synchronized measurement mode, with each measuring range set to Min. (no OUT calculation).
- Value for using 2 judgment outputs with 1 sensor head in MSDS mode, with the unit light receiving time set to 40 μs, light intensity not adjusted (continuous), and 2 points selected (without wide cell function).

I/O CIRCUIT DIAGRAMS



Notes: 1) External insulation COM (-) is insulated from internal 0 V. Always connect to an external power supply of 0 V.

2) * represents 1, 2, 3, 4, 5, or 7, which are OUT numbers.

1, 2, 3, 4, 5, and 7 are judgment outputs belonging to OUT1 through OUT5 and OUT7, which can also be input terminals. 4 and 5 (OUT4 and OUT5) indicate inter-OUT calculations while 7 (OUT7) indicates shape judgment measurement.

HL-D3

PRECAUTIONS FOR PROPER USE

• This catalog has been prepared to aid selection of appropriate products. When using the product, be sure to read the User's Manual.



- Never use this product as a sensing device for personnel protection.
- This product is intended to detect the objects and does not have the control function to ensure safety such as accident prevention.
- When using sensing devices for personnel protection, use products that meet the laws and standards for personnel protection that apply in each region or country, such as OSHA, ANSI and IEC.



- Do not operate products using methods other than those described in the instruction manual included with each product. Control or adjustment through procedures other than those specified may cause hazardous laser radiation exposure.
- The following labels are attached to the products. Handle each product according to the instruction given on the warning label.

HL-D301B

• This product is classified as a Class 2 Laser Product in IEC / JIS standards and FDA* regulations. Do not look at the laser beam directly or through optical devices such as a lens.



HL-D301C

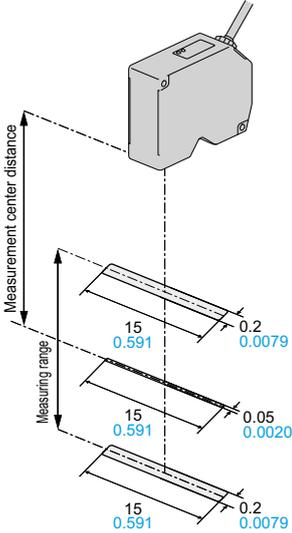
• This product is classified as a Class 3R Laser Product in IEC / JIS standards and FDA* regulations. Never directly look at or touch the laser beam or its reflection.



* This product complies with 21 CFR 1040.10 and 1040.11 Laser Notice No. 50, dated June 24, 2007, issued by CDRH (Center for Devices and Radiological Health) under the FDA (Food and Drug Administration).

Beam size (Unit: mm in)

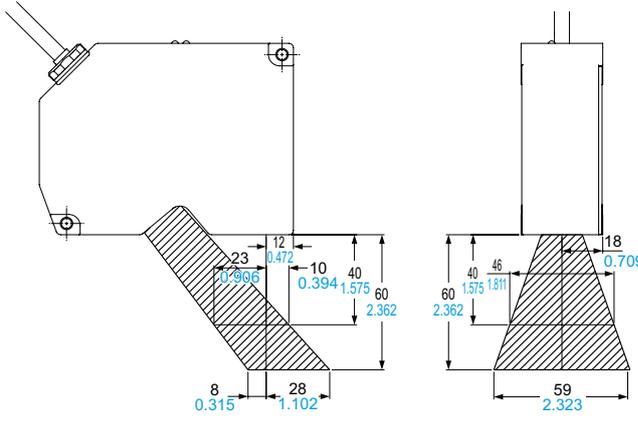
HL-D301B, HL-D301C



Mutual interference (Unit: mm in)

• When installing two or more sensor heads side by side, mutual interference will not occur if the laser spots from other sensor heads do not fall within the shaded areas of the sensor head in the figure below.

HL-D301B, HL-D301C

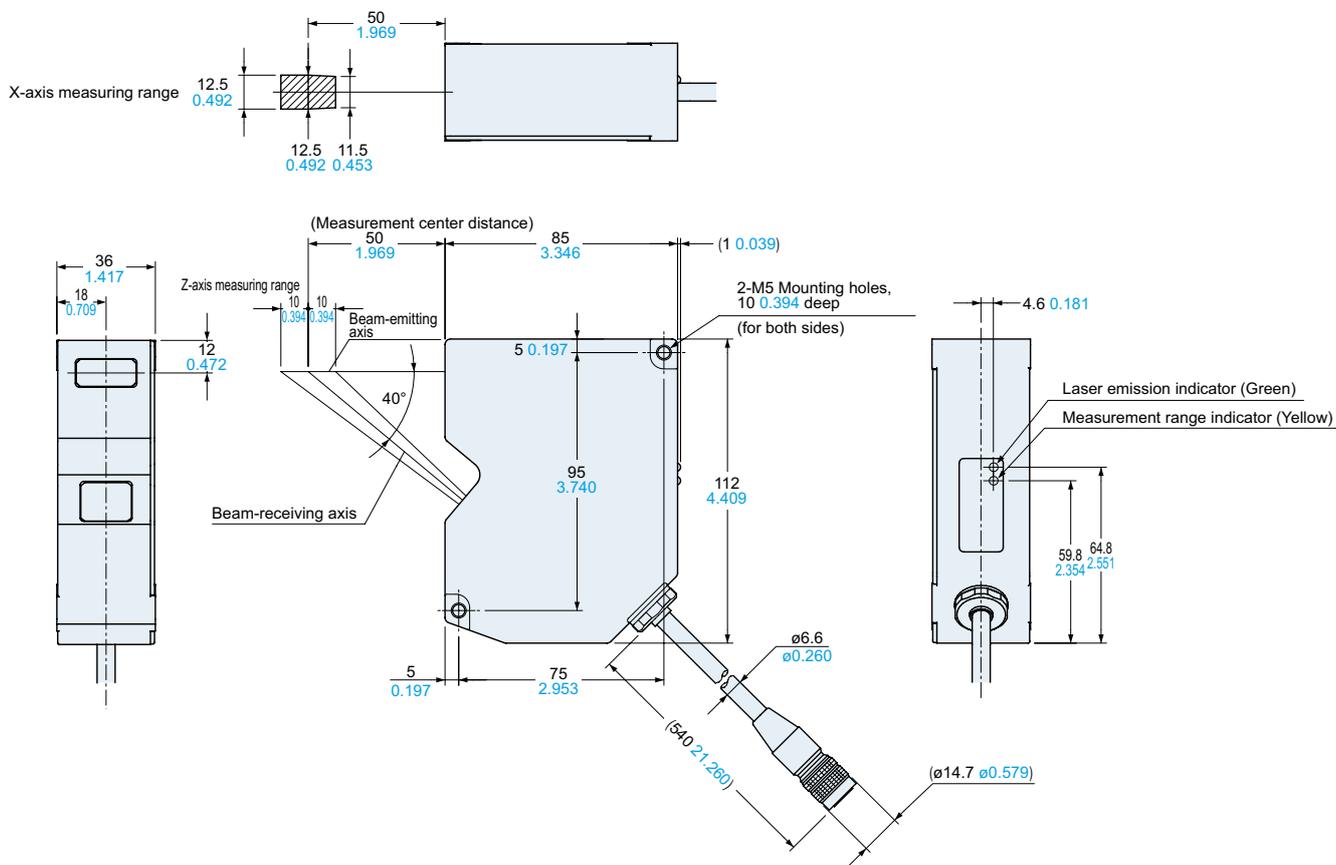


DIMENSIONS (Unit: mm in)

The CAD data can be download from our website.

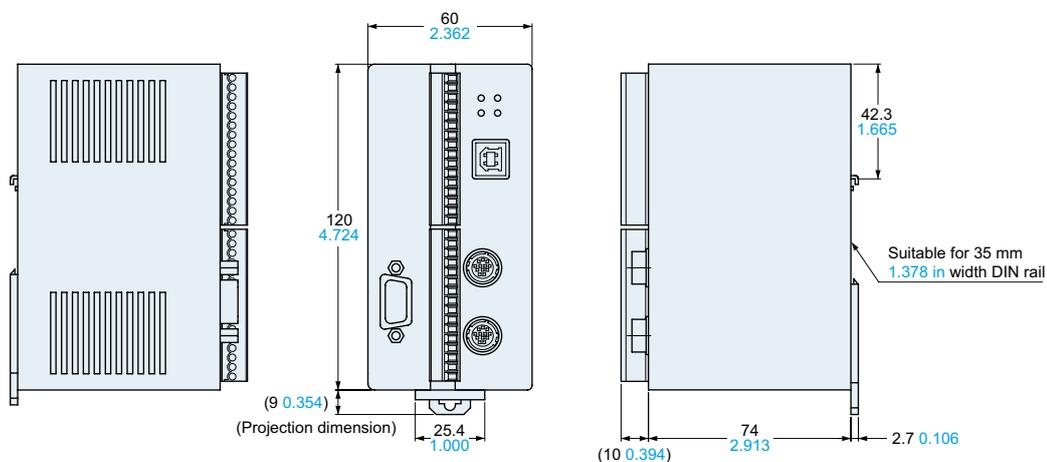
HL-D301B HL-D301C

Sensor head



HL-D3C

Controller



HL-D3 series version upgrade

The following five functions have been added to models produced in and after September 2013:

- Automatic following function for the measurement area
- Increased OUT calculations
- Mask function
- I/O terminal switching function
- Specular reflection installation supported

Disclaimer

The applications described in the catalog are all intended for examples only. The purchase of our products described in the catalog shall not be regarded as granting a license to use our products in the described applications. We do NOT warrant that we have obtained some intellectual properties, such as patent rights, with respect to such applications, or that the described applications may not infringe any intellectual property rights, such as patent rights, of a third party.

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