

LASER SENSOR for MEASUREMENT

## LAH-G1

### Manual

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Thank you for purchasing the LAH-G1-series Compact Laser Displacement Sensor. Please read this operation manual carefully before you install and operate the product. Refer to our website for the latest information on the product as well as the latest version of the manual.

#### **Liability and Copyright for the Hardware**

This manual and everything described in it are copyrighted. You may not copy this manual, in whole or part.

We reserve the right to change the manual/product without notice. In no event will WayCon be liable for direct, special, incidental, or consequential damage resulting from any defect in the product or its documentation, even if advised of the possibility of such damages.

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# Important Symbols

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The following symbols are used in this manual:



## Warning

The warning triangle indicates especially important safety instructions. If they are not adhered to, the results could be fatal or critical injury.



## Caution

Indicates that you should proceed with caution. Failure to do so may result in injury or significant damage to instruments or their contents, e.g. data.



## ◆ NOTE

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Contains important additional information.



## ◆ EXAMPLE

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Contains an illustrative example of the previous text section.



## ◆ PROCEDURE

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Indicates that a step-by-step procedure follows.



## ◆ REFERENCE

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Indicates where you can find additional information on the subject at hand.

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# Chapter 1

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## Introduction

## 1.1 Safety Instructions

The laser is classified in accordance with JIS (JIS C 6802: 2005) and IEC (IEC 60825-1: 2007) standards.

Technical specification	
Laser wavelength	655nm
Maximum output	1mW
Laser class	2

Familiarize yourself with all safety instructions to ensure safe handling of the device. The safety instructions are broken down according to the cause and location of danger.



### Warning

Using the product in a manner other than intended can lead to serious injury and/or significant material damage.

- This product is used to detect objects and does not incorporate control functions for the purpose of maintaining safety including the prevention of accidents.
- Do not use this product as a sensor to protect human bodies. Use products that conform to laws, regulations, and international standards such as OSHA, ANSI, and IEC standards, for applications protecting human bodies.
- Incorporate safety measures, such as a double safety mechanism, into the system if the use of the system is likely to result in serious injury or significant material damage.
- Do not use the system in combustion gas atmospheres. Otherwise, the system may result in explosion.
- This product has been developed/produced for industrial use only.
- Always observe the specifications including the ratings and ambient conditions (see page 79). Otherwise, the system may result in overheating or generate smoke.
- Do not disassemble or modify the system. Otherwise, an electric shock may be received or the system may generate smoke.
- Do not touch the wires when the system is energized. Otherwise, you may receive an electric shock.
- In order to ensure the performance of the system, allow a warm-up time of at least 30 minutes after the system is turned ON.

### 1.1.1 Safety Instructions for Laser Handling

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#### Warning

**Danger of eye damage or burning your skin with exposed laser beam!**

- **Be careful not to stare at the laser beam directly or the reflected light of the mirror surface.**
- **Install the sensor so the laser beam will be located higher or lower than eye level in order not to watch the beam directly while the system is in operation.**
- **Contact WayCon Positionsmesstechnik GmbH if the system breaks down. The product is not provided with a function to stop laser beam radiation automatically when the sensor head is disassembled. Do not disassemble the sensor head, or otherwise you may be exposed to the laser beam.**
- **Do not use the system in methods other than that specified in this manual. You may be exposed to hazardous laser radiation if the system is controlled or adjusted in procedures not specified in this manual.**
- **Read the descriptions of the warning label carefully before use. The warning label (English) is affixed to the side of the sensor head.**
- **You may be exposed to hazardous laser radiation if the system is controlled or adjusted in procedures not specified in this manual**

### 1.1.2 Safety Instructions for Installation, Maintenance, and Inspection

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#### Warning

**Observe the safety instructions for installation and maintenance of the product to prevent injuries or damage!**

#### Installation

- **Do not install the device in the following environments:**
  - **Areas exposed to intense interference light such as direct sunlight. Make sure that the illumination level of the light receiving surface does not exceed 3,000lx under incandescent light.**
  - **Areas with high humidity where condensation is likely to occur**
  - **Areas exposed to corrosive or explosive gases**
  - **Areas exposed to vibration or shock at levels higher than those specified (see page 80)**
  - **Areas exposed to contact with water**
  - **Areas exposed to too much steam or dust**

- The life of the semiconductor laser depends on the ambient temperature. Use the system within the range of the specifications (ambient temperature for sensor head: -10°C to 45°C for operation, -20°C to 60°C for storage. Ambient humidity: 35% to 85% RH).
- Take appropriate measures, such as the use of a cooling fan, to drop the ambient temperature of the sensor head as much as possible if the sensor head is used close to heat-radiating objects.
- The sensor head radiates heat as well. Therefore, be sure to install the sensor head in places with as good thermal conductivity as possible. Mount the sensor head to an aluminum or steel plate with a minimum surface area of 200cm<sup>2</sup> if the ambient temperature is 40°C or higher.
- In the case of installing two or more sensor heads in parallel, mount each sensor head to an aluminum or steel plate with a minimum surface area of 200cm<sup>2</sup> and make sure that the ambient temperature does not exceed 40°C.
- Always keep the emitter and receiver of the sensor head clean. Make sure that the emitter and receiver are free of substances that refract light, such as water, oil, or fingerprints, or surface water, or matters that block light, such as dust and dirt. Clean the emitter and receiver with a soft lint-free cloth or lens cleaning paper.
- Check that the receiver will not receive direct ambient light the same as the laser light in wavelength, such as sunlight. Mount an appropriate object, such as a light shield plate, to the sensor head if high accuracy is especially required.

### Maintenance

- Turn OFF the system to stop laser emission before cleaning the system.
- Molded resin is used in some parts of the system. Do not use organic solvents such as paint thinner or benzene to wipe the dirt on the system.
- Do not wipe the glass portion of the laser aperture too strongly. Scratches on the glass may cause measurement errors.
- Always keep the emitter and receiver of the sensor head clean. Make sure that the emitter and receiver are free of substances that refract light, such as water, oil, fingerprints, surface water, or matters that block light, such as dust and dirt. Inspect the surfaces regularly and always keep them clean.
- Blow away large particles of dust, if any, using a camera lens blower.
- To remove small particles of dust or fingerprints, use a soft lens cleaning cloth or lens cleaning paper and lightly wipe them out.
- Use a cloth moistened with a small amount of alcohol to wipe out tough dirt carefully.

### Inspection

- Inspect the system regularly to maintain the performance of the system and make it possible to use the system under optimum conditions.
- Check that no I/O terminal connections are loose or disconnected.
- Check that the glass surface on the laser aperture is free of dust, dirt, or fingerprints.

- Check that the power supply voltage is within the rated range (21.6 to 26.4V DC).
- Check that the operating ambient temperature is within the range of -10°C to 45°C for the sensor head.
- Check that the operating ambient relative humidity is within the range of 35% to 85%.

### 1.1.3 Safety Instructions for the Power Supply

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- Be sure to supply a rated voltage of 21.6 to 26.4VDC.
- The internal circuit may be damaged if an external surge voltage (single-polarity, full-wave voltage) in excess of  $500V \pm 1.2 \times 50\mu s$  is imposed. Insert a surge absorber between power input terminals if the external surge voltage is likely to exceed 500V.
- Select a power supply with a maximum ripple of 0.5V (peak to peak) and a minimum current capacity of 0.5A.
- Be sure to ground the frame ground terminal (FG) in order to prevent an adverse influence of high-frequency noise if a commercially available switching regulator is used for the power supply.
- A transformer may be connected to the power supply on the condition that the transformer is of isolation type. The product or the power supply may be damaged if an auto transformer is used.
- In order to protect the system from abnormally high voltages from the power supply line, be sure to use an isolated power supply with a built-in protective circuit.
- In the case of using a power supply that does not incorporate a protective circuit, be sure to connect the power supply to the system through a protective element, such as a fuse.

#### Power supply sequence for the sensor head

- Arrange a power supply sequence so that the sensor head will be turned ON earlier than the power supply.
- Arrange a power supply sequence so that the power supply will be turned OFF earlier than the sensor head.
- Do not turn ON the sensor head again within 10 seconds after the sensor head is turned OFF.
- The system will be ready to operate approximately 40 to 50 seconds after the system is turned ON, depending on the contents of settings. Note that the status of the outputs is undefined during startup.
- An analog voltage of 11V and an analog current of approximately 21.6mA will be output until the system becomes ready to operate.
- Do not turn OFF the system while system settings are being saved. In the worst case, the sensor head may be damaged and fail to restart.
- If an instantaneous power failure occurs, the system will operate continuously or go to the initial power-on state, depending on the duration of the

**power failure. Do not use the system in environments where instantaneous power failures occur.**

#### **1.1.4 Noise Countermeasures**

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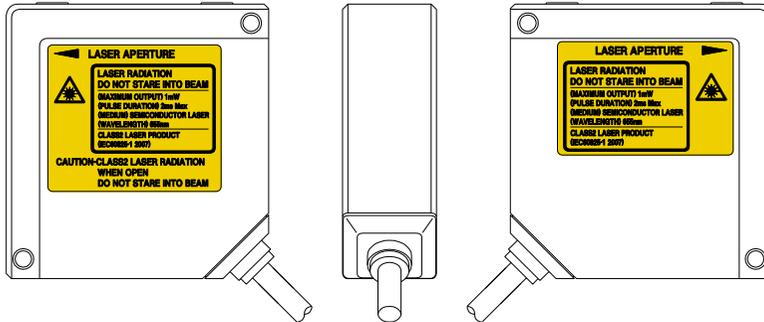
- **Install the system separated as much as possible from noise-generating sources, such as high-tension lines, high-voltage equipment, power lines, power equipment, machines generating high-voltage ON/OFF surges, welding machines, and inverter motors.**
- **Install the system separated as much as possible from radio equipment incorporating transmission circuitry, such as amateur radio transmitters.**
- **Do not touch the connector parts when the system is energized. Keep in mind that the internal circuit may be damaged if an excessive level of static electricity is imposed on the connector parts.**
- **Keep the sensor cable at least 100mm away from other wires and make sure that the sensor cable is not in parallel with them. Separate the sensor cable from high-voltage and power circuit lines. Shield the sensor cable with grounded conduits if it is unavoidable to lay the sensor cable together with high-voltage or power circuit lines.**
- **Keep the I/O signal lines at least 100mm away from power lines and power supply lines. All signal lines should be connected as short as possible.**
- **The analog output of the system is adversely influenced by heavy noise in the power supply. In that case, use a noise filter or noise-cut transformer.**
- **It is recommended to use shield cables for I/O signal wires and connect the shields to the FG.**
- **The analog output is easily affected by external noise. Use the shield cable and lay it as short as possible.**
- **Ground the FG independently at a resistance not exceeding 100Ω. The FG may be adversely affected if the ground is shared with other equipment.**

### 1.1.5 Safety Symbols and Identification

Read the descriptions of the warning stickers carefully before use. The warning sticker (English) is affixed to the side of the sensor head. Please also refer to the list of safety symbols used in this manual (see page ii).



The positions of the stickers on the product are shown below.



## 1.2 CE Compliance

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To ensure compliance with CE regulations, install the product as follows:

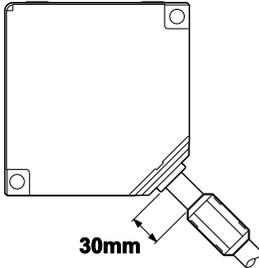


### ◆ NOTE

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- Make sure that the signal and power lines connected to the product are shorter than 30m.
- Attach a suitable ferrite core to the head cable as shown below.



## 1.3 Export to the US

If the laser product is mounted on equipment and exported to the United States, it is subject to the regulation of the Food and Drug Administration (FDA). In order to prevent users from injury caused by laser products, the FDA specifies PART 1040 (Performance Standards for Light-Emitting Products). The FDA classifies laser products according to the degree of risk and provides safety measures for respective classes.

Requirements	Class <sup>1</sup>					
	I	IIa	II	IIIa	IIIb	IV
<b>Performance (all laser products)</b>						
Protective housing [1040.10(f)(1)]	R <sup>2</sup>	R <sup>2</sup>	R <sup>2</sup>	R <sup>2</sup>	R <sup>2</sup>	R <sup>2</sup>
Safety interlock [1040.10(f)(2)]	R <sup>3,4</sup>	R <sup>3,4</sup>	R <sup>3,4</sup>	R <sup>3,4</sup>	R <sup>3,4</sup>	R <sup>3,4</sup>
Location of controls [1040.10(f)(7)]	N/A	R	R	R	R	R
Viewing optics [1040.10(f)(8)]	R	R	R	R	R	R
Scanning safeguard [1040.10(f)(9)]	R	R	R	R	R	R
<b>Performance (laser system)</b>						
Remote interlock connector [1040.10(f)(3)]	N/A	N/A	N/A	N/A	R	R
Key control [1040.10(f)(4)]	N/A	N/A	N/A	N/A	R	R
Emission indicator [1040.10(f)(5)]	N/A	N/A	R	R	R <sup>10</sup>	R <sup>10</sup>
Beam attenuator [1040.10(f)(6)]	N/A	N/A	R	R	R	R
Manual reset mechanism [1040.10(f)(10)]	N/A	N/A	N/A	N/A	N/A	R <sup>13</sup>
<b>Performance (specific-purpose products)</b>						
Medical [1040.11(a)]	S	S	S	S <sup>8</sup>	S <sup>8</sup>	S <sup>8</sup>
Surveying, leveling, alignment [1040.11(b)]	S	S	S	S	NP	NP
Demonstration [1040.11(c)]	S	S	S	S	S <sup>11</sup>	S <sup>11</sup>
<b>Labeling (all laser products)</b>						
Certification/identification [1010.2,3]	R	R	R	R	R	R
Protective housings [1040.10(g)(6),(7)]	D	R <sup>5</sup>				
Aperture [1040.10(g)(4)]	N/A	N/A	R	R	R	R
Class warning [1040.10(g)(1),(2),(3)]	N/A	R <sup>6</sup>	R <sup>7</sup>	R <sup>9</sup>	R <sup>12</sup>	R <sup>12</sup>
<b>Information (all laser products)</b>						
User information [1040.10(h)(1)]	R	R	R	R	R	R
Product literature [1040.10(h)(2)(i)]	N/A	R	R	R	R	R
Service information [1040.10(h)(2)(ii)]	R	R	R	R	R	R

R:	Required
N/A:	Not applicable
S:	Same requirements as for other products of that class.
NP:	Not permitted
D:	Depends on level of inner radiation

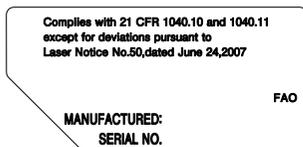
1. The assignment to a class is based on the maximum level of laser exposure during operation.
2. Required wherever and whenever such human access to laser radiation levels that exceed the limits of Class I is not necessary for the product to per-

form its intended function.

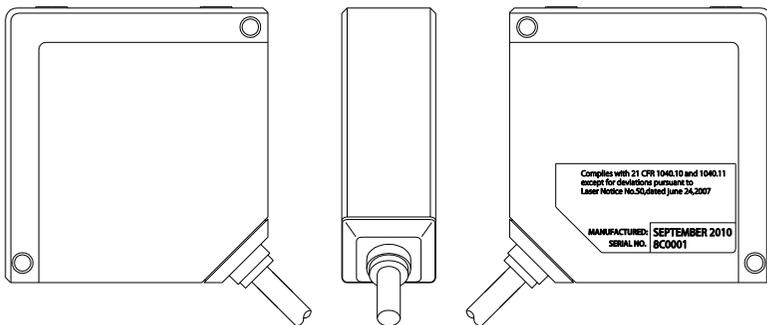
3. Required at the protective housing which is designed to be removed or displaced during operation or maintenance, if removal or displacement of the protective housing could permit human access to laser or collateral radiation.
4. The requirements for interlock differ depending on the class of inner radiation.
5. The contents of stickers differ depending on the level and wavelength of laser radiation inside the protective housing.
6. Warning statement sticker
7. CAUTION logotype
8. The method to measure the level of laser radiation to human body is required.
9. CAUTION if  $2.5\text{mW}/\text{cm}^2$  or less, DANGER if greater than  $2.5\text{mW}/\text{cm}^2$ .
10. Time difference is needed between instruction and emission.
11. Exception should be provided for demonstration of laser products or light shows using laser of Class IIIb or IV.
12. DANGER logotype
13. Required on and after August 20, 1986.

### Certification and identification stickers

The following sticker is used when the product is exported to the United States:



The position of the sticker on the product is shown below.



*Sticker position on the product*

# Chapter 2

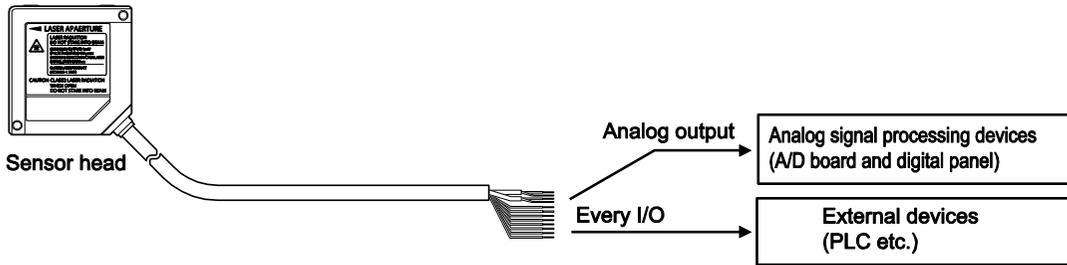
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**Before Use**

## 2.1 System Configuration

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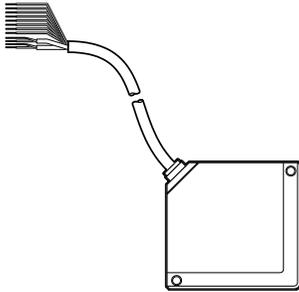
This is how you connect the sensor head to other devices.



## 2.2 List of Items and Accessories

The following parts and accessories are available.

### Sensor heads

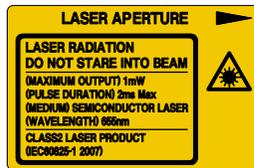


### Instruction manual

The sensor head instruction manual is in English and German.

### Warning labels

The warning label in English is attached to the sensor head.



## 2.3 Parts Description

	<table border="1"> <tr> <td data-bbox="546 262 610 330">①</td> <td data-bbox="610 262 1258 330"><b>Laser indicator (LASER)</b> Lights up in green during laser emission.</td> </tr> <tr> <td data-bbox="546 330 610 397">②</td> <td data-bbox="610 330 1258 397"><b>Alarm indicator (ALARM)</b> Lights up in orange if an alarm occurs during measurement.</td> </tr> <tr> <td data-bbox="546 397 610 465">③</td> <td data-bbox="610 397 1258 465"><b>OUT1 indicator (OUT1)</b> Lights up in yellow during OUT1 output.</td> </tr> <tr> <td data-bbox="546 465 610 533">④</td> <td data-bbox="610 465 1258 533"><b>OUT2 indicator (OUT2)</b> Lights up in yellow during OUT2 output.</td> </tr> <tr> <td data-bbox="546 533 610 600">⑤</td> <td data-bbox="610 533 1258 600"><b>OUT3 indicator (OUT3)</b> Lights up in yellow during OUT3 output.</td> </tr> <tr> <td data-bbox="546 600 610 668">⑥</td> <td data-bbox="610 600 1258 668"><b>[ENTER] key</b> Used to access the functions and to confirm input.</td> </tr> <tr> <td data-bbox="546 668 610 716"></td> <td data-bbox="610 668 1258 716"><b>Digital display</b> Displays measurement values and system errors.</td> </tr> <tr> <td data-bbox="546 716 610 784">⑧</td> <td data-bbox="610 716 1258 784"><b>[UP] key</b> Used to select items or change numerical values.</td> </tr> <tr> <td data-bbox="546 784 610 852">⑨</td> <td data-bbox="610 784 1258 852"><b>[DOWN] key</b> Used to select items or change numerical values.</td> </tr> <tr> <td data-bbox="546 852 610 919">⑩</td> <td data-bbox="610 852 1258 919"><b>Emitter</b> Emits the laser light.</td> </tr> <tr> <td data-bbox="546 919 610 987">⑪</td> <td data-bbox="610 919 1258 987"><b>Receiver</b> Receives reflected light from measurement targets.</td> </tr> <tr> <td data-bbox="546 987 610 1186">⑫</td> <td data-bbox="610 987 1258 1186"><b>Warning label</b> Shows the laser emission position. Read the description carefully before using the sensor.</td> </tr> </table>	①	<b>Laser indicator (LASER)</b> Lights up in green during laser emission.	②	<b>Alarm indicator (ALARM)</b> Lights up in orange if an alarm occurs during measurement.	③	<b>OUT1 indicator (OUT1)</b> Lights up in yellow during OUT1 output.	④	<b>OUT2 indicator (OUT2)</b> Lights up in yellow during OUT2 output.	⑤	<b>OUT3 indicator (OUT3)</b> Lights up in yellow during OUT3 output.	⑥	<b>[ENTER] key</b> Used to access the functions and to confirm input.		<b>Digital display</b> Displays measurement values and system errors.	⑧	<b>[UP] key</b> Used to select items or change numerical values.	⑨	<b>[DOWN] key</b> Used to select items or change numerical values.	⑩	<b>Emitter</b> Emits the laser light.	⑪	<b>Receiver</b> Receives reflected light from measurement targets.	⑫	<b>Warning label</b> Shows the laser emission position. Read the description carefully before using the sensor.
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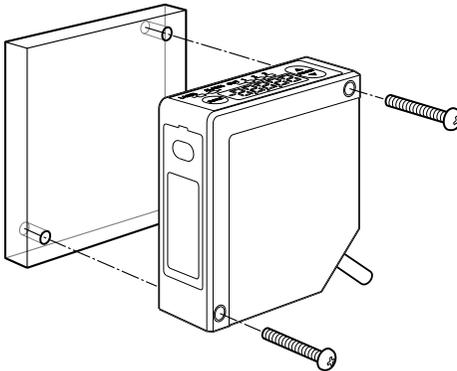
## 2.4 Notes on Mounting

When mounting the sensor, make sure to use the correct method.



### ◆ NOTE

- Before installing the sensor, read the safety instructions about the installation environment, noise countermeasures, and the power supply.
- Fix the sensor head securely with M4 screws inserted into the two screw holes of the sensor head.



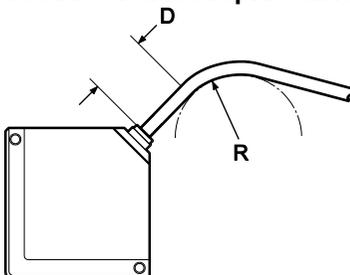
- The tightening torque should be 0.8N•m or less.

### 2.4.1 Mounting the Cables



### ◆ NOTE

- Never use force around the connectors of the sensor head cable and connection cable. Do not bend the cables near the connectors. Doing so may result in cable disconnection.
- Do not pull the cable with a force of more than 29.4N when you connect the cable to the mounted sensor head.
- In the case of moving and using the sensor head, pay attention not to bend the cables in excess. The cable may be bent with a radius of 30mm or more. However, do not bend the cable within 20mm of the sensor head. For applications where cables need to be bent, use the multifunction sensor type because it uses replaceable connection cables.

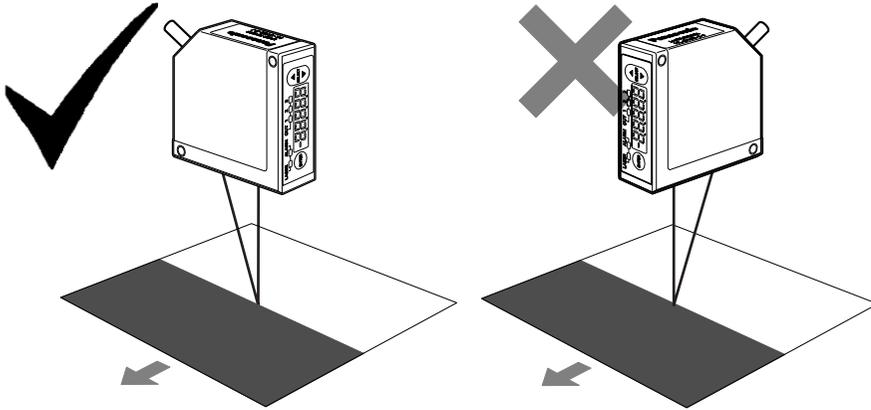


## 2.4.2 Mounting Direction of the Sensor Head

Mount the sensor head in the direction shown below to ensure precise and stable measurement.

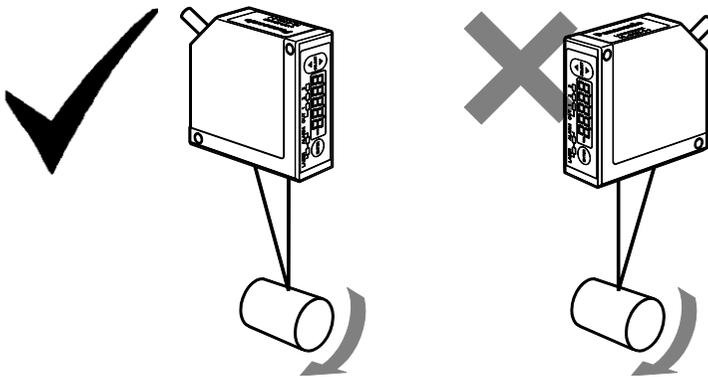
### Measurement of moving targets

When measuring a moving target that has extremely different adjacent colors or materials, mount the sensor head as shown below in order to minimize measurement errors.



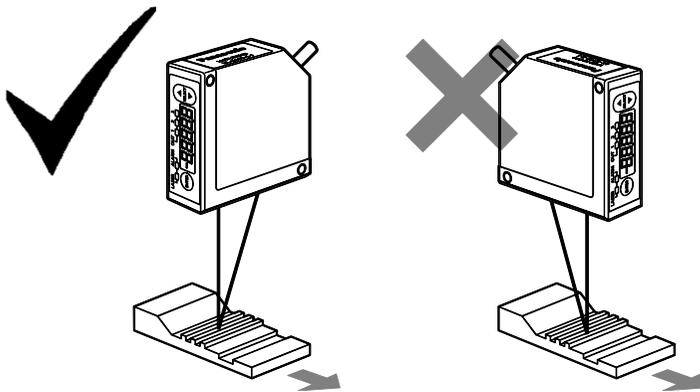
### Measurement of rotating targets

When measuring a rotating target, mount the sensor head as shown below to minimize the adverse influence of vertical oscillation or displacement.



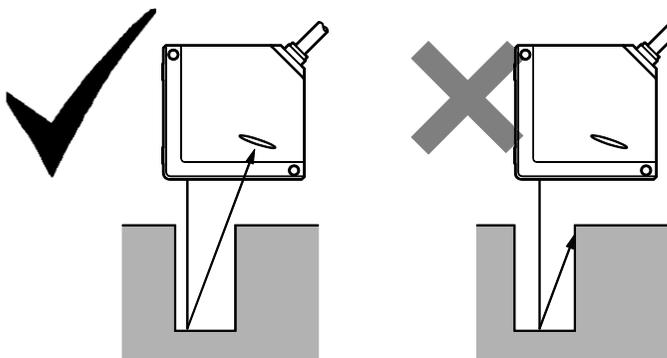
**Measurement of targets with level differences**

When measuring a moving target that has level differences, mount the sensor head as shown below to minimize interferences caused by the edges of the target.



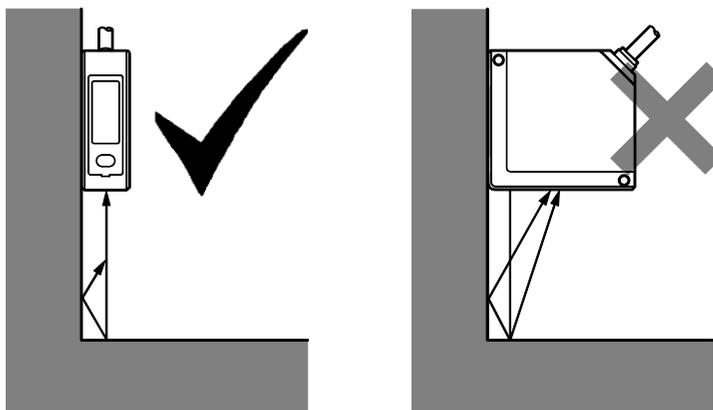
**Measurement of targets in narrow spaces or slots**

When measuring a target in a narrow space or slot, mount the sensor head as shown below so that the light beam between the emitter and the receiver is not blocked.



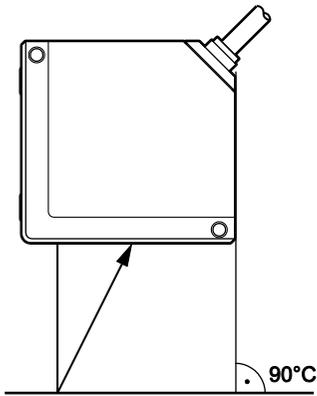
**Mounting the sensor head to a wall**

Mount the sensor head to the wall as shown below to ensure that the receiver does not receive light reflected from the wall at different angles. If there is a lot of reflection from the wall, paint the wall surface matte black.



**Sensor head angle to the center of measurement targets**

Mount the sensor head so that the emitter and receiver will be located parallel to each other as shown below.

**◆ NOTE**

Refer to the sensor head specifications for the measurement center distance and measuring range (see page 83).

# Chapter 3

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## Inputs and Outputs

## 3.1 Wiring Colors



### ◆ NOTE

The sensor heads produced before December 2010 use different wire colors. Please check the wire colors on the sensor head you are using.

#### Analog output lines

Pin No.	Signal name	Function	Lead wire color	
7	A(V)	Analog voltage output	Shielded single conductor	Black
8	AGND	Analog ground		
9	A(I)	Analog current output	Shielded single conductor	Gray
10	AGND	Analog ground		

#### I/O terminal block

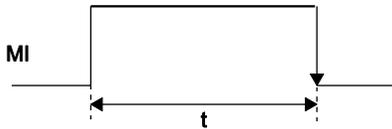
Pin No.	Signal name	Function	Lead wire color
1	OUT1	Judgment output 1	Black
2	OUT2	Judgment output 2	White
3	OUT3	Judgment output 3 or alarm output	Gray
4	TM	Timing input	Pink
5	MI	Multifunction input: Zero set, zero set OFF, reset, change memory, teach, save, and laser control <b>Note: The function of the MI signal is determined by the duration of the signal (see page 22).</b>	Violet
6	NP	NPN/PNP type switching input (default = NPN)	Pink/Violet
16	+V	24V DC input for power supply	Brown
17	0V	Power supply ground	Blue

**◆ NOTE**

- **The input NP acts as a toggle switch. When the input NP is OFF, the sensor head is in NPN mode. When the input NP is ON, the sensor head is in PNP mode. However, the input NP needs to be connected BEFORE you switch the sensor head ON, otherwise it will not work.**
- **The sensor head does not automatically save any of the setting changes you make over the MI input. To maintain the changes even after the next system start, input the MI signal for 480ms or use the control panel, a serial command, or the GT touch panel.**

## 3.2 MI Input

The function of the MI (= multi input) signal is determined by the duration of the signal. To select a function, input the MI signal for the corresponding time  $t$  as listed in the table.



Input the MI signal for the desired period with a tolerance of  $\pm 10\text{ms}$  ( $t \pm 10\text{ms}$ ). You can input two or more MI signals consecutively if you leave a minimum interval of 10ms between the individual signals.

t	Function
30ms	Zero set ON (see page 73)
80ms	Reset (see page 73)
130ms	Select memory M0 (see page 46)
180ms	Select memory M1
230ms	Select memory M2
280ms	Select memory M3
330ms	Teach displacement judgment threshold a
380ms	Teach displacement judgment threshold b
430ms	Zero set OFF (Cancel) (see page 55)
480ms	Save (see page 42)
530ms	Laser ON (see page 69)
580ms	Laser OFF (see page 69)



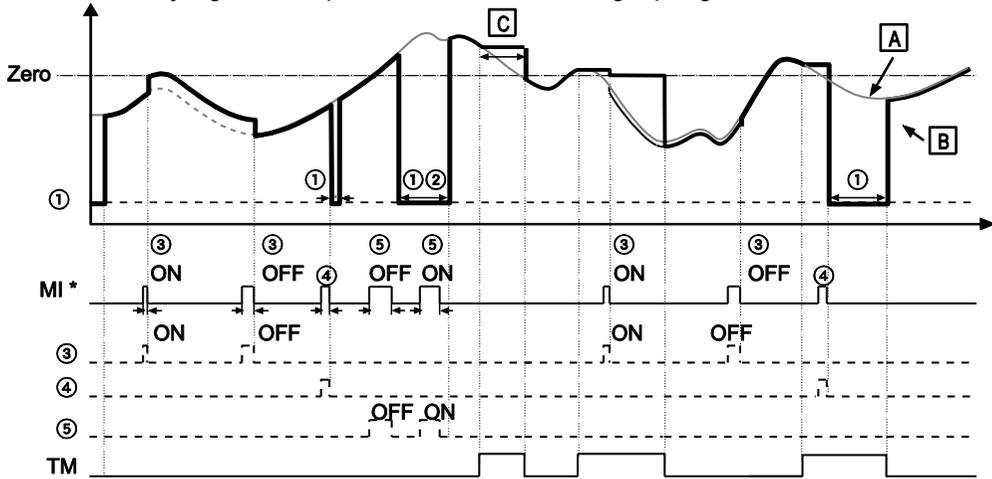
### ◆ NOTE

The sensor head does not automatically save any of the setting changes you make over the MI input. To maintain the changes even after the next system start, input the MI signal for 480ms or use the control panel, a serial command, or the GT touch panel.

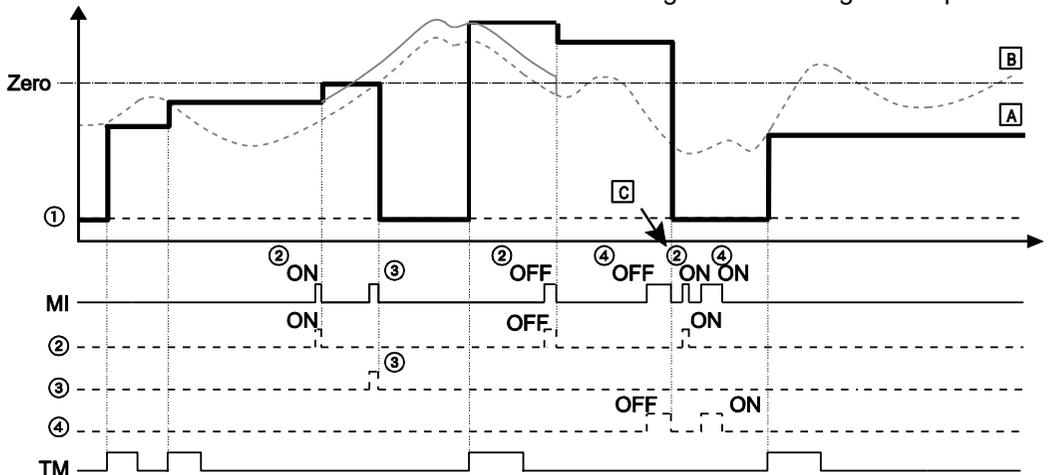
### 3.3 TM Input

The function of the TM (= timing) input is to control the measurement and judgment output. Depending on the timing mode you have selected (see page 68), inputting the TM signal works differently:

- When "Timing Mode" = "Hold": When the timing input is ON, the last measurement value and the judgment output is held until the timing input goes OFF.



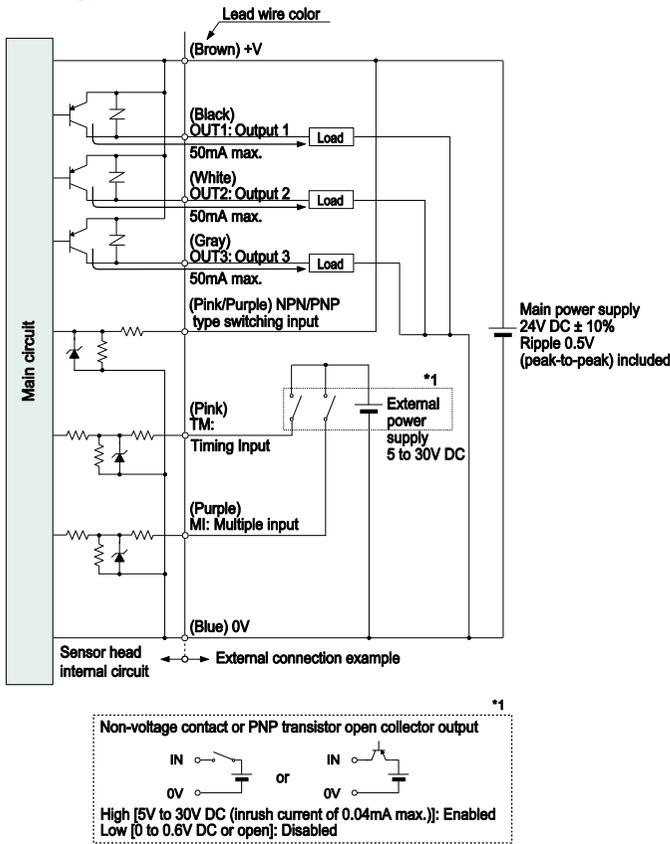
- When "Timing Mode" = "One Shot": rising edge at the timing input triggers one measurement. The measured value will be held until the timing or zero-set signal is input.



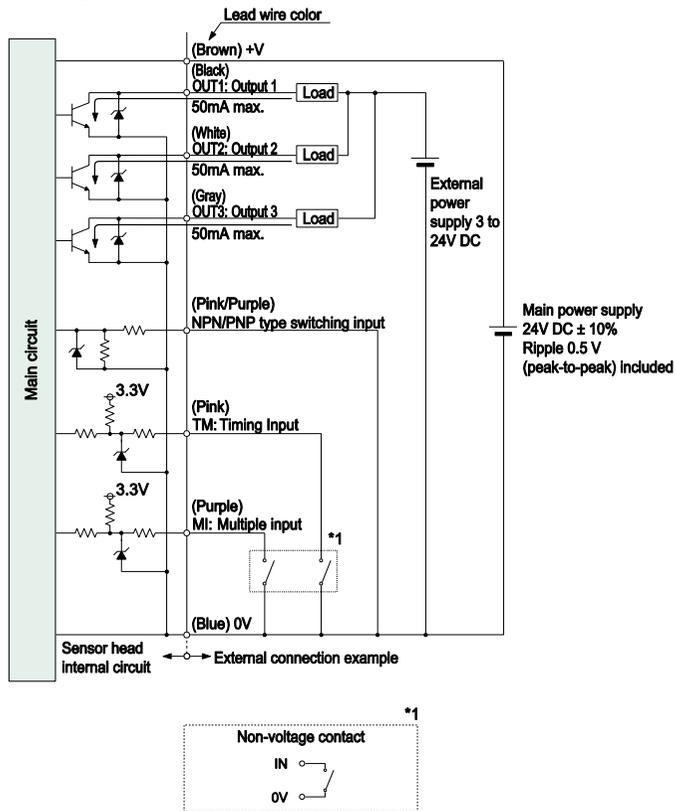
For more information on how the timing signal influences the system behavior, refer to the time diagrams (see page 29).

### 3.4 I/O Circuit Diagrams

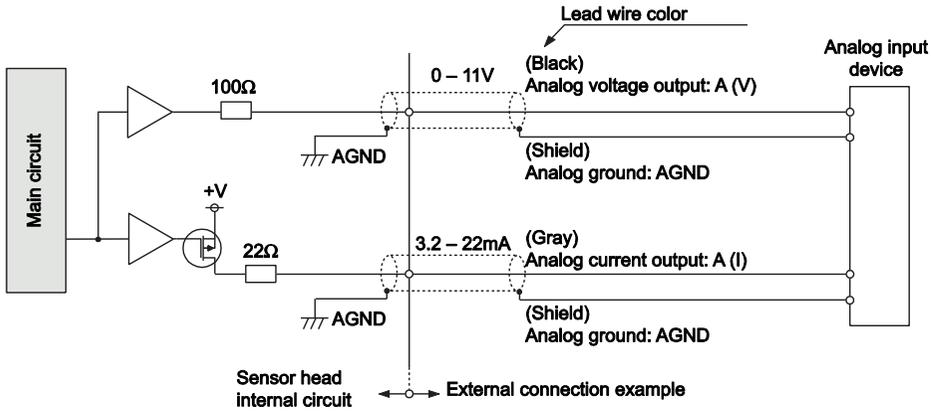
#### PNP type



**NPN type**



## 3.5 Analog Output Circuit



### ◆ NOTE

- Do not short-circuit the analog output terminals.
- Do not apply voltage to the analog output terminals.
- Use shielded wires for the analog output terminals.

## 3.6 When the Status of the Output Data Is Undefined

During the operation of the system it is possible that the status of the output data becomes undefined, i.e. there is no determined value to be output. This is not the same as the alarm status, when the alarm indicator lights up in orange.

The status of the output data becomes undefined under the following circumstances:

- After you have made or changed system settings when the measurement is being re-started.
- After the system has been turned on and has received a reset signal (MI signal ON for 80ms). The status of the output data will remain undefined after a reset until the sensor has performed the number of measurements needed for the average function (see page 50).
- After the laser has been stopped (MI signal ON for 580ms).
- After the sampling cycle has been switched (see page 47).
- After the system has been initialized.
- As long as the sensor has not performed the number of measurements needed for the average function.

When the output data is undefined, the system output is as follows:

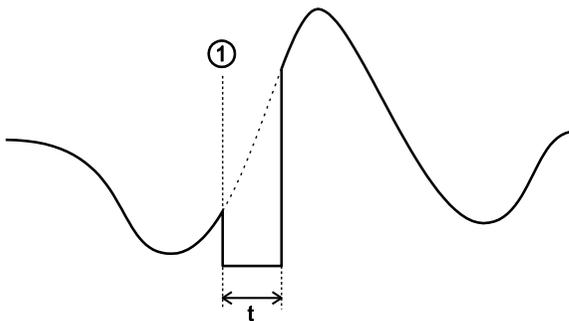
- Digital output: 
- Analog output: 11.000 [V] or 21.6 [mA] (see note 1)



### ◆ NOTE

1. **21.6mA is the initial value. The analog output can be set to a fixed value when the status of the output data is undefined (see page 64).**
2. **While the output data status is undefined, the system will ignore the zero-set signal.**
3. **Depending on the settings, the status of the output data may not become undefined even under the circumstances listed.**

This is an example of how the status of the output data becomes undefined after a reset signal while the system is starting to measure the distance again.



①

Reset signal (MI signal ON for 80ms)

<b>t</b>	Time during which the output data is undefined, i.e. time period during which the sensor measures the distance again.
----------	---

This system behaves differently when the output data is undefined and when the alarm is ON (the alarm indicator is lit up in orange). Refer to the table for details on the differences.

Item	Status: Output data is undefined	Status: Alarm = ON
Description of system status	The measurement data is undefined because the sensor has not performed the number of measurements needed for the average function (see page 50).	Measurement is disabled because the light intensity is poor or because the target object is outside the measuring range.
Digital output	-999.9999 [mm]	The previous value is kept on hold (default setting) or a fixed value (+99999) is displayed (see page 65).
Analog output	The previous value is kept on hold (default setting) or a fixed value (+99999) is displayed (see page 65).	
I/O output	OFF	OFF

### 3.7 Time Diagrams

Depending on the measurement type and setting of the parameter "Timing Mode" (see page 68), the timing of the sensor is different.

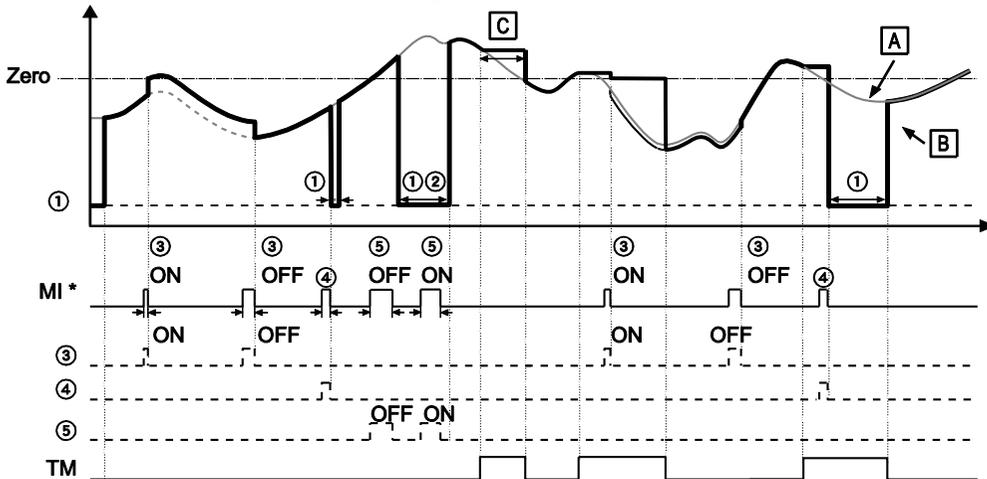


**◆ NOTE**

The function of the MI input is determined by the duration (t) of the signal.

t	Function
30ms	Zero set ON (see page 73)
80ms	Reset (see page 73)
130ms	Select memory M0 (see page 46)
180ms	Select memory M1
230ms	Select memory M2
280ms	Select memory M3
330ms	Teach displacement judgment threshold a
380ms	Teach displacement judgment threshold b
430ms	Zero set OFF (Cancel) (see page 55)
480ms	Save (see page 42)
530ms	Laser ON (see page 69)
580ms	Laser OFF (see page 69)

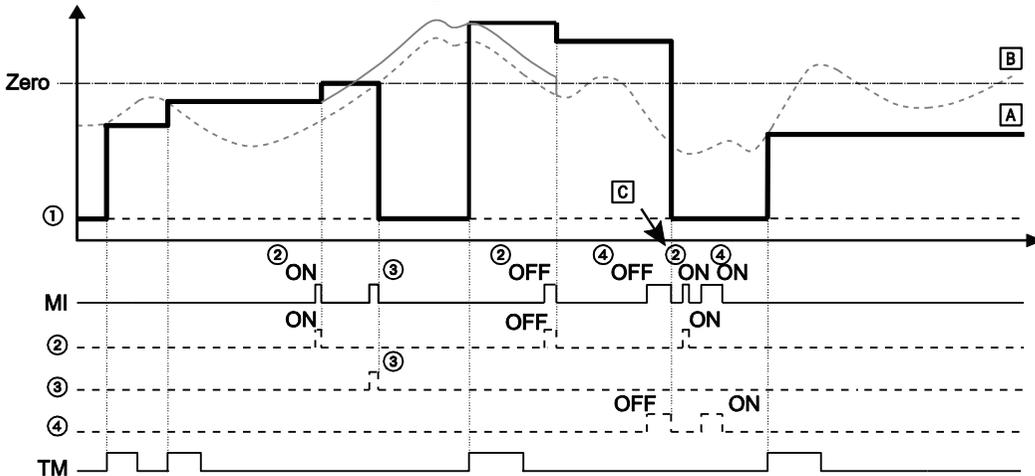
**Normal measurement with "Timing Mode" = "Hold"**



<b>A</b>	Sensor measurement
<b>B</b>	Sensor measurement and output
<b>C</b>	Data is kept on hold by TM signal
MI	Function of MI input depends on signal duration, see table at the top
①	Output data status is undefined
②	Laser has stopped

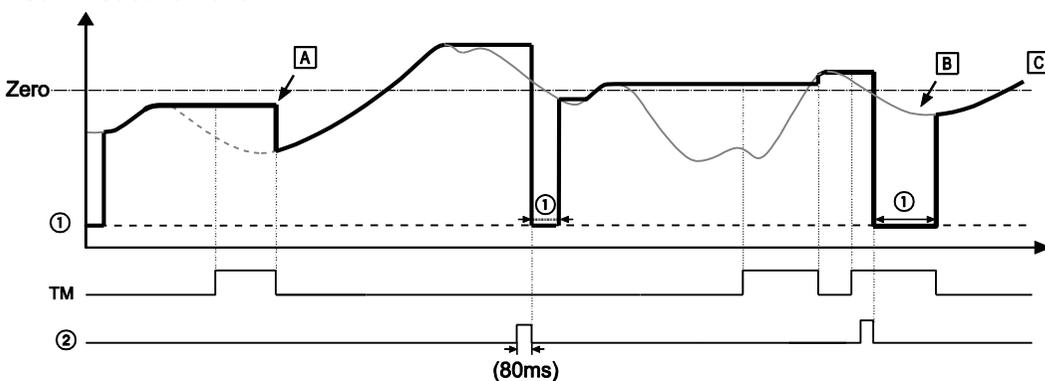
③	Zero-set function
④	Reset function
⑤	Laser operation

**Normal measurement with "Timing Mode" = "One-Shot"**



A	Sensor measurement
B	Sensor measurement and output
C	Zero-set signal is ignored because the output data status is undefined
MI	Function of MI input depends on signal duration, see table at the top
①	Output data status is undefined
②	Zero-set function
③	Reset function
④	Laser operation

**Peak measurement**



A	Reset of measurement and output data when TM turns OFF
B	Sensor measurement
C	Sensor measurement and output

①	Output data status is undefined
②	Reset function



---

**◆ Note**

---

1. When "Timing Mode" = "Hold", it is possible to use the set-to-zero function while the input TM is ON.
2. When "Timing Mode" = "Hold" and TM is ON, selecting the reset function with the input MI causes the output data status to become undefined and remain so until TM turns OFF.
3. While the output data status is undefined, the system will ignore the zero-set signal.
4. When the output data is undefined and TM is ON, the system holds the reset signal and the undefined data status until the input TM turns OFF.
5. The judgment output is determined by comparing the measured value with the threshold values set under "Displacement Judgment" (see page 57). The outputs will be turned OFF while the status of the output data is undefined.
6. If the status of the output data becomes undefined for a reason other than the reset signal being input, the digital display, the analog output and the judgment output will be the same.
7. When the output data status is undefined, the analog outputs revert to the initial setting.
8. When you have entered a value under "Offset", the value will be added when a zero set is executed (see page 54).
9. If you have set "Analysis Mode" to "PEAK to PEAK" and input the zero-set signal, the present measurement value will become zero. If you input the reset signal, the measurement value will start from a negative value (-).

### Signal processing when more than one signal is ON

The table gives an overview of the system behavior when two signals occur at the same time.

Signal = ON	Behavior when timing signal is input (TM switches ON)	Behavior when reset signal is input
Set-to-zero signal (ON/OFF)	Sensor sets digital display to zero and outputs the analog output selected for zero.	These signals cannot occur simultaneously as both are controlled by the MI input (see page 22).
Timing signal (TM)	—	The undefined status of the output data is kept on hold.
Reset signal (MI signal ON for 80ms)	The output data status becomes undefined and will remain undefined as long as TM is ON.	—

### Effect of the timing signal (TM)

Depending on which analysis (measurement) mode you have selected, the timing signal has a different effect.

Analysis mode	System behavior
Normal	When TM switches ON, the measurement value will be put on hold until TM switches OFF.
Peak / Valley	When TM switches ON, the measurement value will be put on hold until TM switches OFF. The peak / bottom value measured will be reset when TM switches OFF.
Peak to peak	When TM switches ON, the measurement value will be put on hold until TM switches OFF. The measurement values will be set to zero when TM switches OFF.

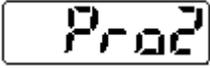
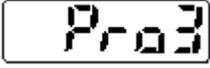
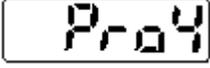
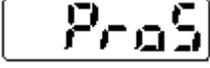
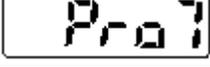
# Chapter 4

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# Functions

## 4.1 Classification of Functions

In this table, all functions are classified into eight categories.

Classification	Digital display	Function
Sensing functions		Function settings for controlling the received light intensity of the sensor.
Data processing functions		Function settings for processing measurement values.
Output functions		Function settings related to output data processing.
Analog functions		Function settings related to analog output processing.
Alarm functions		Function settings related to alarm output processing.
COM functions		Function settings related to communication, see note 1.
System functions		System functions for timing and eco mode, laser control, and version information.
Buffering functions	—	Function settings related to buffering, see note 2.



### ◆ NOTE

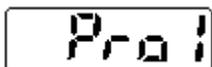
1. COM and buffering functions are only available to the multifunction type. These functions are not available for the standard type.

## 4.2 List of Functions and Default Settings

There are two types of settings:

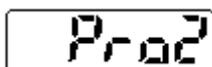
1. Settings that can be saved individually per memory (i.e. 4 different sets of settings). To change to a different set of settings, select another memory (see page 46).
2. Settings that can only be saved for all memories (one set of settings applies to all memories)

### Sensing functions



Function name	Description	Default setting	Type of setting
Memory selection (see page 46)	Selects the memory for editing settings. To perform measurements with the settings saved in the selected memory, you need to switch the sensor head OFF and ON again.	M0	One setting for all memories
Sampling cycle (see page 47)	Sets the sampling cycle for the measurement.	500 $\mu$ s	Individual setting per memory
Shutter time (see page 48)	Controls the receiving light intensity of the sensor.	Auto	Individual setting per memory
Light intensity monitor (see page 49)	Indicates the currently received light intensity.	---	Not applicable

### Data processing functions

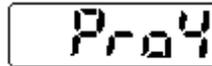


Function name	Description	Default setting	Type of setting
Average times (see page 50)	Sets the number of measurements needed for the average function.	1024	Individual setting per memory
Analysis mode (see page 52)	Sets the measuring mode.	Normal	
Span (see page 53)	Sets the multiplication factor for the measurement value.	1.0000	
Offset (see page 54)	Sets an offset value to be added to/subtracted from the measurement value.	00000mm	
Zero-set OFF (see page 55)	Works as a toggle switch for the zero-set function for measurement values.	OFF	



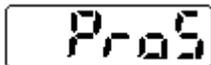
**Output functions**

Function name	Description	Default setting	Type of setting
Judgment output selection (see page 56)	Selects the output operation of OUT1 – OUT3.	2-state (OUT1 and OUT2)	Individual setting per memory
Displacement judgment (see page 57)	• Sets threshold a	+(detection range)	
	• Sets threshold b	-(detection range)	
	• Sets hysteresis	+(0.2% of setting range)	
Judgment output OFF delay (see page 59)	Delays the switching OFF of the judgment output.	OFF	
Measurement value display on panel (see page 60)	Sets the number of rightmost digits to be turned OFF on the digital display.	SET 1	



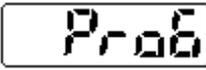
**Analog functions**

Function name	Description	Default setting	Type of setting
Analog output selection (see page 61)	Selects the output type for the analog output: current or voltage.	Output current	Individual setting per memory
Analog scaling (see page 63)	Scales measurement value A.	Negative measuring range	
	Scales current A.	+4.000mA	
	Scales voltage a.	0.000V	
	Scales measurement B.	Positive measuring range	
	Scales current B.	+20.000mA	
Scales voltage b.	10.000V		

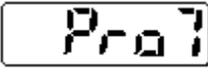


**Alarm functions**

Function name	Description	Default setting	Type of setting
Analog output at alarm (see page 64)	Sets the analog output behavior for when an alarm occurs.	Hold previous value	Individual setting per memory
Digital output at alarm (see page 65)	Sets the digital output behavior for when an alarm occurs.	Hold previous value	
Alarm delay (see page 66)	Sets the number of measurement attempts to be made before an alarm is output.	8 times	

**COM functions** 

These functions are only available for the multifunction type of the sensor.

**System functions** 

Function name	Description	Default setting	Type of setting
Timing mode (see page 68)	Determines how the sensor head works when the timing input is ON.	Hold	One setting for all memories
Laser control (see page 69)	Switches the laser emission ON and OFF.	Emission ON	
Eco mode (see page 70)	Turns OFF the LED indicators on the control panel to save energy while the system is in RUN mode.	Eco OFF	
View version (see page 70)	Displays the version of the firmware.	---	

**Buffering functions**

These functions are only available for the multifunction type of the sensor.

### Other functions

Function name	Description	Default setting	Controlled by
Initialize (see page 41)	Initializes the memory settings currently in use.	---	Keys on control panel
Save (see page 42)	Saves all settings stored in the memories 0 to 3.	---	MI input
Timing (see page 23)	Holds the measurement value.	OFF	TM input
Zero set (see page 73)	Sets the measurement value to zero.	---	MI input
Reset (see page 73)	Resets the measurement value.	OFF	MI input



#### ◆ NOTE

- **COM and buffering functions are only available to the multifunction type. These functions are not available for the standard type.**
- **Each function setting is saved in either one of the following ways:**
  - Via the control panel of the sensor head: Press the [ENTER] key to save the new function setting when you have changed it.
  - Via a serial command (multifunction type only)

## 4.3 Control Panel and Digital Display

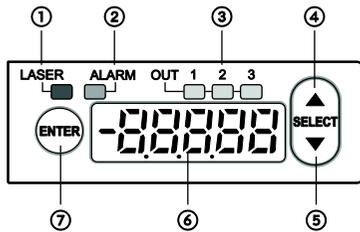
The measurement functions of the sensor are controlled via the control panel. The currently selected function or setting is shown in the digital display.



**◆ NOTE**

**In order to ensure the performance of the system, allow a warm-up time of at least 30 minutes after the system is turned ON.**

The control panel of the sensor head looks as shown below.



①	<b>Laser indicator (LASER)</b> Lights up in green during laser emission.
②	<b>Alarm indicator (ALARM)</b> Lights up in orange if an alarm occurs during measurement.
③	<b>OUT1/OUT2/OUT3 indicator</b> Lights up in yellow during output
④	<b>[UP] key</b> Used to select items or change numerical values.
⑤	<b>[DOWN] key</b> Used to select items or change numerical values.
⑥	<b>Digital display</b> Displays measurement values and system errors.
⑦	<b>[ENTER] key</b> Used to access the functions and to confirm input.

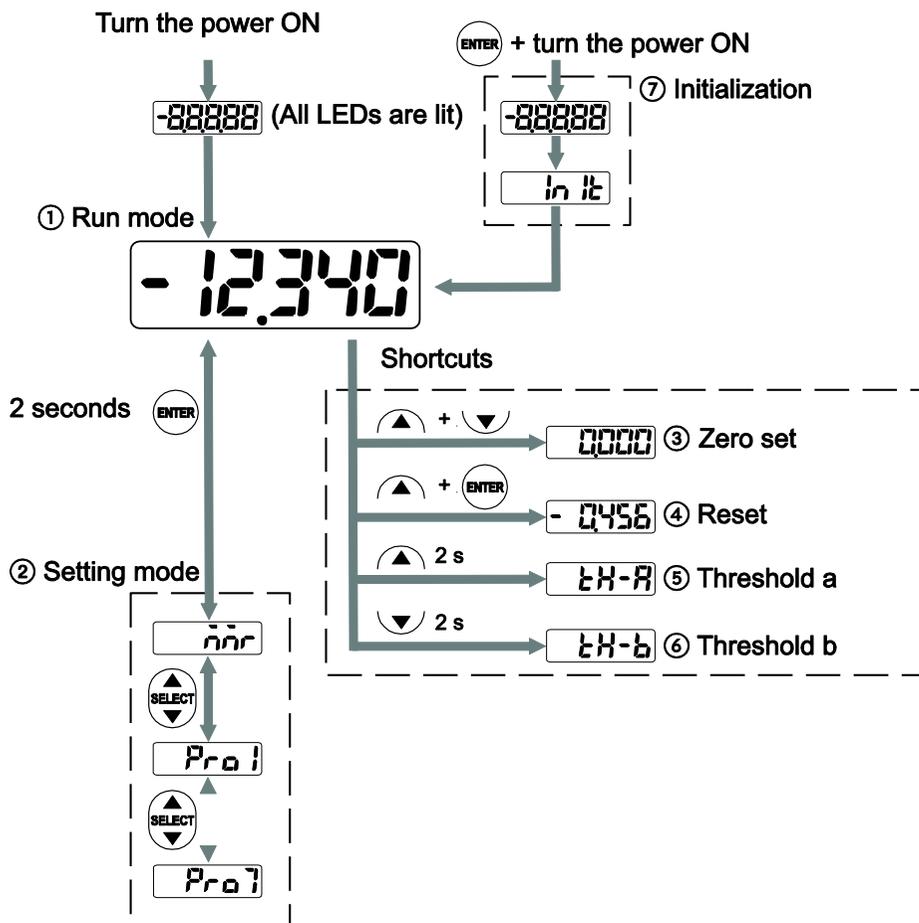
The digital display has the following properties and functions:

Item	Description	Sensor type	Digital display
Decimal point	The position of the decimal point varies with each model.	• 30mm type	
		• 50/80/120mm type	
Undefined status of output data	The status of the output data may become undefined under certain conditions (see page 27).	All types	

Item	Description	Sensor type	Digital display
Alarm status	The function "Digital Output at Alarm" (see page 65) can be set to a fixed value.	• 30mm type	
		• 50/80/120mm type	

### 4.3.1 Basic Operation

The following section explains how to operate the sensor after you switch it ON.



①	<b>Run mode</b> Standard mode after switching ON the sensor. The current measurement value appears in the digital display.
②	<b>Setting mode</b> Use this mode to change the function settings.



- While the initialization is executed, the output data status may become undefined temporarily.



◆ PROCEDURE

1.  + switch power ON

After the start-up screen, the digital display shows "Init".

The memory is initialized and the system is set to RUN mode



4.3.1.2 Save

There are different methods to save setting changes permanently so that after a system restart the new settings are applied:

- In the control panel of the sensor head: Access the option to be changed via the function menu and confirm the change with .
- With the MI input: Input the MI signal for 480ms to save the current settings (see page 22).

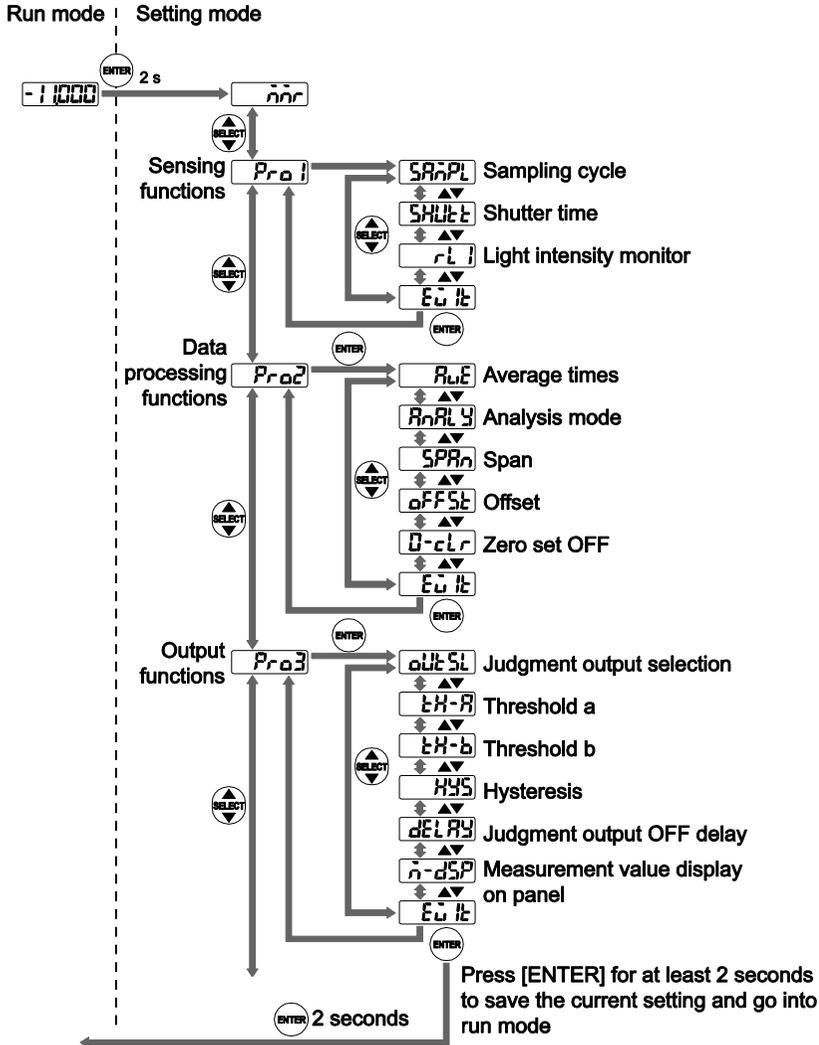


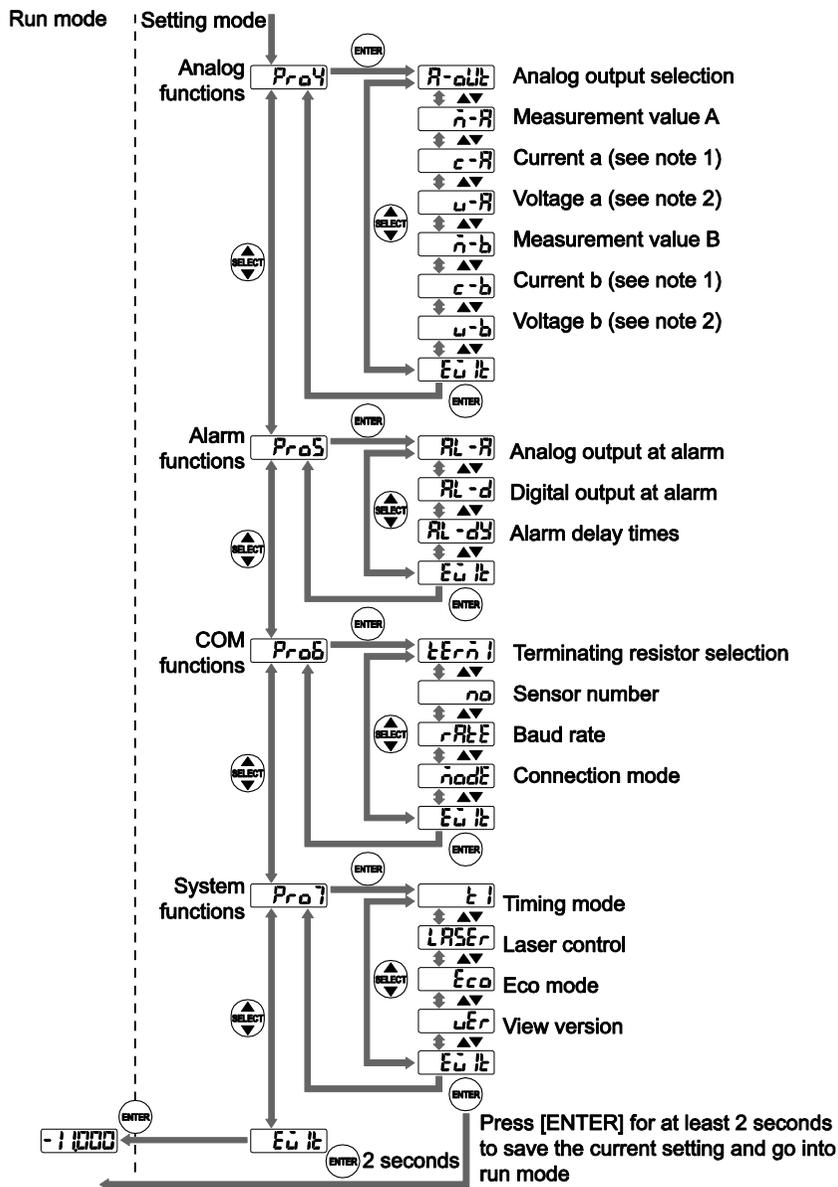
◆ NOTE

- It is not possible to save the state of the timing input (TM). The timing input will be OFF right after the system is switched ON or when you select a different memory.

4.3.2 Function Menu in Setting Mode

Access the functions by pressing the [ENTER] key on the control panel (see page 39) for 2 seconds. The currently selected function or setting is shown in the digital display.





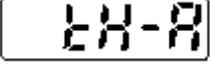
◆ NOTE

1. Available, when "Analog Output Selection" is set to "Voltage"
2. Available when "Analog Output Selection" is set to "Current"

### 4.3.3 Shortcuts

Some sensor functions can be accessed quickly with the help of a shortcut. This way, you do not have to navigate through the complete function menu to make settings.

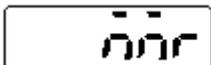
The following shortcuts are available:

Shortcut keys	Function name	Description	Digital display
 + 	Zero set (see page 73)	Sets the measurement value in the digital display as zero.	
 + 	Reset (see page 73)	Resets the measurement value kept on hold by the sensor.	
 2s	Threshold a (see page 57)	Sets an upper limit for judging the measurement value.	
 2s	Threshold b (see page 57)	Sets a lower limit for judging the measurement value.	

## 4.4 Function Settings

The following sections provide detailed information on how to set and use the functions.

### 4.4.1 Memory Selection



Selects the memory for editing settings. To perform measurements with the settings saved in the selected memory, you need to switch the sensor head OFF and ON again.

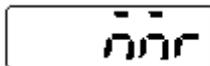
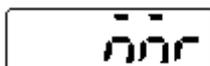
The sensor has 4 memories, M0 to M3, that act as user profiles for saving different sets of measurement settings individually. The bold table entry indicates the default setting.

Setting	Function	Digital display
<b>M0</b>	<b>Memory M0</b>	
M1	Memory M1	
M2	Memory M2	
M3	Memory M3	



#### PROCEDURE

1. 2s
- 2.
3. 3x
4. to confirm



#### NOTE

- When you switch the sensor head ON, it will load the settings from the memory that has been used last.
- Before you change parameter settings, make sure you have selected the right memory.

- After you have changed the settings for a memory, you need to switch the sensor head OFF and then ON again to work with the memory and its changed settings.
- Selecting a different memory may result in a status when the output data is undefined (see page 27).
- If setting changes are made with a serial communications command, save the changes so that the changes will be reflected when the system is turned ON again. To save the changes, use the panel, a serial command, or the GT touch panel.
- You can use the MI input to select a different memory (see page 22).

### 4.4.2 Sensing Functions



This function menu contains settings for controlling the received light intensity of the sensor.

#### 4.4.2.1 Sampling Cycle



Sets the sampling cycle for the measurement.



◆ **NOTE**

When measuring an object with poor reflective properties such as black rubber, make the sampling cycle longer to receive sufficient light for a stable measurement.

The bold table entry indicates the default setting.

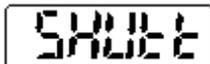
Cycle	Frequency	Digital display	Object properties
200μs	5kHz		bright objects
<b>500μs</b>	2kHz		
1ms	1kHz		
2ms	500Hz		



◆ PROCEDURE

- 1. 2s
- 2.
- 3.
- 4.
- 5.
- 6. to confirm

4.4.2.2 Shutter Time



Controls the receiving light intensity of the sensor.

Depending on the properties of the object to be measured, the amount of reflected light differs. If the shutter time is set to "Auto", the light intensity feedback function automatically modifies the light intensity to an optimum level. If you want to use a fixed shutter time, check the light received by the sensor with the light intensity monitor (see page 49). The light intensity is good when the light intensity monitor displays a value from approximately 1000 to 1300.

Setting	Function	Default setting
Auto	Automatically set shutter time	
1 to 31	Fixed to a percentage of the sampling cycle (see page 47) you have selected, see the table below.	

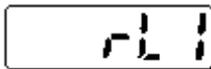
Setting	Shutter aperture						
Auto	Automatic	8	0.24%	16	1.95%	24	15.9%
1	0.04%	9	0.31%	17	2.54%	25	20.7%
2	0.05%	10	0.40%	18	3.30%	26	26.9%
3	0.06%	11	0.53%	19	4.29%	27	35.0%
4	0.08%	12	0.68%	20	5.58%	28	45.5%
5	0.11%	13	0.89%	21	7.25%	29	59.2%
6	0.14%	14	1.16%	22	9.43%	30	76.9%
7	0.18%	15	1.50%	23	12.3%	31	100%



◆ PROCEDURE

- |    |  |            |  |
|----|--|------------|--|
| 1. |  | 2s         |  |
| 2. |  |            |  |
| 3. |  |            |  |
| 4. |  |            |  |
| 5. |  |            |  |
| 6. |  |            |  |
| 7. |  | to confirm |  |

4.4.2.3 Light Intensity Monitor



Indicates the currently received light intensity.

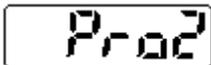
The peak light intensity will be displayed in a range of 0 to 4095. The light intensity is good when the light intensity monitor displays a value from approximately 1000 to 1300.



◆ PROCEDURE

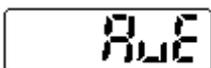
- |    |  |  |  |
|----|--|--|--|
| 1. |  | 2s                                     |  |
| 2. |  |  |  |
| 3. |  |  |  |
| 4. |  | x2                                     |  |
| 5. |  | to display the current light intensity |  |

### 4.4.3 Data Processing Functions



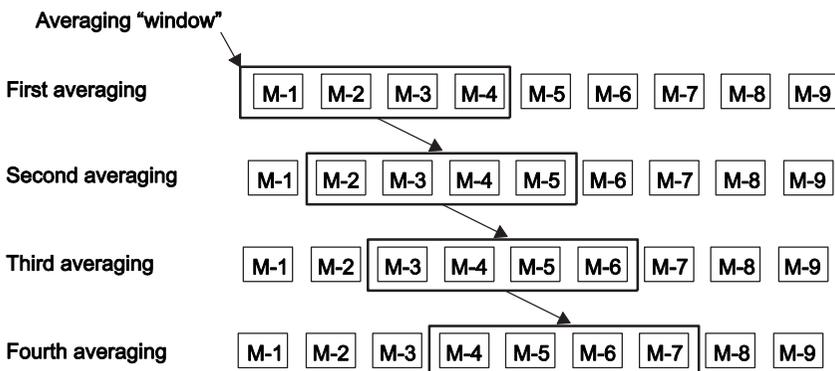
This function menu contains settings for processing measurement values.

#### 4.4.3.1 Average Function



Sets the number of measurements needed for the average function. Use the function to stabilize unstable measurement values and to eliminate variations.

This function works as a moving average function with FIFO. For example, if you have selected the setting "4", it means that the sensor takes 4 measurements (M-1 to M-4), calculates the average and outputs the average. Next, M-1 is discarded, and the sensor moves the averaging "window" by discarding M-1 and adding M-5 so that averaging takes place with M-2 to M-5, see figure below.



The bold table entry indicates the default setting.

Setting	Function	Digital display
1 value	Moving average calculated from 1 value. This means every measurement value will be output.	1
4 values	Moving average calculated from 4 values.	4
16 values	Moving average calculated from 16 values.	16
64 values	Moving average calculated from 64 values.	64
256 values	Moving average calculated from 256 values.	256
<b>1024 values</b>	<b>Moving average calculated from 1024 values.</b>	<b>1024</b>

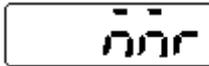
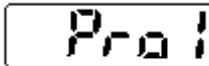
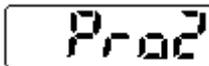
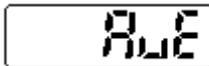
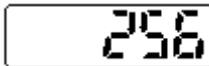


◆ **NOTE**

- Until the moving-average buffer reaches the number of values set here, the output data status is undefined (see page 27).
- An alarm will prevent the sensor from storing measurement values in the moving-average buffer. That means, if an alarm occurs and the moving-average buffer is empty, the alarm has to be turned OFF before the moving-average buffer starts to buffer measurement values. If an alarm occurs when the moving-average buffer already contains some, but not all measurement values needed to calculate the average, the alarm has to be turned OFF before the moving-average buffer will continue to buffer measurement values.



◆ **PROCEDURE**

- |   |  |
|---|--|
| 1.  2s           |    |
| 2.               |    |
| 3.               |    |
| 4.               |   |
| 5.              |  |
| 6.             |  |
| 7.  to confirm |  |

### 4.4.3.2 Analysis Mode (Measuring Mode)



Sets the measuring mode.

There are 4 measuring modes available. The bold table entry indicates the default setting.

Setting	Sample measurement	Function	Digital display
<b>NORMAL</b>		The measurement value is output in real time.	
PEAK		Holds and outputs the maximum measurement value.	
VALLEY		Holds and outputs the minimum measurement value.	
PEAK to PEAK (P-P)		Holds and outputs the difference between the maximum and minimum values (see note).	



#### ◆ NOTE

Use the measuring mode "Peak to peak" for vibration or eccentricity measurement.



#### ◆ PROCEDURE

1. 2s
- 2.
- 3.
- 4.
- 5.
6. 3x

7.  to confirm



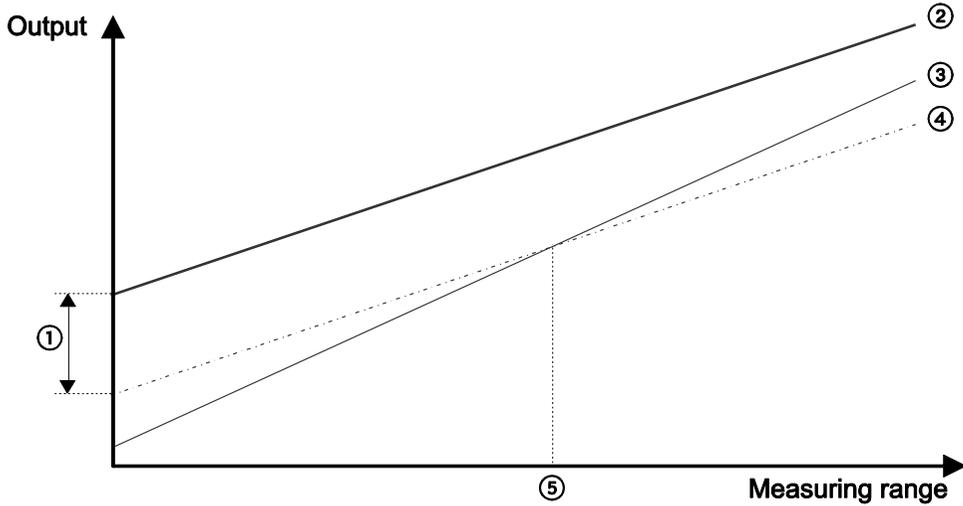
**4.4.3.3 Span**



Sets the multiplication factor for the measurement value.

The formula for calculating the value to output is:

$$\text{final measurement value} = \text{span} \times \text{measurement value} + \text{offset}$$



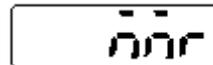
①	Offset value
②	Final measurement value
③	Measured value
④	Spanned measured value
⑤	Center point of measurement

Setting range	Function	Default setting
0.1000 to +9.9999	Set a factor in the range from 0.1000 to +9.9999.	

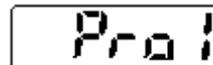


**◆ PROCEDURE**

1.  2s



2. 



3.  
4.  
5.  3x 
6.  to display the current scaling factor  
 The leftmost digit is selected. Press  and  together to select the next digit.   

7.  to change the selected digit 
8.  to confirm 

#### 4.4.3.4 Offset



Sets an offset value to be added to/subtracted from the measurement value.

Setting range	Function	Default setting
-95000 to +95000	Set an offset in a range from 95000 to +95000. (The position of the decimal point varies with each model.)	



#### ◆ NOTE

- To use the size of a master workpiece as an offset, measure it with the sensor and then input the set-to-zero signal.
- Set "Offset" and turn "Zero Set" ON to make the setting value an offset value.
- The display limit of the measurement value is ± 95000. Make sure that the setting value does not exceed the display limit.



◆ PROCEDURE

- |   |  |
|---|--|
| 1.  2s  |  |
| 2.  |  |
| 3.  |  |
| 4.  |  |
| 5.  3x  |  |
| 6.  |  |
| <p>The leftmost digit is selected. Press  and  together to select the next digit.</p> |  |
| 7.  to change the selected digit  |  |
| 8.  to confirm  |  |
|   |  |

4.4.3.5 Zero-set OFF

Works as a toggle switch for the zero-set function for measurement values.

Setting	Function	Digital display
Zero set is ON	The reset signal will set the display to 00000.	
Zero set is OFF	The displays shows the current measurement value.	



◆ NOTE

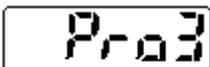
You can use the MI signal (see page 22) to turn this function ON and OFF.



◆ PROCEDURE

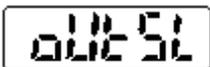
1.	2s	
2.		
3.		
4.		
5.	4x	
6.		
7.	or	
8.	to confirm	

4.4.4 Output Functions



This function menu contains settings related to output data processing.

4.4.4.1 Judgment Output Selection



Selects the output operation of OUT1 – OUT3.



◆ NOTE

- OUT3 usually serves as the alarm output. If you select the setting "3-state", alarms will not be output, as OUT3 will be used for the third judgment result. In this case, check the alarm state with the alarm indicator and alarm readout function.
- When an alarm has occurred, the sensor displays +999.9999 (only if you have set "Digital Output at Alarm" to "Fixed Value"). Whether the alarm will be output via OUT3 or not, depends on the setting of this function.

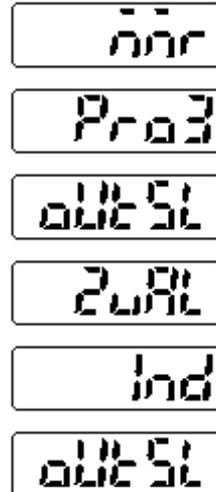
The bold table entry indicates the default setting.

Setting	OUT1	OUT2	OUT3	Threshold a		Threshold b	Display
				ON	OFF		
<b>Logic</b> 	Judgment 1	Judgment 2	Alarm	OUT1	ON OFF	Output status	
				OUT2	ON OFF	Output status	
Independent 	Judgment 1	Judgment 2	Alarm	OUT1	ON OFF	Output status	
				OUT2	ON OFF	Output status	
<b>2-state</b> 	Judgment 1	Judgment 2	Alarm	OUT1	ON OFF	Output status	
				OUT2	ON OFF	Output status	
<b>3-state</b> 	Judgment 1	Judgment 2	Judgment 3	OUT1 (HI)	ON OFF	Output status	
				OUT2 (GO)	ON OFF	Output status	
				OUT3 (LO)	ON OFF	Output status	



◆ PROCEDURE

1. 2s
2. 3x
- 3.
- 4.
5. or
6. to confirm



4.4.4.2 Displacement Judgment

Sets an upper limit (threshold a), a lower limit (threshold b), and the hysteresis for the judgment of measurement values.

Item	Digital display	Setting range
Threshold a		-95000 to +95000
Threshold b		-95000 to +95000
Hysteresis		0 to +95000

The following default values apply:

Measurement center distance	Threshold a	Threshold b	Hysteresis
30mm	+4mm	-4mm	8µm
50mm	+10mm	-10mm	20µm
85mm	+20mm	-20mm	40µm
120mm	+60mm	-60mm	120µm



◆ PROCEDURE

1. 2s
  2. 3x
  - 3.
  - 4.
  5. to display the current threshold
- The leftmost digit is selected. Press and together to select the next digit.
6. to change the selected digit
  7. to confirm
- 



◆ NOTE

- Threshold a needs to be larger than threshold b. However, if the user enters the values the wrong way round, the sensor will automatically use the lower value as threshold b.

- The position of the decimal point varies with each model.

### 4.4.4.3 Judgment Output OFF Delay



Delays the switching OFF of the judgment output.

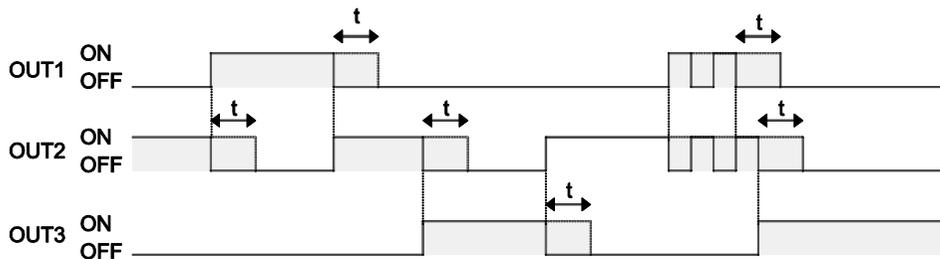


#### ◆ NOTE

This function is useful when the judgment output needs to be transmitted to a control device, but changes too quickly.

The bold table entry indicates the default setting.

Setting	Function	Digital display
<b>OFF</b>	<b>Output according to the sampling cycle</b>	
2ms	Delays switching OFF the judgment output by 2ms.	
4ms	Delays switching OFF the judgment output by 4ms.	
10ms	Delays switching OFF the judgment output by 10ms.	
20ms	Delays switching OFF the judgment output by 20ms.	
40ms	Delays switching OFF the judgment output by 40ms.	
100ms	Delays switching OFF the judgment output by 100ms.	
Hold	Once the output has been switched ON, it will be kept on hold. To release an output kept on hold, you need to input the reset signal.	



The solid lines shows when the turn-OFF signal is input. The dotted lines show how the time t set with this function delays the switching OFF of the judgment output.



◆ NOTE

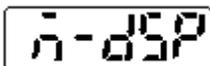
- If an output has not turned OFF yet because the delay time has not elapsed, and the output receives the next ON signal, the delay will be canceled even though it has not been completed. The output stays ON until the delay time after the next OFF signal has elapsed.
- If "Judgment Output Selection" is set to "Logic", "Independent", or "2-state", OUT3 serves as the alarm output and will switch OFF without delay, regardless of the settings made here.



◆ PROCEDURE

1.  2s	
2.  3x	
3.	
4.  3x	
5.	
6.  to change the selected digit	
7.  to confirm	

4.4.4.4 Measurement Value Display on Panel



This function sets the number of rightmost digits to be turned OFF on the digital display.

The bold table entry indicates the default setting.

Setting	Function	Digital display	Example
FULL	All digits are displayed.		
Set 1	The rightmost digit is OFF.		

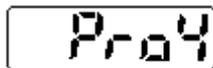
Setting	Function	Digital display	Example
Set 2	The two rightmost digits are OFF.		



◆ PROCEDURE

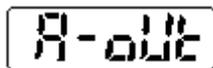
1. 2s
  2. 3x
  - 3.
  4. 5x
  - 5.
  6. or to change the setting
  7. to confirm
- 

4.4.5 Analog Functions



This function menu contains settings related to analog output processing.

4.4.5.1 Analog Output Selection



Selects the output type for the analog output: current or voltage

The selected analog output will be accurate. The bold table entry indicates the default setting.

Setting	Function	Digital display
<b>Current</b>	Output current	
Voltage	Output voltage	



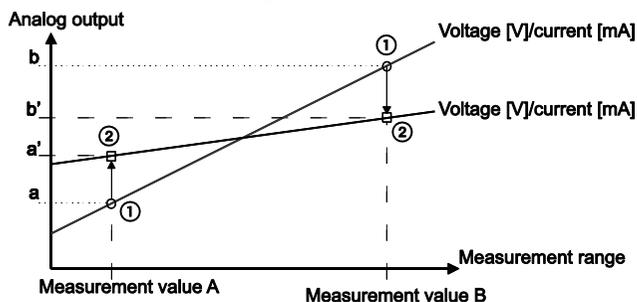
◆ PROCEDURE

- |  |  |
|--|--|
| <p>1.  2s</p> <p>2. </p> <p>3. </p> <p>4. </p> <p>5.  or  to change the setting</p> <p>6.  to confirm</p> | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 5px auto;">ããr</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 5px auto;">Pr04</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 5px auto;">A-0.0t</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 5px auto;">1-0.0t</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 5px auto;">4-0.0t</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 5px auto;">A-0.0t</div> |
|--|--|

### 4.4.5.2 Analog Scaling

This function scales the current or voltage to any value.

Any two measurement values can be used for A and B. Set which current or voltage to output for measurement value A and B. The analog output for measurement values between A and B will be interpolated, see figure below.



Item	Digital display	Setting range	Default setting
Measurement value A		-95000 to 95000	Negative measuring range, see table below
Measurement value B		-95000 to 95000	Positive measuring range, see table below
Current a (note 1)		+4.000 to 20.000	
Current b (note 1)		+4.000 to 20.000	
Voltage a (note 2)		0 to +10.000	
Voltage b (note 2)		0 to +10.000	



#### ◆ NOTE

1. Not displayed when "Analog Output Selection" is set to "Voltage".
2. Not displayed when "Analog Output Selection" is set to "Current".

The following default measurement values A and B apply.

Measurement center distance	Measurement value A	Measurement value B
30mm	-4mm	+4mm
50mm	-10mm	+10mm
85mm	-20mm	+20mm
120mm	-60mm	+60mm



◆ **NOTE**

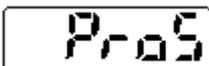
- The display limit of the measurement value is  $\pm 95000$ . Make sure that the setting value does not exceed the display limit.
- Before you make a setting, check the input range of your input device, e.g. an AD board.
- The position of the decimal point varies with each model.



◆ **PROCEDURE**

- |    |  |                              |  |
|----|--|------------------------------|--|
| 1. |  | 2s                           | n̄n̄r  |
| 2. |  |                              | Pr04   |
| 3. |  |                              | R-0Ut  |
| 4. |  | 2x                           | c-R  |
| 5. |  |                              | 04000  |
|    |  |                              | The leftmost digit is selected. Press  and  together to select the next digit. |
| 6. |  | to change the selected digit | 4000   |
| 7. |  | to confirm                   | 5000   |
|    |  |                              | c-R  |

**4.4.6 Alarm Functions**



This function menu contains settings related to alarm output processing.

**4.4.6.1 Analog Output at Alarm**



Sets the analog output behavior for when an alarm occurs.

When an alarm has occurred, for example when the sensor cannot measure the distance because it is too dark, the analog output can be kept on hold or set to a fixed value. The bold table entry indicates the default setting.

Setting	Function	Digital display
Hold	Holds the analog output immediately before the alarm.	
Fixed value	The analog output depends on the setting for the analog output (see page 61). <ul style="list-style-type: none"> <li>• 21.6mA for current output</li> <li>• +11.000V for voltage output</li> </ul>	



◆ PROCEDURE

1. 2s
2. 5x
- 3.
- 4.
5. or to change the setting
6. to confirm

4.4.6.2 Digital Output at Alarm



Sets the digital output behavior for when an alarm occurs.

When an alarm has occurred, for example when the sensor cannot measure the distance because it is too dark, the digital output can be kept on hold or set to a fixed value. The bold table entry indicates the default setting.

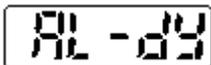
Setting	Function	Digital display
<b>Hold</b>	Holds the digital output immediately before the alarm.	
Fixed Value	Outputs a fixed value: <ul style="list-style-type: none"> <li>• 9.9999 (30mm type)</li> <li>• 99.999 (50/80/120mm type)</li> </ul>	



**◆ PROCEDURE**

- |                               |  |
|-------------------------------|--|
| 1.  2s                        |  |
| 2.  5x                        |  |
| 3.                            |  |
| 4.                            |  |
| 5.                            |  |
| 6.  or  to change the setting |  |
| 7.  to confirm                |  |

**4.4.6.3 Alarm Delay**



Sets the number of measurement attempts to be made before an alarm is output.

When an alarm occurs, for example because measurement was not possible due to lack of light, it will not be output immediately. Instead, the sensor holds and displays the last normal measurement value until the number of times set here has been reached. When the number of times set here has been exceeded, the alarm output (OUT3) will be turned ON. The analog and the digital output will be turned ON according to the setting for analog output at alarm and the setting for digital output at alarm, respectively.



**◆ NOTE**

**This function is useful if you do not require an alarm output as soon as the surface of measured objects changes.**

Setting range	Function	Initial value
0 to 65534	0 (OFF) to 65534 times	
65535	Holds the last measurement value before the alarm occurred.	



◆ PROCEDURE

1.  2s



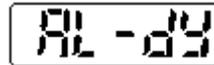
2.  5x



3. 



4.  2x



5. 



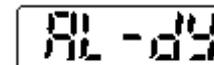
The leftmost digit is selected. Press  and  together to select the next digit.



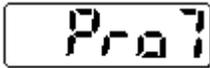
6.  to change the selected digit



7.  to confirm



### 4.4.7 System Functions



This function menu contains system functions for timing and eco mode, laser control, and version information.

#### 4.4.7.1 Timing Mode



Determines how the sensor head works when the timing input is ON.

For information on how the timing signal influences the system behavior, refer to the time diagrams (see page 29). The bold table entry indicates the default setting.

Setting	Function	Digital display
<b>Hold</b>	<b>When the timing input is ON, the last measurement value is held until the timing input goes OFF.</b>	
One Shot	A rising edge at the timing input triggers one measurement. The measured value will be held until the timing or zero-set signal is input.	



#### ◆ PROCEDURE

1. 2s
2. 7x
- 3.
- 4.
5. or to change the setting
6. to confirm

### 4.4.7.2 Laser Control



Switches the laser emission ON and OFF.

Use this function to stop laser emission when the system is not needed for measuring. The bold table entry indicates the default setting.

Setting	Function	Digital display
Emission	Laser emission is ON.	
Stop	Laser emission is OFF.	



#### ◆ NOTE

Note that the status of the output data becomes undefined (see page 27) when you switch the laser emission from OFF to ON.



#### ◆ PROCEDURE

1. 2s
2. 7x
- 3.
- 4.
- 5.
6. or to change the setting
7. to confirm

**4.4.7.3 Eco Mode**



Turns OFF the LED indicators on the control panel to save energy while the system is in RUN mode.

The bold table entry indicates the default setting.

Setting	Function	Digital display
<b>Eco-OFF</b>	<b>No Eco mode has been activated.</b>	<b>E-off</b>
Eco-ON	Only the LEDs forming the digital display will be turned OFF.	E-on
Eco-FULL	All the LEDs will be turned OFF.	E-FUL



**NOTE**

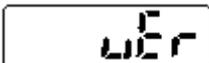
- The LEDs are always lit when the system is in setting mode.
- When the system is set to "Eco-ON" and the LEDs are turned off, the display will come to life again when you press a button. The LEDs will be turned OFF again if no buttons are pressed for 20 seconds.



**PROCEDURE**

1. 2s
2. 7x
- 3.
4. 2x
- 5.
6. or to change the setting
7. to confirm

**4.4.7.4 View Version**



Displays the version of the firmware.



◆ Procedure

- |    |   |  |
|----|---|--|
| 1. |  2s                                      |  |
| 2. |  7x                                      |  |
| 3. |    |  |
| 4. |  3x                                      |  |
| 5. |  to display the current firmware version |  |

### 4.4.8 Functions Controlled by the MI Input

---

Some of the function settings available via the control panel can also be changed with the MI input.

<b>t</b>	<b>Function</b>
30ms	Zero set ON (see page 73)
80ms	Reset (see page 73)
130ms	Select memory M0 (see page 46)
180ms	Select memory M1
230ms	Select memory M2
280ms	Select memory M3
330ms	Teach displacement judgment threshold a
380ms	Teach displacement judgment threshold b
430ms	Zero set OFF (Cancel) (see page 55)
480ms	Save (see page 42)
530ms	Laser ON (see page 69)
580ms	Laser OFF (see page 69)

### 4.4.8.1 Zero Set

---

By inputting the MI signal for 30ms you set the current measurement value and the digital display to zero.



There are two other ways to perform a zero set:

- In run mode, press  and  together
- Send the serial command RZS

For information on how the zero-set signal influences the system behavior, refer to the time diagrams (see page 29).

### 4.4.8.2 Reset

---

By inputting the MI signal for 80ms you reset all measurement values and turn the judgment outputs off.



#### ◆ NOTE

---

- **When the reset signal is input, the output data status becomes undefined (see page 27). The analog output will either be the initial value of 11.000 [V] or 21.6 [mA] or a predefined fixed value, depending on the setting of "Analog Output Selection" (see page 61).**
- **When you perform the reset by sending the serial command RRS, the memory will be cleared.**

There are two other ways to perform a reset:

- In run mode, press  and  together
- Send the serial command RRS

For information on how the reset signal influences the system behavior, refer to the time diagrams (see page 29).

# Chapter 5

---

# Troubleshooting

## 5.1 Problems and Remedies

If an error occurs during operation or you suspect a system failure, identify the possible cause and carry out the corresponding remedy.

Problems can be classified into 5 types:

Type	Description
1	Problem with the sensor head settings
2	Problem with the communication control
3	Problem with the the measurement method or display of measurement values
4	Problem with the alarm or error LED indication
5	Problem with the laser emission



### ◆ NOTE

- If the digital display does not show any measurement values, it is possible that the status of the output data is undefined (see page 27).
- If it seems that the sensor does not accept any setting changes, refer to the section on "Memory Selection" (see page 46).

Type	Problem	Possible cause	Remedy
1	<ul style="list-style-type: none"> <li>• The sensor head indicator does not light up.</li> <li>• The sensor head does not operate.</li> </ul>	The connecting cable is not connected properly.	Check the connection between the sensor head and connection cable.
		The connecting cable is disconnected.	Check the wiring between the connection cable and connector.
		Power is not supplied to the controller.	Check the connection between the 24V DC external power supply and the sensor head.
		The operation of the sensor head is stopped.	Turn the sensor head ON again.
		The eco mode is set to "Eco-FULL".	The LED will be lit by operating any switch. Change the eco-mode settings, if necessary.
		The laser control setting has been turned OFF and this setting has been saved.	Set the laser control setting to ON and save the setting, otherwise the system will start with the laser beam turned OFF.
3	There is a difference between the actual distance to the measurement object and measurement value.	The measurement object is fluctuating or vibrating.	Stop the fluctuation or vibration of the measurement object.
		The measurement object is tilted.	Place the measurement object as perpendicularly as possible.
		The received light waveform is saturated or insufficient.	Adjust the received light intensity using the shutter time.
3	The correct measurement value is not displayed.	The measurement object is out of the measuring range.	Check the measuring range of the sensor head used.
		The scaling setting is not correct.	Set the correct scaling.
		The light emitter/receiver is dirty.	Remove the dirt on the light emitter/receiver.

Type	Problem	Possible cause	Remedy
3	Measurement values vary.	The moving average is small.	Increase the number of moving average.
		The light emitter/receiver is dirty.	Remove the dirt on the light emitter/receiver.
		The mounting direction of the sensor head is incorrect.	Check the mounting direction of sensor head.
		The sensor head or measurement object is tilted.	Check the mounting of the sensor head and the setting position of the measurement object.
2	Multifunction Type  <ul style="list-style-type: none"> <li>• RS485 communication control fails.</li> <li>• Normal communication via RS422/485 is not possible.</li> </ul>		
3, 4	The alarm indicator lights up and measurement is no longer possible (see note).	The reflected beam from the beam emitter is blocked.	Move the position of the beam projection spot or change the mounting direction of the sensor head so the reflected beam should not be blocked.
		The laser beam spot is applied to the R portion (curved surface) of the measurement object.	Apply the beam projection spot to the top of R portion or adjust the beam diameter so it comes larger by moving the measurement object back and forth within the measuring range.
		The reflected beam has directionality because the surface of the object is hairline-finished.	Check the mounting direction of the sensor head.
		The received light intensity is insufficient because the sampling cycle is too short.	Set a longer sampling cycle or shutter time (when shutter time is set to a fixed value).

Type	Problem	Possible cause	Remedy
		The sampling cycle is too long and the received light intensity is too strong.	Set a shorter sampling cycle and reduce the received light intensity by setting a shorter shutter time.

**If an alarm occurs, check the error code of the alarm output by reading the output status with a serial command (see page 94).**

## 5.2 Initialize

---

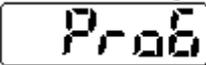
This function is used to delete all the settings from all the memories and returns them to the default settings.



### ◆ NOTE

---

---

- You need to save the settings after initialization (see page 42), or the system will operate with the settings valid before the initialization at the next system start.
- When the initialization of the system is executed through the operation of the panel, all settings except COM settings  and system settings  will return to the factory default settings.
- When you are using the multifunction type and initialize the settings with a serial command, send the "Save" command immediately afterwards, or the system will operate with the settings valid before the initialization at the next system start.
- While the initialization is executed, the output data status may become undefined temporarily.

# Chapter 6

---

## Specifications

## 6.1 Sensor Head Specifications

The sensor head specifications are listed in the table below.



### ◆ NOTE

The following measurement conditions apply unless otherwise specified:

- **Power voltage: 24V DC**
- **Ambient temperature: 20°C**
- **Sampling cycle: 500μs**
- **Number of measurement values used for averaging: 1024 values**
- **Measurement object: white ceramic**

Where standard and multifunction type differ in the specification, the table row is shaded in gray.

Characteristic	Model No.			
	LAH-G103	LAH-G105	LAH-G108	LAH-G112
Supply voltage	24V DC ±10% including ripple 0.5V (P-P)			
Current consumption	100mA max.			
Measurement method	Diffuse reflection			
Measurement center distance	30mm	50mm	85mm	120mm
Measuring range	±4mm	±10mm	±20mm	±60mm
Beam source	Red semiconductor laser Class 2 (JIS/IEC/FDA laser notice No. 50) Max output: 1mW, Emission peak wavelength: 655nm			
Beam dimensions (see note 1)	0.1×0.1mm	0.5×1mm	0.75×1.25mm	1.0×1.5mm
Beam receiving element	CMOS image sensor			
Resolution	0.5μm	1.5μm	2.5μm	8μm
Linearity	±0.1% F.S.			
Temperature characteristics	±0.08% F.S./°C			
Sampling cycle	200μs, 500μs, 1ms, 2ms			
Analog output	<b>Voltage:</b> <ul style="list-style-type: none"> <li>• Output range: 0 to 10.5V (normal), 11V (at alarm)</li> <li>• Output impedance: 100Ω</li> </ul> <b>Current:</b> <ul style="list-style-type: none"> <li>• Output range: 3.2 to 20.8mA (normal), 21.6mA (at alarm)</li> <li>• Load impedance: 300Ω max.</li> </ul>			
OUT1 OUT2 OUT3	Judgment output or alarm output (switchable) NPN open-collector transistor/PNP open-collector transistor (switchable)			
	<b>Settings for NPN:</b> <ul style="list-style-type: none"> <li>• Peak in-flow current: 50mA</li> <li>• Applied voltage: 3 to 24V DC (between output and 0V)</li> <li>• Residual voltage: 2V max. (at in-flow current of 50mA)</li> </ul> <b>Settings for PNP:</b> <ul style="list-style-type: none"> <li>• Peak in-flow current: 50mA</li> <li>• Residual voltage: 2.8V max. (at in-flow current of 50mA)</li> </ul>			

Characteristic		Model No.			
		LAH-G103	LAH-G105	LAH-G108	LAH-G112
	Output operation	Open when the output is ON.			
	Short-circuit protection	Incorporated (Auto-reset)			
	NPN/PNP type switching input	At 0V: NPN open-collector output At supply voltage of 24V DC: PNP open-collector output			
	Timing input	<ul style="list-style-type: none"> <li>NPN operation: ON when connecting or connected to 0V (depending on settings)</li> <li>PNP operation: ON when connecting or connected to positive terminal of external power supply (depending on settings)</li> </ul>			
	Communication interface <b>(multifunction type only!)</b>				
	Multifunction input	Zero set, zero set OFF, reset, memory selection, teaching, save, or laser control depending on input time. <ul style="list-style-type: none"> <li>NPN operation: Depending on time to connect 0V</li> <li>PNP operation: Depending on time to connect positive terminal of external power supply</li> </ul>			
Indicators	Laser radiation indicator	Green LED ON at laser radiation			
	Alarm indicator	Orange LED ON when measurement is disabled due to insufficient amount of light			
	Output indicator	Yellow LED (No. of indicators: 3) ON during output			
	Digital display	Red LED for sign and 5-digit display			
	Degree of protection	LAH-G1: IP67			
	Pollution degree	2			
	Insulation resistance	20M $\Omega$ min. at 250V DC megger (between charged parts and casing)			
	Dielectric withstand	1000V AC for 1 min. (between charged parts and casing)			
	Vibration resistance	Endurance: 10 to 55Hz (at 1-minute cycle), 1.5-mm double-amplitude two hours each in X, Y, and Z directions			
	Shock resistance	500m/s <sup>2</sup> three times each in X, Y, and Z directions			
	Ambient illumination (see note 2)	3,000lx max. (illumination level of light receiving surface under incandescent light)			
	Ambient temperature	-10°C to 45°C (No dew condensation or icing allowed), at storage: -20°C to +60°C			
	Ambient humidity	35 to 85% RH, at storage: 35 to 85% RH			
	Altitude	2000m or less			
	Material	Casing: PBT, front cover: acrylic, cable: PVC			
	Cable length	5m			
	Weight	Approx. 70g (without cable), approx. 320g (including cable), and approx. 380g (with packing)			
	Accessory	Laser warning label: 1 set			
	Applicable standards	Conforming to EMC Directive			

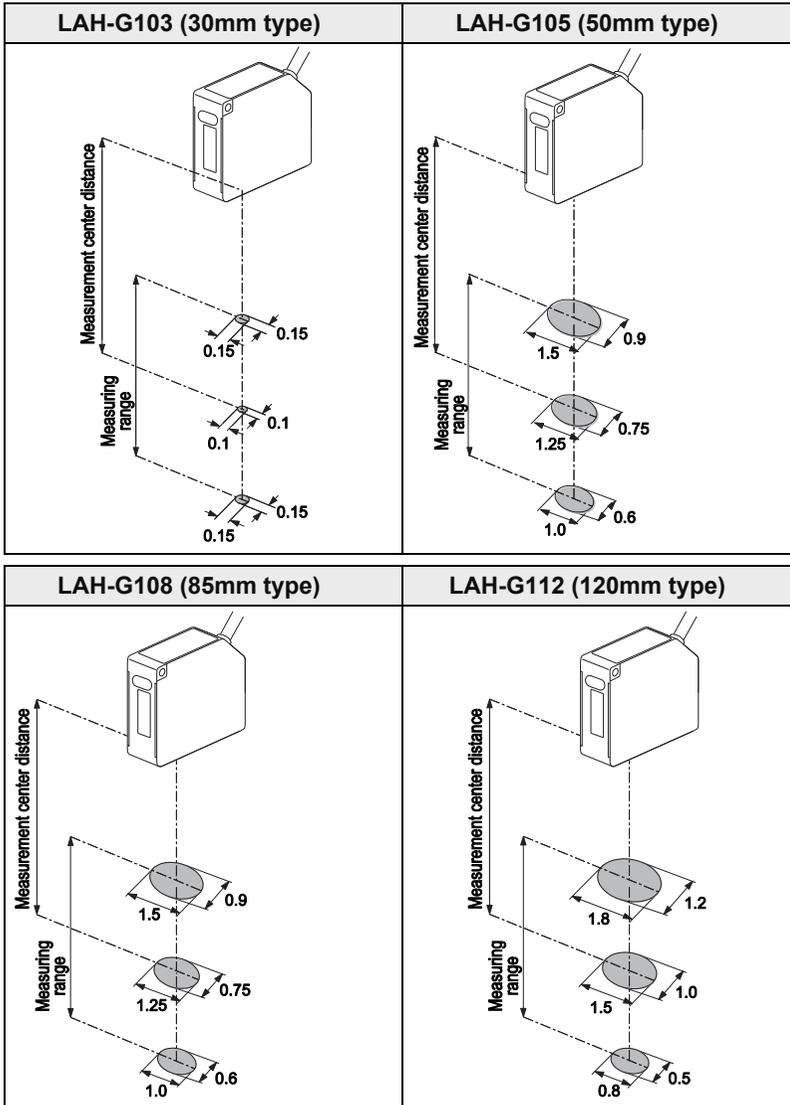
**◆ NOTE**

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1. The beam dimensions are defined by the size of the object at the measurement center distance and determined by  $1/e^2$  (approximately 13.5%) of the center beam intensity. Light reflections and leak lights may affect the measurement value.
2. Variance is  $\pm 0.1\%$  F.S. or less depending on the ambient light.

## 6.2 Beam Dimensions



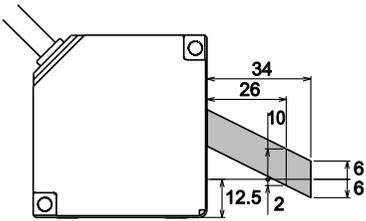
### 6.2.1 Mutual Interference Area



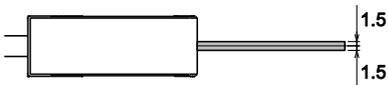
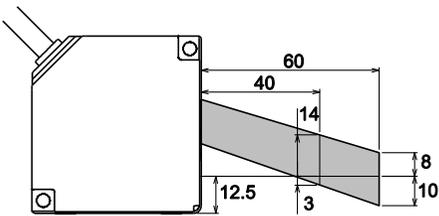
◆ **NOTE**

If you install two or more diffuse reflective sensor heads side by side, mutual interference will occur if the laser spots of the other sensor heads fall within the area shown in gray. Install the sensor heads so that the laser spots of the other sensor heads will fall outside the area shown in gray.

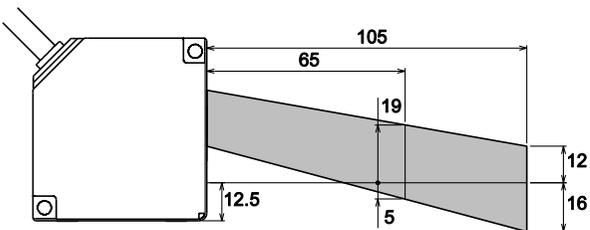
**30mm type (LAH-G103)**



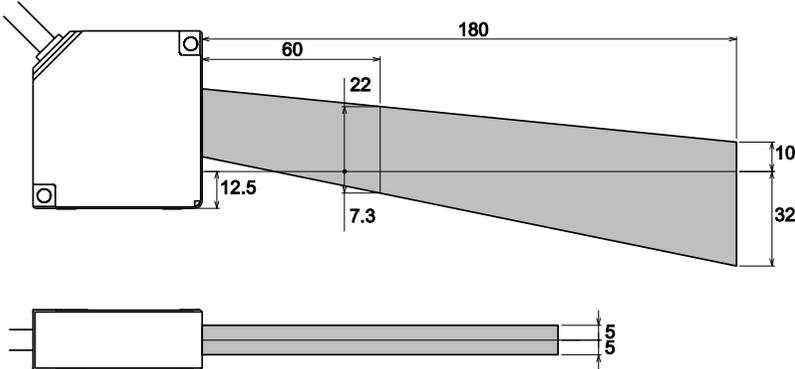
**50mm type (LAH-G105)**



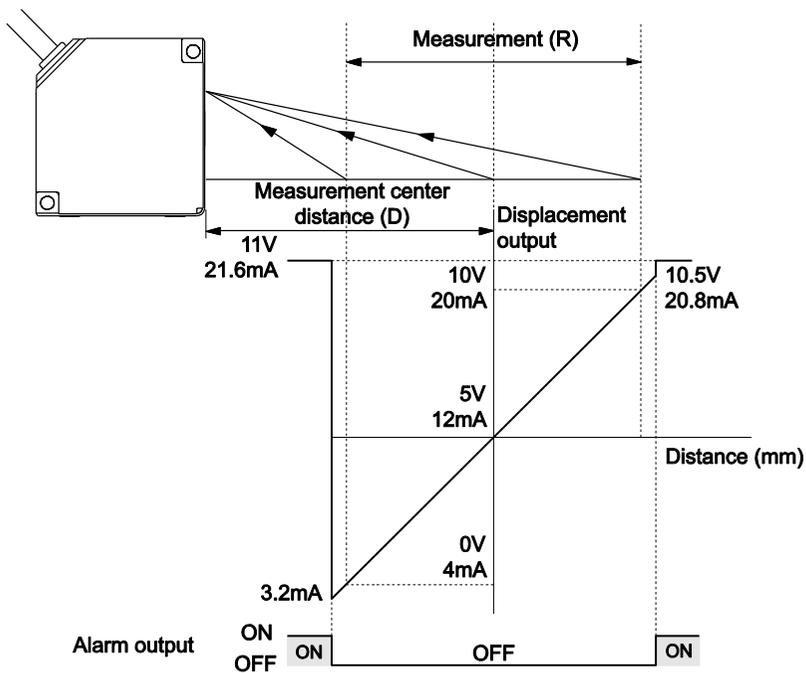
**85mm type (LAH-G108)**



**120mm type (LAH-G112)**



### 6.2.2 Output Characteristics



**◆ NOTE**

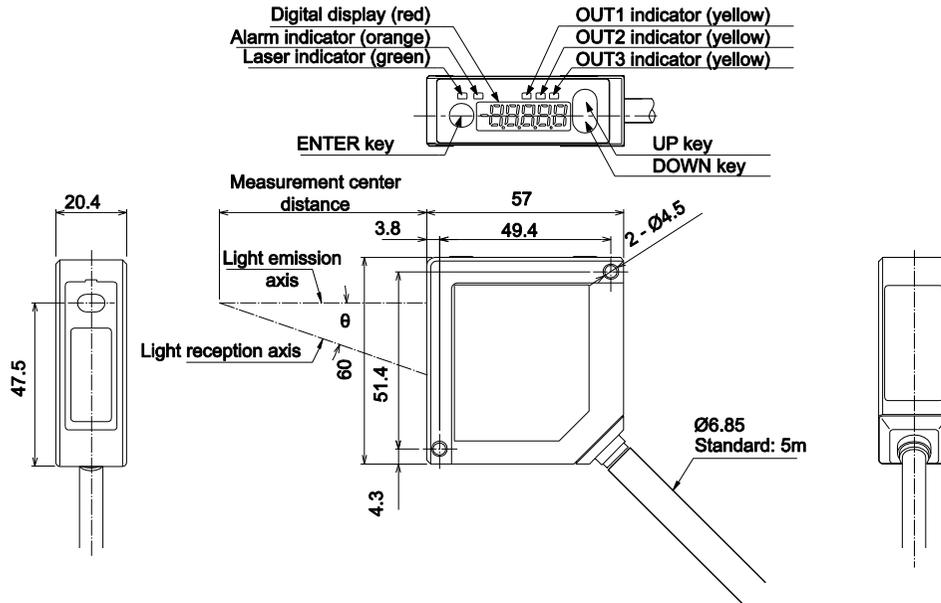
In the figure, the default settings for analog output are used.

	Standard type	Measurement center distance (D)	Measuring range (R)
30mm type	LAH-G103-A-C5	30mm	±4mm
50mm type	LAH-G105-A-C5	50mm	±10mm
85mm type	LAH-G108-A-C5	85mm	±20mm
120mm type	LAH-G112-A-C5	120mm	±60mm

## 6.3 Sensor Head Dimensions

All dimensions are in mm.

### 6.3.1 LAH-G1



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