KEYENCE

Area Imaging Sensor

AI Series

User's Manual

Read this manual before use.
After you read this manual, keep it in a safe place for future reference.

Introduction

Read this manual before using the product in order to achieve maximum performance.
Keep this manual in a safe place after reading it so that it can be used at any time.

Symbols

The following symbols alert you to important messages.
Be sure to read these messages carefully.

> ⚠ DANGER
> **It indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

> ⚠ WARNING
> **It indicates a hazardous situation which, if not avoided, could result in death or serious injury.**

> ⚠ CAUTION
> **It indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.**

> *NOTICE*
> **It indicates a situation which, if not avoided, could result in product damage as well as property damage.**

▶ Important

It indicates cautions and limitations that must be followed during operation.

✎ Point

It indicates additional information on proper operation.

Reference

It indicates tips for better understanding or useful information.

📖 It indicates the reference pages in this manual or the reference pages in separate manuals.

Cautions

(1) Unauthorized reproduction of this manual in whole or part is prohibited.
(2) The contents of this manual may be changed for improvements without prior notice.
(3) An utmost effort has been made to ensure the contents of this manual are as complete as possible.
    If there are any mistakes or question, please contact a KEYENCE office listed in the back of the manual.
(4) Regardless of item (3), KEYENCE will not be liable for any effect resulting from the use of this unit.
(5) Any manuals with missing pages or other paging faults will be replaced.

The company names and product names used in this manual are registered trademarks or the trademarks of their respective companies.

Safety Information for AI Series

General Precautions

> ⚠ **DANGER**
> - Do not use this product for the purpose to protect a human body or a part of a human body.
> - This product is not intended for use in a potentially explosive area. Do not use this product in any hazardous or potentially explosive area.

> ⚠ **WARNING**
> If the product is used in a manner not specified by this manual, the protection provided by the product may be impaired.

> ⚠ **CAUTION**
> - You must verify that the AI Series are operating correctly in terms of functionality and performance before the start and the operation of the AI Series.
> - We recommend that you take substantial safety measures to avoid any damage in the event of a problem occurring.

> **NOTICE**
> - KEYENCE never warrants the function or performance of the AI Series if it is used in manner that differs from the AI Series specifications contained in this instruction manual or if the AI Series are modified by yourself.
> - When the AI Series is used in combination with other instruments, functions and performance may be degraded, depending on operating conditions and the surrounding environment.
> - Do not place the instruments, including peripherals, under the rapid temperature change. It may cause condensation and may damage instruments or peripherals.
> - Remove the power cable from the power supply if you do not use this product for a long time.

Important Instructions

Observe the following precautions to prevent malfunction of the AI Series and to ensure that it is used properly.

Precautions on use

⚠ **CAUTION**

- The power of this product and instruments connected to this product must be turned off when the cable is to be installed or removed. Failure to do so may cause an electric shock or a product damage.
- Use this product in the correct supply voltage. Failure to do so may cause a product damage.

NOTICE

- For instructions
  - Do not turn OFF the power while setting the items, saving the settings, or calibration. Otherwise, all or part of the setting data may be lost.
  - Do not let water, dust or oil stick to the light projecting/receiving section of the sensor. Failure to do so may cause a malfunction.
  - When this product becomes dirty, do not rub it with a wet cloth, benzene, thinner, or alcohol. Doing so may change the color or shape of the unit.
  - If the unit is heavily contaminated, disconnect all the cables including the power supply cable, wipe off the dirt with a cloth soaked with mild detergent, and then wipe with a soft dry cloth.
- External calibration
  - If you use external calibration frequently, set "C6. External calibration" to "Not save" to protect the non-volatile memory in the sensor. If it is set to "ROM save", the lifespan of the non-volatile writing count is 100,000.

Precautions on installation

NOTICE

- To use this product correctly and safely, avoid installing it in the following locations. Failure to do so may cause fire, electric shock, or malfunction.
  - Outdoors
  - Locations that are humid, dusty or poorly ventilated
  - Locations where the temperature is high such as those exposed to direct sunlight
  - Locations where there are flammable or corrosive gases
  - Locations where the unit may be directly subjected to vibration or impact
  - Locations where water, oil, or chemicals may splash onto the unit
- To improve the anti-noise feature, install the unit following the precautions below. Otherwise, a malfunction may occur.
  - Do not mount the unit in a cabinet where high-voltage equipment is already installed.
  - Mount the unit as far from power lines as possible.
  - Separate the unit as far as possible from the devices that emit strong electric or magnetic field (such as solenoid or chopper).
  - Separate the I/O signal line from the power line or high-voltage line.
- For power supply
  - Noise superimposed on the power supply could cause malfunction. Use a stabilized DC power supply configured with an isolation transformer.
  - When using a commercially available switching regulator, be sure to ground the frame ground terminal.
- Devices including this unit are precision components. Do not apply shock or vibration.

Safety Precautions on LED Product

The degree of risk of this product is shown below.

Model	Light source	Risk Group*
AI-H010	Red LED (660nm)	Exempt Group
AI-H020		
AI-H050		
AI-H100		
AI-H160	Infrared LED (850nm)	Exempt Group
AI-B050	Red LED (660nm)	Exempt Group
AI-B100		
AI-B160	Infrared LED (850nm)	Exempt Group

* LED product is classified as shown below according to IEC 62471.

• Exempt Group   Does not pose any photobiological hazard
• Risk Group 1 (Low-Risk)   Does not pose a hazard due to normal behavioral limitations on exposure.
• Risk Group 2 (Moderate-Risk)   Does not pose a hazard due to the aversion response to very bright light sources or due to thermal discomfort.
• Risk Group 3 (High-Risk)   May pose a hazard even for momentary or brief exposure.

Precautions on Regulations and Standards

CSA Certificate

This product complies with the following CSA and UL standards and has been certified by CSA.

• Applicable standards   CAN/CSA C22.2 No.61010-1

                UL61010-1

Be sure to consider the following specifications when using this product as a product certified by CSA.

• Overvoltage category I
• Use this product under pollution degree 3.
• Use this product at the altitude of 2000m or less.
• Indoor use only
• Use one of the following types of power supplies.

    A CSA/UL certified power supply that provides Class 2 output as defined in the CEC (Canadian Electrical Code) and NEC (National Electrical Code) or a CSA/UL certified power supply that has been evaluated as a Limited Power Source as defined in CAN/CSA-C22.2 No.60950-1/UL60950-1.

FCC Regulations

This product complies with the following regulations specified by the FCC.

• Applicable regulation   FCC Part 15 Subpart B ClassA
• This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interface, and (2) this device must accept any interference received, including interference that may cause undesired operation.

CE Marking

Keyence Corporation has confirmed that this product complies with the essential requirements of the applicable EU Directive, based on the following specifications. Be sure to consider the following specifications when using this product in the Member State of European Union.

● EMC Directive

• Applicable Standard   EN60947-5-2

Remarks:

These specifications do not give any guarantee that the end-product with this product incorporated complies with the essential requirements of EMC Directive. The manufacturer of the end-product is solely responsible for the compliance on the end-product itself according to EMC Directive.

Structure of This Manual

1	**Getting Started**	This chapter describes the configurations, overview, package contents, and part names and functions of the AI Series.
2	**Installation and Connection**	This chapter explains the installation and connection procedures for the sensors and amplifiers.
3	**Basic Usage**	This chapter explains the basic usage of the AI Series and its operation flow.
4	**Presence/Difference Check Mode Settings**	This chapter explains the setting methods when using the Presence check mode and Difference check mode.
5	**Feeder Mode Settings**	This chapter explains the setting method when using the Feeder mode.
6	**I/O Control**	This chapter explains the control method for operation of the input/output wires.
7	**Specifications**	This chapter explains the specification and dimensions.
A	**Appendix**	This chapter explains the display and error, the status table, etc.

Contents

6 I/O Control

7 Specifications

Appendices

MEMO

1

Getting Started

This chapter describes the system configurations, overview, package contents check, and part names and functions of the AI Series.

Overview of Detection Mode

This device requires calibration which registers the shape and brightness of the target object to be detected. "Presence check", "Difference check" and "Feeder" can be selected in the detection calibration mode.

Presence check mode

The matching rate of the detected target is determined using the shape and brightness of the target registered during calibration as reference (999). Set a matching rate threshold value to determine what is a good and no good part. Use when detecting the presence of target objects in motion or stationary, or the presence of target objects whose shape might differ.

Example) Presence detection
        Spring

Example) Presence detection
        Adhesive

YES (ON)   NO (OFF)   YES (ON)   NO (OFF)
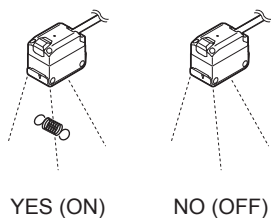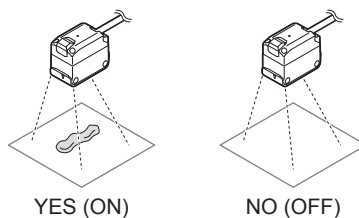
How to select presence check mode

(1) Select the Standard mode.
- In the first starting, or after initial reset running, the Standard mode is selected.
- Select "Standard mode" in "Z1. Application mode" (Page 4-18).

(2) Select "Presence check mode" on the Calibration screen (Page 3-4).

Difference check mode

Differences in shape and brightness are used to determine an OK and NG part. OK and NG workpieces are judged by setting a threshold value for the matching rate. Use when detecting the object difference in shape and orientation such as orientation detection, and presence of assembly parts and labels.

Example) Orientation

Example) Assembly

OK (ON)   NG (OFF)   NO (OFF)   OK (ON)   NG (OFF)   NO (OFF)
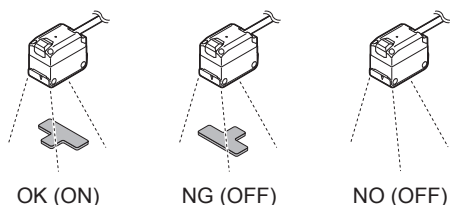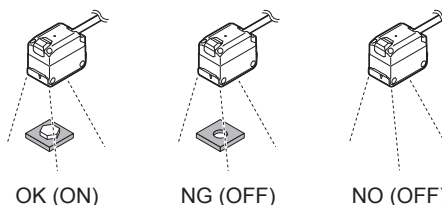
How to select the Difference check mode

(1) Select the Standard mode.
- In the first starting, or after initial reset running, the Standard mode is selected.
- Select "Standard mode" in "Z1. Application mode" (Page 4-18).

(2) Select "Difference check mode" on the Calibration screen (Page 3-4).

Feeder mode

This mode is used when detecting the orientation of the target transported by part feeders of various types. The matching rate of the passing target is determined by the shape and brightness of the target registered during calibration (999). The output turns on when the target is inverted or the target is facing a wrong direction. Passing targets are recognized automatically; and judgment and output update is only transmitted when a target is recognized.

OK (OFF)　　　NG (ON (One shot))　　　No workpiece (No judgment OFF)
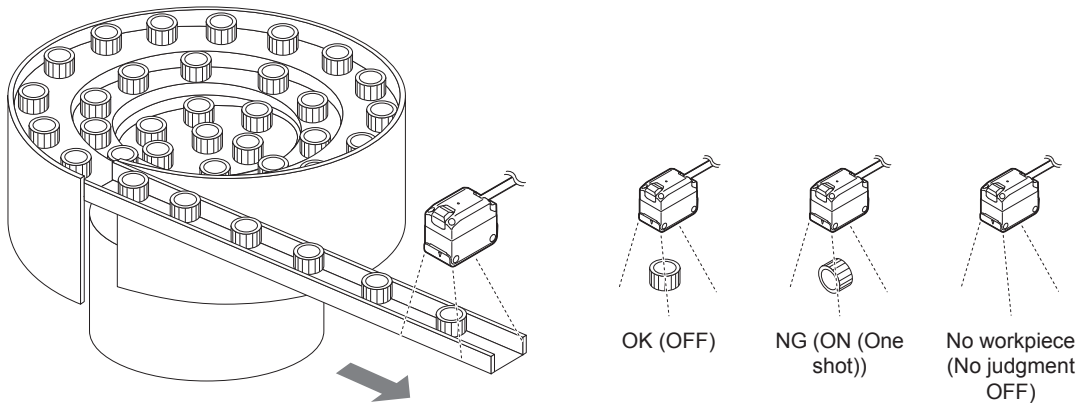
How to select the Feeder mode

Select "Feeder mode" in "Z1. Application mode" (Page 4-18).

Reference

In the first starting, or after initial reset running, the Standard mode is selected.

System configuration

Basic configuration of the separate amplifier type (AI-H Series)

Connector type cable

M8-Loose wires   OP-88095 (2m)
                      OP-88096 (10m)

M8-M8   OP-88069 (2m)

M8-M12   OP-88071 (2m)
            OP-88072 (5m)

AI-H Amplifier

Connector type
AI-1000C

(2m)

**Sensor head
connection cable**
OP-87056 (2m)
OP-87057 (5m)
OP-87058 (10m)

AI-H Amplifier

Cable type
AI-1000

**Sensor head connection
cable connector**
OP-84338

(160mm)

(145mm)

Sensor head

	Installation distance	Detection range
AI-H050	45 to 55 mm	16 x 16 mm
AI-H100	90 to 110 mm	32 x 32 mm
AI-H160	140 to 180 mm	52 x 52 mm

Sensor head

	Installation distance	Detection range
AI-H010	9 to 11 mm	2 x 2 mm
AI-H020	18 to 22 mm	5.6 x 5.6 mm

Polarizing filter

• AI-F01H

Mounting bracket

• Vertical   OP-88100
• Rear   OP-88101

Polarizing filter (accessory*)

• For AI-H050/H100   AI-F05H
• For AI-H160   AI-F10H
  *   Included with sensor head as standard equipment.
      Optional parts are for replacement.

Dome attachment

• Small   AI-D16H
• Large   AI-D32H

Mounting bracket

• Vertical   OP-88104
• Rear   OP-88105
• Adjustable   OP-88106

1

Basic configuration of the built-in amplifier type (AI-B Series)

Cable

M12-Loose wires
OP-88107 (2m)
OP-88108 (10m)

M12L-Loose wires
OP-88109 (2m)
OP-88110 (10m)

M12-M12
OP-88112 (2m)
OP-88113 (5m)

M12L-M12
OP-88111 (1m)
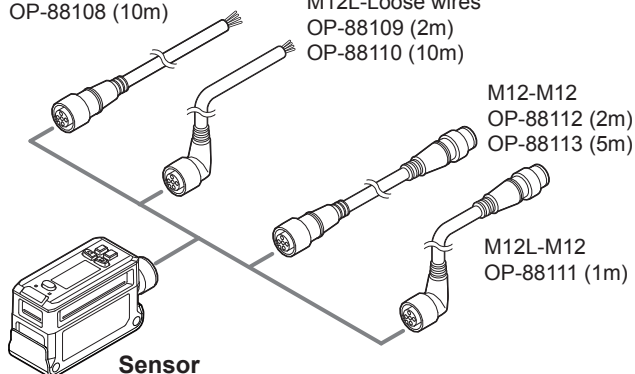
Sensor

	Installation distance	Detection range
AI-B050	45 to 55 mm	16 x 16 mm
AI-B100	90 to 110 mm	32 x 32 mm
AI-B160	140 to 180 mm	52 x 52 mm

Polarizing filter (accessory*)
- For AI-B050/B100   AI-F05B
- For AI-B160   AI-F10B
  *   Included with sensor head as
      standard equipment. Optional
      parts are for replacement.

Mounting bracket
- Vertical   OP-88114
- Rear   OP-88115
- Adjustable   OP-88116

Dome attachment
- Small   AI-D16B
- Large   AI-D32B

Checking Package Contents

The AI Series consists of the models described below. Before use, check that all of the following package contents are included for the purchased model:

Separate amplifier type (AI-H Series): Sensor head
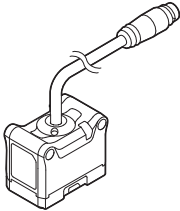
• **AI-H010**　　　　　　• **AI-H050**　　　　　　• **AI-H160**
• **AI-H020**　　　　　　• **AI-H100**
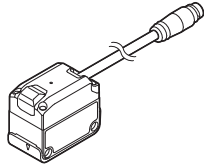
Sensor head x 1

Sensor head x 1
Polarizing filter x 1
(AI-F05H attached)
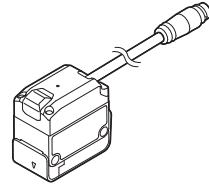
Sensor head x 1
Polarizing filter x 1
(AI-F10H attached)

📖 "Part Names and Functions" (Page 1-11)
📖 "Mounting the Sensor" (Page 2-3)
📖 "Cables" (Page 2-8)

Separate amplifier type (AI-H Series): AI-H amplifier

• **AI-1000**　　　　　　　　　　　　　　• **AI-1000C**
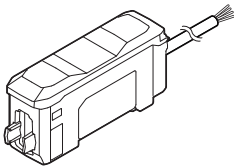
Amplifier for AI-H cable type x 1
Instruction manual x 1
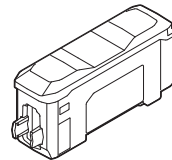
Amplifier for AI-H connector type x 1
Instruction manual x 1

📖 "Part Names and Functions" (Page 1-11)
📖 "Mounting the Sensor Amplifier" (Page 2-7)
📖 "Cables" (Page 2-8)

Separate amplifier type (AI-H Series): Options

Dome attachment
• **AI-D16H**　　　　　　　　　　• **AI-D32H**
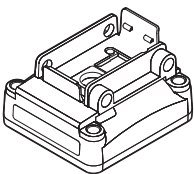
Mounting screw
(M4×L10) x 2
Mounting screw
(M4×L16) x 2
*Double sems screw
Instruction manual x 1
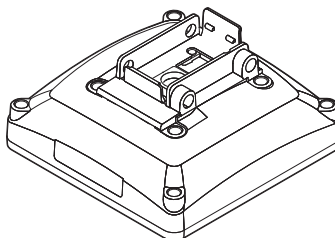
Mounting screw
(M4×L10) x 2
Mounting screw
(M4×L16) x 2
*Double sems screw
Instruction manual x 1

Dome attachment for AI-H (Small) x 1　　Dome attachment for AI-H (Large) x 1
📖 "Mounting the dome attachment" (Page 2-5)

Polarizing filter
• AI-F01H
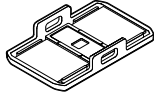
Polarizing filter for AI-H010/020 x 1

• AI-F05H
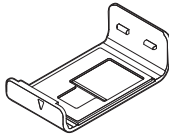
Polarizing filter for AI-H050/100 x 1

• AI-F10H
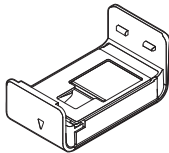
Polarizing filter for AI-H160 x 1

📖 "Mounting the polarizing filter" (Page 2-4)

Sensor head connection cable
• OP-87056 (2m)　　**• OP-87057 (5m)**
• OP-87058 (10m)
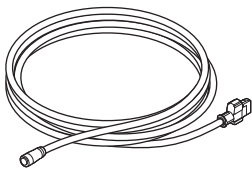
Sensor head connection cable x 1

• OP-84338

Sensor head connector for connection cable x 1

📖 "Connecting sensor and cable" (Page 2-8)

Connector type cable
• OP-88095 (2m)　　**• OP-88096 (10m)**
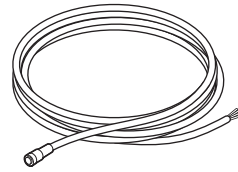
M8-Loose wires cable x 1

• OP-88069 (2m)
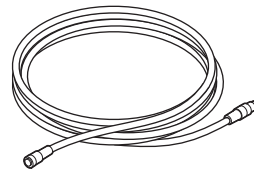
M8-M8 cable x 1

• OP-88071 (2m)　　**• OP-88072 (5m)**
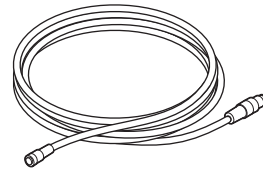
M8-M12 cable x 1

1

Mounting bracket
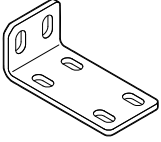
• OP-88100

Vertical mounting bracket
for AI-H010/020 x 1

Mounting screw
(M4 x L10) x 2
*Double sems screw

• OP-88101
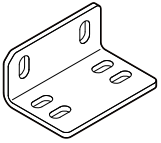
Rear mounting bracket
for AI-H010/020 x 1

Mounting screw
(M4 x L10) x 2
*Double sems screw

• OP-88104
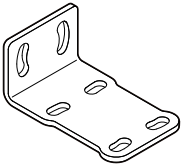
Vertical mounting bracket
for AI-H050/100/160 x 1

Mounting screw
(M4 x L10) x 2
*Double sems screw

• OP-88105
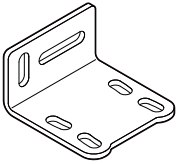
Rear mounting bracket
for AI-H050/100/160 x 1

Mounting screw
(M4 x L10) x 2
*Double sems screw

• OP-88106

Adjustable bracket for AI-H050/100/160
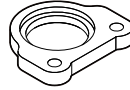
Mounting
bracket x 1

Mounting screw
(M4 x L14) x 2
*Double sems
screw

Bracket x 1

1

Built-in amplifier type (AI-B Series): Sensor

• **AI-B050**
• **AI-B100**

• **AI-B160**

Sensor head x 1
Polarizing filter x 1 (AI-F05B attached)
Instruction manual x 1

Sensor head x 1
Polarizing filter x 1 (AI-F10B attached)
Instruction manual x 1

Built-in amplifier type (AI-B Series): Options

Dome attachment
• **AI-D16B**
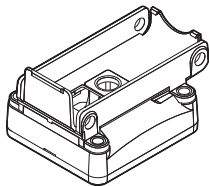
Dome attachment
for AI-B (Small) x 1

Mounting screw
(M4 x L10) x 2
Mounting screw
(M4×L16) x 2
*Double sems
 screw
Instruction
manual x 1

• **AI-D32B**
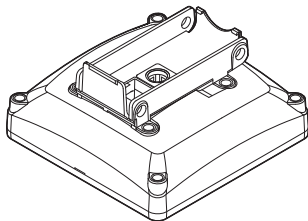
Dome attachment
for AI-B (Large) x 1

Mounting screw
(M4 x L10) x 2
Mounting screw
(M4×L16) x 2
*Double sems
 screw
Instruction
manual x 1

Polarizing filter
• **AI-F05B**

Polarizing filter for AI-B050/100 x 1

• **AI-F10B**

Polarizing filter for AI-B160 x 1

1
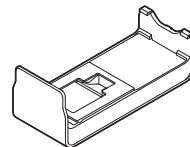
Cable

• OP-88107 (2m)
• OP-88108 (10m)
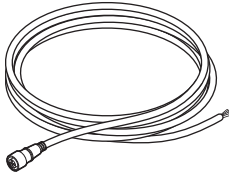
M12-Loose wires cable x 1

• OP-88109 (2m)
• OP-88110 (10m)
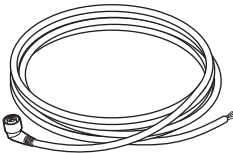
M12 L-Loose wires cable x 1

• OP-88112 (2m)
• OP-88113 (5m)
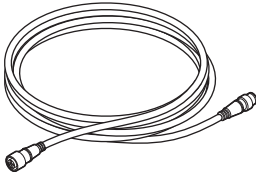
M12-M12 cable x 1

• OP-88111 (1m)
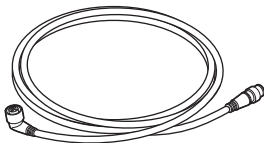
M12 L-M12 cable x 1

"Power/Input-output line wiring" (Page 2-9)

Mounting bracket

• OP-88114

Mounting screw
(M4 x L14) x 2
*Double sems screw

Vertical mounting bracket
for AI-B x 1

• OP-88115

Mounting screw
(M4 x L10) x 2
*Double sems screw

Rear mounting bracket for
AI-B x 1

• OP-88116
Adjustable bracket for AI-B
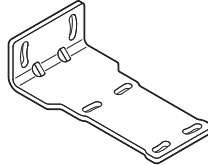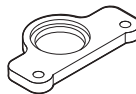
Mounting
bracket for
AI-B x 1

Mounting screw
(M4 x L14) x 2
*Double sems
screw

Bracket x 1

"Mounting the Sensor" (Page 2-3)

Part Names and Functions

Separate amplifier type (AI-H Series): Sensor head

- **AI-H010**
- **AI-H050**
- **AI-H160**
- **AI-H020**
- **AI-H100**

■ Part Names and Functions of the Sensor Head
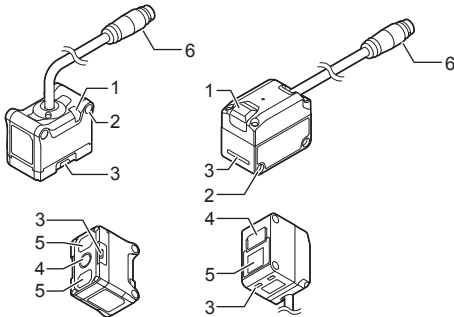
1 Indicator light

Indicates the judgment result and output status.
📖 "Operation of the indicator light" (Page 1-13)

2 Mounting holes

Used for mounting the sensor head.
It is also used for mounting the dome attachment.
📖 "Mounting the Sensor" (Page 2-3)
📖 "Mounting the dome attachment" (Page 2-5)

3 Attachment mounting holes

Used for mounting the polarizing filter or the dome attachment.
📖 "Mounting the polarizing filter" (Page 2-4)

4 Light receiving element

Detects an object.

5 Light

The light source for illuminating the objects.

6 Sensor head connector for connection cable
📖 "Connecting sensor and cable" (Page 2-8)

Separate amplifier type (AI-H Series): Amplifier

- **AI-1000**
- **AI-1000C**

■ Part Names and Functions of the AI-H Amplifier

AI-1000 (Cable type)
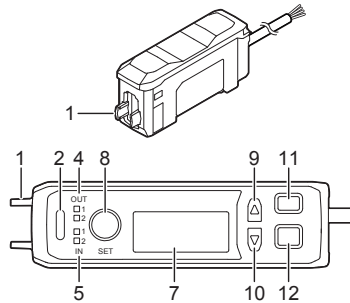
AI-1000C (Connector type)
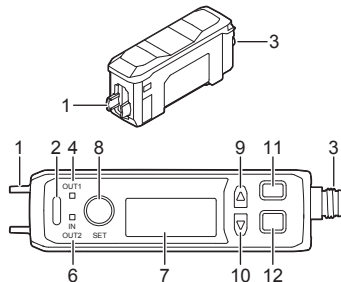
1 Sensor head connector for connection cable
📖 "Connecting sensor head connection cable and AI-H amplifier" (Page 2-8)

2 Indicator light

Indicates the judgment result and output status.
📖 "Operation of the indicator light" (Page 1-13)

3 I/O connector (AI-1000C only)

The connector at the end of the connector type amplifier. Use to supply power to the sensors and connect external devices.

4 Output indicator

When the output is ON (N.O./N.C.), the LED lights up red.

5 Input indicator

When the input is ON, the LED lights up red.

6 Input/Output indicator

The input indicator is used if IN is selected in the I/O line setting; and the output indicator is used if OUT2 is selected in the I/O line setting.
📖 "Operating When Powering On for the First Time" (Page 3-2)

1

7   Display (OLED display)

Displays the sensor state during operation/
setup.

📖 "OLED display" (Page 1-13)

8   [SET] button

Used for calibration.

📖 "Calibration (Registration of Standard
Targets)" (Page 3-4)

9   [▲] button (UP button)

Used for switching screens/changing the setting
values.

10   [▼] button (DOWN button)

Used for switching screens/changing the setting
values.

11   [BACK] button

Used for cancelling the operation.

12   [MODE] button

Used for confirming the operation.

Built-in amplifier type (AI-B Series): Sensor

• **AI-B050**   • **AI-B100**   • **AI-B160**

■ Part Names and Functions of the Sensor
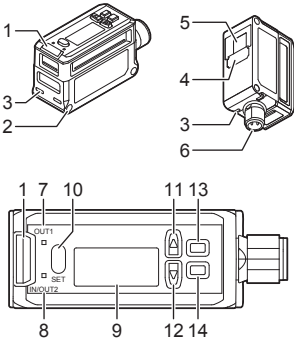
1   Indicator light

Indicates the judgment result and output status.

📖 "Operation of the indicator light" (Page 1-13)

2   Mounting holes

Used for mounting the sensor head.

It is also used for mounting the dome
attachment.

📖 "Mounting the Sensor" (Page 2-3)

📖 "Mounting the dome attachment" (Page
2-5)

3   Attachment mounting holes

Used for mounting the polarizing filter or the
dome attachment.

📖 "Mounting the polarizing filter" (Page 2-4)

4   Light receiving element

Detects an object.

5   Light

The light source for illuminating the objects.

6   I/O connector

The connector for connecting the I/O cables.
Used to supply power to the sensors and/or
connect external devices.

7   Output indicator

When the output is ON (N.O./N.C.), the LED
lights up red.

8   Input/Output indicator

The input indicator is used if IN is selected in
the I/O line setting; and the output indicator is
used if OUT2 is selected in the I/O line setting.
When the input is ON, the input indicator lights
up in red.

📖 "Operating When Powering On for the First
Time" (Page 3-2)

9   Display (OLED display)

Displays the sensor state during operation/
setup.

📖 "OLED display" (Page 1-13)

10   [SET] button

Used for calibration.

📖 "Calibration (Registration of Standard
Targets)" (Page 3-4)

11   [▲] button (UP button)

Used for switching screens/changing the setting
values.

12   [▼] button (DOWN button)

Used for switching screens/changing the setting
values.

13   [BACK] button

Used for cancelling the operation.

14   [MODE] button

Used for confirming the operation.

OLED display

■ Matching rate + Judged image display screen example
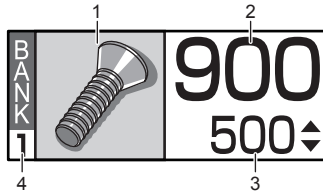
1. Judged image

Displays the object in the sensor's detection range.

2. Matching rate

Displays matching percentage in reference to the shape and brightness of the master part. Display range: 0 to 999 (A higher value represents a better shape and brightness match.)

3. Setting value (Threshold value)

Displays the threshold value, which represents the matching rate needed to determine if the object is the same as the master part. It is set automatically after calibration.

4. Bank number

Displays the bank number currently selected.

Reference

For details on the display screen, refer to the following:
When the Presence/Difference check mode (Standard mode)
📖 "Operations on Run Screen" (Page 4-2)
When the Feeder mode
📖 "Operations on Run Screen" (Page 5-3)

Operation of the indicator light

■ Operation of the indicator light

Indicator light location on the sensor head

Indicator light
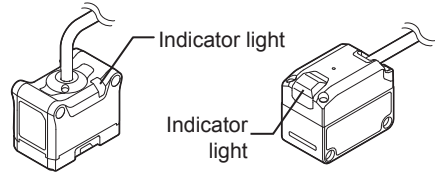
Indicator light

Indicator light location on the amplifier/sensor

Indicator light

Indicator light
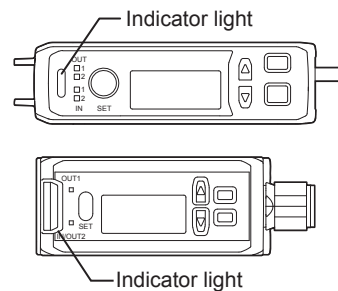
Behavior when the indicator setting* is "Yellow/ Off" (Default)

• Yellow (On).......Output 1 is ON (N.O./N.C.).
• (Off).................Output 1 is OFF (N.O./N.C.).

Behavior when the indicator setting* is "Green/ Red"

• Green (On).......Judgment result is "OK".
• Red (On) ....Judgment result is "NG".
• (Off).................Matching rate is "---".

Common operation

• Green (Flashing) ... Not working properly (calibration is not registered). This is also the case when calibrating, adjusting the detection range, testing inputs and outputs, or intializing. The operation has stopped.
The indicator will flash in approx. 1-second cycles.

• Red (Flashing) ...... An error has occurred.

* The status of the indicator lights can be adjusted by the settings.

📖 "D4. Status LED" (Page 4-11)
📖 "S4. Status LED" (Page 5-12)

MEMO

2

Installation and Connection

This chapter explains how to mount the sensor/amplifier and the wiring methods.

Checking Detection Range and Installation Distance

Checking Detection Range and Installation Distance

The optimal mounting distance between the sensor and the object varies for the AI Series depending on the sensor head type. Check the type and detection range of the sensor head to be used, and mount the sensor head at an appropriate distance for the target.

● **AI-H010/H020**

Indicator light
Detection range H
Detection range V
Installation distance WD

● **AI-H050/H100/H160**

Indicator light
Detection range H
Detection range V
Installation distance WD

● **AI-B050/B100/B160**

Indicator light
Detection range V
Detection range H
Installation distance WD
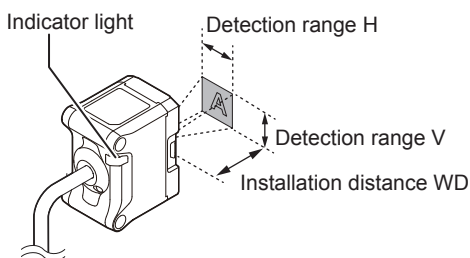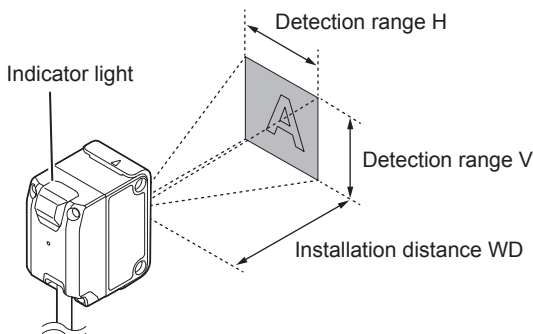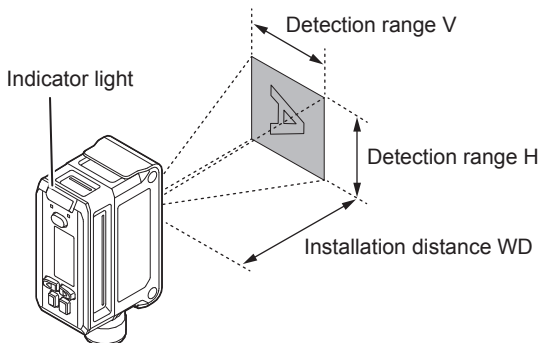
Model	Installed distance (mm)*1	Detection range H x V (mm)*2		
		Zoom*3		
		x1.0	to	x4.0
AI-H010	9 to 11	2 x 2	to	0.5 x 0.5
AI-H020	18 to 22	5.6 x 5.6	to	1.4 x 1.4
AI-H050 /B050	45 to 55	16 x 16	to	4 x 4
AI-H100 /B100	90 to 110	32 x 32	to	8 x 8
AI-H160 /B160	140 to 180	52 x 52	to	13 x 13

*1 Place this product within the tolerance of the installation distance.
   The dimension (thickness) of the polarizing filter is not included.
*2 The detection range when installed in the middle of the installation distance.
*3 The zoom can be adjusted to up to 17 levels within a range of x1.0 to x4.0.
   The magnified area (within the detection range) can be adjusted. (Except for 1 time)

2

Installation and Connection

Mounting the Sensor

✎ **Point**

- Detection range and optimum mounting distances may vary by application. Adjust the position by checking the actual image at the time of installation.
- Place the sensor in areas with minimal ambient light changes. Ambient light includes sunlight, lights of other devices, and photoelectric/laser-based sensors. Use the shield to protect against interference when the location cannot be changed.
- Mount the sensor where no object can block the light or the detection range.
- Detection may become unstable if multiple sensors are placed near each other. Take the following precautionary measures:
  - Use the mutual interference prevention function (sync-input, sync-output).
  - Use the shield to avoid interference.
- Place the built-in amplifier type sensor where you can see the display and access the buttons. Especially when the rear mounting bracket is used, be sure the sensor is not shielded by the wall.

Mounting the Sensor

Reference

Here the illustrations are of the sensor head with a separate amplifier. The sensor for the built-in amplifier type is mounted in the same way.

■ When screws are secured through the sensor head

- Screw: M3 x 2
- Tightening torque: 0.3 to 0.6 N·m
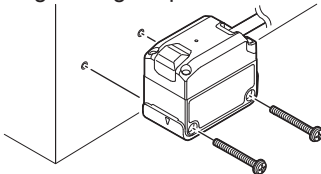
■ When screws are secured to the wall

- Screw: M4 x 2
- Tightening torque: 0.7 to 1.5N·m

M4 penetration

φ4.2

Sectional drawing of the mounting hole
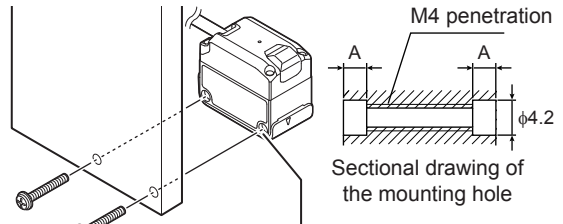
M4 penetration, φ4.2 depth A (both sides)

Model	A
AI-H010/H020	2
AI-H050/H100/H160	1.5
AI-B050/B100/B160	3.3

■ When the vertical mounting bracket is used

Use the screws attached to the vertical mounting bracket to mount it.

- Tightening torque: 0.7 to 1.5N·m
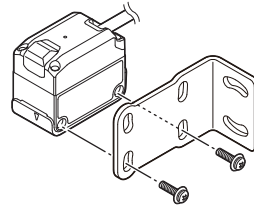
Mounting examples

■ When the rear mounting bracket is used

Use the screws attached to the rear mounting bracket to mount it.

- Tightening torque: 0.7 to 1.5N·m
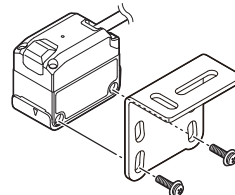
Mounting examples

■ When the adjustable bracket is used

Use the screws attached to the adjustable bracket to mount it.

- Tightening torque: 0.7 to 1.5N·m

Mounting examples

Bring the counter-bore of the center hole to the back side of the sensor and fix with a screw.
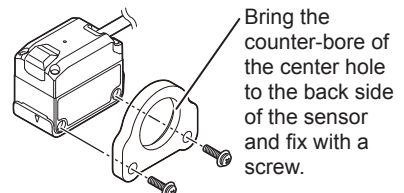
Mounting the Attachments for AI Series

2

Installation and Connection

To reduce the glare on the glossy or metal surface of the target, mount the polarizing filter or the dome attachment.

Mounting the polarizing filter

A polarizing filter is included with the AI Series, except AI-H010/H020.

Sensor head/Sensor	Compatible polarizing filter
AI-H010/H020	AI-F01H *1
AI-H050/H100	AI-F05H
AI-H160	AI-F10H
AI-B050/B100	AI-F05B
AI-B160	AI-F10B

*1 A polarizing filter is not included with AI-H010/H020, and can be purchased separately.

■ When using AI-F05H/F10H/F05B/F10B

1 **Set the hook on the polarizing filter into the groove on the sensor head, and push it in until a clicking sound is heard.**

Hook (1)
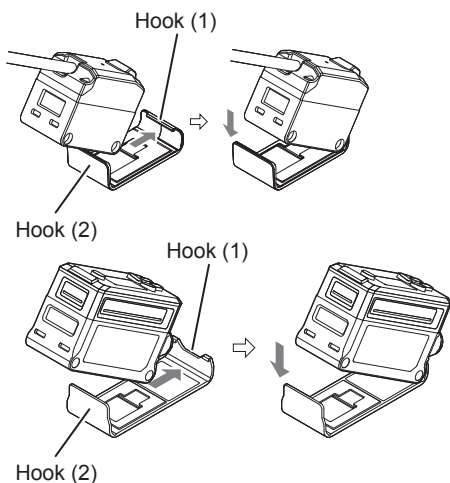
Hook (2)

Hook (1)

Hook (2)

Set the groove on the sensor head/sensor on the hook (1) of the polarizing filter

Push in until a "click" is heard

To remove the filter, pull the hook (2) back rotate the filter forward, to remove hook (1).

■ When using AI-F01H

1 **Align the attachment mounting holes on the sensor head with the hooks on the polarizing filter, and push it in until a clicking sound is heard.**

Attachment mounting sections (both sides)

Hooks
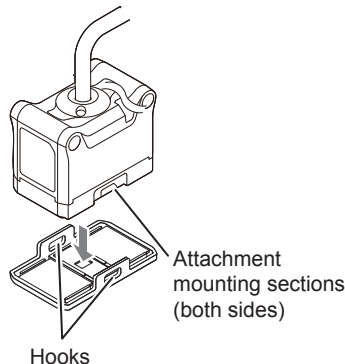
To remove the filter, pull the hook back by the tip of the flathead screwdriver.

Mounting the dome attachment

1 Unmount the polarizing filter.

Remove the polarizing filter if it is attached.

(2)   (2)
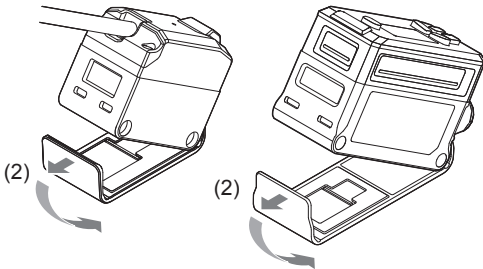
2 Mount the attachment by setting hook (1) into the groove on top of the sensor head, and rotating the attachment towards the bottom of the sensor head until hook (2) clicks into the bottom groove.

Attachment mounting section (groove)

Hook (1)   Hook (2)
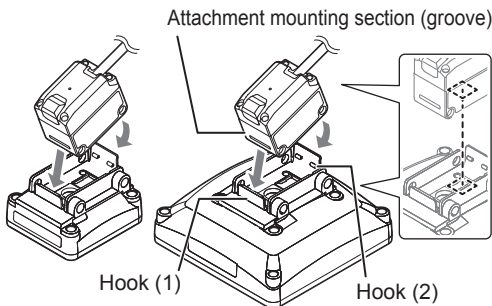
When the AI-D16H is mounted   When the AI-D32H is mounted

Attachment mounting section (groove)

Hook (2)   Hook (1)
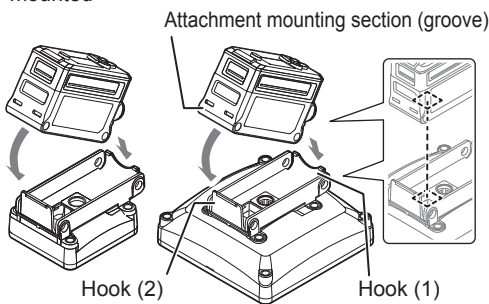
When the AI-D16B is mounted   When the AI-D32H is mounted

Point

Attach the sensor head / sensor so that the internal lighting (LED) fits into the square hole (internal mirror (gold plated)) of the dome attachment.

3 Fix the dome attachment with attached mounting screws.

• Tightening torque : 0.5N·m

Double-washer sems screws for mounting M4×L10

Rear mounting bracket Example: OP-88105

Double-washer sems screws for mounting M4×L16

Double-washer sems screws for mounting M4×L10

Rear mounting bracket Example: OP-88115

Double-washer sems screws for mounting M4×L16
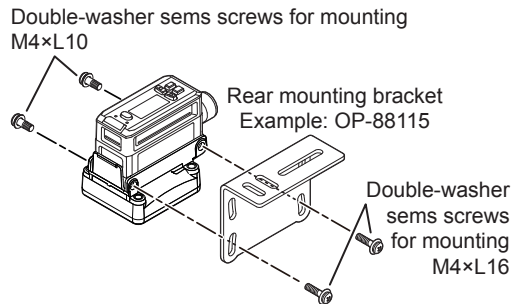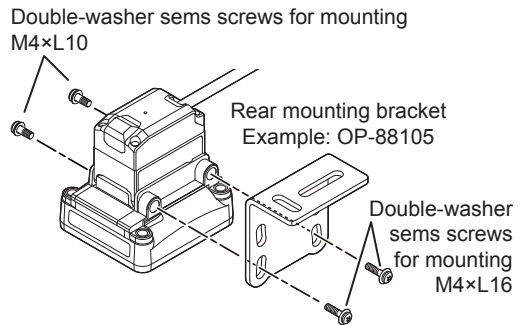
Reference

The vertical mounting bracket (OP-88104/88114), rear mounting bracket (OP-88105/88115), or adjustable bracket (OP-88106/88116) for the AI Series can be used with the dome attachment mounted on the sensor head / sensor.

NOTICE

If the sensor head / sensor and the dome attachment are to be directly mounted to sheet metal without using the optional mounting bracket for AI Series, pay attention to the following items:
• If they are to be secured from the sheet metal side with screws, be sure to use M4 screws, and the tightening torque should be 0.7 to 1.5 N·m.
• If the screws are to be secured from the sensor head side, be sure to use the M3 screws double-washer sems screws or screws with spring washer and flat washer should be used, and the tightening torque should be 0.5 N·m.
"Mounting the Sensor" (Page 2-3)

2

Installation and Connection

Unmounting

Unmount it by rotating the attachment and applying pressure the hook (2) in order to unhook the attachment.

✎ Point

Do not apply too much force to the hook (2). Hook (2) may be damaged.

Installation distance and valid detection range

WD reference surface (front side of the sensor)

Depth of the attachment

Installation distance from the front side of the sensor

Target object
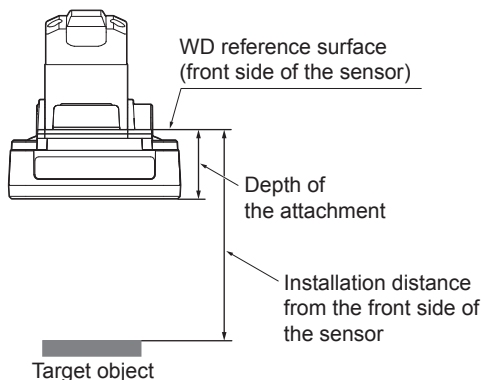
Sensor			Compliant attachment		
Model	Installation distance	Detection range*	Model	Depth	Valid detection range
AI-H050	45-55	16×16	AI-D16H	17.1	16×16
AI-H100	90-110	32×32	AI-D16H	17.1	16×16
			AI-D32H	25.1	32×32
AI-H160	140-180	52×52	AI-D16H	17.1	16×16
			AI-D32H	25.1	32×32
AI-B050	45-55	16×16	AI-D16B	17.1	16×16
AI-B100	90-110	32×32	AI-D16B	17.1	16×16
			AI-D32B	25.1	32×32
AI-B160	140-180	52×52	AI-D16B	17.1	16×16
			AI-D32B	25.1	32×32

* When the sensor is installed in the center of the installation distance, and the zoom magnification is 1.0 time.

✎ Point

- **Installation distance from the front side of the dome attachment is found by subtracting the depth of the attachment from the installation distance of the sensor.**
- **The valid detection range is the detection range where the glare reduction effect is obtained. Depending on the combination of the setting of the sensor, the dome attachment, and zoom magnification (1.0 time to 4.0 times), the valid detection range can often become narrower than the detection range of the sensor.**

Mounting the Sensor Amplifier

Attaching AI-H amplifier

1 **Align the tabs at the bottom of the amplifier with the DIN rail as shown, put down the amplifier in the direction of arrow (2) while pressing it in the direction of arrow (1).**

2 **To remove, uplift the amplifier in the direction of arrow (3) while pressing it in the direction of arrow (1).**
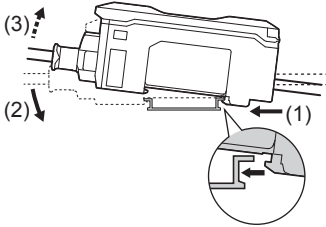
Cables

Connecting sensor and cable

• Connect the sensor head connection cable to the separate amplifier type sensor head.

(1) Align the arrows on the connector and insert
(2) Tighten the connector
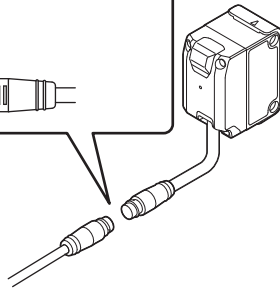
• Connect built-in amplifier type sensor and M12 connector of the cable.
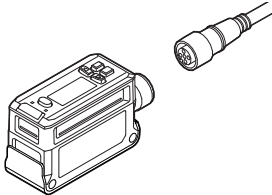
> **Point**
>
> • **Recommended tightening torque**
>   **Separate amplifier type (AI-Hxxx): 0.4 to 0.5N·m**
>   **Built-in amplifier type (AI-Bxxx): 0.8 to 1.0N·m**
> • **After manually tightening the connector firmly, tighten further with tools.**

Connecting sensor head connection cable and AI-H amplifier

1 Connect the sensor head connection cable to the amplifier connector.

Remove the connector lock cover, and insert the cable into the connector on the amplifier till it clicks.
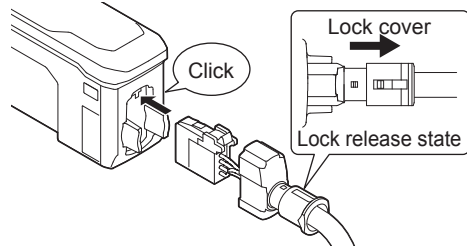
2 Put the lock cover on the connector to secure the cable.
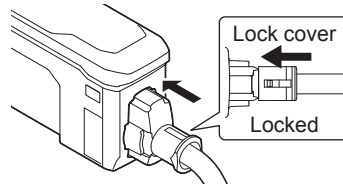
> **Point**
>
> **When removing the sensor head connection cable, pull it out while pressing the lock lever.**
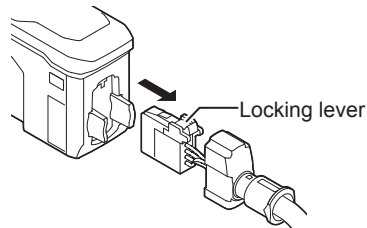
Attaching the sensor head connector for connection cable (OP-84338)

Cut the sensor head cable to the required length so that it can be used.

1 **Cut the cable to the required length, and peel back about 15 mm of the cable insulation from the end.**

> **Point**
>
> **Do not peel away the insulation from the core line.**

2 **Align with the color mark on the cable, and fully insert the wire of the same color.**

The wire should remain in the slot even before crimping.

Insert the cables beyond this point.
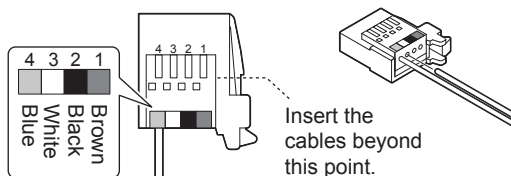
3 **Check that all the cables are inserted into their stipulated positions, then crimp them in parallel with pliers, etc.**
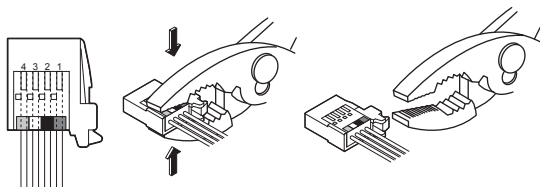
> **Point**
>
> **When the connector is changed, make sure to connect it with the amplifier and check if the sensor is operating properly.**
> **If not, once again crimp the connector with a pair of pliers.**
> **Once the connector is crimped, it cannot be used again.**

Power/Input-output line wiring

■ Selecting NPN output

When NPN is selected in the I/O type for initial settings.
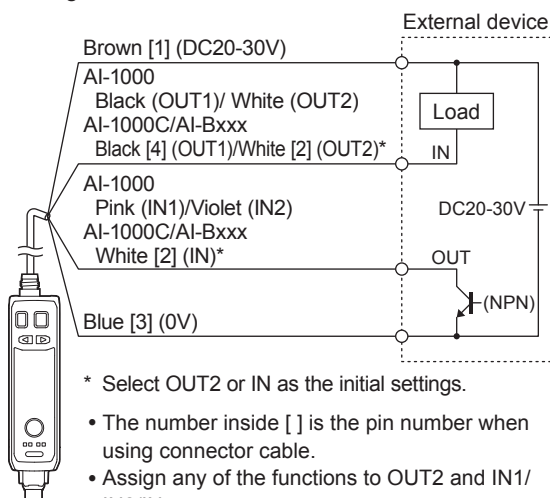
* Select OUT2 or IN as the initial settings.

- The number inside [ ] is the pin number when using connector cable.
- Assign any of the functions to OUT2 and IN1/IN2/IN.

■ Selecting PNP output

When PNP is selected in the I/O type for initial settings.
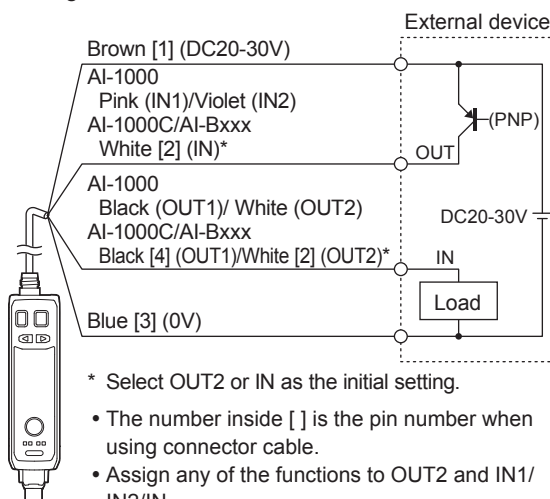
* Select OUT2 or IN as the initial setting.

- The number inside [ ] is the pin number when using connector cable.
- Assign any of the functions to OUT2 and IN1/IN2/IN.

Loose wire colors	Connector Pin No.	Model		Default value
		AI-1000	**AI-1000C AI-Bxxx**	
Brown	1	DC20-30V		-
Blue	3	0V		-
Black	4	OUT1	OUT1	-
White	2	OUT2	OUT2/IN switch	Off
Pink	-	IN1	-	Off
Violet	-	IN2	-	Off

• OUT1: Judgment output 1(fixed)

• Assignable functions for OUT2:

  Error output/Judgment output 2/Sync-output/Off

  (Unused)

• Assignable functions for IN1/IN2 or IN:

  Bank-A/Bank-B/Bank*/Hold (level)/Hold (edge)/

  Reset/External calibration/Sync-input/Light off/Off

  (Unused)

  * When IN is selected in AI-1000C/AI-Bxxx.

• Connector Pin Layout

 M12 connector   M8 connector

• Cable specification

  • AI-1000   Brown/Blue: $0.34mm^2$
              Black/White/Pink/Violet: $0.23mm^2$

  • M8-Loose wires cable
    for AI-1000C: $4 \times 0.2mm^2$

  • M12-Loose wires cable
    for AI-Bxxx: $4 \times 0.2mm^2$

  • M12 L-Loose wires cable
    for AI-Bxxx: $4 \times 0.2mm^2$

• The sensor case and the internal circuit are

  insulated.

Circuit Diagram

Input circuit

Non-voltage input (When NPN output is selected)

When NPN is selected in the I/O type settings, a non-voltage input circuit will be used.

- ON voltage   : 2 V or lower
- OFF current : 0.1 mA or less
- ON current   : 2 mA or less (short circuit)
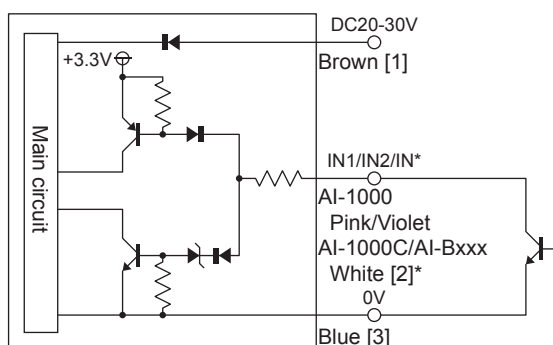
* When IN (White [2]) is selected in AI-1000C/AI-Bxxx

Voltage input (When PNP output is selected)

When PNP is selected in the I/O type settings, a voltage input circuit will be used.

- Maximum rated input   : 30 V
- ON voltage   : 18 V or greater
- ON current   : 2 mA or less (at 30 V)
- OFF current : 0.2 mA or less
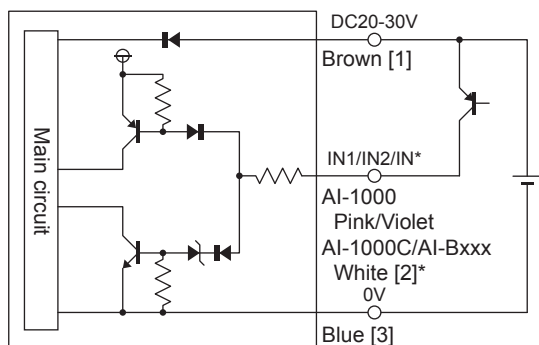
* When IN (White [2]) is selected in AI-1000C/AI-Bxxx

Output circuit

When NPN output is selected

When NPN is selected in the I/O type settings, a NPN open collector output circuit will be used.

- Maximum rating   : 30V, 50mA
- Residual voltage   : 2 V or less
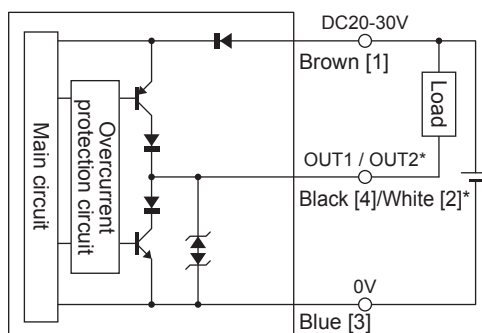
* When OUT2 (White [2]) is selected in AI-A1000C/AI-Bxxx

When PNP output is selected

When PNP is selected in the I/O type settings, a PNP open collector output circuit will be used.

- Maximum rating   : 30V, 50mA
- Residual voltage   : 2 V or less

* When OUT2 (White [2]) is selected in AI-1000C/AI-Bxxx

MEMO

3
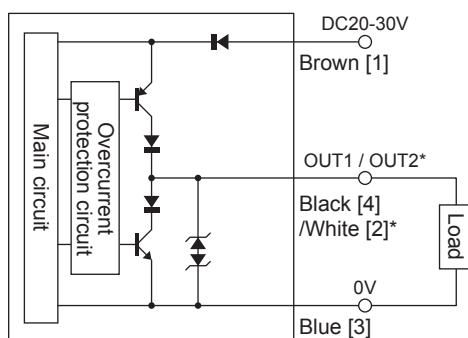
Basic Usage

This chapter explains the operations to perform when powering on the AI Series for the first time, and operations to perform when resetting the unit to factory default settings.

The basic usage section includes the overview of the screens displayed in the Standard mode (Presence check/Difference check) and their operations, calibration and adjustment of tolerance values.

3

Basic Usage

Operating When Powering On for the First Time

For the first time startup, or when the initial reset is performed, the initial settings will be implemented.

> ✎ **Point**
>
> • When the initial settings are completed, the initial setting screen will not be displayed from the next time turning on the power. To change settings other than the language setting, the initial reset is required.
>   📖 "Initial reset (Initialization)" (Page 4-5)
>   📖 "D10. Language" (Page 4-15)
> • Until the initial settings are completed, OUT1 is undefined. (Only when factory default)

1 Select a language with the [▲]/[▼] button, and press the [MODE] button to confirm.

```
1 Language
    English     ⬍
         Next ↵
```
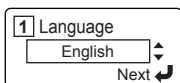
2 Select an I/O type with the [▲]/[▼] button, and press the [MODE] button.

```
2 I/O type
    NPN         ⬍
         Next ↵
```
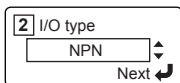
NPN   :NPN output/Non-voltage input
PNP   :PNP output/Voltage input
IO-Link(PNP) :IO-Link

• When "IO-Link(PNP)" has been selected in the I/O type, select the presence of current consumption limit, and press the [MODE] button.

```
2-1 Current limit
     Off         ⬍
          Next ↵
```
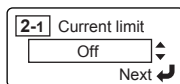
Off : Does not restrict the current consumption of the controller.
On   : Restricts the current consumption of the controller to 200mA or lower.

• When using other than AI-1000, the "I/O select" selection screen appears. Select a function for the white line or the No.2 pin of the connector. Select a function and press the [MODE] button.

```
3 I/O select
    Out 1 + Input  ⬍
          Next ↵
```
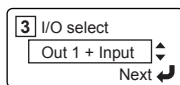
Output1 + Input   : Used as input (IN).
Output1 + Output2 : Used as output (OUT2).

3 Press the [MODE] button.

If the I/O type has been changed to "IO-Link(PNP)", press the [MODE] button to restart it.

4 Select the Detection mode.

Standard mode (Presence/Difference check mode):
It is selected in the initial settings. Directly proceed to step 5.
Feeder mode:
Select "Feeder mode" in "Z1. Application mode" (Page 4-18)

5 Perform calibration.

Standard mode (Presence/Difference check mode):
📖 "Calibration (Registration of Standard Targets)" (Page 3-4)
Feeder mode:
📖 "Calibration (Registration of Standard Targets)" (Page 5-7)

Basic Operations on Run Screen

[▲] UP button
[▼] DOWN button

[BACK] button

[SET] button

[MODE] button

[▲] UP button
[▼] DOWN button

[BACK] button

[MODE] button

[SET] button

3

Basic Usage
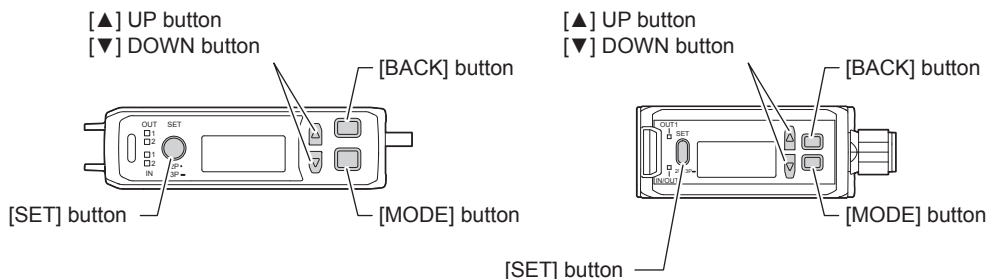
Changing display screen

Short press [MODE] or [BACK] button. The display details can be changed when the button is pressed each time.

📖 "Changing display screen" (Page 4-3)

📖 "Changing of display screen" (Page 5-4)

Adjusting setting value (Threshold)

On the screen where the setting value is displayed, short press or press and hold [▲] or [▼]. When using judgment output 2, select the setting value adjusted by [MODE] or [BACK] button.

📖 "Adjusting the setting values" (Page 4-5)

📖 "Adjusting the setting values" (Page 5-6)

Locking/Unlocking

Press and hold the [BACK] button and the [MODE] button together.

📖 "Key lock function" (Page 4-5)

Switching bank number

Hold the [MODE] button and press the [▲] or [▼] button to switch the bank number.

📖 "Bank Function" (Page 3-6)

Starting calibration

Short press the [SET] button.

📖 "Calibration (Registration of Standard Targets)" (Page 3-4)

📖 "Calibration (Registration of Standard Targets)" (Page 5-7)

Changing detailed settings

Press and hold the [MODE] button.

📖 "Operations on Settings Screen" (Page 4-6)

📖 "Operations on Settings Screen" (Page 5-8)

Clearing statistics

Press and hold the [BACK] button on the screen where statistics is displayed.

Canceling operation

Short press [BACK] button on the screen being displayed.

Initial reset (Initialization)

Hold the [MODE] button and press the [SET] button 5 times from the run screen. Follow the on-screen operations. Perform calibration after initialization.

📖 "Initial reset (Initialization)" (Page 4-5)

Reference

For details about operations on run screen, refer to the followings:

Presence Presence/Difference check mode (standard mode):

📖 "Operations on Run Screen" (Page 4-2)

Feeder mode:

📖 "Operations on Run Screen" (Page 5-3)

Calibration (Registration of Standard Targets)

This device reqires calibration which registers the shape and brightness of the target object. "Presence check" and "Difference check" can be selected in the calibration detection mode in option.

For details about feeder mode, refer to 📖 "Calibration (Registration of Standard Targets)" (Page 5-7).

1. Start a calibration.

Press the [SET] button.

2. Select a detection mode.

Select the mode with the UP/DOWN button, and press the [SET] button.

Mode selection

►Presence check — Detects if there is an object.

►Difference check — Determines the object shape and its orientation.

►Presence check — Object presence detection mode. This detects the presence of moving or stationary targets.

►Difference check — Check difference for orientation, and presence of assemblies.

3. Register a workpiece (Presence)

Use the [MODE] button and [UP/DOWN] button to enlarge the object.

Select zoom function

Adjust magnification/ position

Press the [SET] button.

Example: Presence detection Spring

Example: Presence detection Adhesive

YES (ON)

YES (ON)

4. Register nothing (Absence)

Press the [SET] button.

NO (OFF)

NO (OFF)

The settings are completed.

3. Register the OK workpiece

Use the [MODE] button and [UP/DOWN] button to enlarge the part you want to check.

Select zoom function

Adjust magnification/ position

Press the [SET] button.

Example: Orientation

Example: Assembly

OK (ON)

OK (ON)

4. Register the NG workpiece

Press the [SET] button.

NG (OFF)

NG (OFF)

5. Register nothing (Background)

NO (OFF)

NO (OFF)

The settings are completed.

3

Basic Usage

Point

- Make sure that the object is stationary during calibration.
- Zoom function (enlarge/reduce/position adjustment)
  During the registration in step 3, use the zoom function to adjust the magnification and zoom position. Enlarge the object or the part you want to check and register it so that the detection can be stabilized.

[▲] Enlarge

[▲] Move to the right

[▲] Move to the top

[MODE]

[MODE]

<< >>

[▼] Reduce

[▼] Move to the left

[▼] Move to the bottom
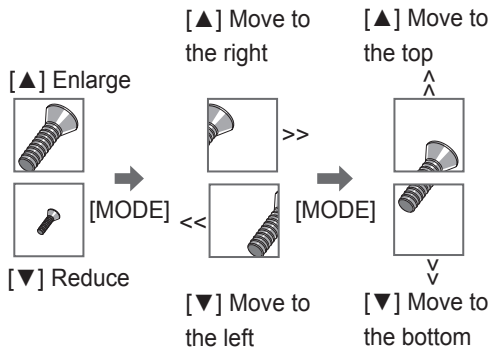
- Points for Stabilizing Detections
  Refer to 📖 "Points for stabilizing detection" (Page A-2).

3

Basic Usage

Bank Function

Bank function (Changeover)

The bank function can be used to register up to four patterns and some settings. The settings of the target will be registered in the currently selected bank. The bank function can be used to switch settings registered in advance, according to the various types of differences between products, etc.

> **\ Point**
>
> • "Standard" and "Feeder Mode" in "Z1. App. mode" cannot be switched using the bank function.
> • If "Z1. App. mode" is changed, the entire bank will be initialized including its registered information.

Settings registered in the bank

■ When "Z1. App. mode" is "Standard"

• Calibration registration information
• Detection range (Zoom ratio/Zoom position)
• Setting value (OUT1/OUT2)
• A1. Response time/A2. Filter/A5.Anti-blur/A6. Diff. chk. mode

■ When "Z1. App. mode" is "Feeder mode"

• Calibration registration information
• Detection range (Zoom ratio/Zoom position)
• Setting value (OUT1/OUT2)
• Trigger position/Trigger threshold
• P1. Response time/P2. Direction/P3.Anti-blur

No. of banks

Model	I/O type	I/O select	Supported No. of banks
AI-1000	Any	Any	4
AI-1000C AI-Bxxx	NPN/PNP	Output 1 + Input	2
		Output 1 + Output 2	1 (No bank)
	IO-Link (PNP)	Any	4

How to switch Bank

■ Switching the bank number using key input

• Select "X1. Bank select".
 📖 "X. Bank Select" (Page 4-16)
• Hold the [MODE] button and press the [▲] or [▼] button on the run screen to switch the bank number.
 📖 "Operations on Run Screen" (Page 4-2)
• The bank will switch to the bank number selected on the "X2. Select" screen.
 📖 "X. Bank Select" (Page 4-16)

> **Reference**
>
> • The selected bank number is retained even if the power is switched off.
> • If "X1. Bank select" is "by ext. input", bank cannot be switched via key input. When an attempt is made to switch the bank via key input, "Bank selected by ext. input" will appear on the screen.

■ Switching the bank by external input line

- Select "by ext. input" in "X1. Bank select".
  📖 "X. Bank Select" (Page 4-16)
- Assign "Bank-A" and "Bank-B" according to the number of banks used in "C4/R5. Input 1 function" and "C5/R6. Input 2 function".
  📖 "C4. Input 1 function (Input function*)/C5. Input 2 function" (Page 4-9)
- If an input line assigned with "Bank-A" or "Bank-B" is retained in the state described below, it will switch to the specified bank number.

Bank number	Bank-A	Bank-B
Bank 0	Off	Off
Bank 1	On	Off
Bank 2	Off	On
Bank 3	On	On

When the input format is NPN
  On: Short circuit with the 0 V line
  Off: Open state
When the input format is PNP
  On: Voltage applied state
  Off: Open state

- "Bank-A" or "Bank-B" not assigned to an input line is treated as input Off.
- For more details on the control method, refer to
  📖 "Bank function (Changeover)" (Page 3-6).

■ Switching the bank number in IO-Link

- Refer to the AI Series User's Manual (IO-Link Edition) for details of the setting method.

3

Basic Usage

MEMO

3

Basic Usage

4

Presence/Difference Check Mode Settings

This chapter explains the setting methods when using Presence check and Difference check in the modes.

Operations on Run Screen

▲ UP / ▼ DOWN   Ⓑ [BACK]

Ⓢ [SET]   Ⓜ [MODE]

4

Presence/Difference Check Mode Settings

Run screen

```
B
N  900
K
0  500
```

Starting calibration   calibration screen   (📖 page 3-4)
Ⓢ
▶ Presence check
Difference check

Complete calibration

Changing detailed settings   Settings screen   (📖 page 4-6)
Ⓜ Press and hold

A ⚙ Sensor   B
   settings   N
             K
             0

Complete setting

Switching bank number   Bank select screen   (📖 page 3-6)
Ⓜ + ▲ / Ⓜ + ▼

Change to
Bank 0

Ⓜ + ▲ Increase bank number
Ⓜ + ▼ Decrease bank number

Release Ⓜ

When key lock is not set

Locking   Locking screen   (📖 page 4-5)
Ⓜ + Ⓑ Press and hold

ⓘ Locked

Complete locking

When key lock is enabled

Unlocking   (📖 page 4-5)   Password screen   Incorrect   Incorrect password screen
Ⓜ + Ⓑ Press and hold   password

Unlock password   Ⓜ
0000   ⓘ Incorrect
Enter ↵   Ⓑ   password

* Only when password lock is on.   Correct
▲ Increase ▼ Decrease   password

Unlocking screen

ⓘ Unlocked

Complete unlocking

Disable unlocking

Initial reset (initialization)   Initial reset screen   (📖 page 4-5)   Initializing screen
Ⓜ + Ⓢ 5 times

Proceed   Press Ⓜ on "OK" selected.   Initializing...
initialization?
Cancel

Switching "OK" and   Initial settings screen
"Cancel" by ▲/▼

1 Language
English
Next ↵

Perform the initial settings.
(📖 page 3-2)

Changing display screen

Ⓜ [MODE] ⬆ Up
Ⓑ [BACK] ⬇ Down

Matching rate + Judged image

When "HOLD (level or edge)" is not used on C4/C5. Input function.

BANK0 900 500⬍

When the output 2 is "std.output 2"

BANK0 900 ①500⬍ ②600
↓Ⓜ ↑Ⓑ
BANK0 900 ①500 ②600⬍

⬆ Increase setting value (threshold)
⬇ Decrease setting value (threshold)

Matching rate + Judged image + LIVE image

When "HOLD (level or edge)" is used on C4/C5. Input function.

BANK0 900 500⬍

When the output 2 is "std.output 2"

BANK0 900 500 ①⬍
↓Ⓜ ↑Ⓑ
BANK0 900 ②⬍ 600

⬆ Increase setting value (threshold)
⬇ Decrease setting value (threshold)

Ⓜ ← Ⓜ
Ⓑ Ⓑ

Judged image + registerd image

Presence/OK workpiece

BANK0 OK ⬇→

NG workpiece*

BANK0 NG ⬇→

Nothing (background)

BANK0 BG

Left : Judged image
Right : Registered image on calibration

Ⓜ↓ ↑Ⓑ   * Only when in Difference check mode   Guide line (frame) is displayed only in the Difference check mode.

Present matching rate

BANK0 900 500⬍

⬆ Increase setting value (threshold)
⬇ Decrease setting value (threshold)

When the output 2 is "std.output 2"

BANK0 900 ①500⬍ ②600 →Ⓜ/Ⓑ→ BANK0 900 ①500 ②600⬍

Ⓜ↓ ↑Ⓑ   Statistics of matching rate (Displayed when D7. Statistics of matching rate is set to "Display on".)

Present matching rate   Maximum matching rate   Minimum matching rate   ⒷPress and hold   Clear statistics value

LIVE 900 Max 950 Min 100 ⬇→ LIVE 900 Max 950 Min 100 ⬇→ LIVE 900 Max 950 Min 100

Ⓜ↓ ↑Ⓑ

When "Hold (edge)" is not used on C4/C5. Input function.

Newest peak matching rate   Newest bottom matching rate   Minimum peak matching rate   Maximum bottom matching rate

Peak 950 Btm. 100 P.min 700 B.max 350 ⬇→ Peak 950 Btm. 100 P.min 700 B.max 350 ⬇→ Peak 950 Btm. 100 P.min 700 B.max 350 ⬇→ Peak 950 Btm. 100 P.min 700 B.max 350

When "Hold (edge)" is used on C4/C5. Input function.

Present matching rate   OK minimum matching rate*   NG maximum matching rate *

LIVE 900 OKmin 700 NGmax 350 ⬇→ LIVE 900 OKmin 700 NGmax 350 ⬇→ LIVE 900 OKmin 700 NGmax 350

* The screen displays when D9. Reverse OK/NG is set to display off. If D9. Reverse OK/NG is set to display on, the OLED screen displays "NG maximum matching rate" and "OK minimum matching rate".

Ⓜ↓ ↑Ⓑ

NG hold (Displayed when D8. NG hold is set to "Display on".)

ⒷPress and hold
Clear NG hold screen

NG HOLD 100

Function of display screen

Matching rate + Judged image
When "Hold (level/edge)" is not used
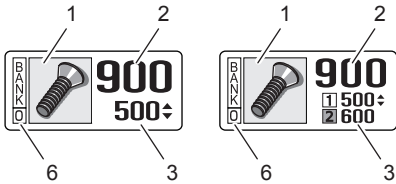
Matching rate + Judged image + LIVE image
When "Hold (level/edge)" is used
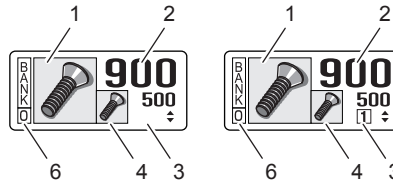
LIVE image + Registered image
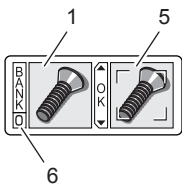
Present matching rate
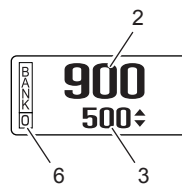
1   Judged image

Displays the image of the judged object.

When "Hold" is not used: Present images are displayed.

When "Hold (level)" is used: Held target images are displayed during being held. Present images are
                                displayed during hold-off.

When "Hold (edge)" is used: Held target images are displayed. The image will be held until the next
                                object is judged.

2   Matching rate

Displays the matching rate of the judged object.

3   Setting value (Threshold)

The threshold for judging the object as "Pass/Fail". When using "std.output 2", displays setting values
of judgment output 1 and 2.

4   LIVE image

Displays the current image.

5   Registered image

Displays the image registered during calibration.

You can select the image by [▲/▼] button.

Presence check mode: Displays the image of Presence/Absence workpiece.

Difference check mode: Displays image of OK workpiece/NG workpiece/Nothing(background).

6   Bank number

Displays the bank number currently being selected.

Adjusting the setting values

The detection reference setting value is set automatically during the calibration. If the judgment by the value (threshold) set automatically is unstable, it can also be adjusted manually.

1 **Press the [MODE] button on the run screen and select the screen that displays the threshold values.**

If OUT2 is enabled, select either OUT1 or OUT2 using the [MODE] button.

2 **Press the [▲]/[▼] button.**

The setting value will be changed.

Reference

- Holding the [▲]/[▼] buttons will cause the setting value to cycle continuously.
- Holding the [▲]/[▼] buttons longer will cause a larger change in the setting value.
- OUT2 setting values

Setting value	Calibration	External Calibration
OUT1	Adjusted automatically	Adjusted automatically
OUT2	Set to the same value as OUT1	No change

Key lock function

Key lock

1 **Press and hold the [BACK] button and the [MODE] button together on the run screen.**

This will enable the key lock.

Reference

- While the key lock is enabled, switching of the display using [BACK] and [MODE] buttons is the only available operation.
- A password needs to be set in advance in order to release the key lock using a password.

  ☐ "D5. Password lock" (Page 4-11)
  ☐ "S5. Password lock" (Page 5-12)

Release key lock

1 **Press and hold both [BACK] and [MODE] buttons.**

When using the password lock function, press the [▲]/[▼] button and enter the password, and then press the [MODE] button.
This will release the key lock.

✎ Point

If the password lock function is enabled, the unit returns to the run screen when a wrong password is entered.

Initial reset (Initialization)

The following operation will initialize the sensor settings.

1 **Hold the [MODE] button and press the [SET] button five times on the run screen or error screen.**

2 **Select [OK] using the [▲]/[▼] buttons, and press the [MODE] button.**

This will initialize the settings.

Reference

The initial reset can also be performed on the settings screen.

☐ "Z2. Initialize" (Page 4-18)

The initial setup screen appears.

3 **Perform the initial setup.**

☐ "Operating When Powering On for the First Time" (Page 3-2)

4

Presence/Difference Check Mode Settings

Operations on Settings Screen

Ⓜ [MODE] Ⓐ Up
Ⓑ [BACK] Ⓥ Down

In each of the following screens, select a parameter by pressing Ⓜ, change the settings by pressing Ⓥ/Ⓐ, and go back to the previous screen by pressing Ⓜ.Ⓑ
Also, press and hold Ⓜ to go back to the run screen.

Ⓜ Press and hold   Ⓑ Press / Ⓜ and hold

A ⚙ Sensor settings (Page 4-7)

A1 Response time → A2 Chatter prev. → A3 Filter times → A4 Adv. settings → A5 Anti-blur
A6 Diff. chk. mode → A Back
Back to A

B ⚙ Area adjust. (Page 4-8)

B1 Zoom → B2 L/R → B3 Up/Dn → B Back
Back to B

C ⚙ I/O settings (Page 4-9)

C1 Output 1 logic → C2 Output 2 func. → C3 Output 2 logic → C4 Input 1/Input func. → C5 Input 2 func.
C6 Ext. calib. → C7 Process data → C8 Output timer → C9 One-shot → C10 Delay time
C11 1-shot time → C12 Hysteresis → C13 Hys. value → C Back
Back to C

D ⚙ Display/Key settings (Page 4-11)

D1 Brightness → D2 Finder → D3 Display → D4 Status LED → D5 Password lock
D6 Password → D7 Statistics → D8 NG hold → D9 Reverse OK/NG → D10 Language → D Back
Back to D

X Bank select (Page 4-16)

X1 Bank select → X2 Select → X Back
Back to X

Y I/O test (Page 4-17)

Y1 Test output 1 → Y2 Test output 2 → Y Back
Back to Y

Z -App. mode -Initialize (Page 4-18)

Z1 App. mode → Z2 Initialize → Z Back
Back to Z

Back to Run mode

Conditions to display each screen described above are listed below.

A3:   When A2 is "Custom"
A5:   When A4 is "On"
A6:   When A4 is "On" and A1 is "100ms"
C2/C3: When OUT2 is an active amplifier or setting.
C4:   When IN1 is a valid amplifier or setting.
C5:   In the case of AI-1000
C6:   When the external calibration is a valid setting.
C7:   When IO-Link (PNP) is a valid setting.
C8:   When the hold (edge) is an invalid setting.
C9:   When the hold (edge) is a valid setting.

C10:   When the hold (edge) is invalid and C8 is either "On-delay" or "Off-delay"
       When the hold (edge) is valid and C9 is "On"
C11:   When the hold (edge) is invalid and C8 is "One-shot"
       When the hold (edge) is valid and C9 is "On"
C12:   When the hold (edge) is an invalid setting.
C13:   When C12 is "Custom"
D2:   In case of AI-H Amplifier
D3:   In the case of a built-in amplifier type sensor
D6:   When D5 is "On"
X1:   When IN1 is a valid amplifier or setting.
X2:   When X1 is "by key"
Y2:   When OUT2 is a valid amplifier or setting

4

Presence/Difference Check Mode Settings

A. Sensor Settings

Set the functions of sensor detection capability.

■ Displaying "A. Sensor settings" screen

1 Press and hold the [MODE] button on the run screen.

The "A. Sensor settings" screen appears.
📖 "Operations on Settings Screen" (Page 4-6)

A1. Response time

Set the time duration from the moment when the object is recognized by the sensor until a signal output.
• Set a longer response time when detecting with high accuracy and/or a dark object.
• The response time should be set lower when detecting an object with high movement speed.
Select from 3ms/10ms/20ms/50ms/100ms.
(Default value AI-H010/020: 10ms, AI-x050/100: 20ms, AI-x160: 50ms)

A2. Chatter prev.

Set the matching rate processing filter.
Utilize the maximum matching rate among the data for the settings, and it reduces the variation. (Default: On)

Off: Filter process is not performed.
On: Use the data for the last 3 times to run the processing filter.
Custom: Use the data for the number of times set to run the filter processing.

Operation example of the filter function

Filter	Change in matching rate							
Off	900	700	860	840	600	800	780	760
3 times	900	900	900	860	860	840	800	800
5 times	900	900	900	900	900	860	860	840

*The maximum matching rate before 900 in the table is assumed as 900.

✎ Point
• Chattering can be prevented by matching rate fluctuation that may occur when the object exits the detection range (i.e. when the matching rate drops).
• The higher the filter count, the more effective the chattering prevention will be. However, this will also increase the response delay that occurs when the matching rate decreases.
• Depending on the state of the response delay, the judged image and the displayed matching rate may not match.
• The response delay that occurs when the matching rate increases is not affected by the filter count.

A3. Filter times

Use the sampling data up until the last several times for the user settings, and run the filter processing and set it in the range of 2 to 50 times. (Default: 3 times)

A4. Advanced settings

Select to display/hide the advanced setting screen. (Default: Off)

A5. Anti-blur

When a calibration is needed to reduce blurring of a fast-moving object, select On. The light-emitting time is shortened. (Default: Off)

✎ Point
• Turn this option On when the image of the object is blurred on the matching rate statistics screen, NG hold screen, etc. due to its movement speed.
• If this is not effective, shorten "A1. Response time".

A6. Difference (Diff. chk. mode)

Used to check differences in incoming parts' orientation. Valid only when the response time is set to 100 ms. (Default: Dir-det. on)

Example

Dir-det. on: The matching rate decreases when the orientation of the OK workpiece changes approx. ±20° or greater. This enables the directional detection of the object.
Dir-det. off: The matching rate does not decrease even when the orientation of the OK workpiece changes. The directional change of the object is not detected.

During calibration

OK workpiece   NG workpiece

While the system is in operation

| Dir-det. On | OK | NG | NG | NG |
| Dir-det. Off | OK | OK | OK | NG |
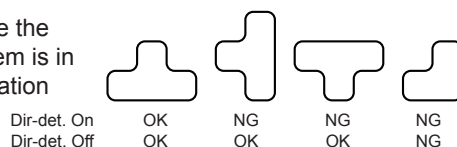
B. Area Adjustment

Set the detection range of the sensor.
Given the full detection range of the sensor, a section can be chosen in order to compensate for any mounting issues or magnification.

✎ Point

- Enlarge the object or the part you want to check and register it for more stable detection.
- When the sensor and target mounting positions are shifted, it can be fixed using [Area adjust.] without re-adjusting the mounting position of the sensor or object, as long as the shift amount is within the maximum filed of view of the sensor.

The zoom ratio and left/right/top/bottom position of the detection range can be adjusted.

Zoom ratio: The target can be enlarged from x1.0 to x4.0.

Position: The position can be moved as desired within the maximum detection range when the zoom ratio is other than x1.0.

■ **Displaying "B. Area adjustment" screen**

1 **Press and hold the [MODE] button on the run screen.**

The "A. Sensor settings" screen appears.

2 **Press the [▼] button once.**

📖 "Operations on Settings Screen" (Page 4-6)

B1. Zoom

Enlarge the detection range. There are 17 zoom levels within the range of x1.0 to x4.0. (Default: x1.0).
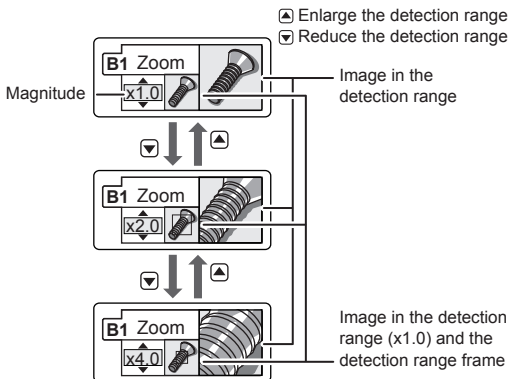
B2. Horizontal movement of detection range (L/R)

For any zoom other than x1.0, the enlarged detection range is moved horizontally.
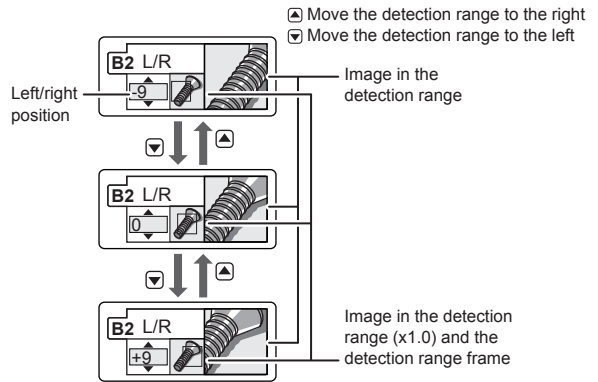
B3. Vertical movement of detection range (Up/Dn)

For any zoom other than x1.0, the enlarged detection range is moved vertically.
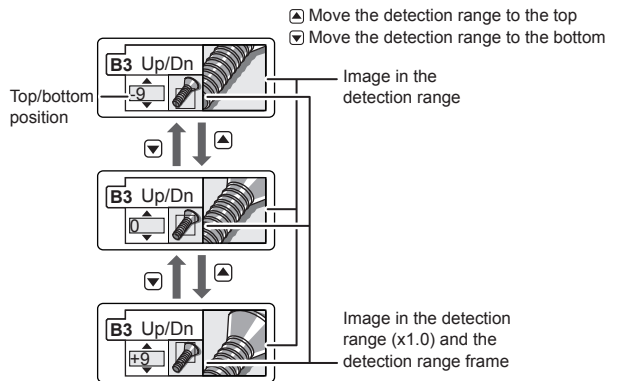
C. I/O Settings

Set I/O operation.

■ Displaying "C. I/O settings" screen

1 Press and hold the [MODE] button on the run screen.

The "A. Sensor settings" screen appears.

2 Press the [▼] button twice.

📖 "Operations on Settings Screen" (Page 4-6)

C1. Output 1 logic

Set N.O./N.C. for output 1. (Default: N.O.)

C2. Output 2 function

Select the function which is assigned to output 2*. (Default: Off)

Off: Output 2 is not used.
Error output: Output signal is sent when an error occurs.
Sync-output: Prevent mutual interference by connecting to another sensor of the AI Series.
📖 "Preventing Mutual Interference (Sync-input/output)" (Page 6-13)
Std. output 2: Use the sensor with 2 output lines.
* When using AI-1000, or when OUT2 is sent to the initial settings for AI-1000C/AI-Bxxx.

C3. Output 2 logic

When the error output or the judgment output 2 is selected, set N.O./N.C. for output 2. (Default: N.O.)

C4. Input 1 function (Input function*)/ C5. Input 2 function

Select the function to be assigned to input 1/input 2/input *. (Default: Off)

Off: Input is not used.
Bank-A/Bank-B/Bank*:
Switch the bank by external input. It is enabling when selected "by ext. input" in "X1. Bank select".
📖 "Bank Function" (Page 3-6)
📖 "Changeover (Bank Input)" (Page 6-5)

Hold (level): Hold the judgment for the duration of a trigger signal.
📖 "Hold (level) input" (Page 6-6)
Hold (edge): Hold the judgment at the time of a trigger signal until next trigger signal is receiving.
📖 "Hold (edge) input" (Page 6-8)
Reset: Clear the held judgment value. Matching rate changes to "---".
📖 "Hold (level) input" (Page 6-6)
📖 "Hold (edge) input" (Page 6-8)
Light off: Turn LEDs off and stop judgment. Matching rate changes to "---".
📖 "Light Off (Projection Termination Input)" (Page 6-10)
External calibration:
Start calibration (register a workpiece) of the Presence check mode.
📖 "Registering the Object (External Calibration Input)" (Page 6-11)
Sync-input: Prevent mutual interference by connecting to another sensor of the AI Series.
📖 "Preventing Mutual Interference (Sync-input/output)" (Page 6-13)
* If IN is selected as the I/O type in the initial settings for AI-1000C/AI-Bxxx

C6. External calibration

Select a saving method for the external calibration result. (Default: Save off)

Save off: Does not save into ROM. Deleted when the power is OFF. External calibration is required the next time the power is turned on.
Save ROM: Saves into ROM. Not deleted when the power is OFF. The lifespan of the save count is 100,000 times.
📖 "Registering the Object (External Calibration Input)" (Page 6-11)

4

Presence/Difference Check Mode Settings

4

C7. Process Data

Select from Level/Edge for the hold trigger operation. (Default: Hold (level))
For more details, refer to AI Series User's Manual (IO-Link Edition).

C8. Output timer

Change the time it takes to switch the output. Select from Off/On-delay/Off-delay/One-shot. (Default: Off)
☐ "Changing Timing of Judgment Output" (Page 6-2)

C9. One-shot output

Select On/Off for One-shot. (Default: Off)
☐ "Changing Timing of Judgment Output" (Page 6-2)

C10. Delay time

Set the delay time within a range of 0 to 5000ms. (Default: 0 ms)
☐ "Changing Timing of Judgment Output" (Page 6-2)

C11. 1-shot time

Set the One-shot time within a range of 1 to 9999ms. (Default: 10 ms)
☐ "Changing Timing of Judgment Output" (Page 6-2)

C12. Hysteresis

Set the judgment hysteresis. (Default: Standard)

Standard: The hysteresis is set automatically to 100.

Custom: Use this option if a different hysteresis value is needed.

✎ Point

When using the hold (edge) input, hysteresis:0 will be used regardless of the setting value of [C12. Hysteresis].

C13. Hysteresis value

When "Custom" is selected, set any hysteresis value within a range of 0 to 999. (Default: 100)

D. Display/Key Settings

Set the display and operation functions.

■ **Displaying "D. Display/Key settings" screen**

1 **Press and hold the [MODE] button on the run screen.**

The "A. Sensor settings" screen appears.

2 **Press the [▼] button three times.**

☐ "Operations on Settings Screen" (Page 4-6)

D1. Brightness of screen

Set the OLED screen brightness. (Default: Auto-dimming)

Always-on:	The light is not reduced, or does not go out.
Auto-dimming	The brightness is reduced one minute after the last button operation. Press any button to restore the original display.
Auto-off:	The screen goes off one minute after the last button operation. Press any button to restore the original display.

D2. Finder

Set the display orientation of the target image. Select from 0°/90°/180°/270°. (Default: 0°)

Indicator light

0° (Default)

0° (Default)	90°	180°	270°
A	⊳	∀	◁
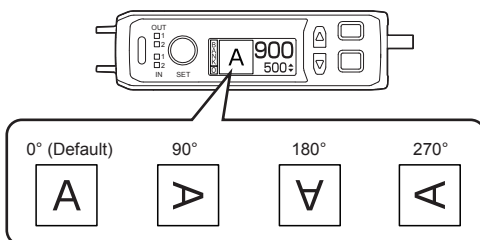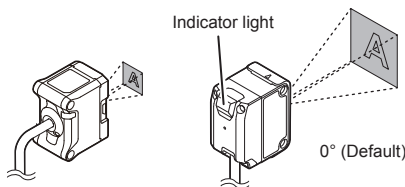
Reference

A built-in amplifier type sensor cannot be changed.

D3. Display direction

Set the screen display direction. Select from Normal/180°. (Default: Normal)

Normal	180°
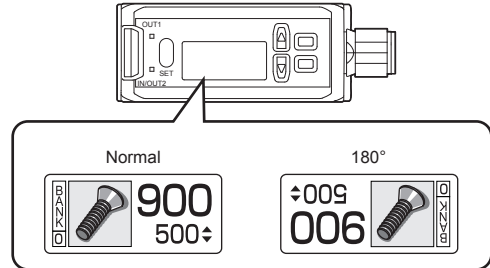
Reference

• The [▲][▼] button operations are switched in accordance with the display direction of the screen.

• The orientation of the object image is not inverted.

• The AI-H amplifier cannot be changed.

D4. Status LED

Select a color for the status indicator from Yellow/Off or Green/Red. (Default: Yellow/Off)
☐ "Operation of the indicator light" (Page 1-13)

D5. Password lock

If you would like to use a password to unlock the buttons, select "On". (Default: Off)

D6. Password

If the password lock is On, a password is set within a range of 0000 to 9999. (Default: 0000)

✎ **Point**

Store the password securely and be careful not to lose it.

4

Presence/Difference Check Mode Settings

D7. Statistics of matching rate

Display off: Statistic display screen is not displayed.

Display on: Displays "Maximum/Minimum (Max/Min)" and "Margins (Peak/Btm./P.min/B.max) or (OKmin/NGmax)" on the run screen.

For information on how to display the statistics display screen, refer to 🔲 "Operations on Run Screen" (Page 4-2).

Maximum/Minimum display

The maximum and minimum matching rate values and their images are displayed.

LIVE	900
Max	950
Min	100

LIVE:
Current matching rate and its image

⏷ ⏶

LIVE	900
Max	950
Min	100

Max:
Maximum matching rate value and its image

⏷ ⏶

LIVE	900
Max	950
Min	100

Min:
Minimum matching rate value and its image

▲/▼ : Switching between LIVE/Max/Min
Ⓑ Press and hold: Clear statistics

Matching rate

— Max.
---- LIVE
— Min.

Time
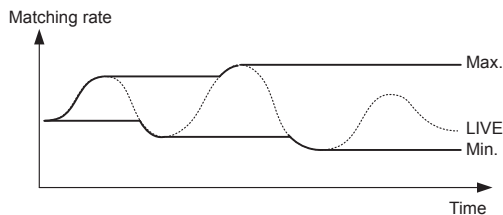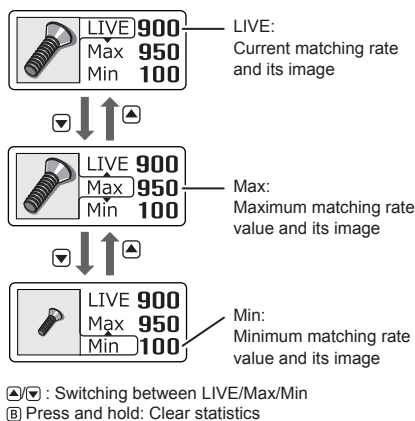
Reference

• Statistics are not applicable when the matching rate is "---" or while operation is stopped.
• The matching rate and image that are held by the hold (level) input are excluded from the statistics.
• If the hold (edge) input is enabled, the matching rate and image that are held are included in the statistics.

Margin display

■ When the hold input is not used/When the hold (level) option input is used

The peak value during ON and the bottom value during OFF are displayed. The detection is stable if the difference between P.min (minimum peak value during ON) and B.max (maximum bottom value during OFF) is large.

Peak	950
Btm.	100
P.min	700
B.max	350

Peak:
Latest value and image of the peak value when ON

⏷ ⏶

Peak	950
Btm.	100
P.min	700
B.max	350

Btm.:
Latest value and image of the bottom value when OFF

⏷ ⏶

Peak	950
Btm.	100
P.min	700
B.max	350

P.min:
Minimum value of peak value (Peak) and its image

⏷ ⏶

Peak	950
Btm.	100
P.min	700
B.max	350

B.max:
Maximum value of bottom value (Btm.) and its image

▲/▼ : Switching Peak/Btm./P.min/B.max
Ⓑ Press and hold: Clear statistics
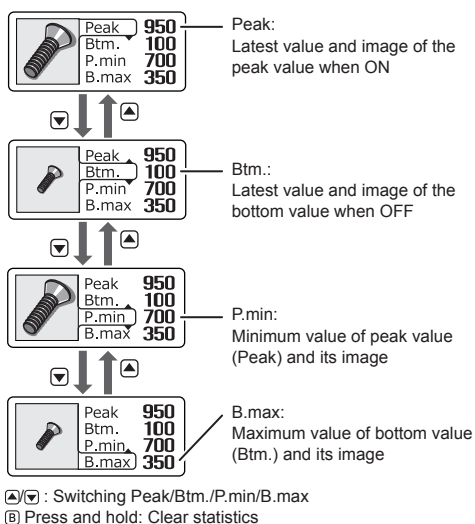
(1) Peak: The latest value and image of the bottom value when ON. Sampling is performed while in ON state, and the peak value (Peak) and image are updated when the matching rate is lower than the setting value.

(2) Btm.: The latest value and image of the bottom value when OFF. Sampling is performed while in OFF state, and the bottom value (Btm.) and image are updated when the matching rate is higher than the setting value.

(3) P.min: The minimum value of peak value (Peak). When the peak value (Peak) is updated, it is compared with the previous minimum value (P.min) and, if the peak value is smaller, the minimum value (P.min) and image will be updated. This can be used to check the margin for the setting value when an object is detected.

(4) B.max: The maximum value of bottom value (Btm.). When the bottom value (Btm.) is updated, it is compared with the previous maximum value (P.max) and, if the bottom value is greater, the maximum value (P.max) and image will be updated. This can be used to check the margin for false detections when an object is not detected.
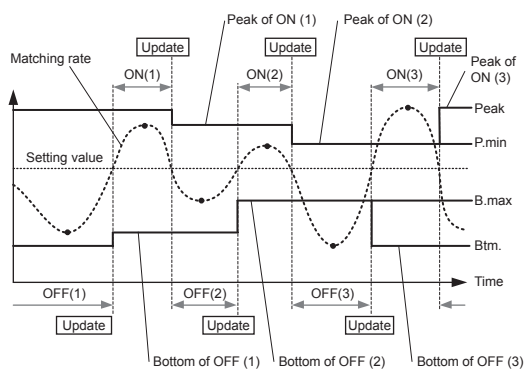
Reference

- Statistics are not applicable when the matching rate is "---".
- If the statistics result has never been updated since the statistics was cleared, the matching rate will be "---" and the image will be displayed as "No data".
- The matching rate and image in the period during which the target is held by the hold (level) input are excluded from the statistics.
- If the hold (level) input turns ON while in ON state and holds a target, or when the lighting off input turns on and the LEDs stop firing, Peak and P.min are updated using the matching rate and image up to that point.
- If the hold (level) input turns ON while in OFF state and holds a target, or when the lighting off input turns on and the LEDs stop firing, Btm. and B.max are updated using the matching rate and image up to that point.
- If the setting value (threshold) is changed, statistics processing will continue based on the new setting value. It will not be cleared.

■ When the hold (edge) input is used

The statistics of the matching rate and image of the object held by the hold (edge) input are displayed. The detection is stable if the difference between OKmin and NGmax is large.

Ⓐ/▼ : Switching LIVE/OKmini/NGmax
Ⓑ Press and hold: Clear statistics
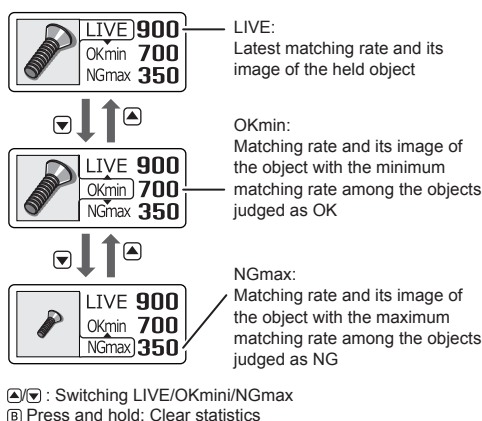
(1) LIVE: The latest matching rate and image of the held object. They are updated during the time they are held.

(2) OKmin: This is the matching rate and image of the object with the minimum matching rate among the objects judged as OK. When the LIVE value is updated, it is compared with the previous minimum value (OKmin) and, if the LIVE value is smaller, the minimum value (OKmin) and image will be updated. This can be used to check the margin between the object judged as OK and the threshold value.

(3) NGmax: This is the matching rate and image of the object with the maximum matching rate among the objects judged as NG. When the LIVE value is updated, it is compared with the previous maximum value (NGmax) and, if the LIVE value is greater, the maximum value (NGmax) and image will be updated. This can be used to check the margin between the object judged as NG and the threshold value.
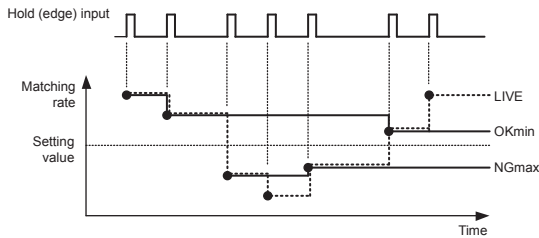
4

Presence/Difference Check Mode Settings

Reference

- Statistics are not applicable when the matching rate is "---" or while the LEDs are off.
- If the statistics result has never been updated since the statistics was cleared, the matching rate will be "---" and the image will be displayed as "No data".
- If the setting value (threshold) is changed, statistics processing continues based on the new setting value. It will not be cleared.

Clearing the statistics value

The statistics value of the Minimum/Maximum display and Margins display are cleared if the following happens:

- When the [BACK] button is held down
- Reset input
- Power Off
- When a calibration is performed/canceled
- When an external calibration is performed
- When the bank is switched
- Setting change (i.e. finish adjusting the detection range, sensor detection setting, matching rate statistics, NG hold, reverse OK/NG display, or change the input function from anything other than hold (edge) to hold (edge) or from hold (edge) to anything other than hold (edge))
- When recovered from a head error

D8. NG hold

Select the display contents of the NG hold display function. This option can be used to check the image of the latest object judged as NG. (Default: Display off)

Display off:	Not displayed.

Display on:	When the object held using the hold (edge) input function is judged as NG (output off), the latest NG object image and matching rate are displayed on the run screen.

For information on how to display the NG hold screen, refer to 📖 "Operations on Run Screen" (Page 4-2).

Point

- The NG hold is not applied when the matching rate is "---" or while the LEDs are off.
- Use this option simultaneously with the hold (edge) input function. This option will behave as described below when used with a function other than the hold (edge) input function.
  - The value is constantly updated to the latest value during NG judgment (Output off).
  - During OK judgment (Output on), the matching rate and image judged as NG immediately before receiving an OK judgment are held. In some cases, an image with the object halfway in the detection range may be held.
  - If the target is held by the hold (level) input, the NG hold image at that point in time will be held.
- The NG hold display can be cleared using the same method as clearing "D7. Matching rate statistics".

D9. Reverse OK/NG

Select the method to display the OK workpiece/NG workpiece onto the calibration screen in Difference check mode. If On is selected, an object with a high matching rate is registered as "NG workpiece". Then output can be set to On (N.O.) for NG workpieces. (Default: Off)

Operations when Off (Default)

	Matching rate	Output (N.O.)	Output (N.C.)
OK workpiece	High	On	Off
NG workpiece	Low	Off	On
No workpiece	Low	Off	On

Operations when On

	Matching rate	Output (N.O.)	Output (N.C.)
OK workpiece	Low	Off	On
NG workpiece	High	On	Off
No workpiece	Low	Off	On

D10. Language

Select a display language. Select from English/ Japanese/English/Chinese (Simplified).

4

Presence/Difference Check Mode Settings

X. Bank Select

Select how to switch banks.

📖 "Bank Function" (Page 3-6)

📖 "Changeover (Bank Input)" (Page 6-5)

■ **Displaying "X. Bank select" screen**

1 **Press and hold the [MODE] button on the run screen.**

The "A. Sensor settings" screen appears.

2 **Press the [▼] button four times.**

📖 "Operations on Settings Screen" (Page 4-6)

X1. Bank select

Set the bank switching method. (Default: by key)
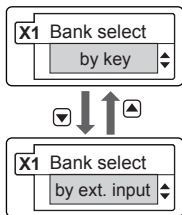
by key:　　　　The bank can be switched by key input.

by ext. input:　The bank can be switched by external input.

X2. Select

If key input is selected to bank switching method, select a bank number to switch to.

▲ Increase bank number
▼ Decrease bank number

Reference

The banks can also be cycled by pressing the [▲] or [▼] button while holding down the [MODE] button on the run screen.

📖 "Operations on Run Screen" (Page 4-2)

4

Presence/Difference Check Mode Settings

Y. I/O Test

Use this test to confirm that the input/output wires are wired correctly. If the input line is set to On during I/O test, the input indicator lights up.

■ Displaying "Y. I/O test" screen

1 Press and hold the [MODE] button on the run screen.

The "A. Sensor settings" screen appears.

2 Press the [▼] button five times.

📖 "Operations on Settings Screen" (Page 4-6)

Y1. Output 1 test/Y2. Output 2 test

Off: Turn off output 1 or output 2. Output indicator light turns off.

On: Turn on output 1 or output 2. Output Indicator lights up.

✎ Point

Input test

• Run the test after setting the input line to Off using the input function.

• If a function has been assigned to the input line, the assigned function will be executed. In particular, be careful not to perform external calibration by mistake.

Output test

• It is also possible to test an output whose assignment has been set to Off using the output function.

4

Presence/Difference Check Mode Settings

Z. Application/Initialization

This section explains how to change the application mode and initialize sensor settings.

■ Displaying "Z. Application/Initialize" screen

1 Press and hold the [MODE] button on the run screen.

The "A. Sensor settings" screen appears.

2 Press the [▼] button six times.

📖 "Operations on Settings Screen" (Page 4-6)

Z1. Application mode

Select an application mode. If changed, the settings will be initialized. (Default: Standard)

Standard:　　　Select it when a general object is detected. "Presence check" and "Difference check" modes are available in this mode.

Feeder mode:　 Select it when any of the objects to be detected are transported by part feeders.

Z2. Initialize

The setting are initialized and restored to the default.

Reference

It is also possible to initialize the settings by holding down the [MODE] button and pressing the [SET] button five times on the run screen or error screen.

📖 "Operations on Run Screen" (Page 4-2)

4

Presence/Difference Check Mode Settings

5

Feeder Mode Settings

Feeder mode is used when detecting the orientation of the object transported by a part feeder and detecting parts of a different type. This chapter explains the setting method when using the Feeder mode.

To switch to Feeder mode, select "Feeder mode" in 📖 "Z1. Application mode" (Page 4-18).

The following items are the same as in Standard mode. For more details, refer to the description for Standard mode.

Q. Area adjustment
📖 "B. Area Adjustment" (Page 4-8)

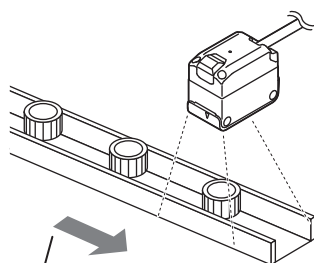X. Bank select
📖 "X. Bank Select" (Page 4-16)
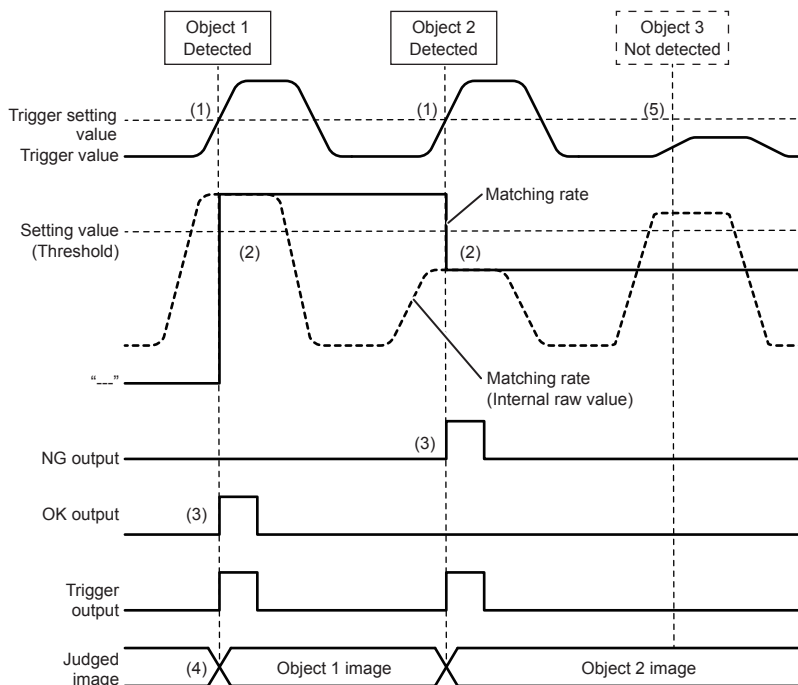
Y. I/O Test
📖 "Y. I/O Test" (Page 4-17)

Z. Application/Initialize
📖 "Z. Application/Initialization" (Page 4-18)

5

Feeder Mode Settings

Feeder Mode Operation

Traveling direction of the object on the part feeder

(1) The trigger value increases when the object enters the trigger position of the detection range. When the trigger value exceeds the trigger setting value, the object is detected and a judgment is performed. When the judgment is performed, a one shot (fixed duration) output is signaled.

📖 "How to register the trigger position" (Page 5-7)

(2) The target is judged as OK if the matching rate exceeds the setting value (threshold). The target is judged as NG if the matching rate is below the setting value (threshold).

(3) If judged as NG, a one shot output of NG is signaled. If judged as OK, a one shot output of OK is signaled.

(4) The image displayed will reflect the latest judgment result (matching rate/image).

(5) No judgment is performed if the object 3 is within the detection range but the trigger value does not exceed the trigger setting value. Adjust the trigger position and trigger setting values as needed.

Point

The detection will be unstable if the difference between the maximum (when the object is passing through) and minimum (when there is a gap between targets) of the trigger value is small. Check the margin in 📖 "Trigger value margin display" (Page 5-14).

Operations on Run Screen

⬆ UP / ⬇ DOWN Ⓑ [BACK]

Ⓢ [SET] Ⓜ [MODE]

Run screen

|B A N K 0| 900 / 500 |

Starting calibration
Ⓢ

Calibration screen
(Feeder mode) (📖 page 5-7)

ⓘ Feeder mode calibration

Complete calibration

Changing detailed settings
Ⓜ Press and hold

Settings screen (📖 page 5-8)

P ⚙ Sensor settings B N K 0

Complete setting

Switching bank number
Ⓜ + ⬆ / Ⓜ + ⬇

Bank select screen (📖 page 3-6)

Change to Bank 0

Ⓜ + ⬆ Increase bank number
Ⓜ + ⬇ Decrease bank number

Release Ⓜ

When key lock is not set

Locking
Ⓜ + Ⓑ Press and hold

Locking screen (📖 page 4-5)

ⓘ Locked

Complete locking

When key lock is enabled

Unlocking (📖 page 4-5)
Ⓜ + Ⓑ Press and hold

Password screen

Unlock password
0000
Enter ↵

Ⓜ

Ⓑ

Incorrect password

Incorrect password screen

ⓘ Incorrect password

Correct password

* Only when password lock is on.
⬆ Increase ⬇ Decrease

Unlocking screen

ⓘ Unlocked

Complete unlocking

Disable unlocking

Initial reset (initialization)
Ⓜ + Ⓢ 5 times

Initial reset screen (📖 page 4-5)

Proceed initialization?
Cancel

Press Ⓜ on "OK" selected.

Initializing screen

Initializing...

Switching "OK" and "Cancel" by ⬆ / ⬇

Initial settings screen

1 Language
English
Next ↵

Perform the initial settings.
(📖 page 3-2)

5

Feeder Mode Settings

Changing of display screen

Matching rate + Judged image + LIVE image

M [MODE]   ▲ Up
B [BACK]   ▼ Down

▲ Increase setting value (threshold)
▼ Decrease setting value (threshold)

LIVE image + Trigger value

▲ Increase setting value (threshold)
▼ Decrease setting value (threshold)

Judged image + registered image

OK workpiece   Trigger position   Nothing (background)

Left : Judged image
Right : Registered image on calibration

Count value

B Press and hold   Clear count value

When S7. Statistics of matching rate is display on.

Present matching rate   Maximum matching rate   Minimum matching rate   B Press and hold   Clear statistics value

Present matching rate   OK minimum matching rate   NG maximum matching rate

When S8. Trigger statistics is display on.

Present Trigger Value   Maximum Trigger Value   Minimum Trigger Value   B Press and hold   Clear statistics value

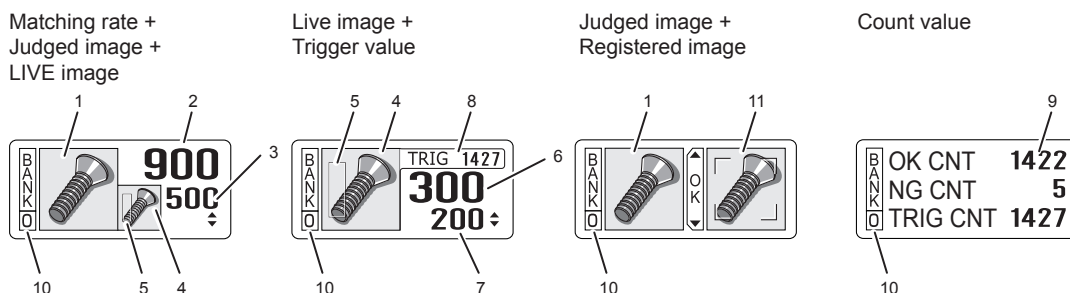
Newest peak Trigger Value   Newest bottom Trigger Value   Minimum peak Trigger Value

When S9. NG hold is display on.

B Press and hold
Clear NG hold screen

5

Feeder Mode Settings

Function of display screen

Matching rate +
Judged image +
LIVE image

Live image +
Trigger value

Judged image +
Registered image

Count value

1   Judged image

Displays the image of the judged object. The image is held until the next object is judged.

2   Matching rate

Displays the matching rate of the judged object. The image is held until the next object is judged.

3   Setting value (Threshold)

The threshold for judging the object as "Pass/Fail".

4   LIVE image

Displays the current image.

5   Trigger position

The area that the object must enter in order to automatically trigger the sensor.

6   Trigger value

The current value in the trigger position area. The trigger value increases more of the object is in the trigger position area. The value decreases when there is no object within the range.

7   Trigger setting value

The threshold for the trigger value.

8   Trigger count

Counts and displays the total number of judged objects (0 to 9999). The background will be white while the trigger value is higher than the trigger setting value.

9   Count value

The number of objects judged as OK, the number of objects judged as NG, and the total number of judged objects are counted and displayed.

10 Bank number

Displays the bank number currently being selected.

11 Registered image

Displays the image registered during calibration. The OK workpiece/Trigger position/No workpiece (background) can be selected by [▲/▼] button.

Reference

About OK count/NG count/Trigger count

- The count range is 0 to 999999. The count stops at the maximum value when it reaches the maximum value.
- The upper limit of the trigger count on the "LIVE image + Trigger value" screen is 9999. The count stops at 9999 when it reaches 9999. If the count over 9999, check it on the "Count value" screen.
- The clear method is same as the method of "S7. Statistics of matching rate" (Page 5-12).

5

Feeder Mode Settings

Adjusting the setting values

The setting value for the OK/NG judgment of the object is set automatically during calibration. If the judgment by the value (threshold) set automatically is unstable, it can also be adjusted manually.

1 **Press the [MODE] button on the run screen and select the screen on which the setting values are displayed.**

📖 "Changing of display screen" (Page 5-4)

2 **Press the [▲]/[▼] button.**

The setting value will be changed.

Reference

• Holding the [▲]/[▼] buttons will cause the setting value to cycle continuously.

• Holding the [▲]/[▼] buttons longer will cause a larger change in the setting value.

Adjusting the trigger setting values

The trigger setting value is the threshold for the trigger value to detect the object which is to be judged when it enters the detection range. Its default value is 200. Adjust the trigger setting value if the detection of the object is unstable.

1 **Press the [MODE] button on the run screen and select the screen on which the trigger setting value is displayed.**

📖 "Changing of display screen" (Page 5-4)

2 **Press the [▲]/[▼] button.**

The trigger setting value will be changed.
Setting range: 0 to 999 (Default: 200)

Point

Set the trigger setting value to a threshold value that can not only detect objects judged as OK, but also those judged as NG (i.e. different orientation/type).

Key lock function

For more details of the key lock function, refer to 📖 "Key lock function" (Page 4-5).
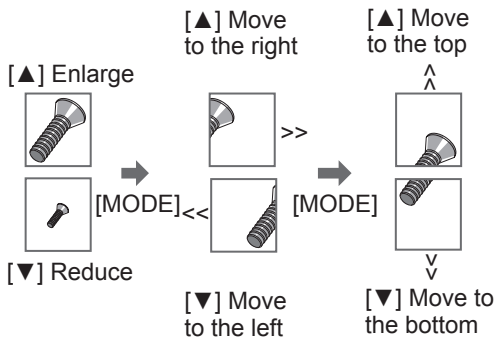
Initial reset (Initialization)

For more details on the initial reset, refer to 📖 "Initial reset (Initialization)" (Page 4-5).

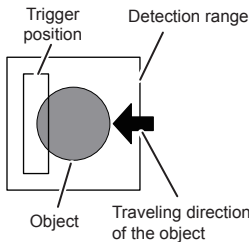# Calibration (Registration of Standard Targets)

Feeder mode requires a calibration to register the shape, brightness and trigger position of the object to be used as the master part. The trigger position is used to detect the object to be judged when it enters the detection range. OK/NG judgment of the object is performed after the object has been detected.

✎ Point

- Make sure that the object is stationary during calibration.
- Use zoom functions as needed (Enlarge/Reduce/Adjust Position)
  During the registration in step 2, use the zoom function to adjust the zoom ratio and zoom position. Enlarge the object or part you want to check and register it so that the detection is stable.

[▲] Enlarge

[▲] Move to the right [▲] Move to the top

[MODE] >> [MODE]

[▼] Reduce

[▼] Move to the left [▼] Move to the bottom

- How to register the trigger position

Trigger position Detection range

Object Traveling direction of the object

- Position the trigger in the traveling direction of the object such that it will pass through the trigger position.
- Position the trigger such that the front edge of the object registered as OK in the traveling direction is inside the trigger position.

Good example   Bad example   Bad example
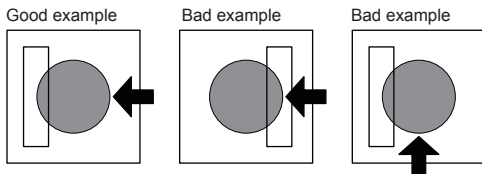
Not placed at the front edge in the traveling direction.
The object will be judged before it enters the detection range.

Not placed in the traveling direction. The object may be missed due to the fluctuations in the passing through position.

- For tips on stabilizing detection refer to
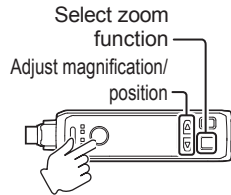 📖 "Points for stabilizing detection" (Page A-2).
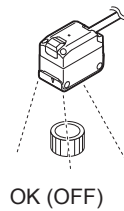
1. Start calibration.
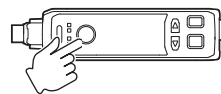
Press the [SET] button.
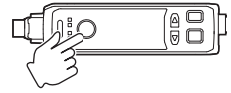
2. Register the OK workpiece

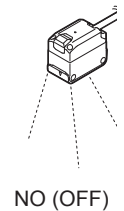Use the [MODE] button and [UP/DOWN] button to enlarge the object.

Select zoom function
Adjust magnification/position

Press the [SET] button.

OK (OFF)

3. Register nothing (Background)

Press the [SET] button.

NO (OFF)

4. Register trigger position

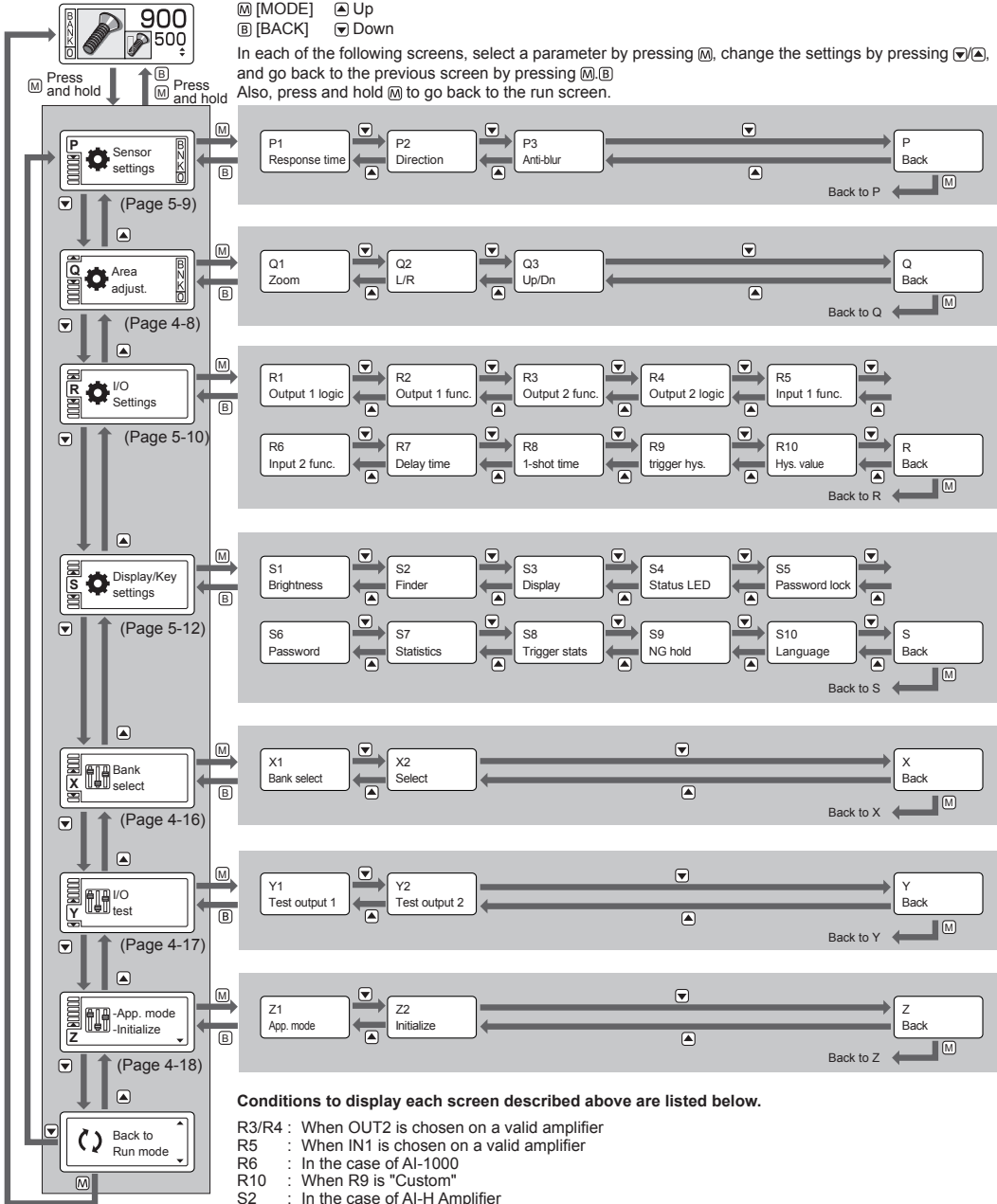Select the trigger position using the [UP/DOWN] buttons.

Select trigger position

Trigger position
SET ○

Select trigger position

Press the [SET] button.

The settings are completed.

5

Feeder Mode Settings

Operations on Settings Screen

Ⓜ [MODE]   ▲ Up
Ⓑ [BACK]   ▼ Down

In each of the following screens, select a parameter by pressing Ⓜ, change the settings by pressing ▼/▲, and go back to the previous screen by pressing Ⓜ.Ⓑ
Also, press and hold Ⓜ to go back to the run screen.

P Sensor settings (Page 5-9)

P1 Response time → P2 Direction → P3 Anti-blur → P Back — Back to P

Q Area adjust. (Page 4-8)

Q1 Zoom → Q2 L/R → Q3 Up/Dn → Q Back — Back to Q

R I/O Settings (Page 5-10)

R1 Output 1 logic → R2 Output 1 func. → R3 Output 2 func. → R4 Output 2 logic → R5 Input 1 func.
R6 Input 2 func. → R7 Delay time → R8 1-shot time → R9 trigger hys. → R10 Hys. value → R Back — Back to R

S Display/Key settings (Page 5-12)

S1 Brightness → S2 Finder → S3 Display → S4 Status LED → S5 Password lock
S6 Password → S7 Statistics → S8 Trigger stats → S9 NG hold → S10 Language → S Back — Back to S

X Bank select (Page 4-16)

X1 Bank select → X2 Select → X Back — Back to X

Y I/O test (Page 4-17)

Y1 Test output 1 → Y2 Test output 2 → Y Back — Back to Y

Z -App. mode -Initialize (Page 4-18)

Z1 App. mode → Z2 Initialize → Z Back — Back to Z

↻ Back to Run mode

Conditions to display each screen described above are listed below.

R3/R4 : When OUT2 is chosen on a valid amplifier
R5   : When IN1 is chosen on a valid amplifier
R6   : In the case of AI-1000
R10   : When R9 is "Custom"
S2   : In the case of AI-H Amplifier
S3   : In the case of a built-in amplifier type sensor
S6   : When S5 is "On"
X2   : When X1 is "by key"
Y2   : When OUT2 is a valid amplifier or setting

P. Sensor Settings

This section explains how to change the sensor detection settings.

■ Displaying "P. Sensor settings" screen

1 Press and hold the [MODE] button on the run screen.

The "P. Sensor settings" screen appears.
📖 "Operations on Settings Screen" (Page 5-8)

P1. Response time

Set the time duration required for an output signal to fire when the object is detected.

- Set a longer response time when high accuracy is required and/or a dark object it to be detected.
- The response time should be set lower when detecting an object with high movement speed.

Select from 3ms/10ms/20ms/50ms/100ms.
(Default value AI-H010/020: 10ms, AI-x050/100: 20ms, AI-x160: 50ms)

P2. Direction

Set up the orientation determination function for feeder mode. (Default: On)

On: The matching rate decreases when the orientation of the OK workpiece changes approx. ±20° or greater. This enables the directional detection of the object.

Off: The matching rate does not decrease even when the orientation of the OK workpiece changes. The directional change of the object is not detected.

Example

During calibration

OK workpiece

While the system is in operation

Detect				
On	OK	NG	NG	NG
Off	OK	OK	OK	NG
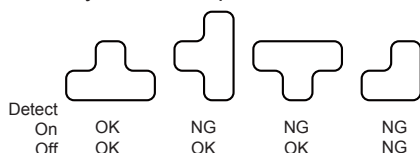
P3. Anti-blur

To reduce blurring of a fast-moving object, turn the anti-blur option On. The light-emission time becomes shorter. (Default: Off)

✎ **Point**

- Turn this option ON when the image of the held object is blurred on the matching rate statistics screen, NG hold screen, etc. due to its movement speed.
- If this is not effective, shorten "P1. Response time".

5

Feeder Mode Settings

R. I/O Settings

Set I/O operation.

■ Displaying "R. I/O settings" screen

1 Press and hold the [MODE] button on the run screen.

The "P. Sensor settings" screen appears.

2 Press the [▼] button twice.

📖 "Operations on Settings Screen" (Page 5-8)

R1. Output 1 logic

Set N.O./N.C. for output 1. (Default: N.O.)

R2. Output 1 function

Select the function which is assigned to output 1. (Default: NG output)

NG output: Performs a one shot (fixed duration) output when the object is judged as NG.
OK output: Performs a one shot output when the object is judged as OK.
Trigger output: Performs a one shot output when an OK/NG judgment of an object exceeding the trigger setting value is performed.

📖 "Feeder Mode Operation" (Page 5-2)
📖 "Standard mode (hold (edge))/Feeder mode" (Page 6-3)

R3. Output 2 function

Select the function which is assigned to output 2*. (Default: Off)

Off: Output 2 is not used.
Error output: Output when an error occurs.
Sync-output: Prevent mutual interference by connecting to another sensor of the AI Series.
📖 "Preventing Mutual Interference (Sync-input/output)" (Page 6-13)
NG output: Performs a one shot (fixed duration) output when the object is judged as NG.
OK output: Performs a one shot output when the object is judged as OK.
Trigger output: Performs a one shot output when an OK/NG judgment of an object exceeding the trigger setting value is performed.

* When using AI-1000, or when OUT2 is selected as the initial settings for AI-1000C/AI-Bxxx.

R4. Output 2 logic

Set the N.O/N.C for when Error output/NG output/ OK output/Trigger output is assigned to Output 2. (Default: N.O.)

R5. Input 1 function (Input function*)/ R6. Input 2 function

Select the function to be assigned to input 1/input 2/input *. (Default: Off)

Off: No input is used.
Bank-A/Bank-B/Bank*:
Switch the bank by external input.
It is enabled when "by ext. input" is selected in "X1. Bank select".
📖 "Bank Function" (Page 3-6)
📖 "Changeover (Bank Input)" (Page 6-5)
Reset: Clear the held judgment value.
Matching rate is "---". Judgment output cannot be reset. (Reset input is invalid when running delay timer or one-shot output.)
Minimum input time and response time of the reset input are same as these of when the hold (edge) input.
📖 "Hold (edge) input" (Page 6-8)
Light off: Turn off LEDs and judgment.
Matching rate is "---".
📖 "Light Off (Projection Termination Input)" (Page 6-10)
Sync-input: Prevent mutual interference by connecting to another sensor of the AI Series.
📖 "Preventing Mutual Interference (Sync-input/output)" (Page 6-13)

* If the initial settings for IN are set for AI-1000C/AI-Bxxx

R7. Delay time

Set the delay time within a range of 0 to 2500ms. (Default: 0 ms)

R8. 1-shot time

Set the one-shot duration within a range of 1 to 9999ms. (Default: 10 ms)

R9. Trigger hysteresis

Set the hysteresis level of the trigger value. (Default: Standard)

Standard: The trigger hysteresis value is set to 20 automatically.

Custom: Select it when a custom trigger hysteresis value is needed.

R10. Hysteresis value

When "Custom" is selected, set any hysteresis value within a range of 0 to 999. (Default: 20)

5

Feeder Mode Settings

S. Display/Key Settings

Set the display and operation functions.

■ **Displaying "S. Display/Key settings" screen**

1 **Press and hold the [MODE] button on the run screen.**

The "P. Sensor settings" screen appears.

2 **Press the [▼] button three times.**

📖 "Operations on Settings Screen" (Page 5-8)

S1. Brightness of screen

📖 Refer to "D1. Brightness of screen" (Page 4-11).

S2. Finder

📖 Refer to "D2. Finder" (Page 4-11).

S3. Display direction

📖 Refer to "D3. Display direction" (Page 4-11).

S4. Status LED

Select the colors for the indicator light from Green/
Red or Yellow/Off. (Default: Green/Red)
📖 "Operation of the indicator light" (Page 1-13)

S5. Password lock

📖 Refer to "D5. Password lock" (Page 4-11).

S6. Password
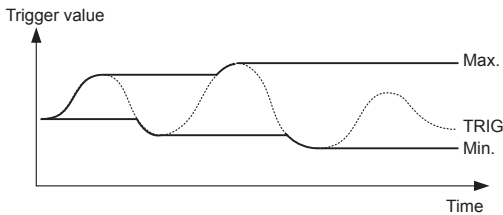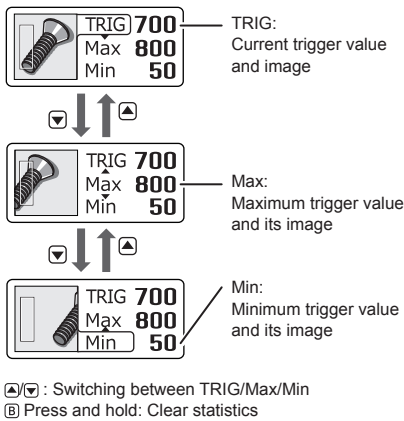
📖 Refer to "D6. Password" (Page 4-11).

S7. Statistics of matching rate

Display off: Statistic display screen is not displayed.

Display on: Display "Maximum/Minimum (Max/ Min) and "Margin (OKmin/NGmax)" on the run screen.

For information on how to display the statistics display screen, refer to 📖 "Operations on Run Screen" (Page 5-3).

Maximum/Minimum display

The maximum and minimum matching rate values and their images are displayed.

LIVE:
Matching rate and image of the latest object

Max:
Maximum matching rate and image of the detected object

Min:
Minimum matching rate and image of the detected object

Ⓐ/Ⓥ : Switching between LIVE/Max/Min
Ⓑ Press and hold: Clear statistics
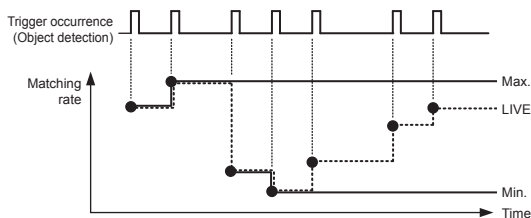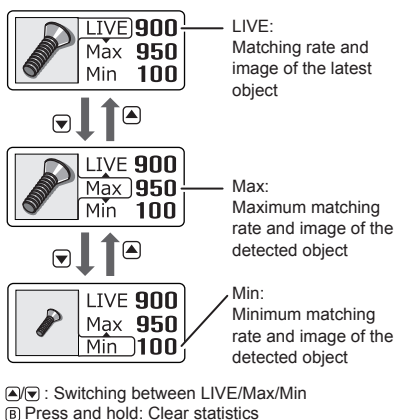
Reference

• Statistics are not applicable when the matching rate is "---" or while the LEDs are turned off.

• The matching rate and image of the object detected are included in the statistics.

5

Feeder Mode Settings

Margin display

The statistics of the matching rate and image of the object detected are displayed. The detection is stable if the difference between OKmin and NGmax is large.

LIVE:
Latest matching rate and image of the detected object

OKmin:
Matching rate and that image with the minimum matching rate among the objects judged as OK

NGmax:
Matching rate and that image with the maximum matching rate among the objects judged as NG

▲/▼ : Switching LIVE/OKmini/NGmax
Ⓑ Press and hold: Clear statistics
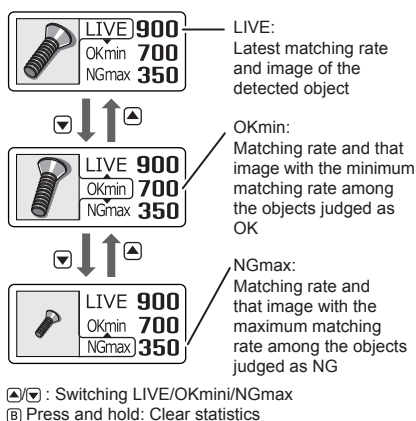
(1) LIVE: The latest matching rate and image of the detected object. They are updated in the timing when the object is detected.

(2) OKmin: The matching rate and image of the object with the minimum matching rate among the objects judged as OK. When the LIVE value is updated, it is compared with the previous minimum value (OKmin) and, if the LIVE value is smaller, the minimum value (OKmin) and image will be updated. This can be used to check the margin between the object judged as OK and the setting value.

(3) NGmax: The matching rate and image of the object with the maximum matching rate among the objects judged as NG. When the LIVE value is updated, it is compared with the previous maximum value (NGmax) and, if the LIVE value is greater, the maximum value (NGmax) and image will be updated. This can be used to check the margin between the object judged as NG and the setting value.
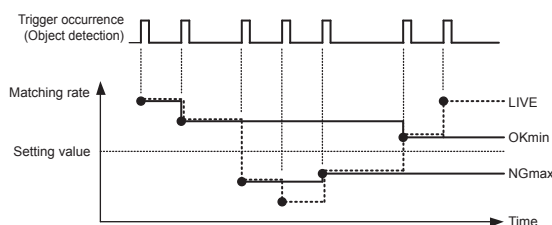
Reference

• Statistics are not applicable when the matching rate is "---" or while the LEDs are turned off.
• If the statistics result has never been updated since clearing the statistics, the matching rate will be "---" and the image will be displayed as "No data".
• If the setting value (threshold) is changed, statistics processing continues based on the new setting value. Clear is not performed.

Clearing the statistics value

The statistics values of the Maximum/Minimum display and Margins display are cleared when the following actions are performed:
• When the [BACK] button is held down
• Reset input
• Power OFF
• When calibration is performed/canceled
• When the bank is switched
• Setting change (i.e. adjusting the detection range, sensor detection settings, matching rate statistics, trigger statistics, or NG hold modes)
• When recovered from a head error

5

Feeder Mode Settings

S8. Trigger statistics

Display off: The trigger statistic display screen is not displayed.

Display on: Displays "Maximum/Minimum (Max/Min) and "Margin (Peak/Btm./P.min/B.max)" of the trigger value on the run screen.

For information on how to display the statistics display screen, refer to 📖 "Operations on Run Screen" (Page 5-3).

Maximum/Minimum trigger value display

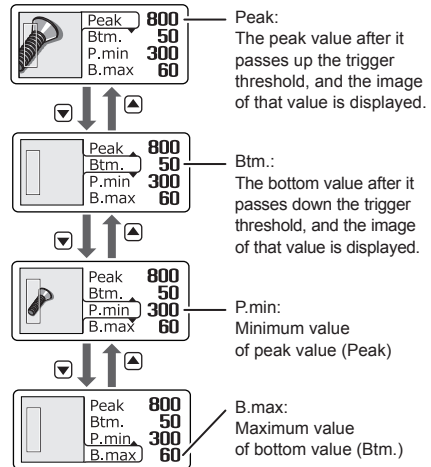The maximum and minimum trigger values and their images are displayed.

TRIG: Current trigger value and image

Max: Maximum trigger value and its image

Min: Minimum trigger value and its image

△/▽ : Switching between TRIG/Max/Min
Ⓑ Press and hold: Clear statistics

Trigger value

Max.

TRIG

Min.

Time

Reference

• Statistics are not applicable when the trigger value is "---" or while the LEDs are off.

Trigger value margin display

In this display, the peak and bottom trigger values seen by the sensor are shown. The detection is stable if the difference between P.min and B.max is large.

Peak:
The peak value after it passes up the trigger threshold, and the image of that value is displayed.

Btm.:
The bottom value after it passes down the trigger threshold, and the image of that value is displayed.

P.min:
Minimum value of peak value (Peak)

B.max:
Maximum value of bottom value (Btm.)

△/▽ : Switching Peak/Btm./P.min/B.max
Ⓑ Press and hold: Clear statistics

(1) Peak: The latest value and image of the peak value that is above the trigger value is displayed. Sampling is performed while the trigger value is higher than the trigger setting value; and the peak value (Peak) and image are updated when it falls below the trigger setting value.

(2) Btm.: The latest value and image of the bottom value that is below the trigger value is displayed. Sampling is performed while the trigger value is below the trigger setting value; and the bottom value (Btm.) and image are updated when it is higher than the trigger setting value.

(3) P.min: The minimum value of peak value (Peak) is displayed. When the peak value (Peak) is updated, it is compared to the previous minimum value (P.min) and, if the peak value is smaller, the minimum value (P.min) and image will be updated. This can be used to check the margin of the trigger value when a object is detected.

(4) B.max: The maximum value of bottom value (Btm.) is displayed. When the bottom value (Btm.) is updated, it is compared to the previous maximum value (P.max) and, if the bottom value is greater, the maximum value (P.max) and image will be updated. This can be used to check the margin of false trigger detections when a object is not present.
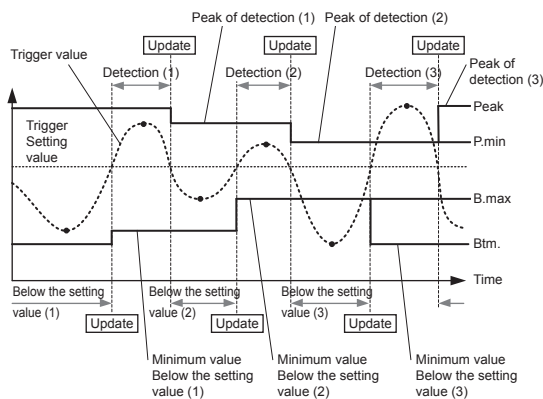
Reference

- Statistics are not applicable when the trigger value is "---" or while the LEDs are off.
- If the statistics result has never been updated since clearing the statistics, the matching rate will be "---" and the image will be displayed as "No data".
- If the trigger setting value is changed, statistics processing continues based on the new trigger setting value. Clear is not performed.
- The trigger statistics can be clear using the same method as ▢ "S7. Statistics of matching rate" (Page 5-12).

S9. NG hold

Select the display contents of the NG hold display function. This option can be used to check the image of the latest object judged as NG. (Default: Display off)

Display off: Not displayed.

Display on: When the detected object is judged as NG (output Off), the latest NG object image and matching rate are displayed on the run screen.

For information on how to display the NG hold screen, refer to ▢ "Operations on Run Screen" (Page 5-3).

Point

- The NG hold is not applied when the matching rate is "---" or while the LEDs are off.
- The NG hold display can be clear using the same method as ▢ "S7. Statistics of matching rate" (Page 5-12).

S10. Language

Select a display language. Select from English/ Japanese/Chinese (Simplified).

5

Feeder Mode Settings

MEMO

5

Feeder Mode Settings

6

I/O Control

This chapter describes how to control each operation with I/O wires.

6

I/O Control

Changing Timing of Judgment Output

Overview of the timer function

The following shows the combinations of the timer functions and settings that are available for the sensor.

Z1. Application	C4./C5. Input function	C8. Output timer	C9. One-shot output	C10. Delay time	C11. 1-shot time
Standard mode	Other than Hold (edge)	OFF	Not selectable	-	-
		On-delay		0 to 5000ms	-
		Off-delay		0 to 5000ms	-
		One-shot		-	1 to 9999ms
	Hold (edge)	Not selectable	OFF	-	-
			ON	0 to 5000ms	1 to 9999ms
Feeder mode	-			**R7. Delay time**	**R8. 1-shot time**
				0 to 2500ms	1 to 9999ms

Standard mode (other than hold (edge) input)

When other than hold (edge) is selected for the input function in standard mode, the timer of the judgment output can be set to OFF, On-delay, Off-delay, or One-shot.
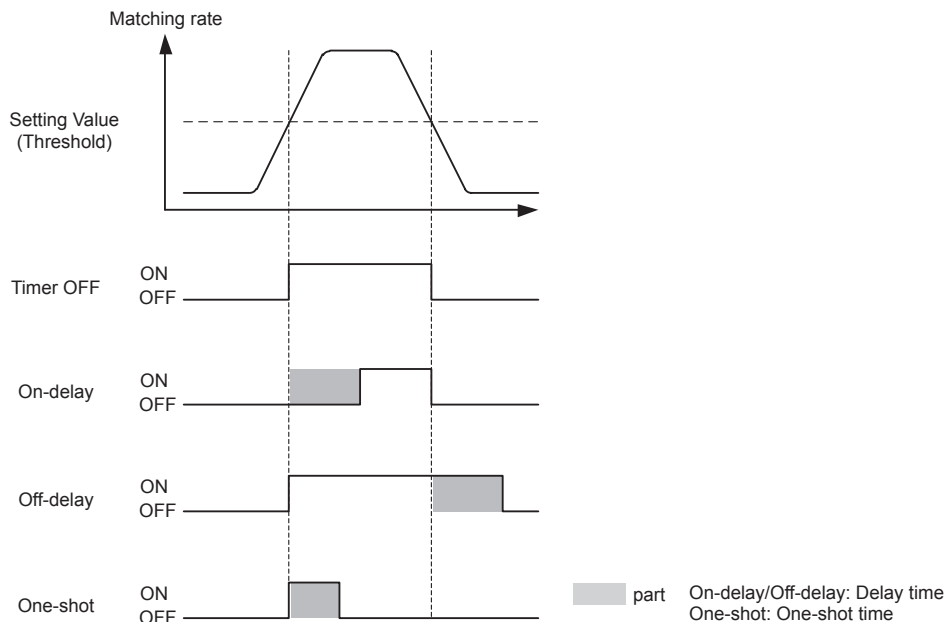
- The ON status of the judgment output is as follows:

  When the output logic is [N.O.]: The NPN or PNP open collector output is ON.

  When the output logic is [N.C.]: The NPN or PNP open collector output is OFF.
- The change in judgment during the one-shot time period is ignored.
- The judgment 1 and judgment 2 operate by a common delay time and one-shot time.

Standard mode (hold (edge))/Feeder mode

When the hold (edge) input and One-shot output are selected by the input function in standard mode, or when feeder mode is set, the timer of the judgment output is set to One-shot output with a delay timer.
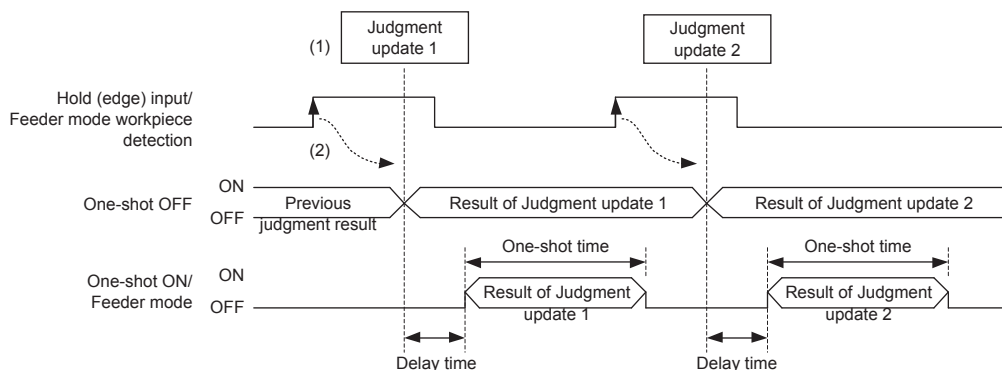
(1) The judgment is updated by the hold (edge) input in standard mode or the workpiece detection in feeder mode.

(2) For details on the response delay time, refer to 📖 "Hold (edge) input" (Page 6-8).

- The ON status of the judgment output is as follows:

  When the output logic is [N.O.]: The NPN or PNP open collector output is ON.

  When the output logic is [N.C.]: The NPN or PNP open collector output is OFF.

- The judgment output 1 in standard mode operates as shown above. The judgment output 2 operates by the One-shot OFF regardless of the one-shot output setting.

- The NG output/OK output/Trigger output in the Feeder mode operates at the common delay time and one-shot time.

Discarding of one-shot output

When using the one-shot output, make sure to meet the following condition:

Judgment update interval > One-shot time

If this condition is not met, the next one-shot output that occurs during the one-shot output will be ignored and thus not be output.
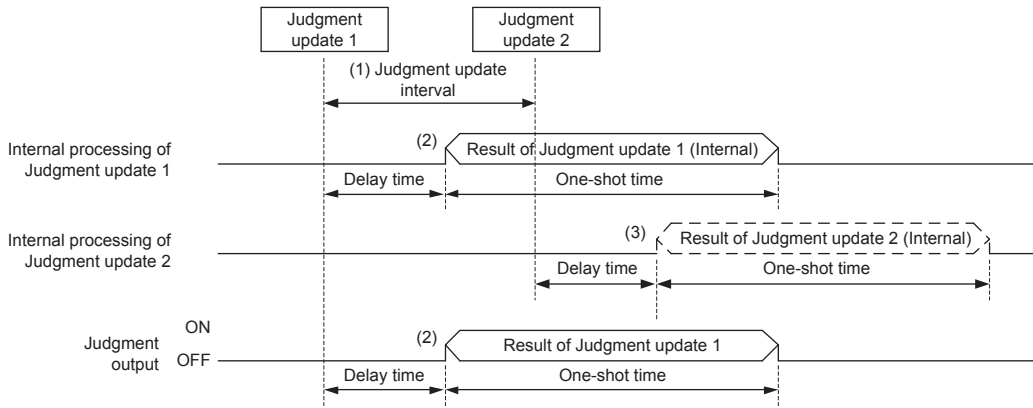
(1) This is an example where the judgment update interval is shorter than the one-shot time.

(2) The result of the judgment update 1 is output correctly because the one-shot output has already finished.

(3) When the result of the judgment update 2 is output, the result of judgment update 1 is being output via the one-shot output. Therefore, judgment output 2 will be discarded and thus not be output.

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I/O Control

Changeover (Bank Input)

The Bank input enables you to easily change the setup of a product by loading pre-stored judgment conditions.

📖 "Bank function (Changeover)" (Page 3-6)
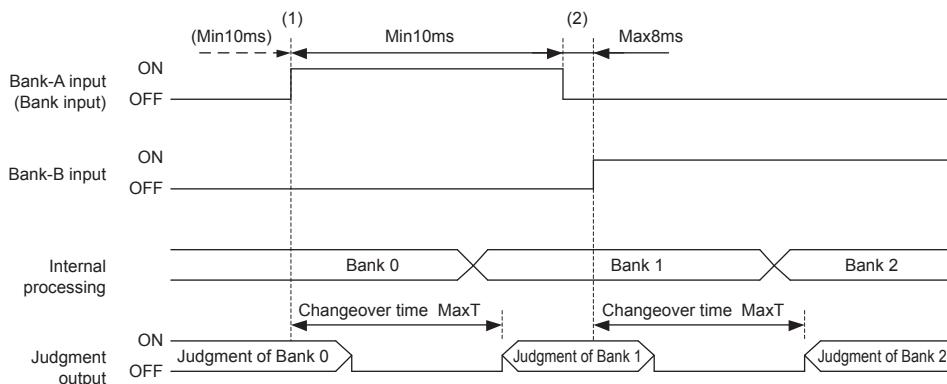
(1) The Bank input remains on after being switched to the status of the target Bank number. The minimum input time is 10 ms.

📖 "Switching the bank by external input line" (Page 3-7)

(2) When switching Bank-A and Bank-B at the same time, switch them 8 ms apart or less.

- Assign the Bank inputs in "C4./C5. Input function".
- When "Output 1 + Input" is set to the initial setting of AI-1000C/AI-Bxxx, only Bank 0 or Bank 1 can be selected. If "Output 1 + Output 2" is selected, the Bank function is disabled.
- When switching the Bank number using an input wire, set the 📖 "X1. Bank select" (Page 4-16) to "by external input".
- The matching rate during Bank switching becomes "---" and the judgment output becomes OFF.
- The ON status of the input is as follows: when the input and output format is NPN, the line is short-circuited to 0V; and when PNP, voltage is applied.
- The ON status of the judgment output is as follows:
    When the output logic is [N.O.]: The NPN or PNP open collector output is ON.
    When the output logic is [N.C.]: The NPN or PNP open collector output is OFF.
- The minimum input time of the Bank input is 10 ms regardless of the status: ON or OFF.
- The changeover time (T) of the Bank differs depending on the setting of the response time.

A1. Response time	T
3ms	100ms
10ms	130ms
20ms	180ms
50ms	350ms
100ms	540ms

If "A1. Response time" of the Bank number to be switched to is different, the changeover time of the Bank number whose "A1. Response time" is longer is applied.
Example) When switching from the Bank of 100 ms to the Bank of 3 ms, the switching time is 540 ms.

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I/O Control

Holding Judgment (Hold Input)

Hold (level) input

The judgment result can be held at any timing using the hold (level) input. The reset status can also be held by combining the hold (level) with the reset input.
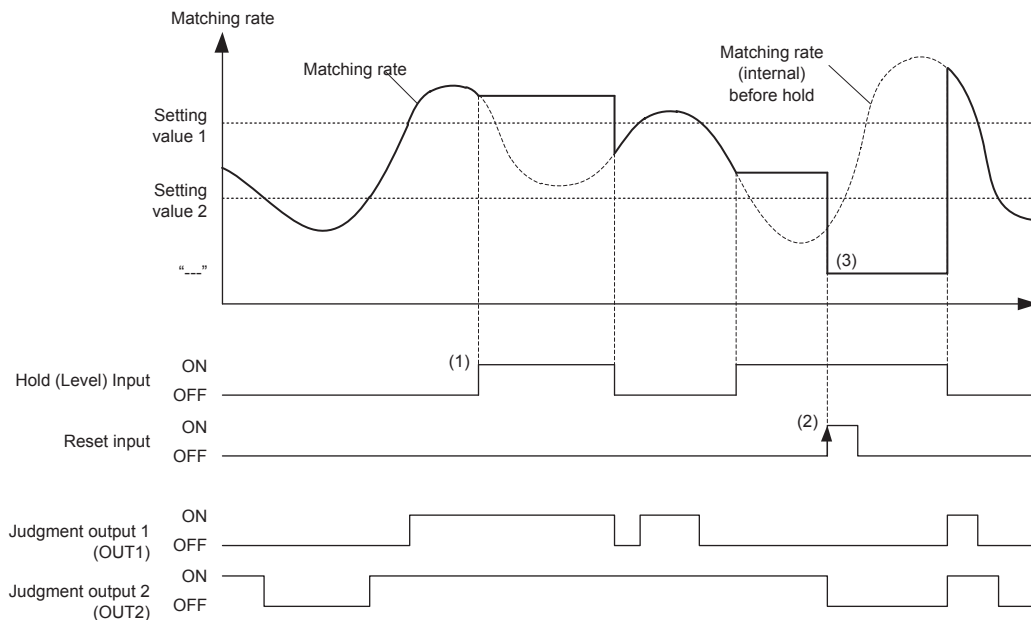
(1) The matching rate, image, and judgment output are held with the hold (level) input is ON. Those values are held as long as the hold (level) input is on.

(2) The matching rate, image, and judgment output are reset when the reset input is turned ON.

(3) The matching rate after the reset becomes "---" and the judgment output turns OFF. "No data" is displayed for the image.

• Assign the hold (level) input and reset input in the "C4./C5. Input function".

• The ON status of the input is as follows: when the input and output format is NPN, the line is short-circuited to 0V line; and when PNP, voltage is applied.

• The ON status of the judgment output is as follows:
  When the output logic is [N.O.]: The NPN or PNP open collector output is ON.
  When the output logic is [N.C.]: The NPN or PNP open collector output is OFF.

• The status, after the hysteresis function is taken into account, is held. Therefore, the status where the judgment output is ON may be held regardless is the matching rate is the same as, or very close to, the setting value (threshold). This can be used to reduce chatter.

• The above judgment outputs are operations when "C8. Output timer" is Off. Timing of the judgment output can be changed.

Timing details

```
                              (MinT1)                    MinT1
                        ON              ┌──────────────────────────┐
Hold (level) input                      │                          │
                       OFF ─────────────┘                          └──────────
                                          (MinT3)    MinT3
                        ON                         ┌────┐
Reset input                                        │    │
                       OFF ────────────────────────┘    └──────────────────────
                             MaxT2              MaxT4            MaxT2
                        ON  ◄──►              ◄──────►          ◄──►
Judgment output            No hold   ╳    Hold    ╳   Hold   ╳  No hold
                       OFF
```
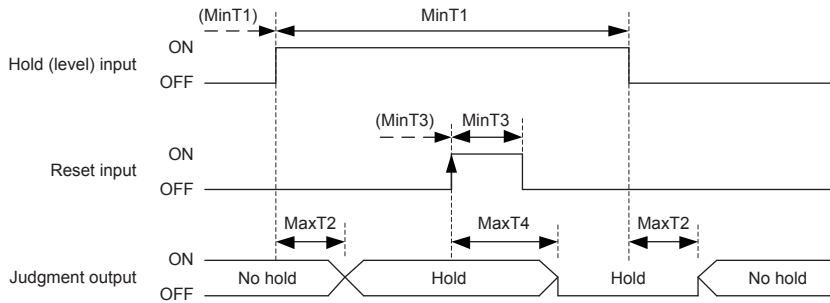
The minimum input time (T1) and response time (T2/T4) differ depending on the setting of the "A1. Response time".

A1. Response time	T1	T2	T3	T4
3ms	4ms	6ms		23ms
10ms	8ms	13ms		30ms
20ms	12ms	23ms	20ms	40ms
50ms	26ms	53ms		70ms
100ms	49ms	103ms		120ms

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I/O Control

Hold (edge) input

The hold (edge) input is used to hold values until the next input.
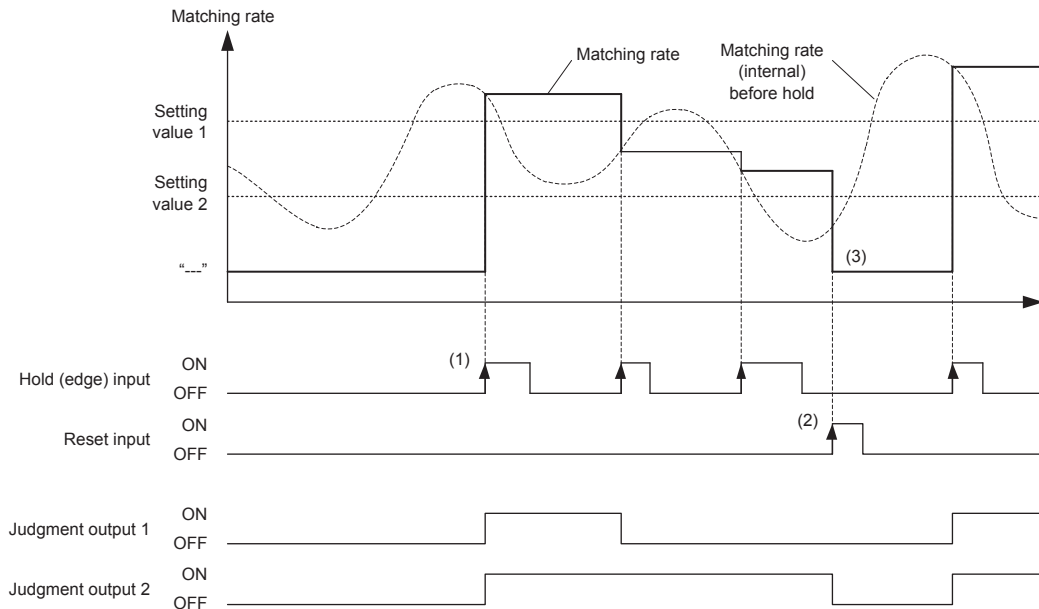
(1) The matching rate, image, and judgment output are held when the hold (edge) input is ON. The value is held until the next hold (edge) input.

(2) The matching rate, image, and judgment output are reset when the sensor receives a reset input.

(3) The matching rate after the reset input becomes "---" and the judgment output turns OFF. "No data" is displayed for the image.

(4) In the following cases, the reset status is held until the hold (edge) input becomes ON.
Power ON/Calibration performed/Bank change/Setting change (detection range, sensor detection setting, hold input, application)

- Assign the hold (edge) input and reset input in the "C4./C5. Input function".
- The ON status of the input is as follows: when the input and output format is NPN, the line is short-circuited to 0V line; and when PNP, voltage is applied.
- The ON status of the judgment output is as follows:
  When the output logic is [N.O.]: The NPN or PNP open collector output is ON.
  When the output logic is [N.C.]: The NPN or PNP open collector output is OFF.
- The above judgment outputs are operations when "C9. Oneshot output" is Off. Timing of the judgment output can be changed to the one-shot output with delay timer.
  ☐ "Changing Timing of Judgment Output" (Page 6-2)

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I/O Control

Timing details
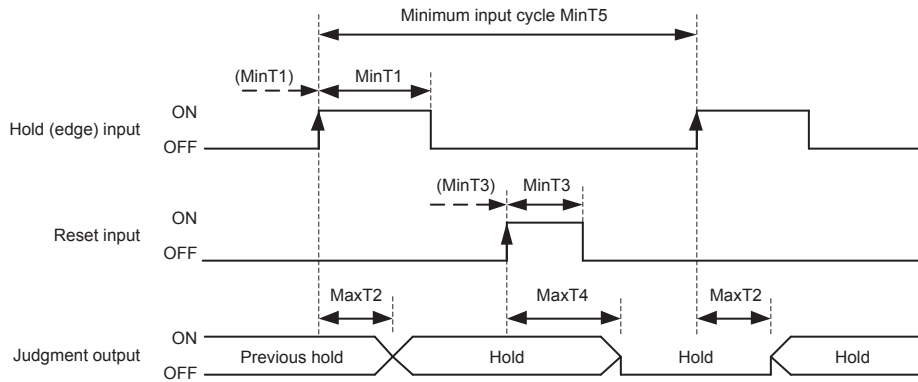
- When the hold (edge) input is performed within the minimum input cycle (T5), the judgment may not be correctly held.
- The response time (T2/T4) and minimum input cycle (T5) differ depending on the setting of the "A1. Response time".

A1. Response time	T1	T2	T3	T4	T5
3ms		6ms		23ms	8ms
10ms		13ms		30ms	18ms
20ms	1ms	23ms	20ms	40ms	32ms
50ms		53ms		70ms	76ms
100ms		103ms		120ms	150ms

Light Off (Projection Termination Input)

While the projection termination input is ON, the projection of LED and judgment is terminated.
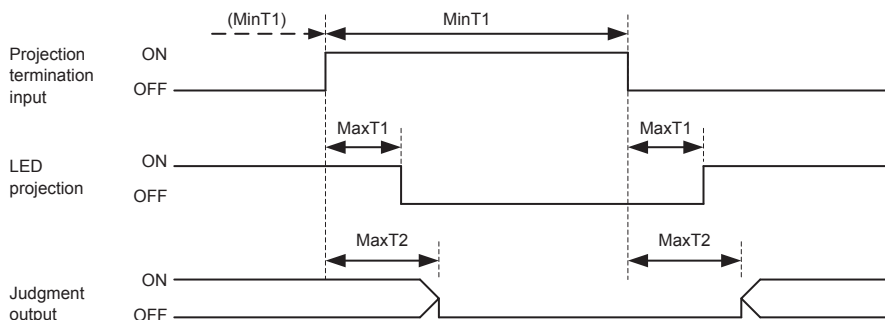
- Assign the projection termination input in the "C4./C5. Input function".
- The matching rate during projection termination becomes "---" and the judgment output turns OFF. "Light off" is displayed for the image.
- In the case of projection termination during a hold input, the projection is terminated and the value is held.
- In the case a hold input during projection termination, the projection termination status is held.
- The ON status of the input is as follows: when the input and output format is NPN, the line is short-circuited to 0V line; and when PNP, voltage is applied.
- The ON status of the judgment output is as follows:
   When the output logic is [N.O.]: The NPN or PNP open collector output is ON.
   When the output logic is [N.C.]: The NPN or PNP open collector output is OFF.
- The minimum input time (T1), response time of LED projection (T1), and response time of judgment output (T2) differ depending on the setting of the "A1. Response time".

A1. Response time	T1	T2
3ms	4ms	6ms
10ms	8ms	13ms
20ms	12ms	23ms
50ms	26ms	53ms
100ms	49ms	103ms

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I/O Control

Registering the Object (External Calibration Input)

The registered image can be changed through calibration performed by external input. This function can detect a variety of workpieces that the Bank function cannot detect.

> ✎ **Point**
>
> • Only the Presence in standard mode is available. The Difference check and Feeder modes are unavailable for this function.
> • Set the unit up for calibration by external input.
> • Registration without a workpiece (background) is not performed. The image registered by calibration becomes the registration image without a workpiece (background).
> • The setting value (threshold) of Judgment output 1 is automatically adjusted. The setting value of Judgment output 2 is not changed.
> • When there is a large difference in the shape or contrast between the object registered by external input and the object registered by button operation, detection may become unstable.
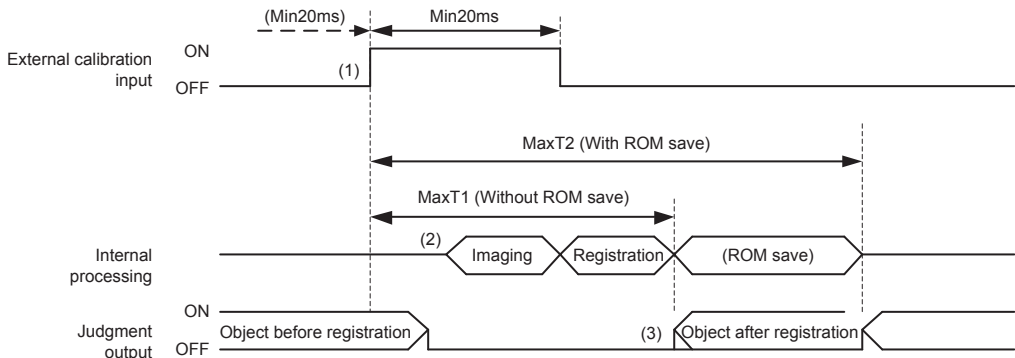
(1) Place the object to register in the sensor's detection range and turn ON the external calibration input.

(2) Register the object placed after calibration (with workpiece) was performed.

(3) Resume the judgment based off of the newly registered object.

• Assign the external calibration input in the "C4./C5. Input Function".
• The matching rate during the external calibration process becomes "---" and the judgment output turns OFF. "Registering.." is displayed on the screen.
• Register the object (image) when the external calibration was input. (The object that is held by the hold input is not registered.)
• The ON status of the input is as follows: when the input and output format is NPN, the line is short-circuited to 0V line; and when PNP, voltage is applied.
• The ON status of the judgment output is as follows:
  When the output logic is [N.O.]: The NPN or PNP open collector output is ON.
  When the output logic is [N.C.]: The NPN or PNP open collector output is OFF.

- The minimum input time of the external calibration input is 20 ms regardless of the input status: ON or OFF.
- The response time of the external calibration input (T1/T2) differs depending on the settings of "A1. Response time" and "C6. External calibration".

A1. Response time	T1 (without ROM save)	T2 (with ROM save)
3ms	110ms	3310ms
10ms	150ms	3350ms
20ms	210ms	3410ms
50ms	410ms	3610ms
100ms	650ms	3850ms

- If external calibration failed, "Calib. error" is displayed on the screen and the registered information is not updated. If error output is assigned, the error output turns ON. After two seconds, the system is automatically recovered from the error.

  📖 "Display and Error" (Page A-6)

NOTICE

- **If you use external calibration frequently, set "C6. External calibration" to "Save off" to protect the non-volatile memory in the sensor.**
- **If set to the "Save ROM", do not turn OFF the power during external calibration. Otherwise, all or part of the setting data may be lost.**

C6. External calibration	Registered calibration information when powered OFF	Number of external calibrations (Lifetime)
Save off	Will be deleted. External calibration is required at the time of next startup.	No limit
Save ROM	Will not be deleted. Can be used after the next startup.	100,000 times

6

I/O Control

Preventing Mutual Interference (Sync-input/output)

When multiple sensors in the AI series are installed adjacent to each other, mutual interference may occur due to the influence of surrounding light emitted from another sensor. The mutual interference prevention function eliminates this effect by projecting light from each sensor at separate times.

How to use the mutual interference prevention function

Cables

- Connect the output line of sensor A (OUT2) with the input line of sensor B (IN1/IN2/IN). In addition, make sure the 0V line is shared.
- Similarly, connect multiple sensors to prevent mutual interference within the suggested range. (For AI-1000C/AI-Bxxx, up to two units)

OUT2: Sync-output
IN1 or IN2: Sync-input
OUT2: Sync-output
IN1 or IN2: Sync-input
OUT2: Sync-output
IN1 or IN2: Sync-input

Sensor A

Sensor B

Sensor C

Sensor D

Interference may occur in the detection range if the projection of a nearby sensor enters the detection range.

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I/O Control
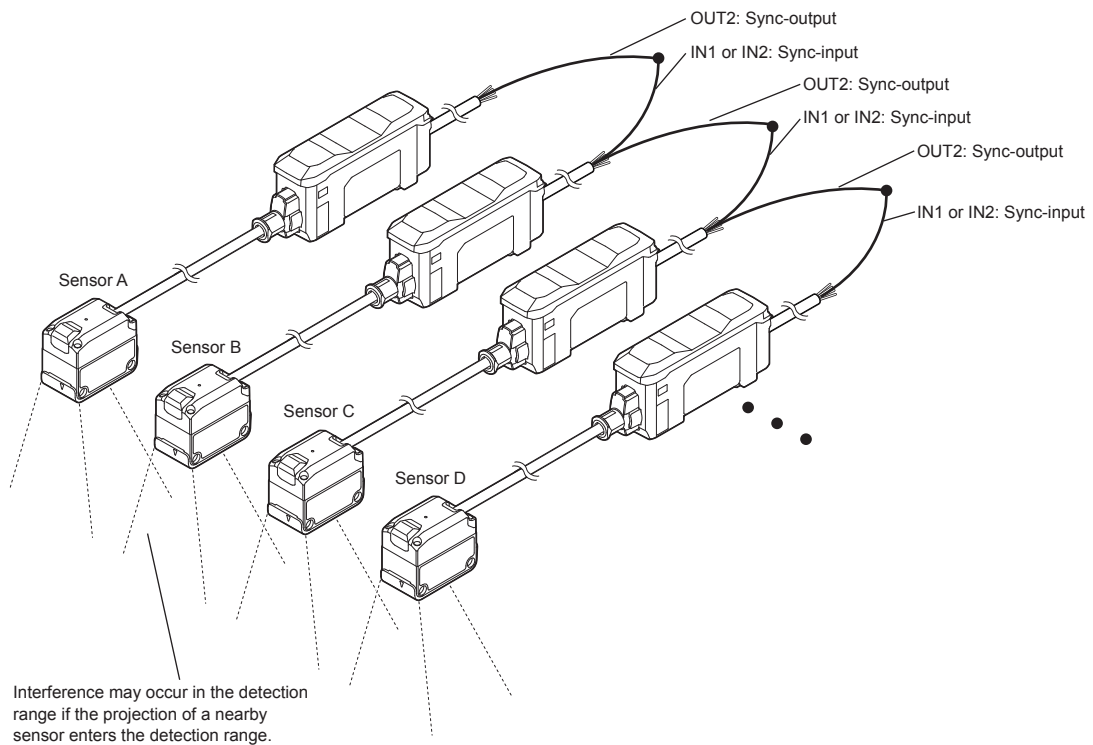
🖎 **Point**

Note the following when adding wires, otherwise, the mutual interference prevention function may not work properly.

- Make sure the 0V line of the sensors is shared.
- Be careful the cables do not loop, such as the sync-output of sensor C is connected to the sync-input of sensor B as shown in the above figure.
- Do not connect one output to multiple inputs in parallel.

Setting

■ Setting example 1

Example of mutual interference prevention when installing two units of AI-1000C or AI-Bxxx adjacent to each other

Setting	Sensor A (on Sync-output side)	Sensor B (on Sync-input side)
Input-output format (Initial setting)	Make sure both sensors are NPN or PNP (IO-Link (PNP)). (PNP and IO-Link (PNP) may be mixed)	
I/O setting (initial setting) *Only for AI-1000C/AI-Bxxx	Output 1 + Output 2	Output 1 + Input
A1. Response time	Set the same response time.	
C2. Output 2 function	Sync-output	-
C4. Input function	-	Sync-input of the input line to use

Reference

• The mutual interference prevention function automatically works between Sensor A and Sensor B. (The effect of excess light is eliminated by projecting light from Sensor A and Sensor B at separate times.)
• If Sensor B is AI-1000C or AI-Bxxx, it cannot prevent mutual interference after connecting the third or subsequent sensor because the sensor has no output 2 line.

■ Setting example 2 (3 units of AI-1000)

Example of prevention of mutual interference when three units of AI-1000 are installed adjacent to each other

Setting	Sensor A (on Sync-output side)	Sensor B (on Sync-input side) (on Sync-output side)	Sensor C (on Sync-input side)
Input-output format (Initial setting)	Make sure all sensors are NPN or PNP (IO-Link (PNP)). (PNP and IO-Link (PNP) may be mixed)		
A1. Response time	Set the same response time.		
C2. Output 2 function	Sync-output	Sync-output	-
C4. Input 1 function C5. Input 2 function	-	Sync-input of the input line to use	Sync-input of the input line to use

Reference

The mutual interference prevention function automatically works between Sensor A, Sensor B, and Sensor C. (The effect of excess light is eliminated by projecting light from Sensor A, Sensor B, and Sensor C at separate times.)

Operation of indicators and interference prevention error

Sensor A (on Sync-output side)	Sensor B (on Sync-input side)			Measures
Output Indicator (OUT2)	Input Indicator (IN1/IN2/IN)	Indicator light	Status	
Light up red	Light up red	Other than flashing red	Operating normally.	
			Interference has occurred.	• Connect the cables correctly.
	Flashing red	Flashing red	Interference prevention error • The response time setting differs from that of Sensor A. • Influenced by noise.	• Make sure the response time setting is the same on both sensors. • Check the installation environment.
	Off	Other than flashing red	• The Input function of Sensor B is not correctly set.	• Make settings correctly.
		Flashing red	Interference prevention error • The cables are not correctly connected. • The Output 2 function of Sensor A is not correctly set. • There is an inconsistency in the input-output format between Sensor A and Sensor B. • An error (head error/over-current error) has occurred in Sensor A. • Sensor A I/O test in progress	• Connect the cables correctly. • Make sure settings are correct. • Resolve the error in Sensor A. • End the input and output test of Sensor A.
Off			Interference prevention error • The Output 2 function of Sensor A is not correctly set.	• Make sure settings are correct.

Restriction on the mutual interference prevention function

Range of mutual interference prevention

There is a restriction on the number of units where mutual interference can be prevented based on what is set in "A1. Response time".

A1. Response time	AI-1000	AI-1000C / AI-Bxxx
3ms	2 units	
10ms/20ms	3 units	2 units
50ms/100ms	4 units	

* AI-1000 has both the Output 2 wire and Input wire, and thus can connect multiple units to prevent mutual interference.
* Up to only two units of AI-1000/AI-Bxxx can be used because Output 2 or Input need to be selected (not both). (When Sensor A with Output 2 selected is connected to Sensor B with Input selected, the Sensor B has no output wire and thus cannot be connected to Sensor C.)

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I/O Control

Example of 9 units (Sensor A - I) connected

How to read the table:

- The target sensor does not interfere with a sensor with the "✓" mark. The sensor may interfere with a sensor with the ✓ mark.
- The sensors that can prevent mutual interference with the target sensor are as follows: the units (the number of preventative units - 1) connected to the sync-output side and the units (the number of preventative units - 1) connected to the sync-input side of the target sensor.
- If the response time is 20 ms, Sensor B and Sensor C do not interfere with Sensor A. The other sensors may interfere with Sensor A.
- If the response time is 3 ms, Sensor D and Sensor F do not interfere with Sensor E. The other sensors may interfere with Sensor A.
- The same applies to Sensor F through Sensor I.

	A1. Response time	A	B	C	D	E	F	G	H	I
Sensors that do not interfere with Sensor A	3ms	-	✓	×	×	×	×	×	×	×
	10ms/20ms	-	✓	✓	×	×	×	×	×	×
	50ms/100ms	-	✓	✓	✓	×	×	×	×	×
Sensors that do not interfere with Sensor B	3ms	✓	-	✓	×	×	×	×	×	×
	10ms/20ms	✓	-	✓	✓	×	×	×	×	×
	50ms/100ms	✓	-	✓	✓	✓	×	×	×	×
Sensors that do not interfere with Sensor C	3ms	×	✓	-	✓	×	×	×	×	×
	10ms/20ms	✓	✓	-	✓	✓	×	×	×	×
	50ms/100ms	✓	✓	-	✓	✓	✓	×	×	×
Sensors that do not interfere with Sensor D	3ms	×	×	✓	-	✓	×	×	×	×
	10ms/20ms	×	✓	✓	-	✓	✓	×	×	×
	50ms/100ms	✓	✓	✓	-	✓	✓	✓	×	×
Sensors that do not interfere with Sensor E	3ms	×	×	×	✓	-	✓	×	×	×
	10ms/20ms	×	×	✓	✓	-	✓	✓	×	×
	50ms/100ms	×	✓	✓	✓	-	✓	✓	✓	×

Mutual interference response time

The time it takes for the mutual interference prevention function to work properly differs depending on the setting of "A1. Response time" and the number of connected units.

Power ON (add 3 seconds to the time shown below)/Proper I/O wiring/Change to the bank which has different setting of response time/Setting change (Response time/Output 2 function/Input function)/Start and end of setting change for detection range/End of input-output test

A1. Response time	Time
3ms	(Number of connected units - 1) * 1 second or less
10ms/20ms	(Number of connected units - 1) * 2 seconds or less
50ms	(Number of connected units - 1) * 3 seconds or less
100ms	(Number of connected units - 1) * 6 seconds or less

7

Specifications

This chapter describes the specifications of sensors, and dimensions.

7

Specifications

Specifications

Separate amplifier type: Sensor head

Model		AI-H010	AI-H020	AI-H050	AI-H100	AI-H160
Installation distance		9 to 11 mm	18 to 22 mm	45 to 55 mm	90 to 110 mm	140 to 180 mm
Detection range*	Zoom 4.0 times to Zoom 1.0 time	0.5x0.5 mm to 2x2 mm	1.4x1.4 mm to 5.6x5.6 mm	4x4 mm to 16x16 mm	8x8 mm to 32x32 mm	13x13 mm to 52x52 mm
	Digital zoom	1.0 to 4.0 times (17 levels) adjustment, zoom position adjustment function				
Light receiving element		Monochrome CMOS				
Projection	Light source	Red LED (660 nm)				Red LED (850 nm)
	Lighting system	Pulse lighting				
Indicator		1 indicator (Green/Red/Yellow)				
Environmental resistance	Ambient temperature	-10 to +50°C (No freezing)				
	Ambient humidity	35 to 85% RH (No condensation)				
	Vibration	10 to 55 Hz, 1.5 mm double amplitude, 2 hours each for X, Y, and Z axes				
	Shock resistance	$500 m/s^2$, 3 times for each of the 6 directions				
	Enclosure rating	-		IP67*[2]		
Material		Body: Zinc die-cast/PBT, Front cover: Acrylic (Hard coating), Cable: PVC				
		Indicator light : TPU		Indicator light : PPSU, Body part of polarizing filter : POM		
Weight		Approx. 50g		Approx. 70g (including polarizing filter)		

*1 When installed at the center position of installation distance.

*2 Except when mounting polarizing filter and dome attachment.

Separate amplifier type: AI-H Amplifier

Model		AI-1000	AI-1000C
Connection type		6-core cable	M8 Connector (4-core)
Detection mode		Presence check mode / Difference check mode / Feeder mode	
Response time		Switchable among 3 ms/10 ms/20 ms/50 ms/100 ms	
Timer		Off/Off-delay/On-delay/One-shot	
Bank feature		Number of Banks: Max. 4	Number of Banks: Max. 2
Other functions		Filter, Orientation detection, Anti-blur, Hysteresis, Mutual interference prevention, Indicator color changing, Finder display orientation, Statistics display, NG hold display, Keylock, I/O test	
Display		OLED display	
Compatible languages		English/Japanese/Chinese (Simplified)	
Indicator	Main indicator	1 indicator (Green/Red/Yellow)	
	I/O Indicator	4 indicators (Red): OUT1/OUT2/IN1/IN2	2 indicators (Red): OUT1/OUT2 or IN
Input		No-voltage input/voltage input is switchable For no-voltage input: ON voltage 2 V or lower, OFF current 0.1 mA or lower, ON current 2 mA (short circuit) For voltage input: Maximum input rating 30 V, ON voltage 18 V or higher, OFF current 0.1 mA or lower, ON current 2 mA or lower (for 30 V)	
	Inputs	2: IN1/IN2	1: IN or no input [1]
	Function	Assignable functions: Bank/Hold (level)/Hold (edge)/Reset/Eternal calibration/ Interference prevention input (sync-input)/Light off	
Output		Open collector output: Switchable between NPN and PNP, N.O. and N.C. Maximum rating: 30 V, 50 mA, Remaining voltage: 2 V or less	
	Inputs	2: OUT1/OUT2	1: OUT1 or 2: OUT1/OUT2[1]
	Function	Assignable functions for OUT2: Error output/Judgment output 2/Interference prevention output (sync-output)	
Communication function		IO-Link: Specification v. 1.1 (1.0)/COM2 (38.4 kbps)	
Rating	Power voltage	DC 20 to 30 V , Ripple (P-P) 10% included	
	Consumption current	0.35A or less (When the power supply voltage is 20 V, excluding the output load)	
Environmental resistance	Ambient temperature	-10 to +50°C (No freezing)	
	Ambient humidity	35 to 85% RH (No condensation)	
	Vibration	10 to 55 Hz, 1.5 mm double amplitude, 2 hours each for X, Y, and Z axes	
Material		Case/Dust cover: Polycarbonate, Button: POM, Display panel: Acrylic	
Weight		Approx. 110g (including 2m cable)	Approx. 40g

*1 Assign OUT2 or IN to I/O setting (white wire or 2nd pin of M8 connector).

7

Specifications

Built-in amplifier type

Model		AI-B050	AI-B100	AI-B160
Installation distance		45 to 55 mm	90 to 110 mm	140 to 180 mm
Detection range*	Zoom from 4.0 times to 1.0 time	4x4 mm to 16x16 mm	8x8 mm to 32x 32 mm	13x13 mm to 52x52 mm
	Digital zoom	1.0 to 4.0 times (17 levels) adjustment, zoom position adjustment function		
Light receiving element		Monochrome CMOS		
Projection	Light source	Red LED (660 nm)		Red LED (850 nm)
	Lighting system	Pulse lighting		
Detection mode		Presence check mode / Difference check mode / Feeder mode		
Response time		Switchable among 3 ms/10 ms/20 ms/50 ms/100 ms		
Timer		Off/Off-delay/On-delay/One-shot		
Bank feature		Number of Banks: Max. 2		
Other functions		Filter, Orientation detection, Anti-blur, Hysteresis, Mutual interference prevention, Indicator color changing function, Screen display orientation, Statistics display, NG hold display, Keylock, I/O test		
Display		OLED display		
Compatible languages		English/Japanese/Chinese (Simplified)		
Indicator	Main indicator	1 indicator (Green/Red/Yellow)		
	I/O Indicator	2 indicators (Red): OUT1/OUT2 or IN		
Input		No-voltage input/voltage input is switchable For no-voltage input: ON voltage 2 V or lower, OFF current 0.1 mA or lower, ON current 2 mA (short circuit) For voltage input: Maximum input rating 30 V, ON voltage 18 V or higher, OFF current 0.1 mA or lower, ON current 2 mA or lower (for 30 V)		
	Inputs	1: IN or no input *2		
	Function	Assignable functions: Bank/Hold (level)/Hold (edge)/Reset/Eternal calibration/Interference prevention input (sync-input)/Light off		
Output		Open collector output: Switchable between NPN and PNP, N.O. and N.C. Maximum rating: 30 V, 50 mA, Remaining voltage: 2 V or less		
	Inputs	1: OUT1 or 2: OUT1/OUT2*2		
	Function	Assignable functions for OUT2: Error output/Judgment output 2/Interference prevention output (sync-output)		
Communication function		IO-Link: Specification v. 1.1 (1.0)/COM2 (38.4 kbps)		
Rating	Power voltage	DC 20 to 30 V, Ripple (P-P) 10% included		
	Consumption current	0.3 A or less (When the power supply voltage is 20 V, excluding the output load)		
Environmental resistance	Ambient temperature	-10 to +50°C (No freezing)		
	Ambient humidity	35 to 85% RH (No condensation)		
	Vibration	10 to 55 Hz, 1.5 mm double amplitude, 2 hours each for X, Y, and Z axes		
	Shock resistance	500m/s^2, 3 times for each of the 6 directions		
	Enclosure rating	IP67*3		
Material		Body: Zinc die-cast/PBT, Front cover: Acrylic (Hard coating), Operation indicator: TPU, Button: POM, Display sheet: PET, Body part of polarizing filter: POM		
Weight		Approx. 120g (including polarizing filter)		

*1 When installed at the center position of installation distance.

*2 Assign OUT2 or IN to the I/O setting (white wire or 2nd pin of the M12 connector).

*3 Except when mounting polarizing filter and dome attachment.

7

Specifications

Dimensions

Separate amplifier type Sensor head

Sensor head

■ AI-H010/H020
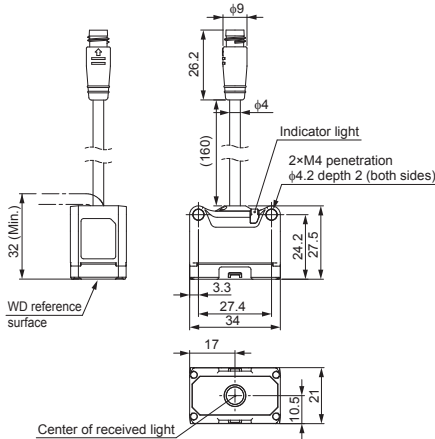
■ AI-H010/H020 + AI-F01H

■ AI-H010/H020 + OP-88100
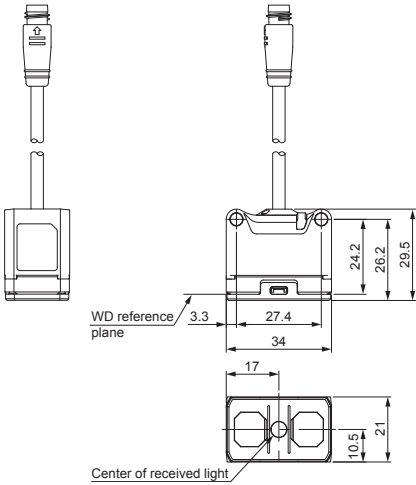
■ AI-H010/H020 + OP-88101

7

Specifications
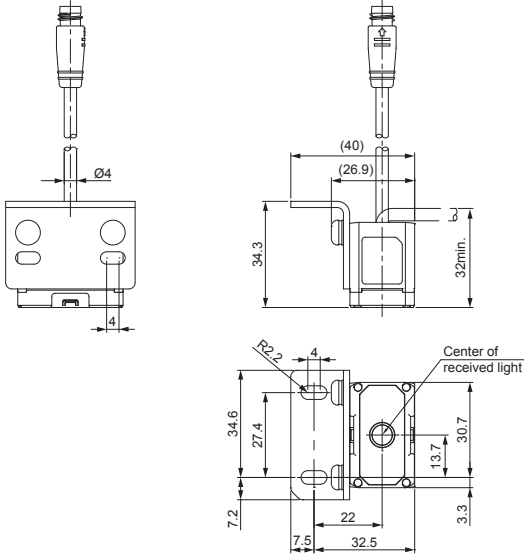
■ AI-H050/H100 (With AI-F05H)
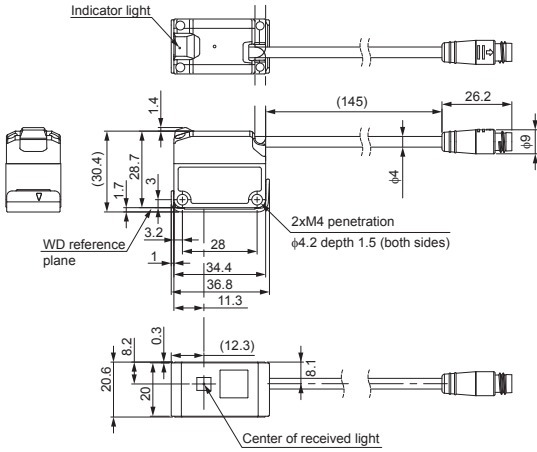

■ AI-H050/H100 (With AI-F05H) + OP-88104
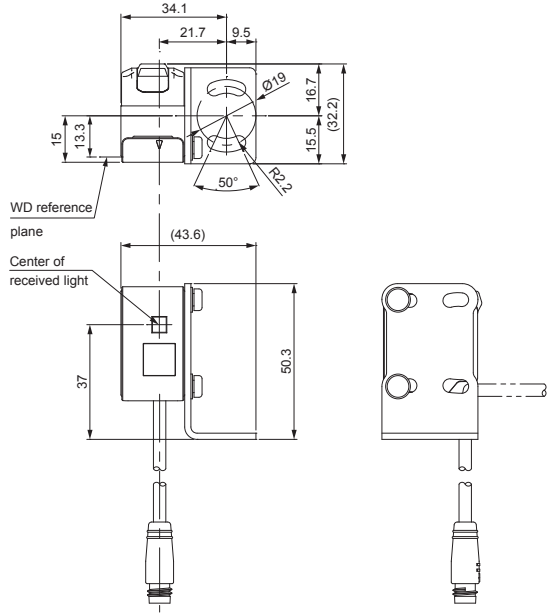
■ AI-H160 (With AI-F10H)
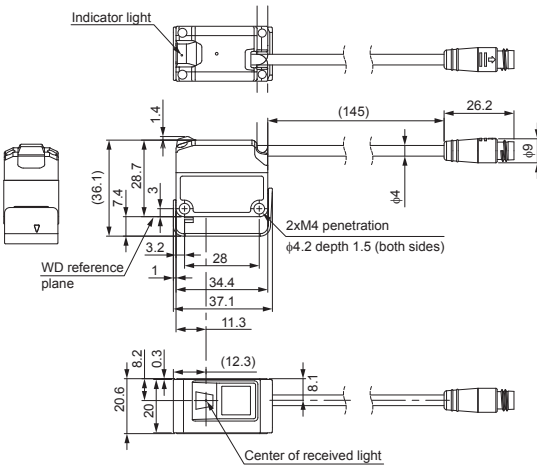
■ AI-H160 (With AI-F10H) + OP-88104
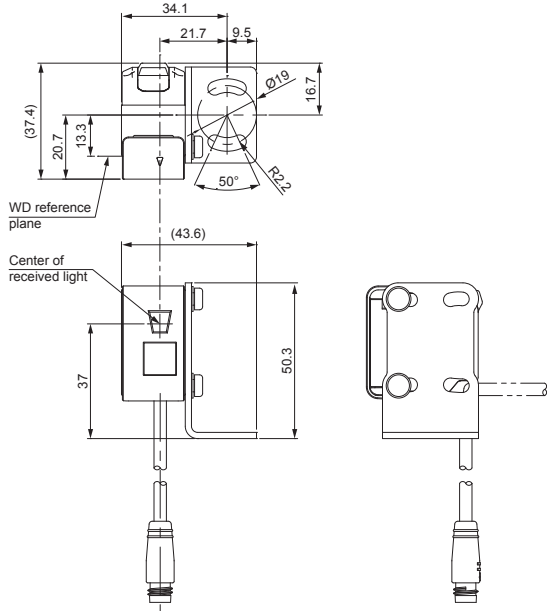
7

Specifications

■ AI-H050/H100 (With AI-F05H) + OP-88105
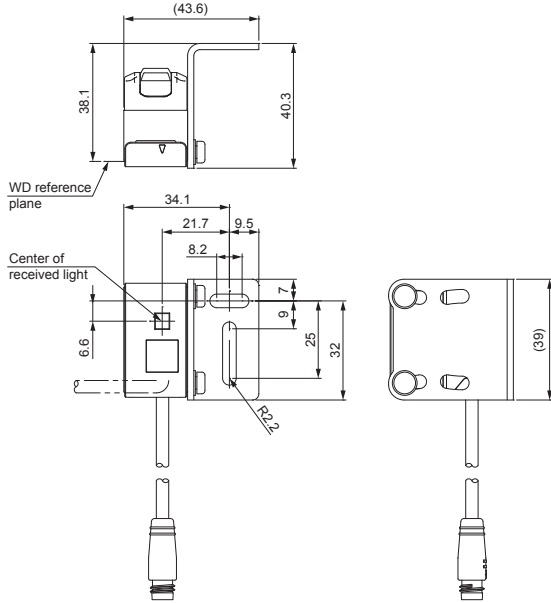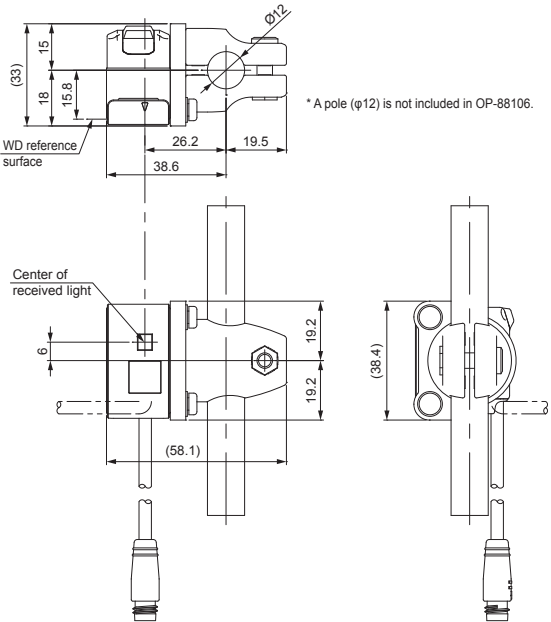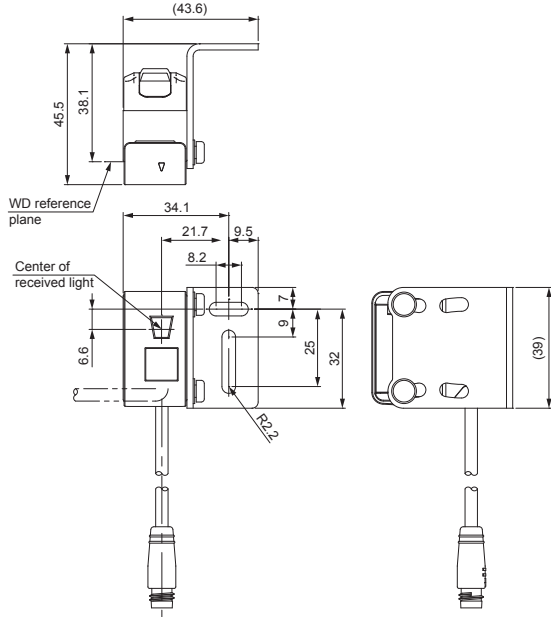
WD reference plane

Center of received light

■ AI-H050/H100 (With AI-F05H) + OP-88106

WD reference surface

* A pole (φ12) is not included in OP-88106.

Center of received light

■ AI-H160 (With AI-F10H) + OP-88105

WD reference plane

Center of received light

■ AI-H160 (With AI-F10H) + OP-88106

WD reference surface

* A pole (φ12) is not included in OP-88106.

Center of received light

7

Specifications

■ AI-H050/H100/H160 + AI-D16H

WD reference plane

Center of received light

■ AI-H050/H100/H160 + AI-D16H + OP-88104

WD reference plane

Center of received light

■ AI-H100/H160 + AI-D32H

WD reference plane

Center of received light

■ AI-H100/H160 + AI-D32H + OP-88104

WD reference plane

Center of received light

7

Specifications
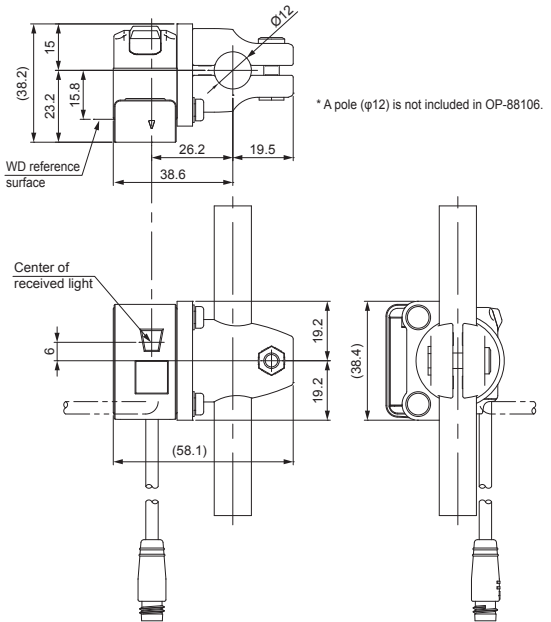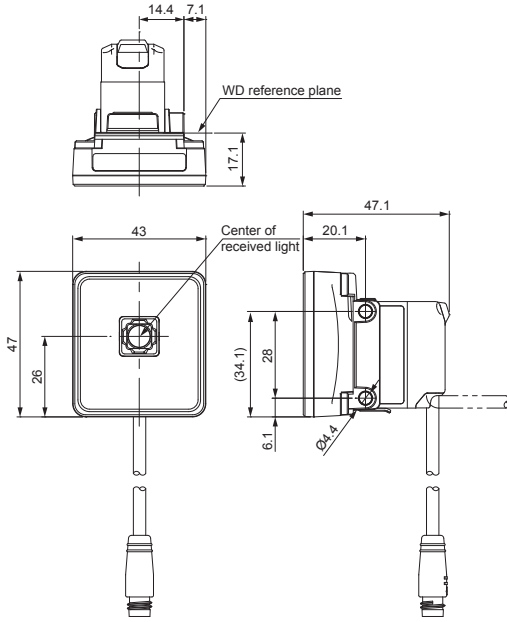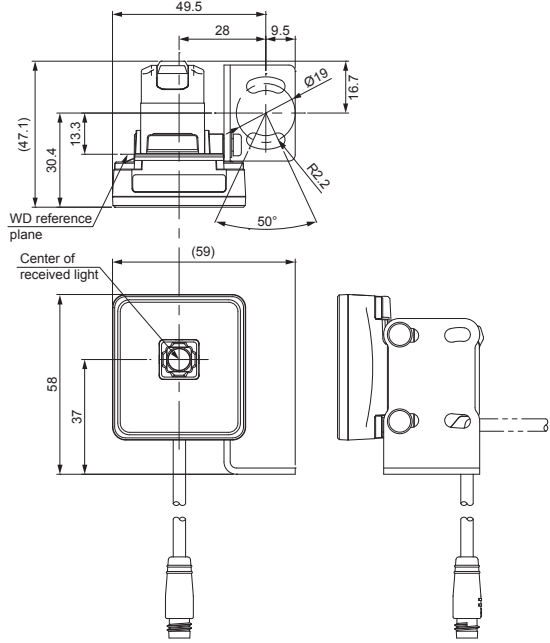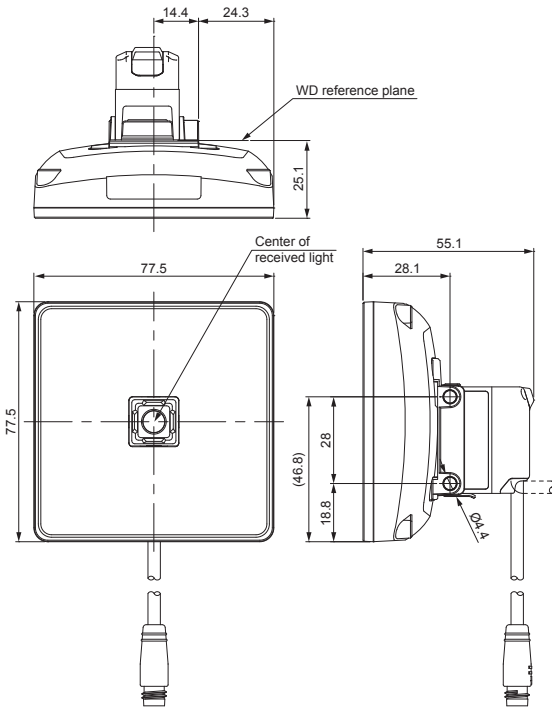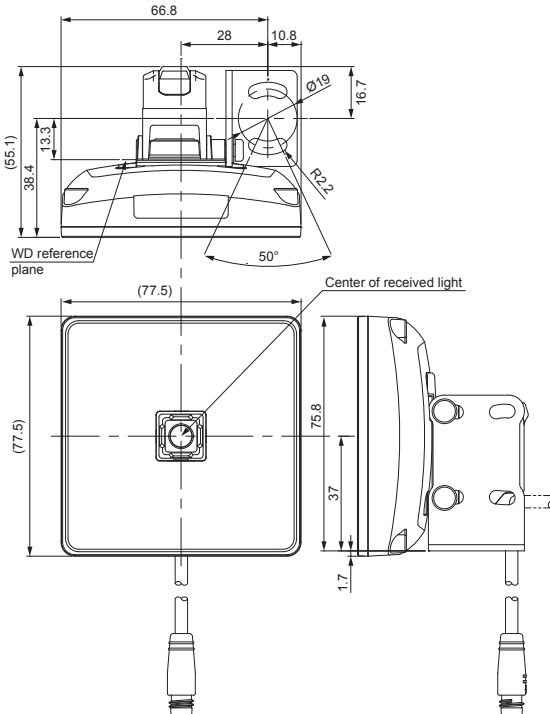
■ AI-H050/H100/H160 + AI-D16H + OP-88105

■ AI-H100/H160 + AI-D32H + OP-88105
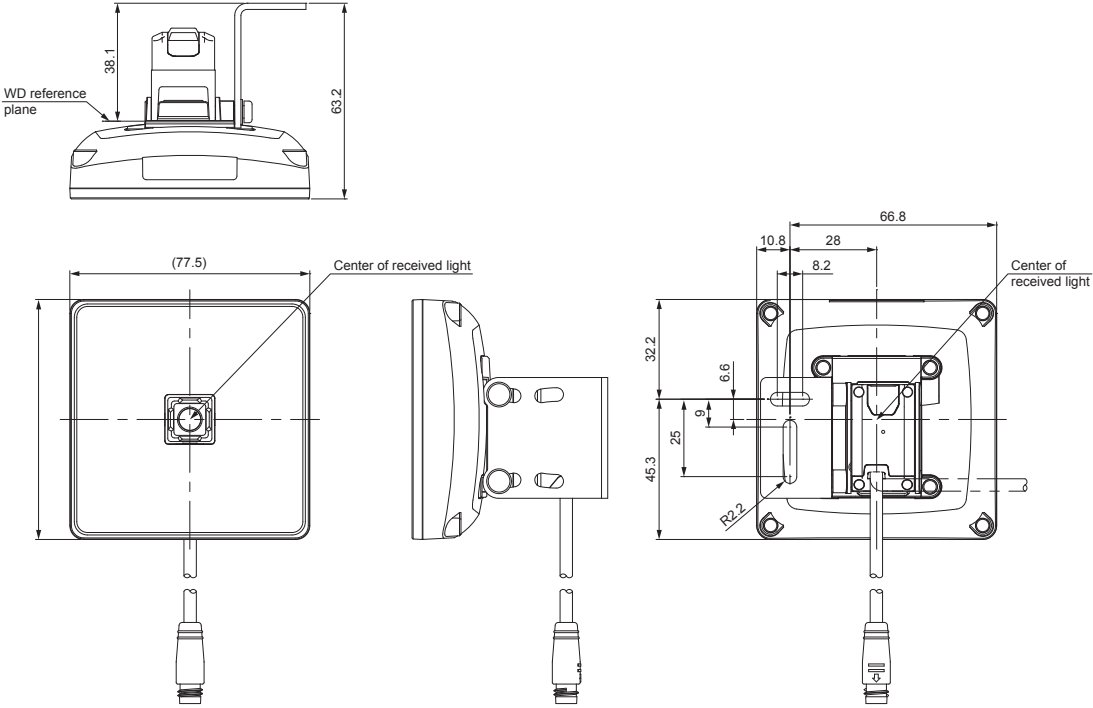
7

Specifications

■ AI-H050/H100/H160 + AI-D16H + OP-88106
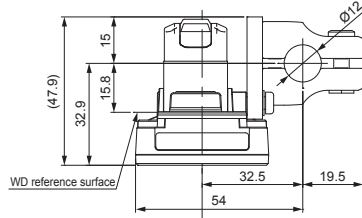
Ø12

15

(47.9)

15.8

32.9

WD reference surface

32.5

19.5

54

* A pole (φ12) is not included in OP-88106.

Center of received light

27

6

20.1

(73.5)

(47)

■ AI-H100/H160 + AI-D32H + OP-88106

Ø12

15

(55.9)

15.8

40.9

WD reference plane

32.5

19.5

71.3

* A pole (φ12) is not included in OP-88106.

Center of received light

(77.5)

(77.5)

6

44.7

32.8

(90.8)

7

Specifications
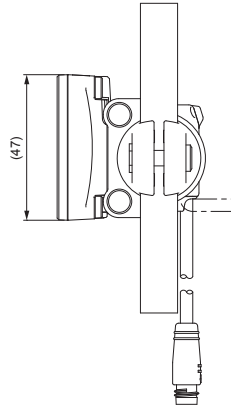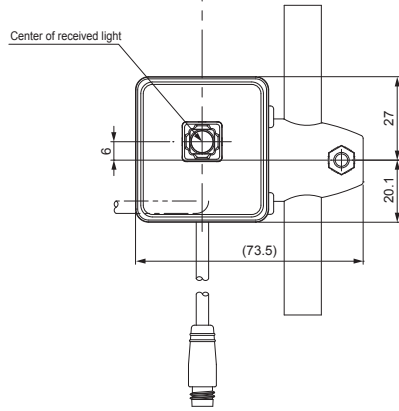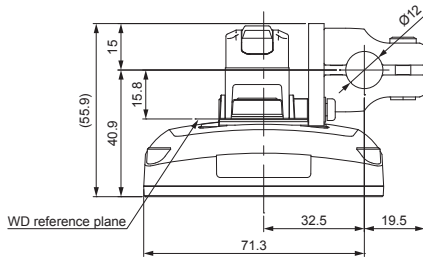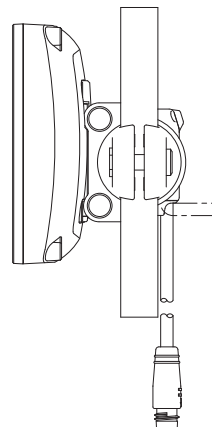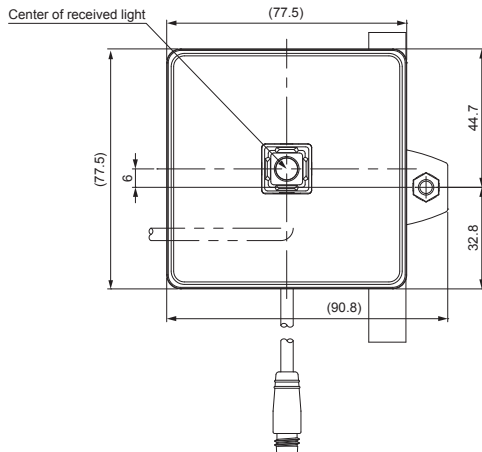
AI-H010/H020 optional parts

■ Polarizing filter : AI-F01H

5.8 2

33.6

20.4

■ Vertical Mounting bracket : OP-88100

23
(5.5) 12
19 11.5
4
4.4

5 13
46.9 27.4
4
12.5

Material:SUS304
t=2

■ Rear Mounting bracket : OP-88101

41.8
(7.2) 27.4
19 11.5
4
4.4

(7.2) 27.4
28.3 18.3
10.1
4
4

Material:SUS304
t=2
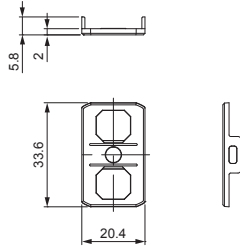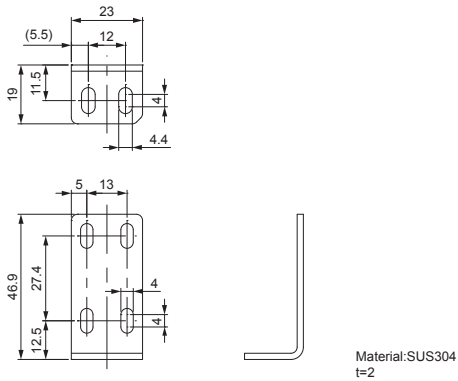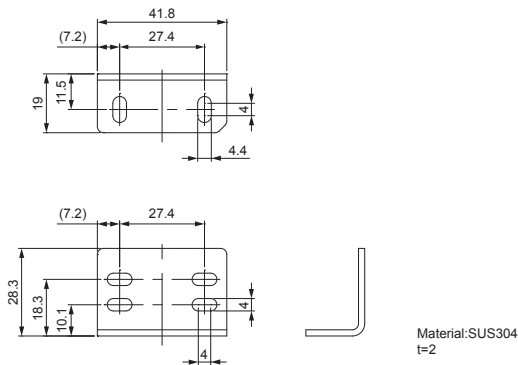
AI-H050/H100/H160 optional parts

■ Polarizing filter for AI-H050/H100 : AI-F05H

A positioning guide for light receiving center

20
Center of
received light 7.9
12.3
36.8

7.9

The thickness of the filter part :1.7mm

12.3
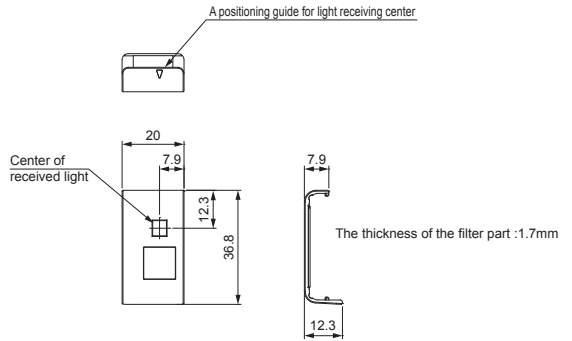
■ Polarizing filter for AI-H160 : AI-F10H

A positioning guide for light receiving center

20
Center of
received light 7.9
12.3
37.1

13.6

The thickness of the filter part :7.4mm

18

7

Specifications

■ **Dome attachment (small) : AI-D16H**

Distance from a WD reference surface

17.1
28.2

Center of received light
20.1
Ø4.4
47
26
28
6.1
43

■ **Dome attachment (large) : AI-D32H**

Distance from a WD reference surface

25.1
36.2

Center of received light
28.1
Ø4.4
77.5
28
18.8
77.5

■ **Vertical mounting bracket : OP-88104**

Ø19
50°
13.5
23
R2.2

8°
R2.2
45.1
50.3
17.1
8°
(5.2)
20.6
31

Material:SUS304
t=2

■ **Rear mounting bracket : OP-88105**

32
(16)
16
7
23
13.5
8.2
4.4
R2.2
4.4

39
28
R2.2
40.3
35.1
10°
16.5
10°
10°

Material:SUS304
t=2

■ Adjustable mounting bracket : OP-88106

Bracket
Material: Zinc die-casting
*A pole (φ12) is not included in this product.

Hookup drawing

25.5
13
(36.9)
32.5
Ø27
3.3
4.4
Ø12

5
38.4
(5.2)
28
Ø4.4
5.2
18
33
Ø20.1
Spot facing φ24 d=2
Material:SUS304

(37.5)

Sensor head connection cable

■ OP-87056(2m)/ OP-87057(5m)/ OP-87058(10m)

Model	L (mm)
OP-87056	2000
OP-87057	5000
OP-87058	10000

L
27.2
A
Ø9.5
7.2
Ø4.8, 4x0.22mm²
Ø11
21.4
20.6
10.4
C
B
9.4
C-C
C

A	B	Color
1	1	Brown
2	3	White
3	4	Blue
4	2	Black

A   B

7
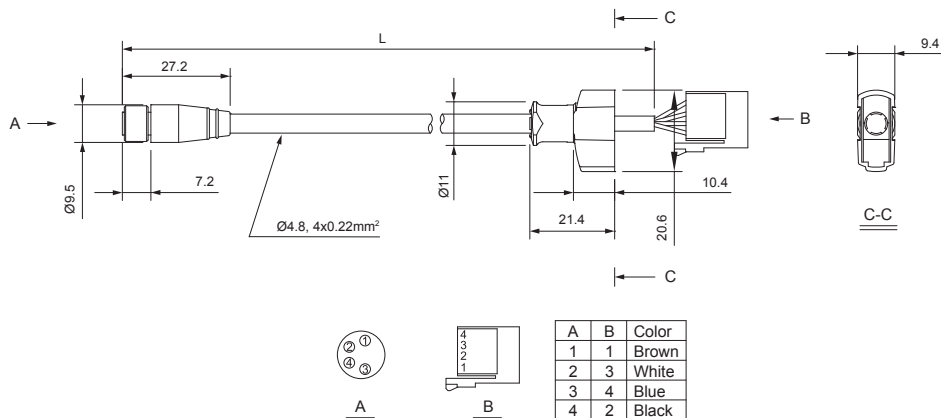
Specifications

Separate amplifier type Amplifier

AI-H Amplifier

■ AI-1000
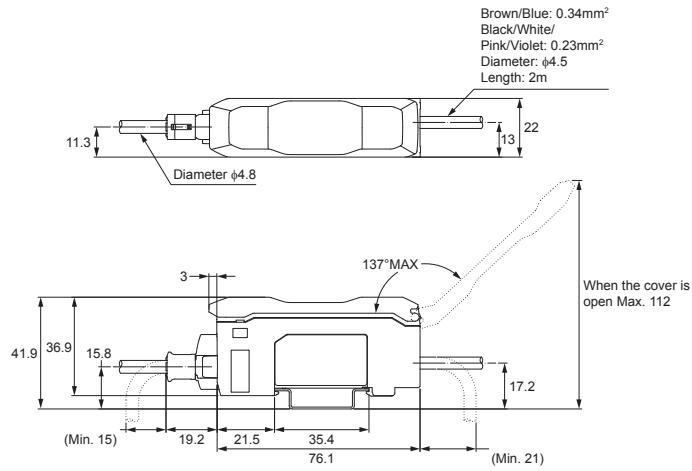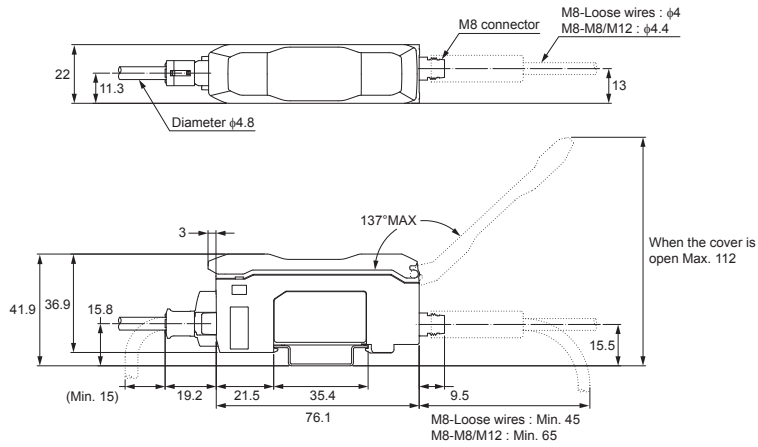
Brown/Blue: 0.34mm²
Black/White/
Pink/Violet: 0.23mm²
Diameter: φ4.5
Length: 2m

11.3

13
22

Diameter φ4.8

3

137°MAX

When the cover is
open Max. 112

41.9 36.9   15.8

17.2

(Min. 15)   19.2   21.5   35.4

76.1   (Min. 21)

■ AI-1000C

M8 connector

M8-Loose wires : φ4
M8-M8/M12 : φ4.4

22
11.3

13

Diameter φ4.8

3

137°MAX

When the cover is
open Max. 112

41.9 36.9   15.8

15.5

(Min. 15)   19.2   21.5   35.4   9.5

76.1

M8-Loose wires : Min. 45
M8-M8/M12 : Min. 65

Connector type cable

■ M8-Loose wires : OP-88095(2m)/OP-88096(10m)

Ø3.7 (4x0.2mm²)

Ø9.5

26.7

L

	L (mm)
OP-88095	2000
OP-88096	10000
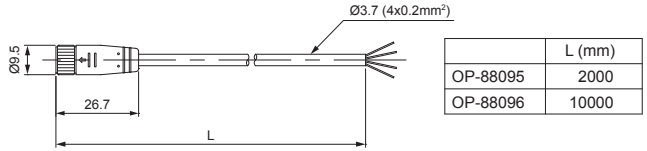
Pin arrangement

No.	Color
①	Brown
②	White
③	Blue
④	Black

■ M8-M8 : OP-88069(2m)

33.7   2000   38.7

Ø10

Ø10

M8 (4pin)   Ø4.4 (4x0.25mm²)   M8 (4pin)

■ M8-M12 : OP-88071(2m)/OP-88072(5m)

OP-88071:2000
OP-88072:5000

33.7   46.8

Ø10

Ø14.8

M8 (4pin)   Ø4.4 (4x0.25mm²)   M12 (4pin)

7

Specifications
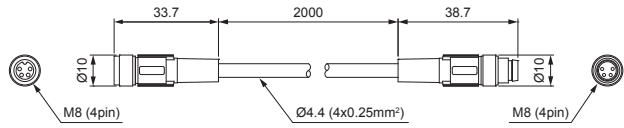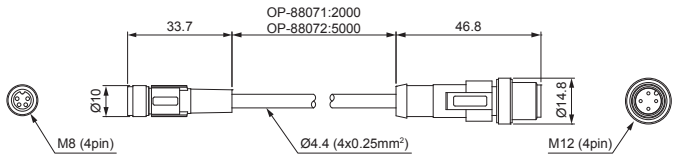
Built-in amplifier type

Sensor

■ AI-B050/B100 (With AI-F05B)

Indicator light

Display   Button x5

66.2 (Min.)
47.2
1.7
(38.2)
36.5
3.5
1.7
Ø4
Ø14
14.4
3.5   1.4
49
56
2xM4 penetration
φ4.2 depth 3.3 (both sides)
30
58.3
24.2
24.6
WD reference
plane
Center of received light
(31.4)

L-shaped connector:

32.4
Ø14
14.4
46.2 (Min.)

■ AI-B160 (With AI-F10B)

Indicator light

Display   Button x5

66.2 (Min.)

47.2

1.7

(43.8)

36.5

7.3

3.5

24.2

24.6

WD reference plane

Ø4

Ø14

14.4

49   3.5

56   1.7

30

58.3

2xM4 penetration
φ4.2 depth 3.3 (both sides)

Center of received light

(31.4)

L-shaped connector:

32.4

Ø14

14.4

46.2 (Min.)

7

Specifications
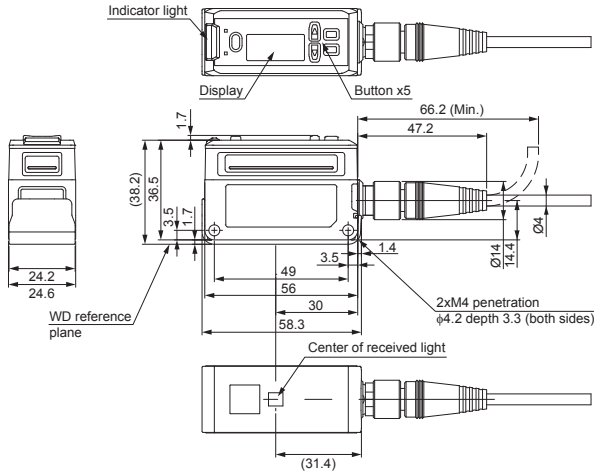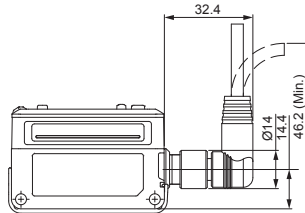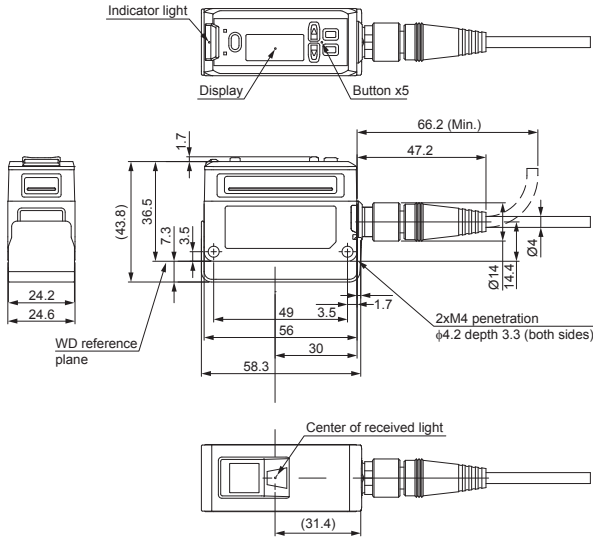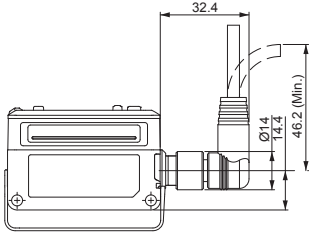
■ **AI-B050/B100 (With AI-F05B) + OP-88114**
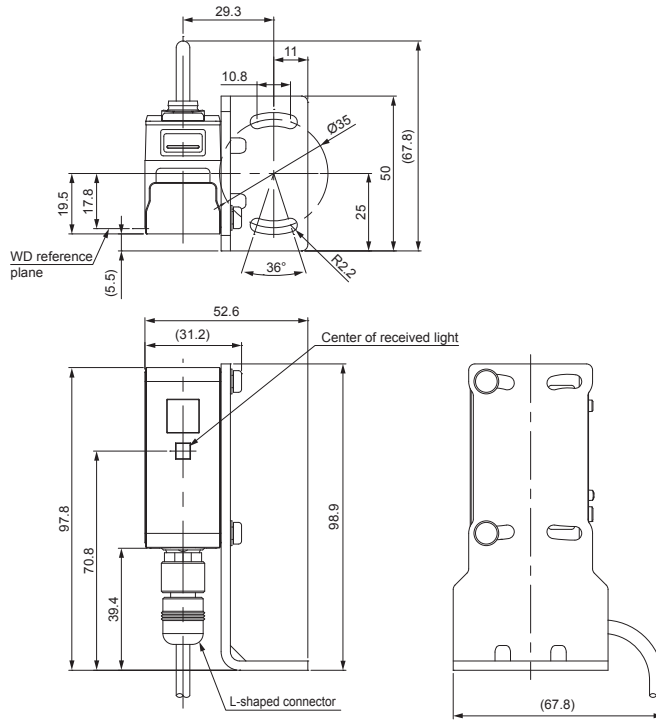
■ **AI-B160 (With AI-F10B) + OP-88114**
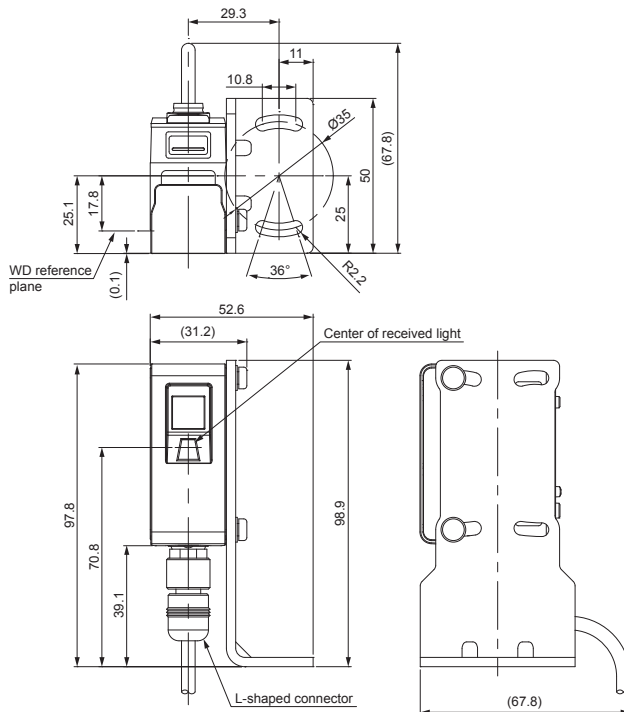
■ **AI-B050/B100 (With AI-F05B) + OP-88115**

■ **AI-B160 (With AI-F10B) + OP-88115**

7

Specifications
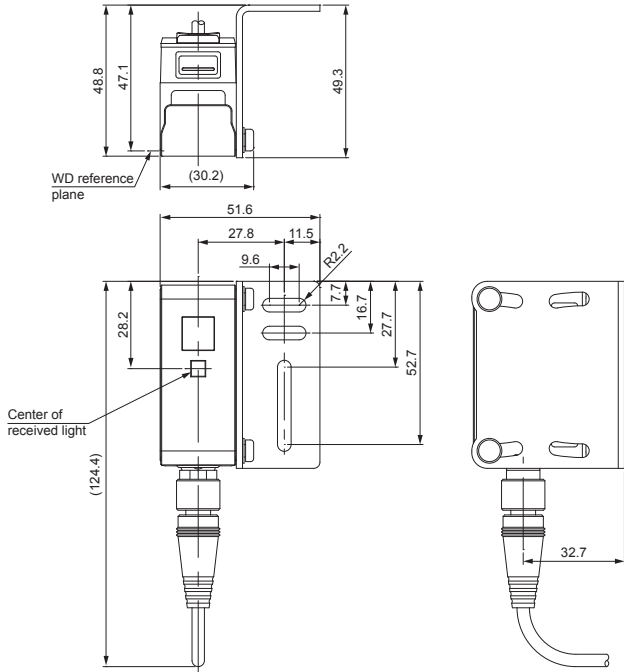
■ **AI-B050/B100 (With AI-F05B) + OP-88116**
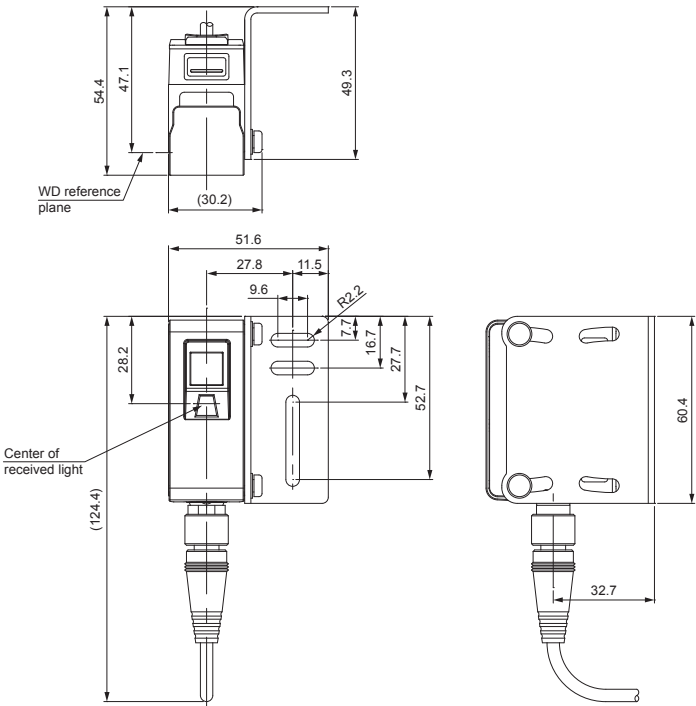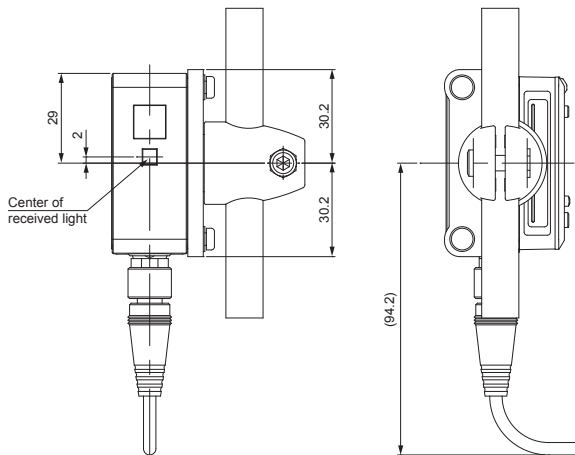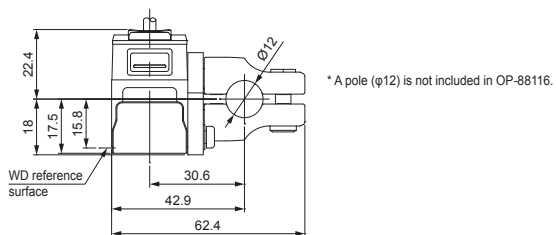
* A pole (φ12) is not included in OP-88116.

■ **AI-B160 (With AI-F10B) + OP-88116**

* A pole (φ12) is not included in OP-88116.

7

Specifications

■ AI-B050/B100/B160 + AI-D16B

WD reference plane

17.1

14.5 7

43

Center of received light

27.5

58.6

(123.7)

55.3

20.6

5

49

■ AI-B100/B160 + AI-D32B

14.5 24.3

WD reference plane

25.1

77.5

Center of received light

77.5

(134.9)

63.3

28.6

16.2

49

7

Specifications
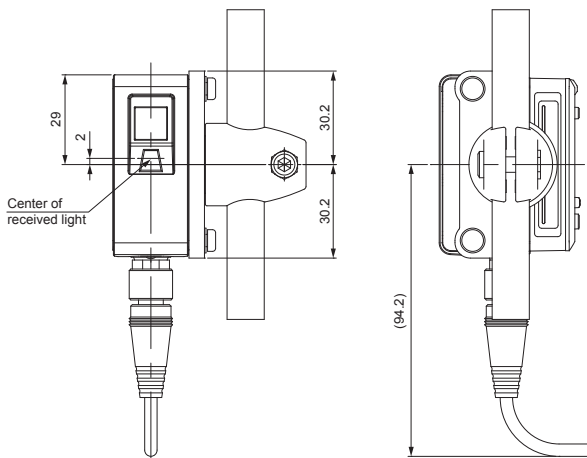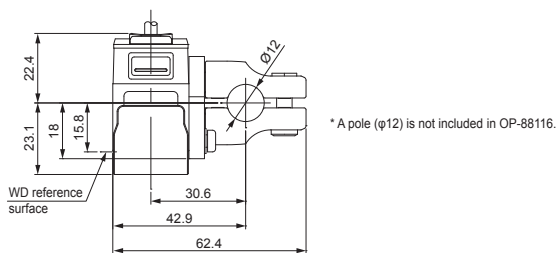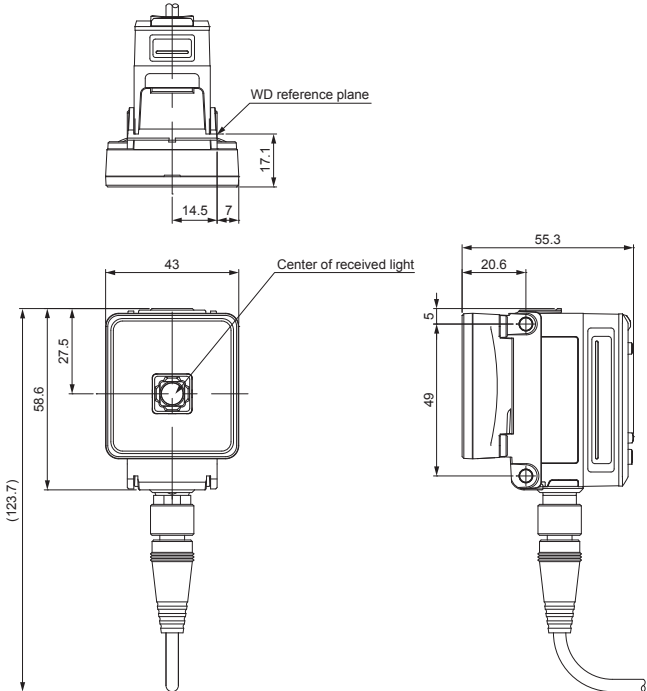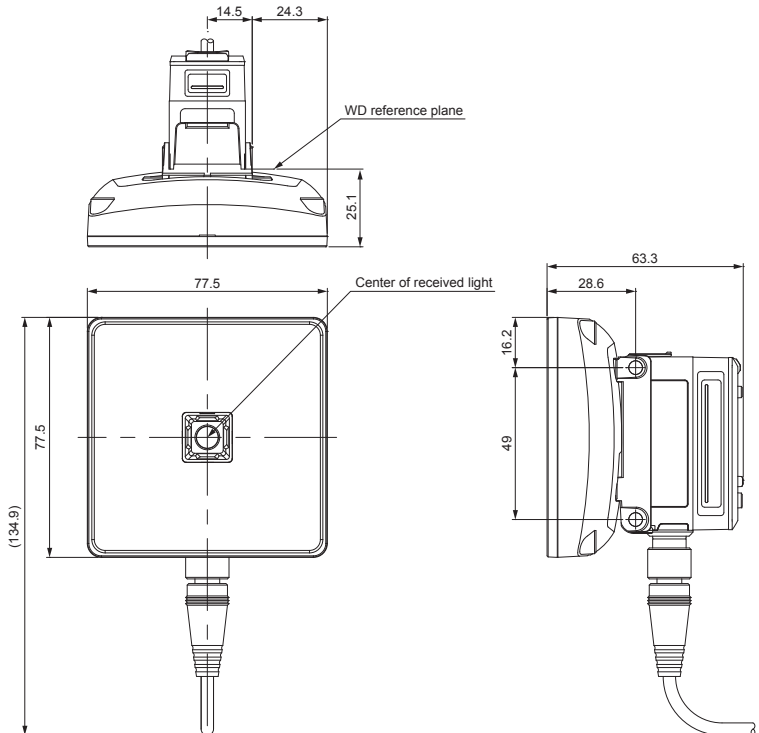
■ **AI-B050/B100/B160 + AI-D16B + OP-88114**
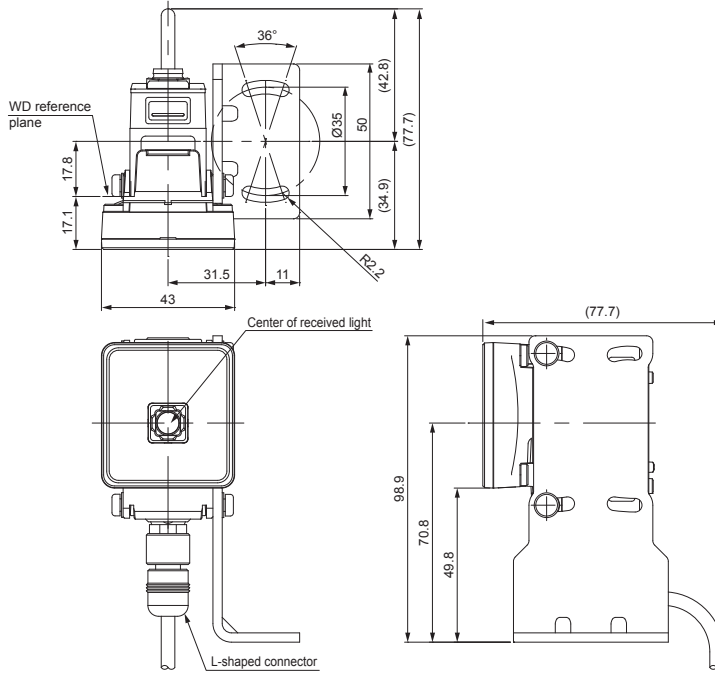
■ **AI-B100/B160 + AI-D32B + OP-88114**

7

Specifications
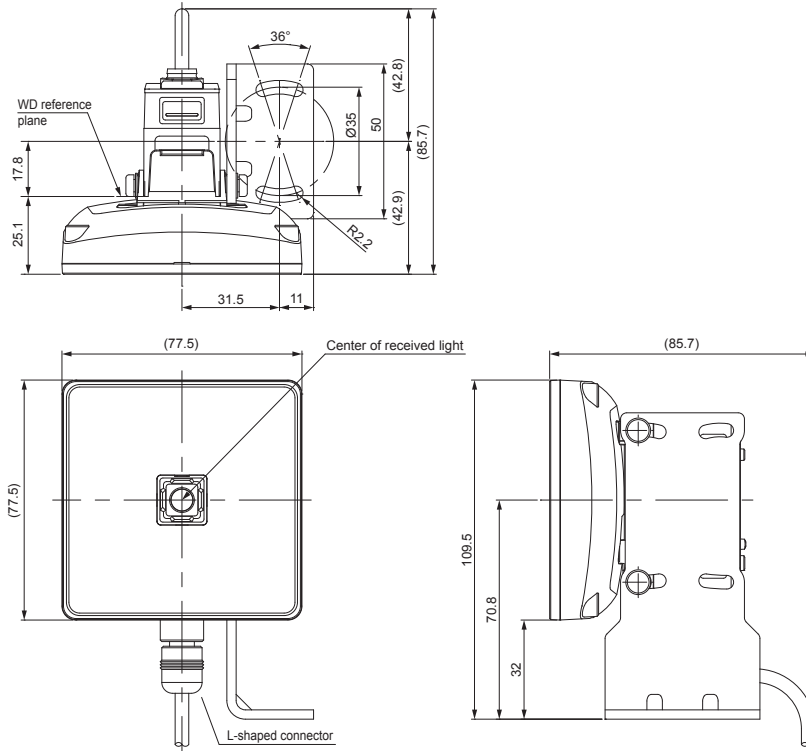
■ **AI-B050/B100/B160 + AI-D16B + OP-88115**
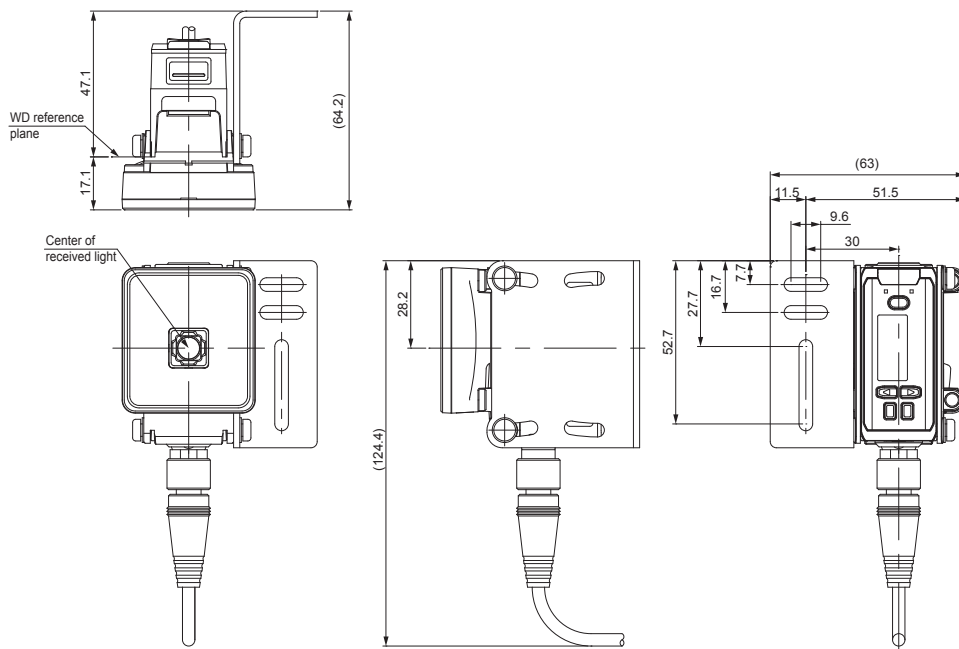
■ **AI-B100/B160 + AI-D32B + OP-88115**

7

Specifications
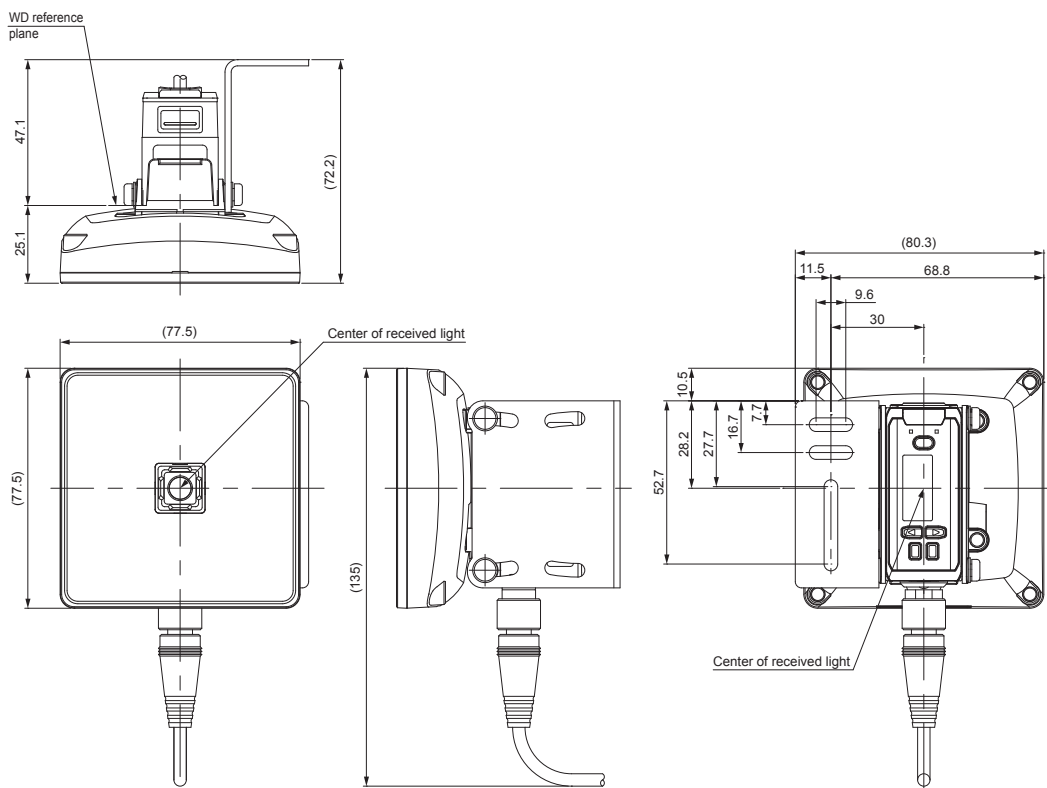
■ AI-B050/B100/B160 + AI-D16B + OP-88116
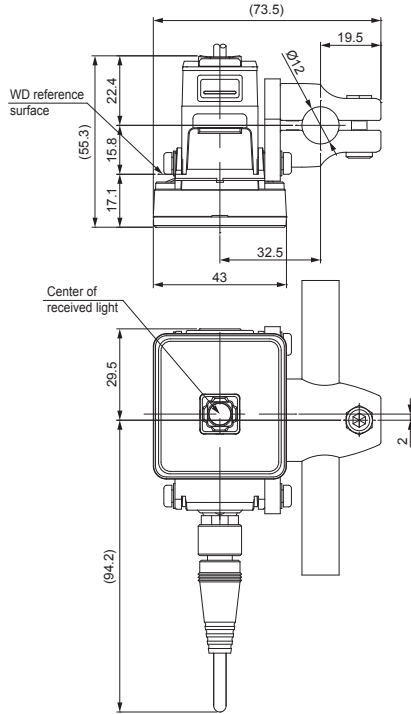
* A pole (φ12) is not included in OP-88116.

■ AI-B100/B160 + AI-D32B + OP-88116

* A pole (φ12) is not included in OP-88116.

7

Specifications

Option

■ Polarizing filter for AI-B050/B100 : AI-F05B

Center of received light

24.2
12.1
10.6
31.4
58.4
16.6

The thickness of the filter part :1.7mm
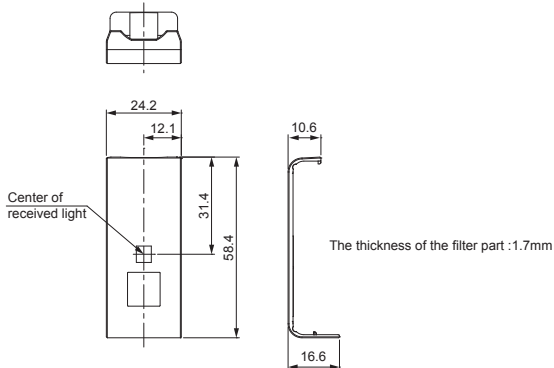
■ Polarizing filter for AI-B160 : AI-F10B

Center of received light

24.2
12.1
16.3
31.7
58.7
22.3

The thickness of the filter part :7.3mm

■ Dome attachment (small) : AI-D16B

Distance from a WD reference surface

17.1
32.1

Center of received light

20.6
Ø44.4
58.6
47
49
26
5
1.5
43

■ Dome attachment (large) : AI-D32B

Distance from a WD reference surface

25.1
40.1

Center of received light

28.6
Ø44.4
77.5
49
16.2
77.5

■ Vertical mounting bracket : OP-88114

Ø35
36°
17
28
R2.2

8°
R2.2
93.2
98.9
44.2
8°

(10.7)
28.6
50

Material:SUS304
t=3

■ Rear mounting bracket : OP-88115

52.7
27.7
16.7
7.7
4.4
27
15.5
9.6
R2.2
4.4

60.4
49
R2.2
49.3
43.6
10°
10°
13.6

Material:SUS304
t=2

7

Specifications

■ **Adjustable mounting bracket : OP-8816**

Bracket
Material: Zinc die-casting
*A pole (φ12) is not included in this product.

Hookup drawing

Material:SUS304

Cable

■ **M12-Loose wires OP-88107(2m)/ OP-88108(10m)**

Ø4 (4x0.2mm²)

	L (mm)
OP-88107	2000
OP-88108	10000

Pin arrangement

No.	Color
①	Brown
②	White
③	Blue
④	Black

■ **M12L-Loose wires OP-88109(2m)/ OP-88110(10m)**

Pin arrangement

No.	Color
①	Brown
②	White
③	Blue
④	Black

Ø4.0 (4x0.2mm²)

	L(mm)
OP-88109	2000
OP-88110	10000

■ M12-M12 : OP-88112(2m)/ OP-88113(5m)

Ø4 (4x0.28mm²)

Ø12

Ø12

M12,P=1

A → Ø14

Ø14.1 ← B

43.7

45

L

Pin arrangement

A	B
No.	No.
①	①
②	②
③	③
④	④

A

B

	L (mm)
OP-88112	2000
OP-88113	5000

■ M12L-M12 : OP-88111(1m)
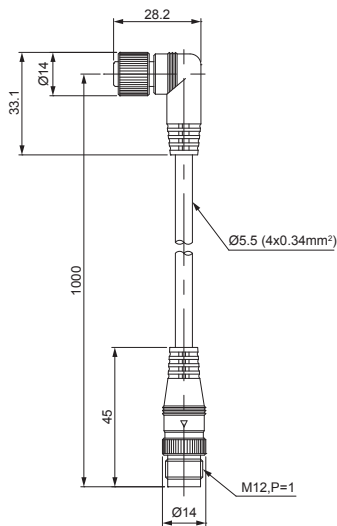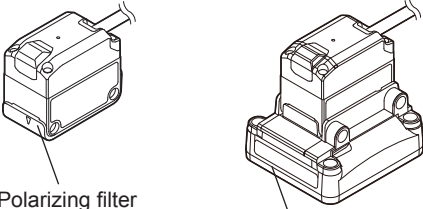
28.2

Ø14

33.1

Ø5.5 (4x0.34mm²)

1000

45

M12,P=1

Ø14

7

Specifications

MEMO

Appendices

A

Points for stabilizing detection

Reduce glare on glossy surfaces and metallic surfaces
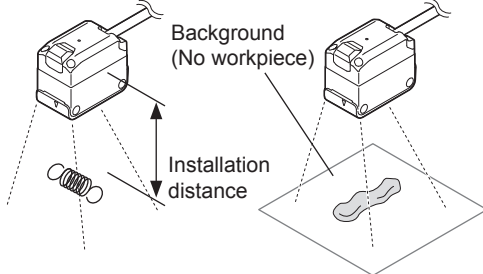
Polarizing filter
(Included*)
Use the Polarizing filter.

* Not included in
AI-H010/020.

Dome attachment : small
or large

If there is no
improvement with the
polarizing filter, use the
dome attachment.

Install sensor at the correct distance

Reduce background effect

Background
(No workpiece)

Installation
distance

Place the target at
the correct distance.
(Page 2-2)
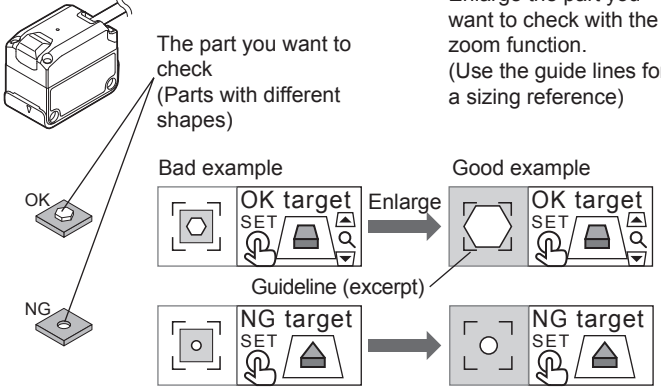
Place the object
against an even, solid
background. Avoid
backgrounds with
patterns or variations.

A

During calibration, enlarge the object with the zoom function and register it (Page 3-4).

Presence check mode / Feeder mode:
Enlarge the target to be detected, and
register it.
Difference check mode: Enlarge the portion of the part to be
compared, and register it.

The part you want to
check
(Parts with different
shapes)

Enlarge the part you
want to check with the
zoom function.
(Use the guide lines for
a sizing reference)

OK

NG

Bad example

OK target
SET

NG target
SET

Enlarge

Guideline (excerpt)

Good example

OK target
SET

NG target
SET

Changing Response Time

Extend "A1/P1. Response
time".
The detection performance is
improved. (Page 4-7)

Changing Setting Value (Threshold)

Set the value (threshold for
judgment) manually and
adjust it. (Page 4-5)

Using Difference check mode
If the background affects the
Presence check mode, use
Difference check mode.
(Page 3-4)

Changing Trigger Setting Value
If the detection of judgment
target is unstable on Feeder
mode, adjust the trigger
setting value.
(Page 5-6)

Changing Sensor

Change to a sensor with
shorter installation distance.
(Page 2-2)

Quick setup example

To calibrate for part presence
in the Difference check mode .... Register nothing (background) for "Register the NG
workpiece" portion of the calibration. (Page 3-4)

Register OK workpiece	Register NG workpiece	Register nothing
YES (ON)	NO (OFF)	NO (OFF)
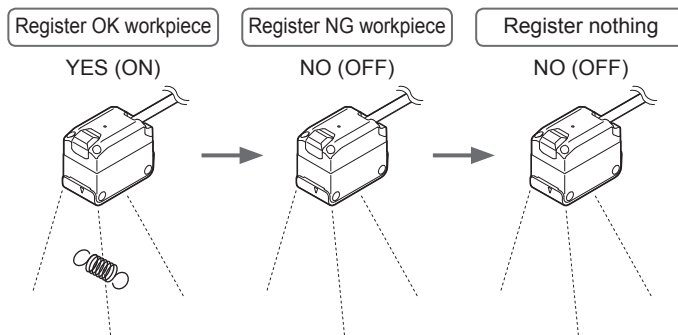
To turn on the output for a NG workpiece .... Change "D9. Reverse OK/NG" (Page 4-15) to "On".
(Difference check mode only)

To prevent chattering .... Ensure calibration is done properly.
Increase the processing count of "A2. Chatter prev." (Page
4-7). Also increase "C13. Hysteresis value" (Page 4-10).

To support high speed targets .... Turn "A5. Anti-blur" (Page 4-7) "On". Shorten "A1. Response
time" (Page 4-7).

To synchronize with a trigger sensor .... Assign the hold (level) or the hold (edge) to the input wire in
"C4/C5. Input function" (Page 4-9). (Page 2-9)

To allow for rotation of the target
in the Difference check mode .... Change "A6. Difference check mode (Diff. chk. mode)" (Page
4-7) to "Direction detection off (Dir-det. off)". (Response time
of 100 ms only)

A

Status Table

Status table

Status		Indicator			OLED screen	
		Indicator light	Input Indicator	Output Indicator	Matching rate	
Operation *1	In normal operation	Normal operation *5	*6	*7	Normal operation	
	After reset	Off	*6	*7	---	
	Terminated projection	Off	*6	*7	---	
	In external calibration	Off	*6	*7	---	
	Bank being switched	Off	*6	*7	---	
	Calibration not registered	Flash green	*6	*7	---	
Detection range being adjusted		Flash green	*6	*7	Setting screen	
In calibration		Flash green	*6	*7	Setting screen	
I/O test in progress		Flash green	*13	*14	Setting screen	
Initializing		Flash green	Off	Off	Initialization screen	
Error	Overcurrent error *2	Flashing red	*6	Off	*12	
	Calibration error *3	Flashing red	*6	*7	*12	
	Sync error *2	Flashing red	*6	*7	*12	
	Error XX	Flashing red	Off	*7	Error screen	
When power is turned on *4		Off	Off	Off	Startup screen	

"✓/×" indicates if it is Enabled/Disabled.

ON/OFF indicates the following status. The operation differs depending on the output logic setting (N.O./N.C.).

• When N.O.   ON: The NPN or PNP open collector output is ON.

        OFF: The NPN or PNP open collector output is OFF.

• When N.C.   ON: The NPN or PNP open collector output is OFF.

        OFF: The NPN or PNP open collector output is ON.

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	OLED screen	Input					Output	
	Image	Bank	Hold	Reset	Projection stop	External calibration	Judgment output	Error
	Normal operation	✓	✓	✓	✓	✓	Judgment result *8	OFF
	"No data"	✓	✓	✓	✓	✓	OFF	OFF
	"Terminated projection" *11	✓	✓	✓	✓	×	OFF	OFF
	"Registering.."	*9	*9	*9	*9	×	OFF	OFF
		*10	*10	*10	*10	*10	OFF	OFF
	Normal operation	✓	×	×	○	×	OFF	OFF
	Setting screen	×	×	×	×	×	OFF	OFF
	Setting screen	×	×	×	×	×	OFF	OFF
	Setting screen	*13	*13	*13	*13	*13	*14	*14
	Initialization screen	×	×	×	×	×	OFF	OFF
	*12	✓	✓	✓	✓	✓	OFF	OFF
	*12	✓	✓	✓	✓	✓	OFF	ON
	*12	✓	✓	✓	✓	✓	OFF	ON
	Error screen	×	×	×	×	×	OFF	ON
	Startup screen	×	×	×	×	×	OFF	OFF

*1 Run screen, setting screen (except for Detection range being adjusted or I/O test)

*2 Automatically recovered after the error is resolved.

*3 Recovered after two seconds.

*4 The power-on reset time is up to three seconds.

*5 The indicator status depends on the setting of "D4/S4. Status LED."

*6 When the input is ON, flashing red; when OFF, light is off. For an input with no function assigned to, always lit off.

*7 When the NPN or PNP open collector output is ON, light is red; when OFF, light is off. For an output with no function assigned to, the light is always off.

*8 When the matching rate is the same as the setting value (threshold) or larger, ON; when smaller, OFF. (With hysteresis)

*9 Executed after external calibration is completed.

*10 Executed after Bank switching is completed.

*11 During a value hold, the held image is displayed. "L.OFF" is displayed on the LIVE screen.

*12 An error message is displayed on the normal run screen.

*13 The input indicator operates according to the ON/OFF status of the input. Change the assignment of the input wire to OFF for the input function and then test the input. When any function is assigned to the input wire, the assigned function operates.

*14 The output and output indicator operate according to the ON/OFF status of the output test. The output with OFF assigned can also be tested.

Display and Error

Display	Contents	Countermeasure
---	• The calibration has not been performed. • Terminated projection. • The matching rate has not been updated by hold input. • It has been reset by reset input.	Indicator light flashes green. • Please perform the calibration. Other than indicator light flashes green. • Check the hold input and the reset input.
Light off	Projection is terminated due to the projection termination input.	Turn off the projection termination input.
Locked	It is in Keylock mode. Button operation is locked.	Release the keylock.
Overcurrent	Excessive current is flowing in the output line.	• Please use the sensor with a load within the rated range. • Please make sure that the output cable is not touching other cables or frame.
Calib. error	The external calibration failed. • Calibration is done while the projection is terminated. • Calibration is being done in a mode other than Presence check mode.	• Please perform during light projection. • Use with Presence check mode. • Perform calibration using the button before using an external signal to start calibration.
Sync error	The interference prevention (sync-input, sync-output) does not function properly.	Check the assignment and wiring of the input and output wires.

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■ Separate amplifier type

Display	Contents	Countermeasure
Error 01 **Amplifier** **memory error**	• An abnormality occurred inside the amplifier. • There will be an error if the power turned off or noise was present while the settings are changed or calibration is performed.	• Turn on the power again. • Please initialize. • If this error occurs frequently, contact your service office.
Error 02 **Head** **com. error**	• Sensor head is not connected. • The head cable is disconnected. • Sensor head failure. • Incompatible sensor head is connected.	• Check whether the sensor head is connected correctly. • Check whether the head cable is disconnected. • Check the wiring of the head cable to the connector. • Check the types of the sensor head and the amplifier. • If this error occurs frequently, contact your service office.
Error 03 (xx) **Hardware** **error: head**	An abnormality occurred inside the sensor.	• Turn on the power again. • Replace the sensor head. • If this error occurs frequently, contact your service office.
Error 08 **Unsupported** **version: head**	Incompatible sensor head is connected.	• Check the types of the sensor head and the amplifier.
Error 09 **Head setting** **mismatch**	• Combination of the sensor head and the amplifier has changed. • There will be an error if the power turned off or noise was present while the settings are changed or calibration is performed.	• Restore the sensor head/amplifier combination to normal. • Please initialize. • To use the sensor in this combination, initialize the sensor head being connected and perform calibration. If the sensor head type is changed, adjust the response time again.
Error 10 (xx) **Head** **memory error**	• An abnormality occurred inside the sensor head. • There will be an error if the power turned off or noise was present while the settings are changed or calibration is performed.	• Turn on the power again. • Please initialize. • If this error occurs frequently, contact your service office.
Error 15 **Setting** **error**	An inappropriate setting or an inappropriate combination of settings is written during the IO-Link communication.	• Correct the settings. • Turn on the power again.

A

| Reference |

Hold the [MODE] button and press the [SET] button 5 times on the error screen to initialize.

■ Built-in amplifier type

Display	Contents	Countermeasure
Error 01 **Error 10 (xx)** **Memory** **error**	• An abnormality occurred inside the sensor. • There will be an error if the power turned off or noise was present while the settings are changed or calibration is performed.	• Turn on the power again. • Please initialize. • If this error occurs frequently, contact your service office.
Error 02 **Error 03 (xx)** **Error 08** **Error 09** **System** **error**		
Error 15 **Setting** **error**	An inappropriate setting or an inappropriate combination of settings is written during the IO-Link communication.	• Correct the settings. • Turn on the power again.

Reference

Hold the [MODE] button and press the [SET] button 5 times on the error screen to initialize.

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Replacing a Sensor/Amplifier

Save the setting information other than the registered image in calibration

Save the registered image in calibration (Up to 4 Banks)
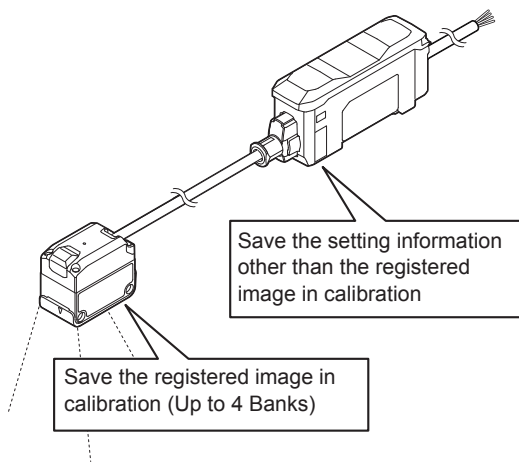
▶ Important

The setting information of the separate amplifier type is saved in the memory of the AI-H amplifier and the sensor head. Therefore, when the sensor head or AI-H amplifier is replaced, the registered image in calibration or other information may be initialized to prevent an inconsistency of settings.

When replacing the sensor head

When connecting a different sensor head, due to a failure of the sensor head or line modification, with the AI-H amplifier that has been used, follow the table below.

Sensor head to connect		Status/message at startup	Setup
Model	Status		
Sensor head is the same model	Factory default	• "Head change detected." is displayed. • The calibration setting information in the amplifier is cleared.	• Please perform calibration. • The settings are not changed.
	Initialized by user operation	• The system starts with the run screen (with calibration unregistered). • The calibration setting information in the amplifier is cleared.	
	Combined with another amplifier	• "Mismatch between sensor head and amplifier." is displayed. • The sensor head must be initialized.	• When the sensor head is initialized, "Calibration is initialized." is displayed. • Please perform calibration. • The settings are not changed.
		The system starts with the run screen.	• When the settings (calibration setting information, sensor detection setting, detection range setting, IO-Link current restriction) are the same between the amplifiers, there is no need to change settings. • The settings are not changed. The image saved in the sensor head is used as the registered image in calibration.
Sensor head is a different model		• "Mismatch between sensor head and amplifier." is displayed. • The sensor head must be initialized.	• When the sensor head is initialized, "Response time and calibration are initialized." is displayed. • Please perform calibration. • Set the response time again as needed. The settings other than the response time are not changed.

*When multiple Banks are used, perform calibration for each of the Banks.

When replacing the AI-H amplifier

When connecting a different amplifier, due to a failure of the amplifier or other reasons, to the sensor head that has been used.

AI-H Amplifier	Status/message at startup	Setup
• Factory default • Initialized by user • Combined with a sensor head in the same model	"Mismatch between sensor head and amplifier." is displayed. The sensor head must be initialized.	• When the sensor head is initialized, "Calibration is initialized." is displayed. • When the settings are factory default, the initial setting screen appears. Please change initial settings. • Perform calibration and change necessary settings.
	The system starts with the run screen (with calibration unregistered). The calibration setting information in the amplifier is cleared.	• Perform calibration and change necessary settings.
	The system starts with the run screen.	• When the settings (calibration setting information, sensor detection setting, detection range setting, IO-Link current restriction) are the same between the amplifiers, there is no need to change settings. • The settings are not changed.
Combined with a sensor head of a different model	"Mismatch between sensor head and amplifier." is displayed. The sensor head must be initialized.	• When the sensor head is initialized, "Response time and calibration are initialized." is displayed. • Perform calibration and make necessary settings.

*When multiple Banks are used, perform calibration for each of the Banks.

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Revision History

Print Date	Version	Revisions
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